ABSTRACT  Information technology is rapidly advancing and making its way into many primary care settings. The technology may provide the means to increase the delivery of cancer preventive services. The aim of this systematic review is to examine the literature on information technology impacts on the delivery of cancer preventive services in primary care offices. Thirty studies met our selection criteria. Technology interventions studied to date have been limited to some type of reminder to either patients or providers. Patient reminders have been mailed before appointments, mailed unrelated to an appointment, mailed after a missed appointment, or given at the time of an appointment. Telephone call interventions have not used technology to automate the calls. Provider interventions have been primarily computer-generated reminders at the time of an appointment. However, there has been limited use of computer-generated audits, feedback, or report cards. The effectiveness of information technology on increasing cancer screening was modest at best. The full potential of information technology to unload the provider-patient face-to-face encounter has not been examined. There is critical need to study these new technologic approaches to understand the impact and acceptance by providers and patients. (CA Cancer J Clin 2006;56:26–36.) © American Cancer Society, Inc., 2006.

INTRODUCTION

In 2000, an estimated 10 million new cancer diagnoses and 6 million cancer deaths occurred in the world. By 2020, the number of new cancers will grow by 15 million and cancer deaths may double.1 Cancer remains a major public health problem in the United States and other developed countries. Currently, one in four deaths in the United States is due to cancer.2 A total of 1,372,910 new cancer cases and 570,280 deaths are expected in the United States in 2005.2 Cancer has surpassed heart disease as the leading cause of death for persons younger than 85 since 1999.2 Cancer death rates decreased for all cancers combined (1.1% per year since 1993) and for many of the top 15 cancers occurring in men and women.3 This measurable minimal decline for overall cancer death rates reflects progress in the prevention, early detection, and treatment of cancer. However, there remains significant opportunity for improvement.

For many of the top 15 cancers occurring in men and women in the United States, there are primary and secondary preventive service strategies that could significantly reduce the burden. However, primary care clinicians and health care systems face substantial barriers in delivering these preventive services. There have been numerous reviews4–11 on the efficacy of tools to increase delivery of cancer preventive services for primary care clinicians and health care systems as well as summaries of reviews.12 This vast array of data is best summarized in three areas. First, effective interventions to increase preventive services in primary care exist, but there is considerable variation in the level of change achieved. The effect size is usually very small to moderate. Second, tailoring interventions to address specific barriers to change appears to be important. Third, multifaceted interventions may be more effective than a single intervention, but the tools assessed to date have not been adequate in encompassing the complexity of such interventions.
Information technology is rapidly advancing and making its way into many primary care settings. By “information technology,” we mean 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 information. Information technology includes computers, ancillary equipment, software, firmware and similar procedures, services (including support services), and related resources. Family physicians using computers for medical practice activities increased from 33% to 45% during the 1980s. A recent survey of 9,466 internists reported that 82% use computers for personal or professional reasons. In professional settings, internists utilized computers to help administratively manage their practice. Internists were less likely to have computers with the functionality to clinically manage their patients. In contrast, others have noted that primary care physicians prefer to receive reminders regarding outpatient action items electronically rather than in a paper format.

Information technology may provide the platform to develop and test new interventions to increase the delivery of cancer preventive services that addresses multiple barriers and aspects of the interaction between clinicians and patients. The aim of this systematic review is to examine the literature on information technology impact on the delivery of cancer preventive services in primary care offices. The literature will be synthesized to direct future research and guide decisions by primary care clinicians with respect to information technology adoption and use in their practice.

METHODS

Model

To provide a theoretical organizing framework for our evaluation of studies, we have adapted the 5A’s framework recommended by the US Preventive Services Task Force. The 5A’s framework provides a helpful structure for understanding where individual technologies intervene and exert their influence on screening behavior.

Study Identification

The literature search was conducted for English language articles in five databases: MEDLINE (1980 to April 2005), CINAHL (1982 to April 2005); EMBASE (1988 to April 2005), Cochrane Central Register of Controlled Trials (CCRCT, second quarter, 2005), and Science Citation Index (SCI; 1980 to April 2005). The MEDLINE, CINAHL, EMBASE, and CCRCT searches were conducted via the Ovid interface. The majority of the topical search retrieval was obtained via MEDLINE using medical subject headings including: mass screening; medical informatics applications; neoplasms; reminder systems; physician’s practice patterns; and medical record systems, computerized. In addition, limited text word searching was utilized.

Due to the large volume of literature and the variability of subject indexing among the databases, and for the purpose of organization, six discrete searches were selectively conducted in MEDLINE, CINAHL, and EMBASE. These searches focused on: screening of all information systems in office-based practice and primary care; broad/general search on screening and information systems; prevention and health promotion of cancer; use of the electronic health record and cancer screening/prevention; cancer prevention and physician practice patterns; and cancer screening and reminder systems. Corresponding key word searches with Boolean syntax were conducted in CCRCT and SCI.

Three evaluators (MJ, DN, and MR) reviewed each of the identified articles independently to determine whether the study was relevant. Publications were rejected for consideration if the article was a review, opinion article, descriptive of a new technology, or was used in a health context not readily available in the United States (eg, follow-up contacts for Pap smears in a health system with the public health system following and contacting women
outside of their physician’s office). A number of publications were found that were duplicate reports of a single study or serial reports from the same study. To avoid the undue effect of a single study, the most recent publication was evaluated in more detail. The cited literature referenced in relevant studies were also examined for possible studies.

**Study Classification**

The three evaluators then independently read each publication to classify it in each of the following areas: 1. Primary author and year. 2. Nature of intervention and comparison group. 3. Intervention target (eg, patient, provider, or both). 4. Timing of intervention (eg, before, during, or after an appointment). 5. Target cancer prevention or control. 6. Setting (eg, community or academic). 7. Outcome measure and effectiveness of the intervention. 8. Opportunistic or periodic prevention. 9. Duration of intervention and follow up.

“Opportunistic” refers to whether the intervention was targeting patient or provider at every possible contact point compared with just intervening at periodic or health maintenance examinations. The evaluators met as a group to review their classifications and discussed any disagreements and arrived at a consensus of opinion for all studies.

**FIGURE 1 5A’s Framework.**
RESULTS

There were 30 studies identified meeting the criteria outlined above. The characteristics of the identified study are in Table 1. The target cancers have been primary breast, cervical, and colorectal. The studies have been primarily focused on either the patient or provider, with 14 of the studies limited to just providers. In 13 of the studies, the intervention is limited to during the time of the appointment. Half of the studies were conducted in academic or training sites with few of the studies examining implementation of a system across multiple office settings, which limits the generalizability to private practice or community settings. All of the studies have used opportunistic screening; none limited the intervention to periodic or health maintenance appointments. The duration of the interventions were 6 months to 5 years, with the most common being 1 year.

The intervention and comparison used in each study are in Table 2 along with the effectiveness and effect size. The technology interventions studied to date have been limited to some type of reminder to either patients or providers. The patient reminders have been mailed before appointments, mailed unrelated to an appointment, mailed after a missed appointment, or given at the time of an appointment. There have been telephone calls, but these interventions have not used technology to automate the calls. The provider interven-

| Reference                  | Point of Intervention |
|----------------------------|-----------------------|
|                            | Patient | Provider |
|                            | Before   | During   | After   |
|                            | Breast   | Cervix   | Colon   |
|                            | Setting   |
|                            | Duration   |
| Becker, et al.20           | x        | x        | x       |
| Burack, et al.21           | x        | x        | x       |
| Burack, et al.22           | x        | x        | (Patient) | x | (Provider) |
| Burack, et al.23           | x        | x        | (Patient) | x | (Provider) |
| Burack, et al.24           | x        | x        | x       |
| Campbell, et al.25         | x        | x        | (Patient) | x | (Provider) |
| Chambers, et al.26         | x        | x        | x       |
| Fordham, et al.27          | x        | x        | x       |
| Frame, et al.28            | x        | x        | x       |
| Garr, et al.29             | x        | x        | x       |
| H. Goldberg, et al.30      | x        | x        | x       |
| D. Goldberg, et al.31      | x        | x        | x       |
| Harris, et al.32           | x        | x        | x       |
| Landis, et al.33           | x        | x        | x       |
| Litzelman, et al.34        | x        | x        | x       |
| McDonald, et al.35         | x        | x        | x       |
| McDowell, et al.36         | x        | x        | x       |
| McPhee, et al.37           | x        | x        | x       |
| McPhee, et al.38           | x        | x        | x       |
| Murphy, et al.39           | x        | x        | x       |
| Nease, et al.40            | x        | x        | x       |
| Nguyen, et al.41           | x        | x        | x       |
| Ornstein, et al.42         | x        | x        | (Patient) | x | (Provider) |
| Tape, et al.43             | x        | x        | x       |
| Tierney, et al.44          | x        | x        | x       |
| B. Turner, et al.45        | x        | x        | x       |
| R. Turner, et al.46        | x        | x        | x       |
| Weingarten, et al.47       | x        | x        | x       |
| Williams, et al.48         | x        | x        | x       |
| Yarnell, et al.49          | x        | x        | x       |

*All studies were opportunistic in nature.
†HMO = health maintenance organization.
‡PCP = primary care physician.
| Author                  | Nature of Intervention                                                                 | Comparison Intervention                                                                 | Effect Size                                                                 |
|------------------------|-----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Becker, et al.          | Patient reminder by mail and provider reminder on chart                                  | Provider-only reminder and no reminders (three-group randomized controlled design)       | FOBT: combined +14.6% versus provider +5.6% (P = 0.017 versus no reminder)   |
|                        |                                                          | Mammogram: combined +20.5% versus provider +19.7% (P = 0.02 versus no reminder)          |                                                                            |
|                        |                                                          | Pap test: combined +29.9% versus provider +4.7% (P = NS† versus no reminder)             |                                                                            |
| Burack, et al.          | Provider reminders and mailed reminders to patients and limited intervention (full Intervention) | Provider/Staff education, facilitated mammogram appointment scheduling, elimination of out-of-pocket costs with limited Intervention (two-group randomized controlled design) | Mammogram: full intervention +18% versus limited Intervention |
|                        |                                                          | Mammogram: provider reminder 36% versus no reminder 22% at one of two sites               |                                                                            |
|                        |                                                          | Pap test: provider reminder only +1% (P = NS versus usual care); patient reminder only +1% (P = NS versus usual care); both reminders +4% (P = 0.05 versus usual care) |                                                                            |
| Burack, et al.          | Patient reminder letter, provider reminder notice, or both                                | Usual practice (four-group randomized controlled design)                                 |                                                                            |
|                        |                                                          | Mammogram: reminder +19% (P = 0.01 versus usual care)                                   |                                                                            |
|                        |                                                          | Pap test: reminder +35% (P = NS versus usual care)                                     |                                                                            |
|                        |                                                          | FOBT: reminder +21% (P < 0.01 versus usual care)                                       |                                                                            |
|                        |                                                          | Pap test: overall +6% (P = NS versus usual care); aged 18 to 49 years +5% (P = NS versus usual care); aged 50 to 70 years +32% (P = 0.026 versus usual care) |                                                                            |
| Burack, et al.          | Patient reminder letter, provider reminder notice, or both                                | Usual care (four-group randomized controlled design)                                   |                                                                            |
|                        |                                                          | Mammogram: reminder only (two-group randomized controlled design)                      |                                                                            |
|                        |                                                          | Pap test: reminder +35% (P = NS versus usual care)                                   |                                                                            |
|                        |                                                          | FOBT: reminder +21% (P < 0.01 versus usual care)                                       |                                                                            |
|                        |                                                          | Sigmoïdoscopy: reminder +35% (P < 0.01 versus usual care) versus audit -3% (P = NS versus usual care) |                                                                            |
| Chambers, et al.        | Provider computer reminder                                                                 | Usual care (two-group randomized controlled design)                                   |                                                                            |
|                        |                                                          | Mammogram: reminder +7% (P = 0.011 versus usual care)                                  |                                                                            |
| Fordham, et al.         | Patient reminder postcards, audits, and provider reminders                                | Usual care (six-group, two-stage randomized controlled design)                        | Breast exam: reminder +17% (P < 0.05 versus usual care) versus audit +25% (P < 0.01 versus usual care) |
|                        |                                                          | Mammogram: reminder +19% (P < 0.01 versus usual care)                                  |                                                                            |
|                        |                                                          | Pap test: reminder +35% (P = NS versus usual care)                                     |                                                                            |
|                        |                                                          | FOBT: reminder +21% (P < 0.01 versus usual care)                                       |                                                                            |
|                        |                                                          | Sigmoïdoscopy: reminder +35% (P < 0.01 versus usual care) versus audit -3% (P = NS versus usual care) |                                                                            |
| Frame, et al.           | Provider and patient computer reminder                                                    | Manual flow sheets (two-group randomized controlled design)                           | Breast exam: +11% (P = 0.01 versus manual)                                     |
|                        |                                                          | Mammogram: +23% (P = 0.002 versus manual)                                              |                                                                            |
|                        |                                                          | Pap test: +9% (P = 0.02 versus manual)                                                  |                                                                            |
|                        |                                                          | FOBT: +15% (P < 0.001 versus manual)                                                   |                                                                            |
| Garr, et al.            | Provider and patient computer reminder                                                    | Usual care (pre- and postintervention design)                                         | Mammogram: +0.1% (P = NS versus preintervention)                             |
|                        |                                                          | Pap test: +3.4% (P < 0.0001 versus preintervention)                                   |                                                                            |
|                        |                                                          | FOBT: +0.1% (P = NS versus preintervention)                                           |                                                                            |
| H. Goldberg, et al.     | Provider computer reminder                                                                 | Usual care (two-group controlled time series trial)                                   | Mammogram: +47% (P = 0.02 versus usual care)                                  |
|                        |                                                          | FOBT: +3% (P = NS versus usual care)                                                   |                                                                            |
| D. Goldberg, et al.     | Computer mailing of FOBT kits and reminders before an appointment to patients            | Usual care (two-group randomized controlled design)                                   | Mammogram: +35.7% (P < 0.001 versus usual care)                             |
| Harris, et al.          | Provider computer reminder                                                                 | No prompt (time series: no prompt, nurse prompt, computer reminder)                  | Breast exam: +7% (P = NS versus no prompt)                                    |
|                        |                                                          | Mammogram: +29% (< 0.001 versus no prompt)                                             |                                                                            |
|                        |                                                          | Pap test: −16% (P = NS versus no prompt)                                               |                                                                            |
|                        |                                                          | FOBT: +2% (P = NS versus no prompt)                                                    |                                                                            |
| Landis, et al.          | Provider reminder or patient letter in a 2 × 2 design                                      | Usual care (four-group, two-stage randomized controlled design)                       | Mammogram: reminders and letters +20% (P = NS versus usual care)            |
|                        |                                                          | Mammogram: reminders and letters +20% (P = NS versus usual care)                       |                                                                            |
| Litzelman, et al.       | Computer reminder with required provider response                                         | Computer reminders with no required provider response (two-group randomized controlled design) | Mammogram: +7% (P = 0.036 versus no required response)                        |
|                        |                                                          | Pap test: +3% (P = NS versus no required response)                                     |                                                                            |
|                        |                                                          | FOBT: +12% (P = 0.0007 versus no required response)                                   |                                                                            |
| McDonald, et al.        | Provider computer reminder                                                                 | Usual care (two-group randomized controlled design)                                   | Mammogram: +6% (P = 0.0005 versus usual care)                                |
|                        |                                                          | Pap test: +15% (P = 0.0005 versus usual care)                                         |                                                                            |
|                        |                                                          | FOBT: +33% (P = 0.0001 versus usual care)                                             |                                                                            |
| McDowell, et al.        | Provider computer reminder, patient letter, or patient telephone call                    | Usual care (four-group randomized controlled design)                                   | Physician reminder +2.4% (P = NS versus usual care)                          |
|                        |                                                          | Patient letter +12.2% (P < 0.005 versus usual care)                                   |                                                                            |
|                        |                                                          | Patient phone call +6.3% (P < 0.005 versus usual care)                                 |                                                                            |

(cont)
| Author | Nature of Intervention | Comparison Intervention | Effect Size |
|--------|------------------------|-------------------------|-------------|
| Nguyen, et al.⁴¹ | Provider computer reminder, patient education | Usual care (six-group, two-stage randomized controlled design) | Breast exam: reminder +18.5% (P < 0.001 versus usual care); audit +14.1% (P = 0.006 versus usual care); education +1.7% (P = NS versus usual care) |
| | | | Mammogram: reminder +11% (P = 0.031 versus usual care); audit +10% (P = 0.05 versus usual care); education +11.8% (P = 0.006 versus usual care) |
| | | | Pap test: reminder +6.5% (P = NS versus usual care); audit +5.1% (P = NS versus usual care) |
| | | | FOBT: reminder +14.8% (P = 0.002 versus usual care); audit +6.7% (P = NS versus usual care) |
| | | | Sigmoideoscopy: reminder +6.9% (P = 0.002 versus usual care); audit +0.5% (P = NS versus usual care) |
| McPhee, et al.⁴⁸ | Provider computer reminder and provider/patient education materials | Usual care (two-group randomized controlled design) | Breast exam: +8.7% (P = 0.032 versus usual care) |
| | | | Mammogram: +4.7% (P = NS versus usual care) |
| | | | Pap test: +30.7% (P = 0.014 versus usual care) |
| | | | FOBT: +14.5% (P = 0.001 versus usual care) |
| | | | Sigmoideoscopy: +11.4% (P = NS versus usual care) |
| Murphy, et al.⁴⁹ | Computer generated letter to patient | Usual care (pre- and postintervention design) | FOBT: +11% versus preintervention |
| Nease, et al.⁴⁰ | Provider computer reminder | Usual care (pre- and postintervention design) | Mammogram: ~7% (P = NS versus preintervention) |
| | | | FOBT: +9.9% (P = 0.0037 versus preintervention) |
| Nguyen, et al.⁴¹ | Provider computer reminder, patient education aids in native language (Vietnamese), provider education (CME, newsletter, oncology data query program) | Usual care (two-group randomized controlled design) | Pap test: +26.6% (P = 0.004 versus usual care) |
| | | | Breast exam: ~4.4% (P = NS versus usual care) |
| | | | Mammogram: +1.7% (P = NS versus usual care) |
| Ornstein, et al.⁴² | Provider computer reminder and computer generated letter to patient | Usual care (four-group randomized controlled design) | FOBT: +17.7% (P < 0.0001 versus usual care) |
| | | | Mammogram: +15.7% (P < 0.0001 versus usual care) |
| Tape, et al.⁴³ | Provider electronic medical record | Usual paper chart (two-group randomized controlled design) | Sigmoideoscopy: +2.7% (P < 0.05 versus paper chart) |
| | | | FOBT: +2.7% (P = NS versus paper chart) |
| | | | Mammogram: +2.4% (P = NS versus paper chart) |
| | | | Pap test: +0.8% (P = NS versus paper chart) |
| Tierney, et al.⁴⁴ | Provider (physician) report card (feedback) | Visit reminder and usual care (four-group, two-stage randomized controlled design) | FOBT: feedback +13% (P < 0.01 versus usual care); reminder +33% (P < 0.01 versus usual care) |
| | | | Pap test: feedback +4% (P = NS versus usual care); reminder –2% (P < 0.05 versus usual care) |
| B.Turner, et al.⁴⁵ | Provider computer reminder | Patient preventive health questionnaire (prospective, controlled design) | Mammogram: feedback +14% (P < 0.01 versus usual care); reminder +16% (P < 0.01 versus usual care) |
| | | | Breast exam: reminder +16% (P < 0.05 versus usual care); questionnaire +12.4% (P < 0.05 versus usual care) |
| | | | Mammogram: reminder +4.8% (P = NS versus usual care); questionnaire +31.6% (P < 0.05 versus usual care) |
| | | | Pap test: reminder +12.8% (P = NS versus usual care); questionnaire –1.9% (P = NS versus usual care) |
| | | | FOBT: reminder +15.9% (P < 0.05 versus usual care); questionnaire +9.9% (P = NS versus usual care) |
| R.Turner, et al.⁴⁶ | Provider computer reminder | Patient-held guide (two-group randomized design) | FOBT: reminder +1% versus guide –5% (P = NS) |
| | | | Pap test: reminder +3% versus guide –11% (P = NS) |
| | | | Breast exam: reminder +3% versus guide –2% (P = NS) |
| | | | Mammogram: reminder +11% versus guide +3% (P = NS) |
| Weingarten, et al.⁴⁷ | Provider computer reminder | Usual care (two-group randomized controlled design) | FOBT: +5% (P = NS versus usual care) |
| | | | Mammogram: +8.8% (P < 0.05 versus usual care) |
| Williams, et al.⁴⁸ | Touchscreen-generated reminder to provider and patient | Usual care (two-group randomized controlled design) | Breast exam: +37% (P < 0.05 versus usual care) |
| | | | FOBT: +1.0% (P = NS versus usual care) |
| | | | Sigmoideoscopy: +1.3% (P = NS versus usual care) |
| | | | Pap smear: +2.7% (P = NS versus usual care) |
| Yarnall, et al.⁴⁹ | Provider computer reminder | Not available (outcome was process-based on compliance to usage) | Not available |

*FOBT = fecal occult blood test.
†NS = not significant.
tions have been primarily computer-generated reminders at the time of an appointment. There has been limited use of computer-generated audits, feedback, or report cards.27,37,44

The effectiveness of the information technology on increasing cancer screening was modest at best. There are some limitations in making the comparison across study designs that range from pre- and postdesigns to randomized control trials.

**DISCUSSION**

First, due to the differences in current indexing practices in and among the electronic databases, an exhaustive identification of all published English-language studies on this topic is a complex task. Therefore, we cannot ensure that we have examined all of the published English language works in this area. Second, there are very likely numerous unpublished studies relevant to this area. It remains to be determined if the results of these studies would sway the assessment given that most unpublished studies contain negative findings. Third, the published data lack significant participation of community-based practices. Therefore, the conclusions one can draw may have no validity for community-based physicians. Finally, the limited amount of data published in this area highlight the need for more effort into this critical area of prevention.

The published research using information technology to increase cancer screening is almost exclusively testing the impact of computer-generated reminders to either the provider or the patient. The delivery of the reminders is almost universally at the time of an appointment, regardless of the reason for the appointment. In addition, there is only so much that providers and patients can attend to during the appointment time, even if you include waiting room and departure time. A unique aspect of information technology is the ability to unload demands on appointment face-to-face time. However, no investigators have pushed into examining the impact of such an approach. There is a critical need to study these new technologic tools that push into areas such as before arriving at the office, in the waiting room, and after the office appointment, as highlighted in Figure 1. There is no need for yet another study of reminder systems unless the investigation examines the impact in community-based offices followed for longer than a year.

The literature on this topic is somewhat limited, but studies using information technology in other areas of health care provide some guidance. Other health care issues studied include other preventive services, reducing no-show appointments, clinical decision making, chronic disease management, patient education, and risk assessment.50–53 The majority of the work has been on patient or provider point-of-service reminders. As in cancer prevention, the effect is modest. There remains essentially no exploration of information technology into other areas highlighted in Figure 1.

Despite increasing recognition of the importance of preventive services, such services are not provided in primary care practice as often as recommended. One of the most important reasons is the lack of a systematic, organized approach within practices. The American Cancer Society Ad Hoc Advisory Group on Preventive Health Care Reminder Systems reviewed evidence-based reports and expert opinion to summarize current knowledge about office systems for clinical preventive service in 1996.54 This article describes the process of developing an office system for preventive care, beginning with writing a practice policy, auditing charts for baseline performance, developing and implementing a plan for efficient delivery of preventive care, involving office staff, and monitoring progress. The concepts presented in this report are critical to successfully introducing new information technology into primary care practices.

Information technology interventions in primary care should be viewed contextually and not just in isolation. Several groups have used the “tools, teamwork, and tenacity” terms to emphasize that successful intervention in busy practices requires more than just tools.55,56 Busy primary care practices need to have functioning communication processes that allow them to prioritize
preventive services and incorporate new approaches into their routine operational flow.

This perspective is further reinforced by applying complexity science models to primary care practice.57,58 Briefly stated, primary care practices are complex, adaptive systems that evolve processes in response to multiple factors, often without being aware of why and how they have arrived at their current processes. Without the ability to reflectively incorporate new innovations and adapt them to their needs, practice innovations frequently result in a temporary change with rapid return to the practice’s previous way of doing things. For practices to be able to effectively implement and sustain technology-based interventions to enhance colorectal cancer screening, they must either already have developed their own functional reflective processes or be assisted in developing these processes.

Information technology to enhance delivery of preventive services is ever-changing but is most broadly moving from stand-alone systems into modules that are integrated within commercial electronic health record systems (EHRs). Unfortunately, we were unable to find any studies reporting differential outcomes between EHRs and stand-alone systems. In the absence of reported studies, the challenges reported by others in reviewing clinical decision-support systems generalize to EHR-embedded modules as well.50,59 Systems that automatically prompt users, provide specific recommendations rather than assessments, and provide support at the time of decision making are most successful. A longitudinal, qualitative study of decision support also provides further confirmation of these principles.60 It remains to be seen whether EHR modules incorporate these design principles now or in the future.

One primary care specialty society has placed a high focus on EHRs as a key component of “new model” care.51 With this focus, the specialty society hopes to use technology to improve the delivery of preventive services as well as improve disease management.

What Should Clinicians Do Now?

For primary care physicians and their staff, these are challenging times. There is an ever-increasing availability of electronic medical records, which contain a variety of approaches to managing the clinical aspects of one’s practice. The research on information technology and cancer prevention offers very little guidance at this time. There are a few pearls of wisdom from the literature reviewed. Requiring providers to respond to computer-generated reminders improves their compliance with preventive care protocols, especially for elderly patients, who had the lowest control physician compliance.34 Therefore, having the computer just generate a reminder is not sufficient. The reasons for not responding to the reminder include “not applicable” (test done elsewhere, patient too ill, no uterus), “next visit” (physician too busy, patient too ill), and “patient refuses” (test not necessary or too costly, patient too busy or fears result). Gathering this information can guide further evaluation of the practice and enhancements of the system.

As with most technology, the ability to expand and be flexible will allow the system to better meet the physician’s needs. If a physician’s expectation is to buy a system with a single upfront investment and turn it on, he/she will be wasting their time and effort. To obtain any return on their investment or impact on their practice, a physician has to take a broader, more inclusive approach to group change and not just a single individual’s change. If a physician’s practice is more than 10 years old and has more than three providers, then look back in some of the thicker paper charts. A physician will see various efforts to alter practice patterns. Various flow sheets or paper reminder forms will represent these efforts. They were used by a few individuals within the practice and did not have widespread use or impact. The same could happen to computers if the effort to change does not involve the entire group from the front door to the back door.

There will also be significant learning curves, which will cost time, money, and patience. These learning curves will keep reoccurring as new changes and updates are made. A physician has to be committed to career-long adaptation and changes. Many health systems and hospitals are developing, purchasing, and implementing various information technologies to improve prac-
It remains to be determined how much effort primary care providers have put into participating in the decision-making process. If the leaders of the process only hear from the subspecialty, hospital-based providers, then the technology will never meet the needs of primary care providers.

Gaps and Future Research

We have limited our search to the role of interactive technology in improving established secondary prevention of cancer in the office setting; thus, this discussion will not address the gaps and future research in primary prevention such as smoking cessation, diet, and exercise. As previously discussed, the reviewed studies have been concentrated in academic practice settings, dealt almost exclusively with patient or physician reminders and prompts, and were short-term. Questions remain as to the long-term effectiveness, feasibility, and generalizability of the interventions. In particular, little empirical data are available on how the practices as organizations changed in response to the implementation of the technological intervention and how this affected the outcome. We know little about the unintended consequences and benefits of these interventions that may affect the practices, such as patient-physician communication and relationship, workflow, and the process of the screening itself (eg, follow up of abnormal screening results).

Audit and feedback of professional activity have the potential to change practice. Information technology can facilitate audits and feedback. A recent review of the 85 studies suggests the effects are small to moderate. The effect is largest when the baseline adherence to recommended practice is low.9 Similarly, a review of 131 decision-aids studies reported variable effect. The aids improve people’s knowledge of options, create realistic expectations, reduce difficulty in decision making, and increase participation in the process, but the outcomes are only modestly increased in cancer screening. In addition, the resources needed for implementation of most decision aids is beyond those of most community-based primary care providers.10

A review of interventions to implement prevention in primary care published in 1996 found 55 studies of 2,000 health professional involving 99,000 patients. The reviewers concluded that there was no solid basis for assuming that a particular intervention or package of interventions will work. Effective interventions to increase preventive activities in primary care exist, but there is considerable variation in the level of change achieved, with effect sizes usually small or moderate. Tailoring interventions to address specific barriers to change in a particular setting is probably important. Multifaceted interventions may be more effective than single interventions, because more barriers to change can be addressed.8

Future research should thus incorporate the following:

1) To address generalizability, strong consideration should be made to perform the studies in heterogeneous community practice settings, utilizing practice-based research networks.

2) More emphasis should be placed on assessing the process outcomes, particularly the organizational structure (eg, workflow and personnel role changes) and the nature of the clinical encounters (eg, patient-physician communication, duration of the encounter, type of encounter such as periodic versus opportunistic, and issues addressed during the encounter) affected by the implementation of the interventions.

3) Long-term effectiveness and viability should be addressed, including cost-effectiveness and cost-benefit analyses.

4) Approaches other than prompts and reminders should be evaluated. Examples would include tying technology with behavioral interventions, such as tailored messages and decision aids that positively affect informed and shared decision making. The intervention should be founded on a strong theoretical framework.

5) Various communication channels should be utilized, such as using practice Web sites (which may be personalized for each patient) and e-mails to enhance communication before and after the clinical encounters, computer kiosks in the waiting room, and the utilization...
of nonclinician staff to perform technology-assisted and enhanced interventions within or outside of the clinical encounters.

6) The effect of intervention on the process of the screening practice itself should be evaluated.

Examples would include gravitation to a particular screening modality (e.g., increased incorporation of fecal occult blood tests compared with other colorectal cancer screening modalities) and follow up of abnormal screening results.

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