

Electronic Medical Records to Increase the Clinical Treatment of Tobacco Dependence

A Systematic Review

Raymond G. Boyle, PhD, MPH, Leif I. Solberg, MD, Michael C. Fiore, MD, MPH, MBA

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.

(Am J Prev Med 2010;39(6S1):S77–S82) © 2010 American Journal of Preventive Medicine

Introduction

In 2008, an estimated 46 million people or 20.6% of all adults in the U.S. were cigarette smokers.¹ Although this represents a substantial decline in smoking prevalence over the past 50 years,² prevalence has remained relatively constant for the last few years, and it is far short of the *Healthy People 2010* goal of 12%.³

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.⁴ 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.⁵ 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,⁶ so a substantial national investment is being made in EMR adoption. The Health Information Technology for Economic and Clinical Health Act (HITECH Act)⁷ 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

ClearWay MinnesotaSM (Boyle); HealthPartners Research Foundation (Solberg), Minneapolis, Minnesota; and University of Wisconsin Center for Tobacco Research and Intervention (Fiore), Madison, Wisconsin

Address correspondence to: Raymond G. Boyle, PhD, MPH, Director of Research, ClearWay Minnesota, 8011 34th Avenue South, Suite 400, Minneapolis MN 55425. E-mail: rboyle@clearwaymn.org.

0749-3797/\$17.00

doi: 10.1016/j.amepre.2010.08.014

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:

- A. trials of an EMR intervention on quit rates;
- B. trials of an EMR intervention on change in clinician behavior;
- C. use of an EMR to collect data for an observational study;
- D. use of an EMR for some other purpose such as recruiting smokers for a different type of study;
- E. 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 1. Objectives of the included studies

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

EMR, electronic medical record

Table 2. RCTs of EMR-based interventions for smoking cessation

Study	Number of clinics/ providers	Study period	Methods	Outcome measures	Results
Bentz (2007) ¹¹	19 primary care 10 intervention/57 MDs 9 comparison/55 MDs	12 months	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	Ask, Advise, Assess, Assist calculated monthly	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)
Linder (2009) ¹³	26 primary care clinics 12 intervention/14 control	9 months	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	Documentation of smoking status Contact with a quitline counselor	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%)

EMR, electronic medical record

and all measured changes in the U.S. Public Health Service guideline-recommended action steps,^{5,8} 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 clinics to either intervention or control conditions and assessed outcomes from EMR and other data. These studies are summarized in Table 2.

Bentz and colleagues¹¹ 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.¹³ 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 study¹³ 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 Portland¹¹ 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 3. Noncontrolled studies of EMR-based interventions for smoking cessation

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

EMR, electronic medical record; QL, quitline

Only one of these studies¹³ 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. McCullough¹⁴ and Spencer¹⁷ 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 colleagues¹² 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. Bentz¹⁰ 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 Shrader¹⁵ added smoking status to an EMR for pharmacists to document education on quitting and medication. Finally, Bentz⁹ 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

al.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.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 Bentz¹⁰ and Linder¹³ 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.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.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.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.²³ For example, in the trial by Bentz and colleagues,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,^{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.^{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.

Over the last 5 years, MCF has served as an investigator in research studies at the University of Wisconsin that were funded by Pfizer, GlaxoSmithKline, and Nabi Biopharmaceuticals.

No other financial disclosures were reported by the authors of this paper.

This paper was supported by ClearWay MinnesotaSM as part of a supplement entitled ClearWay MinnesotaSM: Advancing Tobacco Control Through Applied Research (Am J Prev Med 2010;39[6S1]).

References

1. CDC. Cigarette smoking among adults and trends in smoking cessation—U.S., 2008. *MMWR Morb Mortal Wkly Rep* 2009;58(44):1227–32.
2. Fiore M, Baker T. Stealing a march in the 21st century: accelerating progress in the 100-year war against tobacco addiction in the U.S. *Am J Public Health* 2009;99(7):1170–5.
3. U.S. Department of Health and Human Services. *Healthy People 2010, Volume II*. Washington DC: U.S. Government Printing Office, November 2000. Available at: www.healthypeople.gov/Document/HTML/Volume2/23PHI.htm#_Toc491137855.
4. Solberg L, Asche S, Boyle R, Boucher J, Pronk N. Frequency of physician-directed assistance for smoking cessation in patients receiving cessation medications. *Arch Intern Med* 2005;165(6):656–60.
5. Fiore M, Jaen C, Baker T, et al. Treating tobacco use and dependence: 2008 update clinical practice guideline. Rockville MD: USDHHS, Public Health Service; 2008.
6. Blumenthal D. Stimulating the adoption of health information technology. *N Engl J Med* 2009;360(15):1477–9.
7. Steinbrook R. Health care and the American Recovery and Reinvestment Act. *N Engl J Med* 2009;360(11):1057–60.
8. Fiore MC, Bailey WC, Cohen SJ, et al. Treating tobacco use and dependence. Clinical practice guideline. Rockville MD: U.S. Department of Health and Human Services. Public Health Service. June 2000
9. Bentz C, Davis N, Bayley B. The feasibility of paper-based tracking codes and electronic medical record systems to monitor tobacco-use assessment and intervention in an Individual Practice Association (IPA) model health maintenance organization (HMO). *Nicotine Tob Res* 2002;4(1S):S9–S17.
10. Bentz C, Bayley K, Bonin K, Fleming L, Hollis J, McAfee T. The feasibility of connecting physician offices to a state-level tobacco quit line. *Am J Prev Med* 2006;30(1):31–7.
11. Bentz C, Bayley K, Bonin K, et al. Provider feedback to improve 5A's tobacco cessation in primary care: a cluster randomized clinical trial. *Nicotine Tob Res* 2007;9(3):341–9.
12. Frank O, Litt J, Beilby J. Opportunistic electronic reminders. Improving performance of preventive care in general practice. *Aust Fam Physician* 2004;33(1–2):87–90.
13. Linder J, Rigotti N, Schneider L, Kelley J, Brawarsky P, Haas J. An electronic health record-based intervention to improve tobacco treatment in primary care: a cluster-randomized controlled trial. *Arch Intern Med* 2009;169(8):781–7.
14. McCullough A, Fisher M, Goldstein A, Kramer K, Ripley-Moffitt C. Smoking as a vital sign: prompts to ask and assess increase cessation counseling. *J Am Board Fam Med* 2009;22(6):625–32.
15. Ragucci K, Shrader S. A method for educating patients and documenting smoking status in an electronic medical record. *Ann Pharmacother* 2009;43(10):1616–20.
16. Sherman S, Takahashi N, Kalra P, et al. Care coordination to increase referrals to smoking cessation telephone counseling: a demonstration project. *Am J Manag Care* 2008;14(3):141–8.
17. Spencer E, Swanson T, Hueston W, Edberg D. Tools to improve documentation of smoking status. Continuous quality improvement and electronic medical records. *Arch Fam Med* 1999;8(1):18–22.
18. Szpunar S, Williams P, Dagros D, Enberg R, Chesney J. Effects of the tobacco use cessation automated clinical practice guideline. *Am J Manag Care* 2006;12(11):665–73.
19. McDaniel A, Stratton R, Britain M. Systems approaches to tobacco dependence treatment. *Annu Rev Nurs Res* 2009;27:345–63.
20. Vandembroucke J, von Elm E, Altman D, et al. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration. *Ann Intern Med* 2007;147(8):W163–W194.
21. Schulz K, Altman D, Moher D. CONSORT 2010 Statement: updated guidelines for reporting parallel group randomized trials. *Ann Intern Med* 2010;152(11):726–32.
22. Fiore M. The new vital sign. Assessing and documenting smoking status. *JAMA* 1991;266(22):3183–4.
23. Boyle R, Solberg L. Is making smoking status a vital sign sufficient to increase cessation support actions in clinical practice? *Ann Fam Med* 2004;2:3.
24. Murray R, Coleman T, Antoniak M, et al. The effect of proactively identifying smokers and offering smoking cessation support in primary care populations: a cluster-randomized trial. *Addiction* 2008;103(6):998–1006; discussion 1007–8.
25. Fiore MC, McCarthy DE, Jackson TC, et al. Integrating smoking cessation treatment into primary care: an effectiveness study. *Prev Med* 2004;38(4):412–20.
26. Perry R, Keller P, Fraser D, Fiore M. Fax to quit: a model for delivery of tobacco cessation services to Wisconsin residents. *WMJ* 2005;104(4):37–40, 44.
27. Rothemich S, Woolf S, Johnson R, et al. Promoting primary care smoking-cessation support with quitlines: The QuitLink Randomized Controlled Trial. *Am J Prev Med* 2010;38(4):367–74.
28. Willett J, Hood N, Burns E, et al. Clinical faxed referrals to a tobacco quitline: reach, enrollment, and participant characteristics. *Am J Prev Med* 2009;36(4):337–40.
29. Wadland W, Holtrop J, Weismantel D, Pathak P, Fadel H, Powell J. Practice-based referrals to a tobacco cessation quit line: assessing the impact of comparative feedback vs general reminders. *Ann Fam Med* 2007;5(2):135–42.
30. Kobinsky KH, Redmond LA, Smith SS, Yepassis-Zembrou PL, Fiore MC. The Wisconsin Tobacco Quit Line's Fax to Quit program: participant satisfaction and effectiveness. *WMJ* 2010;109(2):79–84.