An Electronic Health Record–Based Intervention to Improve Tobacco Treatment in Primary Care

A Cluster-Randomized Controlled Trial

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Background: To improve the documentation and treatment of tobacco use in primary care, we developed and implemented a 3-part electronic health record enhancement: (1) smoking status icons, (2) tobacco treatment reminders, and (3) a Tobacco Smart Form that facilitated the ordering of medication and fax and e-mail counseling referrals.

Methods: We performed a cluster-randomized controlled trial of the enhancement in 26 primary care practices between December 19, 2006, and September 30, 2007. The primary outcome was the proportion of documented smokers who made contact with a smoking cessation counselor. Secondary outcomes included coded smoking status documentation and medication prescribing.

Results: During the 9-month study period, 132,630 patients made 315,962 visits to study practices. Coded documentation of smoking status increased from 37% of patients to 54% (+17%) in intervention practices and from 39% of patients to 46% (+11%) in control practices (P < .001 for the difference).

Conclusion: This electronic health record–based intervention improved smoking status documentation and increased counseling assistance to smokers but not the prescription of cessation medication.

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TOBACCO USE REMAINS THE NO. 1 CAUSE OF PREVENTABLE DEATH IN THE UNITED STATES.1-2 TOBACCO TREATMENT DECREASES MORBIDITY AND MORTALITY AND IS HIGHLY COST-EFFECTIVE.3-5 THE US PUBLIC HEALTH SERVICE RECOMMENDS ROUTINE USE OF THE “5 A’S”: ASKING ALL PATIENTS ABOUT TOBACCO USE, ASSESSING SMOKERS’ WILLINGNESS TO QUIT, ADVISING SMOKERS TO QUIT, ASSISTING SMOKERS IN QUITTING BY PRESCRIBING SMOKING CESSATION MEDICATIONS AND REFERRING PATIENTS FOR COUNSELING, AND ARRANGING FOLLOW-UP. BRIEF INTERVENTIONS DELIVERED BY CLINICIANS IN OFFICE PRACTICES ARE EFFECTIVE IN INCREASING CESSATION RATES, BUT MORE INTENSIVE ASSISTANCE IS MORE EFFECTIVE.6 FOR EXAMPLE, CONNECTING SMOKERS TO IN-PERSON OR TELEPHONE-BASED SMOKING CESSATION COUNSELING ROUGHLY DOUBLES THE ODDS OF QUITTING.7-7

However, despite public health efforts encouraging treatment for tobacco use, many patients are not asked about tobacco use and even fewer tobacco users receive assistance quitting.8-12 Physicians cite limited time, lack of expertise, and concern about failure as barriers to providing consistent treatment.13 One time-saving solution is to have physicians refer smokers to trained counselors outside the office visit.13

Electronic health record (EHR) use is expanding,14 and EHRs have the potential to increase adherence to guidelines.15-16 However, nationally, EHRs have not been associated with improved tobacco counseling.17 Electronic health records could be used to remind clinicians to document smoking status and deliver brief advice, prompt clinicians to prescribe cessation medications, and facilitate referrals to counseling. We developed, implemented, and tested in a cluster-randomized controlled trial an EHR enhancement to increase documentation of smoking status, prescription of tobacco treatment medications, and referral of patients to tobacco treatment counseling. Our primary aim was to increase rates at which smokers made contact with cessation counseling after an office visit.

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METHODS

DESIGN OVERVIEW AND RANDOMIZATION

We matched 26 primary care practices based on size (number of annual visits) and practice type (hospital based, community based, or community health center) and randomly assigned them to intervention or usual care.\textsuperscript{18,19} We randomized practices instead of physicians to facilitate the introduction of the intervention, reduce contamination of the control group, and potentially increase the effectiveness of the intervention through peer effects.\textsuperscript{20,21} The intervention period was 9 months (December 19, 2006, to September 30, 2007). The institutional review board of Partners Healthcare approved the study protocol, including a waiver of informed consent for participating clinicians and patients.

SETTING AND PARTICIPANTS

The Partners Primary Care Practice–Based Research Network includes 26 primary care practices affiliated with Brigham and Women’s Hospital and Massachusetts General Hospital that use the longitudinal medical record. The longitudinal medical record is an internally developed, Web-based, fully functional EHR that includes notes from primary care and subspecialty practices, coded problem lists, a health maintenance grid for documenting preventive counseling and health habits, medication prescribing, and medication allergies. Smoking status can be documented in coded fashion using the problem list (smoking or former smoking) or a tobacco-specific field within the health maintenance grid (never smoker, former smoker, or current smoker). Clinicians can also enter tobacco use as a non-coded problem on the problem list. The practices in this study began using the longitudinal medical record between 1999 and 2003.

INTERVENTION

In intervention practices, clinicians received 3 enhancements to the EHR: smoking status icons, tobacco treatment reminders, and a Tobacco Smart Form. First, 2 smoking status icons were introduced. If a patient’s smoking status was not documented in coded fashion in the problem list or the smoking health maintenance field, a black icon with an image of a cigarette and a question mark appeared at the top of all EHR pages for that patient. Clicking on this icon took clinicians to the tobacco health maintenance screen to document smoking status. A scarlet icon with the image of a cigarette appeared at the top of all EHR pages of patients documented as current smokers or as recent quitters (within 3 years of their quit date; Figure 1). Clicking on the scarlet icon took the clinician directly to the Tobacco Smart Form. No icon appeared for patients documented as never smokers or as former smokers with more than 3 years since their quit date.

Second, clinicians in intervention practices received tobacco treatment reminders. These were listed along with other preventive, chronic disease, and medication management reminders at the top of the patient summary page, the first page seen when selecting a patient’s medical record (depending on a variety of patient factors, the number of reminders listed can range from 0 to a maximum of approximately 10). For patients with no coded smoking status, the reminder read, “No known smoking status. Click here to enter status.” For patients documented as current smokers, the reminder read, “Patient may be a current smoker. Assess readiness to quit and offer assistance.” For recent quitters, the reminder read, “Former smoker. Confirm still not smoking and congratulate patient.” Clicking on any reminder took clinicians to the tobacco health maintenance screen, which included a button to access the Tobacco Smart Form.

Third, clinicians in intervention practices had access to the Tobacco Smart Form (Figure 1). Smart Forms are a novel set of EHR applications that provide documentation-based clinical decision support.\textsuperscript{22,23} The Tobacco Smart Form included informa-
tion and reminders about patients' smoking status and an order set that facilitated the ordering of smoking cessation medications (nicotine products, bupropion hydrochloride, or varenicline), documenting of actions, printing of patient education materials, and referring smokers by e-mail to a tobacco treatment counselor or by fax to the Massachusetts telephone Quiltline. The generation of an e-mail referral to a certified tobacco treatment specialist took approximately 3 mouse clicks.

After receiving the referral e-mail that included demographic and contact information, smoking history, and clinician information, all of which had been filled in beforehand, the counselor made up to 3 attempts to contact the patient by telephone. After making contact, the counselor conducted 1 brief counseling session based on a protocol used in a previous study. The counselor assessed the readiness of the patient to quit, encouraged him or her to set a quit date, provided a brief motivational intervention to smokers not ready to set a quit date, facilitated the receipt of smoking cessation medication from patients' clinicians, and referred the patient to other cessation services (groups offered by hospitals or the Massachusetts telephone Quiltline). The counselor documented the outcome of referrals in the EHR and sent a report by e-mail to the referring health care professional.

Clinicians using the Tobacco Smart Form could also print a fax referral form (filled in beforehand) that had been sent by their office to the state telephone Quiltline. On receiving this form, the Quitline staff proactively called smokers to offer the state's smoking cessation resources, including written materials, free telephone counseling, or referral to in-person smoking cessation programs. The enhancements were introduced to intervention practices with an introductory e-mail to clinicians, 1 practice visit by an investigator, and periodic e-mails to encourage use of the enhancements. No incentives were provided to clinicians or patients. No additional organizational supports were introduced during the intervention period. Clinicians in control practices saw no tobacco-related icons or reminders and did not have access to the Tobacco Smart Form. They could refer smokers to the state Quitline or to hospital programs but could not e-mail the tobacco treatment counselor through the EHR.

OUTCOMES

The primary outcome was contact between a documented smoker and any form of smoking cessation counseling. We defined a documented smoker as a patient who made a visit to any study practice during the intervention period and had coded smoking status listed on the tobacco health maintenance screen or the problem list or had tobacco use indicated in noncoded fashion on the problem list (identified by searching for tob, smok, cig, or pack). Because smoking status changes over time, a documented smoker had to have an indication of active smoking at some point during the intervention period (eg, a patient whose documentation changed from never smoker to current smoker to former smoker during the intervention period was considered a documented smoker). We defined contact with smoking cessation counseling as documentation that the tobacco counselor reached the patient by telephone, the smoker attended a hospital in-person smoking program, or the state Quitline had reached the smoker for an initial evaluation. We chose this primary outcome because we sought to increase the rate of the key assist step in tobacco treatment, the initiation of contact with counseling. Secondary outcomes included changes in documentation of smoking status, tobacco treatment medication prescribing, and referrals to smoking cessation services.

DATA ANALYSIS

Patients were the unit of analysis. We extracted information on the number and type of clinician (staff physician, trainee, or nurse practitioner or physician assistant), sex, and years since graduation from medical school (for physicians). We also measured how many individual clinicians prescribed tobacco cessation medications, used the Tobacco Smart Form at least once (in the intervention practices), and referred patients for counseling. We examined differences between control and intervention practices in the characteristics of all patients and of documented smokers who made a visit during the intervention period. This included information about the number of patient visits during the intervention period; patient age, sex, income by zip code, ethnicity (from registration information), primary language, and primary insurance; and medical problems in the EHR problem list. Patients with missing data were excluded from comparisons.

To examine changes in documentation, we compared the smoking status of patients who made a visit to 1 of the study practices in the 9 months before the start of the intervention period with patients who made a visit to the practice during the intervention period. We compared documentation between intervention and control practices by examining documentation on the day before the start of the intervention and the last day of the intervention. Because not all patients made a visit in both the pre-intervention and intervention periods, we could not directly examine changes in smoking status for all individuals. However, we examined the proportion of documented smokers at the start of the intervention period who were documented nonsmokers by the end of the intervention period as a closer estimate of actual smoking cessation. We extracted information about 3 classes of tobacco treatment medications—nicotine replacement products, bupropion, and varenicline—from the EHR medication module prescribed during the intervention period. Hypothesizing that patients at higher risk might be more likely to receive tobacco treatment, we examined documentation of smoking status, the prescription of tobacco treatment medication, referrals to smoking cessation services, and contact with cessation counseling for the group of patients with hypertension, hyperlipidemia, diabetes mellitus, coronary artery disease, vascular disease, chronic lung disease, or smoking-related cancer on their problem lists.

POWERMATERIALS

A sample size of approximately 2200 documented smokers in each group had 80% power to detect a 3% increase in smokers who made contact with the smoking cessation counselor, from 3% to 6% of smokers, using a 2-sided chi-square test adjusted for clustering by clinician (assuming an intraclass correlation of 0.05 and each clinician seeing, on average, 34 patients) and an alpha of 0.05. We used standard descriptive statistics to compare clinicians and patients. Patients with missing data were excluded from these comparisons. To account for the level of randomization, we adjusted all statistical analyses (chi-square test for categorical variables and t test for continuous variables) for clustering by practice using PROC GENMOD in SAS version 9.1; SAS Institute Inc, Cary, North Carolina. We evaluated a model, adjusting for clustering by practice, with smoking status as the dependent variable and practice status (intervention vs control), time (before or during the intervention period), and an interaction term between practice status and time as the dependent variables. The interaction term allowed us to examine the significance of changes in documentation over time between control and intervention practices. We considered P < 0.05 statistically significant.

RESULTS

CLINICIAN AND PATIENT CHARACTERISTICS

During the intervention period, there were 315,962 visits by 132,630 patients to 521 clinicians in the 26 control and intervention practices (Figure 2). No significant differences...
were found between the control and intervention practices in clinician type, sex, and years since graduation from medical school (Table 1). Of the 207 clinicians in the intervention practices, 90 (44%) used the Tobacco Smart Form at least once.

No significant sociodemographic differences were found among patients or documented smokers with a visit to control or intervention practices (Table 2). The nonsignificant differences in race/ethnicity and language between the control and intervention practices were a consequence of 2 community health centers with large Latino patient populations having been randomized to the intervention group.

CHANGES IN SMOKING DOCUMENTATION

In comparing patients who made a visit in the 9 months before the intervention period with patients who made a visit during the intervention period, documentation rates increased from 35% to 46% (+11%) in the control practices and from 37% to 54% (+17%) in the intervention practices (P < .001; Table 3). The increase in documentation in the intervention practices was attributable to increased documentation for patients who were former smokers and never smokers.

Among the subgroup of 9589 patients who had at least 1 visit to a study practice in the 9 months before the intervention period, were documented as smokers, and also made at least 1 visit to a study practice during the intervention period, more patients in the intervention practices were recorded as nonsmokers by the end of the study (5.3% [208/3956] vs 1.9% [109/5633] in control practices; P < .001).

OUTCOMES AMONG DOCUMENTED SMOKERS

No difference was found in the proportion of documented smokers in the control and intervention practices who were prescribed a tobacco cessation medication (Table 4). Significantly more documented smokers were referred to smoking cessation counseling in the intervention practices (+4.5% vs 0.4% in control practices; P < .001). This finding was attributable mainly to referrals by clinicians to the tobacco counselor, although a small, statistically significant increase was found in referrals to the Quitline. Similarly, significantly more documented smokers in intervention practices achieved the primary outcome, contact with tobacco counseling (3.9% vs 0.3% in control practices; odds ratio, 12.1; 95% confidence interval, 3.3-27.6; P < .001). This finding also was primarily attributable to the tobacco counselor and less so to increased contact with the Quitline.

Outcomes for the subgroup of higher-risk patients (patients with hypertension, hyperlipidemia, diabetes mellitus, coronary artery disease, vascular disease, chronic lung disease, or smoking-related cancer on their problem lists) were similar. For example, among the 3682 higher-risk patients who were documented smokers, 4.1% (112/2715) of patients in the intervention group and .3% (12/3668) of patients in the control group achieved the primary outcome (P < .001).

In this cluster-randomized controlled trial, introduction of an EHR-based intervention improved several processes of tobacco treatment in primary care practices. The intervention increased documentation of smoking status, referral of smokers for tobacco treatment, and documented contact of smokers with cessation counseling, an assist that other studies show roughly doubles the odds of quitting.3,7 The intervention did not increase the prescription of cessation medications. In addition to improving several process measures, there was a suggestion that outcomes of care may have also improved. Among patients who were documented smokers at the start of the intervention period, more were documented nonsmokers by the end of the intervention period in the intervention practices compared with control practices, although this outcome may be simply attributable to improved documentation.

Effective models for implementing the assist step in tobacco treatment by clinicians is critical because clinicians provide assistance at much lower rates than they document smoking status or provide brief advice.8-12 Increasing rates of assistance have been resistant to intervention.
in part owing to multiple competing demands for physicians' time and smokers' resistance to acceptance of counseling.13,25-27 The negligible rate of performance of these ac-
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vention, in part owing to multiple competing demands for physi-
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vention, in part owing to multiple competing demands for physi-

Table 2. Patient Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Control (n=68 309)</th>
<th>Intervention (n=64 321)</th>
<th>P Value</th>
<th>Control (n=5915)</th>
<th>Intervention (n=5292)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of clinic visits during intervention period, mean (SD)</td>
<td>2.4 (1.9)</td>
<td>2.3 (1.9)</td>
<td>.64</td>
<td>2.8 (2.3)</td>
<td>2.8 (2.3)</td>
<td>.95</td>
</tr>
<tr>
<td>Age, mean (SD), y</td>
<td>49 (17)</td>
<td>48 (16)</td>
<td>.88</td>
<td>49 (15)</td>
<td>48 (14)</td>
<td>.93</td>
</tr>
<tr>
<td>Income by zip code, mean (SD), $d</td>
<td>55 224 (20 641)</td>
<td>55 654 (24 663)</td>
<td>.60</td>
<td>49 299 (16 230)</td>
<td>47 917 (19 529)</td>
<td>.67</td>
</tr>
<tr>
<td>Female, No. (%)</td>
<td>44 220 (65)</td>
<td>39 086 (61)</td>
<td>.38</td>
<td>42 73 (62)</td>
<td>31 79 (60)</td>
<td>.26</td>
</tr>
<tr>
<td>Race and ethnicity, No. (%)</td>
<td>White</td>
<td>46 790 (69)</td>
<td>37 201 (58)</td>
<td>4865 (70)</td>
<td>2999 (57)</td>
<td>.82</td>
</tr>
<tr>
<td></td>
<td>Latino</td>
<td>5920 (9)</td>
<td>13 101 (20)</td>
<td>607 (9)</td>
<td>1090 (21)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Black</td>
<td>6088 (9)</td>
<td>5149 (8)</td>
<td>.77</td>
<td>751 (11)</td>
<td>659 (13)</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>9511 (14)</td>
<td>8870 (14)</td>
<td>688 (10)</td>
<td>544 (12)</td>
<td></td>
</tr>
<tr>
<td>Language, No. (%) d</td>
<td>English</td>
<td>61 788 (91)</td>
<td>52 084 (81)</td>
<td>6372 (93)</td>
<td>4387 (83)</td>
<td>.37</td>
</tr>
<tr>
<td></td>
<td>Spanish</td>
<td>2951 (4)</td>
<td>8676 (14)</td>
<td>.40</td>
<td>248 (4)</td>
<td>56 (10)</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>3191 (5)</td>
<td>3405 (5)</td>
<td>266 (4)</td>
<td>34 (7)</td>
<td></td>
</tr>
<tr>
<td>Primary insurance, No. (%) d</td>
<td>Private</td>
<td>47 046 (69)</td>
<td>43 108 (67)</td>
<td>4190 (61)</td>
<td>3050 (58)</td>
<td>.70</td>
</tr>
<tr>
<td></td>
<td>Medicare</td>
<td>12 390 (18)</td>
<td>9881 (15)</td>
<td>1365 (20)</td>
<td>957 (18)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Medicaid</td>
<td>5532 (8)</td>
<td>6702 (10)</td>
<td>.86</td>
<td>934 (14)</td>
<td>919 (17)</td>
</tr>
<tr>
<td></td>
<td>No insurance/self-pay</td>
<td>3310 (5)</td>
<td>4608 (7)</td>
<td>424 (6)</td>
<td>365 (7)</td>
<td></td>
</tr>
<tr>
<td>Medical problems, No. (%) e</td>
<td>Hypertension</td>
<td>15 818 (23)</td>
<td>13 539 (21)</td>
<td>1796 (28)</td>
<td>1536 (26)</td>
<td>.70</td>
</tr>
<tr>
<td></td>
<td>High cholesterol levels</td>
<td>14 935 (22)</td>
<td>12 551 (20)</td>
<td>1851 (27)</td>
<td>1278 (24)</td>
<td>.63</td>
</tr>
<tr>
<td></td>
<td>Diabetes mellitus</td>
<td>5027 (2)</td>
<td>4670 (7)</td>
<td>.93</td>
<td>675 (10)</td>
<td>560 (11)</td>
</tr>
<tr>
<td></td>
<td>Cardiovascular disease</td>
<td>5067 (7)</td>
<td>4176 (6)</td>
<td>.82</td>
<td>735 (11)</td>
<td>463 (9)</td>
</tr>
<tr>
<td></td>
<td>Depression or anxiety</td>
<td>13 399 (20)</td>
<td>11 104 (17)</td>
<td>.007</td>
<td>2233 (32)</td>
<td>1774 (34)</td>
</tr>
<tr>
<td></td>
<td>Chronic lung disease</td>
<td>7412 (11)</td>
<td>6761 (11)</td>
<td>.78</td>
<td>1184 (17)</td>
<td>905 (17)</td>
</tr>
<tr>
<td></td>
<td>Smoking-related cancer</td>
<td>539 (1)</td>
<td>477 (1)</td>
<td>.52</td>
<td>90 (1)</td>
<td>67 (1)</td>
</tr>
<tr>
<td></td>
<td>Non-smoking-related cancer</td>
<td>5029 (7)</td>
<td>4294 (7)</td>
<td>.97</td>
<td>436 (6)</td>
<td>310 (6)</td>
</tr>
</tbody>
</table>

a Patients who made at least 1 visit to a study practice during the intervention period.
b Patients who had “smoking” or a noncoded smoking entry on their problem list or “current smoker” listed in the smoking section of the electronic health record at any point during the intervention period.

Table 3. Documentation of Smoking Status From the Start to the End of the Study Period

<table>
<thead>
<tr>
<th>Patient</th>
<th>Control Practices</th>
<th>Intervention Practices</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Start, No. (%) (n=78 868)</td>
<td>End, No. (%) (n=68 309)</td>
<td>Change, %</td>
</tr>
<tr>
<td>Any smoking documentation</td>
<td>27 345 (35)</td>
<td>31 620 (46)</td>
<td>+11</td>
</tr>
<tr>
<td>Current smoker</td>
<td>6630 (8)</td>
<td>6796 (10)</td>
<td>+2</td>
</tr>
<tr>
<td>Former smoker</td>
<td>6981 (9)</td>
<td>7726 (11)</td>
<td>+7</td>
</tr>
<tr>
<td>Never smoker</td>
<td>14 934 (18)</td>
<td>17 098 (25)</td>
<td>+7</td>
</tr>
</tbody>
</table>

a Start is the smoking status as of the day before the intervention period for patients who made a visit in the 9 months before the study period. End is the smoking status as of the last day of the intervention period for patients who made a visit during the study period. The number of current smokers at the end of the intervention period is less than the number of documented smokers in Table 2 and Table 4 because patients could have their status changed from current smoker to former smoker.
b P value is for the difference in changes between the intervention and control practices, adjusted for clustering by practice.
Table 4. Outcomes Among Documented Smokers

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Control (n=6915)</th>
<th>Intervention (n=5292)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prescribed medication*</td>
<td>136 (2.0)</td>
<td>98 (2.0)</td>
<td>.40</td>
</tr>
<tr>
<td>Nicotine replacement</td>
<td>34 (0.5)</td>
<td>30 (0.6)</td>
<td>.84</td>
</tr>
<tr>
<td>Bupropion hydrochloride</td>
<td>40 (0.6)</td>
<td>35 (0.7)</td>
<td>.83</td>
</tr>
<tr>
<td>Varenicline</td>
<td>76 (1.1)</td>
<td>39 (0.7)</td>
<td>.47</td>
</tr>
<tr>
<td>Referred to smoking counseling</td>
<td>29 (0.4)</td>
<td>235 (4.5)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Tobacco counselor, by e-mail</td>
<td>NA</td>
<td>209 (4.0)</td>
<td>NA</td>
</tr>
<tr>
<td>Local stop-smoking program</td>
<td>27 (0.4)</td>
<td>17 (0.3)</td>
<td>.57</td>
</tr>
<tr>
<td>Quitline, by fax*</td>
<td>2 (0.03)</td>
<td>36 (0.7)</td>
<td>.008</td>
</tr>
<tr>
<td>Contact with smoking counseling*</td>
<td>20 (0.3)</td>
<td>202 (3.9)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Tobacco counselor, by telephone</td>
<td>NA</td>
<td>184 (3.5)</td>
<td>NA</td>
</tr>
<tr>
<td>Local stop-smoking program, in person</td>
<td>18 (0.3)</td>
<td>9 (0.2)</td>
<td>.32</td>
</tr>
<tr>
<td>Quitline, by telephone*</td>
<td>2 (0.03)</td>
<td>22 (0.4)</td>
<td>.01</td>
</tr>
</tbody>
</table>

Abbreviation: NA, not applicable.
*Documented smokers are patients who had “smoking” or a noncoded smoking entry on their problem list or “current smoker” listed in the smoking section of the electronic health record at any point during the intervention period.

P value is adjusted for clustering by practice. Intracluster correlation coefficients were 0.013 for prescribed medication, 0.007 for referral to smoking counseling, and 0.005 for contact with smoking counseling.

Patients who had allergies to the smoking medications were removed from the denominator. The sample sizes were 6729 control patients and 5154 intervention patients for any medication; 6902 control patients and 5283 intervention patients for nicotine replacement; 6778 control patients and 5186 intervention patients for bupropion hydrochloride; and 6873 control patients and 5261 intervention patients for varenicline.

Quitline is the Massachusetts state telephone quitline.

Primary outcome.

Discussion

Documentation improved in the control practices, consistent with secular trends, but documentation increased to a greater extent in intervention practices. In particular, documentation in the intervention practices increased for former smokers and never smokers but not current smokers. Documentation is an important step in tobacco treatment for individual patients and populations. In the United Kingdom, proactively identifying smokers increased use of cessation services and quit attempts. Clear, coded documentation, as opposed to free-text entries in visit notes, could facilitate outreach to smokers outside scheduled visits and enable population-based tobacco management within a health care system.

The failure of our intervention to increase rates of prescription of smoking cessation medications has several potential explanations. First, having referred patients to counseling, clinicians in intervention practices may have thought a medication prescription was unnecessary. Second, our study period coincided with the introduction of a new pharmacotherapeutic agent, varenicline, whose marketing included direct-to-consumer advertising. This may have increased rates of its prescription in the control group. Third, nicotine replacement products can be purchased without a prescription. Clinicians are less likely to enter over-the-counter medications in the EHR than prescription medications. Because the 3-part intervention was introduced as a package, we cannot determine the relative value of individual intervention components. For example, the smoking status icon, the reminder, or both might have increased smoking status documentation. Access to the Tobacco Smart Form likely facilitated e-mail referrals to the tobacco counselor and fax referrals to the state Quitline. Clinicians may have preferred accessing the tobacco counselor by e-mail because it was logistically easier than generating and sending a fax. Alternatively, clinicians may have preferred a within-system counselor over the state Quitline.

Other similar interventions have varied in their effectiveness. In an uncontrolled intervention at 10 California Veterans Administration practices, Sherman and colleagues used EHR-based referrals to care coordinators, who subsequently attempted to contact and connect smokers with the state Quitline. The number of referrals to the state Quitline increased markedly after implementation, but, as in our study, no change was found in prescribing of medications. In a pre-post study, Szpunar and colleagues introduced an EHR-based tobacco counseling system that involved both nurses and physicians. It increased the rate at which patients were asked about tobacco use but not the rate of assistance of patients. Bentz and colleagues used EHR data to provide monthly feedback to clinicians in a cluster-randomized controlled trial. The feedback resulted in increases in assessment, advising, and assistance of patients to quit using tobacco. The combination of such retrospective feedback with prospective decision support tools, such as those we implemented, has the potential to further improve tobacco treatment. This study has limitations that should be considered. First, the study took place in a network of academically affiliated primary care practices using a locally developed EHR. However, the basic form of the intervention—a smoking status icon and e-mail referral capability—is easily generalizable to other practice types and EHRs. Indeed, portions of our intervention have been built into other EHRs, although not as a package and not as rigorously tested. Our results could also differ in settings with varied access to different types of tobacco treatment programs. Second, our main outcomes are only proxies for actual smoking cessation, but they have repeatedly been shown to be associated with increased quit rates. Third, patients could have participated in tobacco treatment programs other than those we assessed. However, there should have been balanced outcomes ascertainment between the intervention and control practices. Fourth, we did not assess the acceptability of the intervention to clinicians or the opportunity costs of the intervention. Despite these limitations, a major strength of our study is that the intervention was made available to all clinicians in randomly selected practices. Participation was not selective by patients, clinicians, or practices with a particular interest in tobacco treatment.

Tobacco use is the leading preventable cause of death in the United States, and tobacco treatment is highly effective. Despite the availability of national tobacco treatment guidelines since 1996, primary care clinicians fail to identify the smoking status of all their patients and provide treatment to few patients because of time constraints, competing demands, lack of expertise, and pessimism about the probability of success. Interventions that allow primary care physicians to quickly and efficiently identify and refer patients to tobacco treatment might increase rates of tobacco counseling and increase smoking cessation rates. In a cluster-
randomized controlled trial, we found that the use of an EHR-based enhancement increased rates of documentation, referrals, and contact with tobacco treatment. Health care systems and clinicians may be able to provide more efficient, effective tobacco treatment by using health information technology to centralize their tobacco treatment efforts.

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