Electronic Medical Records to Increase the Clinical Treatment of Tobacco Dependence

A Systematic Review

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Context: The expanded use of electronic medical records (EMRs) may provide an opportunity to increase the use and impact of clinical guidelines to promote tobacco-cessation treatment in primary care settings. The objective of this systematic review is to evaluate the evidence for such an effect.

Evidence acquisition: After a systematic search of the English-language literature regarding an EMR effect on either smoking cessation or clinician behavior, relevant articles were abstracted and findings summarized from both observational studies and RCTs.

Evidence synthesis: Of ten identified studies of EMRs and tobacco, only two RCTs were found. Adding tobacco status as a vital sign resulted in an increase in some clinical guideline recommended actions, particularly documentation of smoking status. There was insufficient evidence to quantify the effect of an EMR on changes in patient smoking behaviors.

Conclusions: While the use of EMRs to prompt or provide feedback on the clinical treatment of tobacco dependence demonstrates some promising results, substantial additional research is needed to understand the effects of EMRs on provider and patient behavior.

Introduction

In 2008, an estimated 46 million people or 20.6% of all adults in the U.S. were cigarette smokers. Although this represents a substantial decline in smoking prevalence over the past 50 years, prevalence has remained relatively constant for the last few years, and it is far short of the Healthy People 2010 goal of 12%.

Approximately 30 million smokers in America visit a primary care physician each year (about 65% of all smokers), but only a small minority of these patients leave their primary care encounter linked to evidence-based counseling, medications, and/or follow-up that could boost their likelihood of successful cessation. Evidence-based U.S. Public Health Services clinical practice guidelines for treating tobacco use and dependence recommend systematic identification and intervention for this high-risk behavior. Changes in health systems operations that institutionalize the identification and clinical treatment of patients who use tobacco are a particularly promising way to better use the primary care visit to help patients quit tobacco use. System-level changes that might increase the frequency of effective cessation delivery are taking advantage of the electronic health record for clinician reminders, linking patients to services, and monitoring and feedback.

Health information systems such as electronic medical records, computerized decision support systems, and electronic prescribing are increasingly identified as potentially valuable components to improve the quality and efficiency of patient care. Electronic medical records (EMRs) are likely to disseminate rapidly now that there are legal and financial incentives to do so. There is widespread hope that electronic connectedness will lead to improvements in healthcare quality and costs, so a substantial national investment is being made in EMR adoption. The Health Information Technology for Economic and Clinical Health Act (HITECH Act) contained within the American Recovery and Reinvestment Act of 2009 will provide $36 billion to promote electronic medical records and to form regional centers to foster community-wide electronic health information exchanges.

These two occurrences—inadequate tobacco-cessation support during clinical encounters and this rapid dissemination of EMRs—create a need to evaluate the evidence for any beneficial connections between the two, and to
identify gaps in this evidence. Therefore, a systematic literature review was conducted to identify studies that address the relationship between EMRs and the use or impact of tobacco-cessation clinical guidelines.

**Evidence Acquisition**

The search included the electronic retrieval systems and databases PubMed (MEDLINE), Ovid CINAHL, ISI Web of Science, Engineering Village, Embase, and Academic Search Premier. The search was limited to studies published in English from January 1990 to December 2009. A search was completed for the combination of the following in each database: (1) medical records or health records; (2) electronic or automated; (3) smoking or tobacco.

In addition, the reference lists of retrieved studies were scanned for additional papers, and content experts were contacted to identify other published or unpublished studies.

**Review of Identified Studies**

The title and abstract identified using the Keyword searches were read independently by two of the authors. The reviewers were looking for research interventions involving adult smokers and an electronic medical record where the EMR was used to facilitate cessation support, either directly or indirectly (e.g., by providing audit and feedback). The abstracts were categorized as either:

- trials of an EMR intervention on quit rates;
- trials of an EMR intervention on change in clinician behavior;
- use of an EMR to collect data for an observational study;
- use of an EMR for some other purpose such as recruiting smokers for a different type of study;
- use of an EMR for some purpose unrelated to cessation.

A copy was obtained of the full text for articles categorized as A, B, or C, and for any abstract where the categorization was unclear. Disagreements were resolved by consensus discussion. A data abstraction form that included an assessment of study and report quality assessment was created, tested, and used to review each article that appeared to meet the above criteria. Two authors independently extracted data about the research design and outcomes.

The literature search generated 147 studies (84 from MEDLINE). After excluding 52 duplicates, 95 unique abstracts were examined. The authors reviewed the full text of 20 articles and identified ten trials that fit categories A–C.

**Evidence Synthesis**

Table 1 is a summary of the ten studies that tested the use of an EMR to increase the treatment of adult smokers. All of the studies were conducted in primary care settings.

<table>
<thead>
<tr>
<th>Study</th>
<th>Objective</th>
<th>Met review criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bentz (2002)⁹</td>
<td>To increase documentation of tobacco use</td>
<td>No—Observation of status and cessation advice added to EMR</td>
</tr>
<tr>
<td>Bentz (2006)¹⁰</td>
<td>To connect physician offices with a state quitline</td>
<td>No—Observation of two methods available in an EMR</td>
</tr>
<tr>
<td>Bentz (2007)¹¹</td>
<td>To test the impact of 5A feedback assistance with tobacco cessation</td>
<td>Yes—RCT</td>
</tr>
<tr>
<td>Frank (2004)¹²</td>
<td>To increase documentation of smoking status with reminders</td>
<td>No—Single clinic, unblinded</td>
</tr>
<tr>
<td>Linder (2009)¹³</td>
<td>To improve documentation and treatment of tobacco use</td>
<td>Yes—Cluster-RCT</td>
</tr>
<tr>
<td>McCullough (2009)¹⁴</td>
<td>To evaluate the addition of smoking vital sign questions</td>
<td>No—Pre–post design; no control</td>
</tr>
<tr>
<td>Ragucci (2009)¹⁵</td>
<td>To measure change in patient smoking</td>
<td>No—Pre–post design; no control</td>
</tr>
<tr>
<td>Sherman (2008)¹⁶</td>
<td>To test an EMR-based referral for smoking-cessation telephone counseling</td>
<td>No—Uncontrolled group-randomized trial</td>
</tr>
<tr>
<td>Spencer (1999)¹⁷</td>
<td>To increase documentation of smoking status</td>
<td>No—Observation of vital sign</td>
</tr>
<tr>
<td>Szpunar (2006)¹⁸</td>
<td>To test new EMR screens on physician compliance with steps of the tobacco guideline</td>
<td>No—Convenience sample of clinics in study</td>
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</table>

EMR, electronic medical record
and all measured changes in the U.S. Public Health Service guideline-recommended action steps, also known as the 5A’s: asking every patient if they use tobacco, advising all tobacco users to quit, assessing willingness to make a quit attempt, assisting patients with quitting, and arranging follow-up for patients.

The majority of studies found were observational, using historical controls, or quasi-experimental (n=8). Only two studies fulfilled criteria for RCTs. Both of these studies were cluster randomized trials that assigned clinicians to either intervention or control conditions and assessed outcomes from EMR and other data. These studies are summarized in Table 2.

Bentz and colleagues randomized 19 primary care clinics (n=10 intervention and 9 control) in Portland OR to receive provider-specific monthly reports based on EMR data on referrals to the state tobacco quitline. Their intervention involved both modification of the medical record to support a fax referral to the state telephone helpline, and feedback to clinicians based on data generated by the EMR. Providers received their own performance data in comparison to the clinic average and a benchmark goal. Intervention clinics had higher percentages of asking (94.5% vs 88.1%, p=0.05), advising (71.6% vs 52.7%, p<0.001) assessing interest in quitting (65.5% vs 40.1%, p<0.001), and assisting with quitting (20.1% vs 10.5%, p<0.001). However, despite the greater ease of making quitline referrals in intervention clinics and getting data about their results, the two groups did not differ in this action.

Linder et al. randomized 12 practices to intervention and 14 to control in Boston MA. The intervention was an enhanced electronic record that included smoking icons, treatment reminders, and a new form to facilitate ordering medications and counseling referrals. Documentation of smoking increased in intervention practices from 37% to 54% compared to the control clinics’ change from 35% to 46% (p<0.001). The authors attributed the intervention clinics’ increase in documentation to increased assessment of patients who were never-smokers or former smokers.

In both these studies, referral to telephone-based cessation counseling was a measured outcome. The Boston study found significantly more smokers from the intervention clinics made contact with a cessation counselor (4.5% vs 0.4%, p<0.001) compared to smokers in the control clinics. The study in Portland found no difference in referral (3.9% vs 3.6%) or reach (2.8% vs 2.4%) percentages between intervention and control clinics. However, they did report a 53% increase in referral (p=0.26) and a 46% increase in reaching the quitline (p=0.05) among smokers in the intervention condition after adjusting for case mix and the presence of a clinic champion.

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of clinics/providers</th>
<th>Study period</th>
<th>Methods</th>
<th>Outcome measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bentz (2007)</td>
<td>19 primary care clinics/10 intervention/57 MDs, 9 comparison/55 MDs</td>
<td>12 months</td>
<td>Cluster randomized clinical trial EMR-generated feedback vs no feedback Changes to the EMR: 1. Clinical guideline 5A’s added 2. Direct fax referral to quitline</td>
<td>Ask, Advise, Assess, Assist calculated monthly</td>
<td>Higher use of Ask, Advise, Assess, Assist in feedback compared to control No difference in referral to quitline (3.6% control vs 3.9% feedback)</td>
</tr>
<tr>
<td>Linder (2009)</td>
<td>26 primary care clinics/12 intervention/14 control</td>
<td>9 months</td>
<td>Cluster randomized clinical trial Primary outcome: smokers connecting with cessation counselor Changes to the EMR: 1. EMR enhancement of smoking status icons 2. Tobacco treatment reminders 3. Smart form to facilitate ordering meds and fax/e-mail counseling referrals</td>
<td>Documentation of smoking status Contact with a quitline counselor</td>
<td>Higher percentages of documented smoking in the intervention clinics (+17%) compared to control (+11%) Quitline contact was higher among intervention clinic patients than control (3.9% vs 0.3%)</td>
</tr>
</tbody>
</table>
Only one of these studies measured patient smoking cessation indirectly, using changes in the EMR documentation of smoking status. They reported significantly more smokers in the intervention clinics documented as nonsmokers by the end of the study compared to the control clinics (5.3% vs 1.9%, \( p < 0.001 \)).

The additional studies are summarized in Table 3. Each measured some of the 5A guideline–recommended steps. The most common measurement was change in the documentation of smoking status (\( n = 7 \)) based on the addition of smoking as a vital sign into the medical record. Post-intervention increases in the other guideline recommended steps varied across the studies. For example, Szpunar et al.\(^{18} \) found an increase in assessment of willingness to quit. McCullough\(^{14} \) and Spencer\(^{17} \) saw increases in both assessing a plan to quit and counseling smokers to quit.

Various quality weaknesses were found across these studies. For example, Sherman et al.\(^{16} \) reported an uncontrolled intervention at Veterans Administration clinics. Although medical practices were randomized, the intervention could not be blinded from the control practices. Frank and colleagues\(^{12} \) randomized patients in one clinic, but providers were not blinded. Szpunar et al.\(^{18} \) included matched control clinics to a convenience sample of intervention clinics. Bentz\(^{10} \) included two methods of referral across one health system, but the study lacked any randomization to the conditions. In an observational study with no control group, Ragucci and Shrader\(^{15} \) added smoking status to an EMR for pharmacists to document education on quitting and medication. Finally, Bentz\(^{9} \) reported the results of a pilot study that documented an increase in smoking status in one clinic without a control.

### Discussion

This systematic review found only two randomized controlled studies that tested the use of an existing EMR to improve documentation and treatment of tobacco use in primary care settings, by reminders, feedback, and/or facilitation of referrals. These studies found only modest improvements in some clinical guideline–recommended actions for tobacco. None of the reviewed studies included a direct assessment of patient quit rates. Although Linder et

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<th>Methods</th>
<th>Results</th>
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</thead>
<tbody>
<tr>
<td>Bentz (2002)(^{19} )</td>
<td>1 EMR-based</td>
<td>3 months</td>
<td>Changes to the EMR:</td>
<td>Smoking status documentation increased 79% to 88%</td>
</tr>
<tr>
<td>Bentz (2006)(^{10} )</td>
<td>19 primary care</td>
<td>12 months</td>
<td>Interested smokers referred to QL:</td>
<td>Reached: 17% brochure 53% fax</td>
</tr>
<tr>
<td>Frank (2004)(^{12} )</td>
<td>1</td>
<td>12 months</td>
<td>Physicians–patient panel randomized to control or intervention;</td>
<td>No change in assessment of smoking status (1.8% control vs 2.0% intervention)</td>
</tr>
<tr>
<td>McCullough (2009)(^{14} )</td>
<td>3</td>
<td>12 months</td>
<td>Smoking status and plan to quit added to EMR</td>
<td>Status increased (71% vs 84%) Plan to quit increased (25.5% to 51%)</td>
</tr>
<tr>
<td>Ragucci (2009)(^{15} )</td>
<td>3</td>
<td>12 months</td>
<td>Pharmacists documented status in new EMR template; educated on benefits of quitting and medications</td>
<td>Of 90 smokers included, 42% quit</td>
</tr>
<tr>
<td>Sherman (2008)(^{16} )</td>
<td>18 (10 intervention)</td>
<td>10 months</td>
<td>EMR referral to care coordinator/QL</td>
<td>45% reached; Intervention providers more likely to refer to QL (15.6% vs 0.7%)</td>
</tr>
<tr>
<td>Spencer (1999)(^{17} )</td>
<td>1</td>
<td>19 months</td>
<td>Smoking status and provider counseling</td>
<td>Smoking status increased 18.4% to 80.3%; counseling increased 17.1% to 48.3%</td>
</tr>
<tr>
<td>Szpunar (2006)(^{18} )</td>
<td>6; 4 control, 2 intervention</td>
<td>Pre: 9 weeks Post: 18 weeks</td>
<td>Pre–post design; 5A data collected by phone survey</td>
<td>Post-implementation increase in 5A’s</td>
</tr>
</tbody>
</table>

EMR, electronic medical record; QL, quitline
al.\textsuperscript{13} reported documented change in smoking status between time periods, this measure is problematic because of variability in the completeness and the quality of data recorded in the EMR. The other uncontrolled studies do not provide consistent findings on all key outcomes. They demonstrated that over the short term, documentation of smoking status does increase following the addition of a vital sign for smoking status, but its association with other cessation support actions was variable.

Clearly this is insufficient evidence to come to any conclusion about whether the EMR can substantially increase tobacco treatment clinical interventions; and even less about which specific EMR changes produce which effects on guideline implementation and cessation. Thus there is a huge information gap about this potentially important tool. Given the substantial technologic investment being made on the national level, there is now a unique opportunity and need to study the use of the EMR and other technologies to support evidence-based tobacco treatment.\textsuperscript{19}

Most clinical research studies involving preventive measures such as smoking treatment have been observational rather than randomized, so it is not surprising that the current review found only two of ten studies that met criteria as RCTs. In part, this may reflect the difficulty of implementing modifications to existing electronic systems, especially doing so in a subset of user clinics, but it also highlights the challenge of designing robust intervention studies within “real-world” clinical settings. The studies by Bentz\textsuperscript{10} and Linder\textsuperscript{13} demonstrated the utility and creativity of group-randomized trials to accomplish the goal of testing EMR modifications for smoking-cessation treatment.

Since it is not practical for all clinical research to be conducted as trials, there is a need to increase both the quality of observational studies and their reporting. To this end, the STROBE statement was published recently as a step to improve the quality of observational study reports.\textsuperscript{20} The STROBE statement was created from the work of the CONSORT group, which has published guidelines to help improve the quality of reporting randomized clinical trial results and, by extension, the design of clinical trials.\textsuperscript{21} Clinical researchers engaged in observational research are encouraged to refer to the STROBE statement and checklist for guidance to improve the reporting of observational research.

It was surprising to find the number of studies that limited their focus to increasing the level of provider documentation ($n=4/10$). This likely reflects national efforts to make smoking status a routine vital sign.\textsuperscript{22} Although documenting smoking status is an important first step in the continuum of treatment of smoking patients, routine documentation may not be sufficient to increase other tobacco treatment steps.\textsuperscript{23} For example, in the trial by Bentz and colleagues,\textsuperscript{10} the intervention arm asked 94\% of patients about tobacco but provided assistance for only 20\%. While the identification of smokers is likely to be a helpful step for population-based efforts to provide assistance,\textsuperscript{24,25} it is not sufficient by itself.

More than half of these observational studies described efforts to facilitate assistance for clinicians in connecting smokers with cessation counseling services outside the medical practice. This reflects an ongoing effort to provide an effective treatment option that increases the delivery of smoking-cessation assistance while saving busy clinician time. Several recent papers have examined facsimile referral to quitline counseling as an option for patients willing to quit smoking.\textsuperscript{10,26–30} Further research appears necessary to determine how to efficiently and effectively use the EMR to increase fax referrals and enrollments by fax-referred smokers.

The primary aim of this review was to determine the depth of the evidence supporting EMRs as a means of enhancing the delivery of effective smoking-cessation treatments in primary care settings, but the absence of enough data from RCTs means no causal inferences can be made. This is the most important limitation of the review. Any review cannot discount the possibility that the search missed some published studies or that studies with negative results were not published. Because of the small number of randomized trials published, the choice was made to also describe the relatively few uncontrolled studies as a representation of the overall literature and to see whether there might be some potential lessons from such studies.

In summary, this review found only two trials that adequately tested the effect of EMRs on smoking treatment in primary care. It appears that adding tobacco status as a vital sign increases some clinical guideline-recommended actions, primarily documentation of smoking status. There is a large need for additional research to further our understanding of the effect of EMRs on provider behaviors and patient smoking.

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