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A content analysis of electronic health record (EHR) functionality to support tobacco treatment

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Abstract

Government regulations have created new incentives for health systems to implement changes in electronic health records (EHRs) to reduce tobacco use among patients. The purpose of this study is to conduct a content analysis of EHR modifications aimed at supporting tobacco cessation and to document these modifications using a 5 A's framework (i.e., Ask, Advise, Assess, Assist, Arrange). Fourteen trials were identified that met inclusion criteria. A content analysis of EHR functionality in these trials was conducted by two independent reviewers between February and June 2015. For "Ask," all trials provided for the documentation of smoking status in the EHR. For "Advise," 35.7 % of EHRs provided functionality related to helping a clinician provide advice to quit. For "Assess," more than half (57.1 %) of EHRs included a feature to document a patient's willingness to quit. For "Assist," EHRs offered features for medication prescribing (78.6 %), providing educational materials to patients (57.1 %), referring a patient to the quitline (50.0 %), referring a patient to a tobacco treatment specialist (42.9 %), and documenting the provision of counseling (35.7 %). Finally, for "Arrange," EHRs supported the following up of patients (35.7 %) and allowed tobacco treatment specialists to "pass back" patient notes to primary care providers (28.6 %). Studies that have modified EHRs for tobacco treatment have done so across the steps in the 5 As model, with most modifications occurring to support documenting smoking status (Ask) and assisting with medication prescribing (Assist). As health systems attempt to comply with Meaningful Use regulations, an understanding of the range of EHR modifications to support tobacco treatment is warranted.

Keywords

Electronic health record, EHR, Electronic medical record, EMR, Behavioral informatics, Smoking cessation

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Implications

Researchers: Studies are needed that explore the contribution of a range of EHR features on smoking cessation outcomes.

Practioners: Practioners who modify EHRs for smoking cessation should consider the range of fields included in this analysis.

Policymakers: Given the range of options presented in the current analysis, policymakers should consider specifying how EHRs should support smoking cessation counseling across a range of functionality in the 5 A's framework.

Introduction

Despite being the leading preventable cause of death in the USA [1], tobacco use is undertreated in health systems. While 70 % of cigarette smokers report having visited a health care provider in the previous year, approximately 50 % of those reported receiving counseling about their smoking [2, 3]. Furthermore, of those who received a provider's advice to quit, only 31.7 % reported using counseling and/or medications in their quit attempt [4].

With the passage of the Health Information Technology for Economic and Clinical Health (HITECH) Act (2009) and associated Meaningful Use regulations, new financial incentives exist for health care systems to adopt systemic approaches to treating tobacco use with their patients. Meaningful use incentivizes health systems to adopt and use certified electronic health records (EHRs) in order to improve care quality and patient and population health [5].

Meaningful Use regulations have been divided into stages: stage 1 focuses on data capture and sharing, stage 2 focuses on improvements in clinical processes, and stage 3 focuses on improvements in outcomes [6, 7]. For tobacco control, Meaningful Use regulations call for the documentation in the EHR of screening for tobacco use and the provision of counseling for smoking cessation [6, 7].

Spurred by new regulations, the adoption of EHRs has increased substantially in recent years. In 2013, almost half of doctor's offices had an EHR system that met basic criteria (includes notes, prescriptions,

history, lab allergies), a fourfold increase since 2006 [8]. Likewise, in 2013, approximately 60 % of non-federal hospitals used a basic EHR, an increase from just under 10 % in 2008 [9]. Less clear is the degree to which health care reform has led to changes in tobacco screening and counseling in health systems.

Meaningful Use regulations contain specific provisions for how EHRs should address tobacco use. In the current stage (stage 2), health systems receive incentives if a high percentage (80 %) of patients are screened for tobacco use one or more times within 24 months, and if those identified as tobacco users receive a tobacco cessation counseling intervention [10]. A cessation counseling intervention includes the provision of brief counseling (3 min or less) and/or pharmacotherapy. For screening, EHRs are required to contain a structured data field that documents a patient's smoking status and categorizes the status into one of several pre-specified categories (i.e., current every day smoker, current some day smoker, former smoker, never smoker, unknown status) [11, 12]. While Meaningful Use regulations specify how tobacco use screening should occur in the EHR, less guidance is offered on how the tobacco cessation counseling intervention might be implemented or documented.

Recent studies have attempted to empirically assess whether EHRs can be effective as tools for promoting tobacco treatment [13–15]. A recent Cochrane review of 16 EHR interventions conducted between 1999 and 2014 attempted to systematically assess the impact of modifications to EHRs on tobacco dependence treatment initiation by providers [13]. The review concluded that EHR modifications to support smoking cessation led to increases in tobacco use documentation in the EHR and referrals of patients to cessation counseling. The effect of EHR modifications on patient quit rates was reported only for one randomized trial, and while promising, the authors of the review concluded that their general impact on quit rates was unclear [13]. Another study based on a national survey of physician practices found that physician practices that used more sophisticated EHRs (e.g., those that included general features for the electronic ordering of tests and prescriptions, warnings of drug interactions or contraindications, and reminders regarding guideline-based interventions) were significantly more likely to record smoking status, counsel patients on smoking cessation, and document prescribing medications to support cessation efforts than those using less sophisticated EHRs [15]. None of the aforementioned studies [13–15] attempted to systematically describe the types of modifications to EHRs for tobacco treatment support.

In order to comply with Meaningful Use regulations and other regulations, health systems need to modify their EHRs to not only document smoking status, but also to support the provision of tobacco cessation counseling interventions. To our knowledge, no prior studies exist that have documented the range of EHR features implemented to promote tobacco treatment, nor the degree to which features adhere to established best practice cessation guidelines. For example, in Boyle et al., all types of EHR modifications aimed at support for patients who use tobacco were considered together [13]. Studies that were included ranged from those that simply added a reminder for recording smoking status to the EHR, to those that had more comprehensive changes, including the provision of electronic referrals to the quitline and the inclusion of order sets for ordering medications and other cessation materials [13, 14, 16]. As more health systems adopt and modify their EHRs to promote tobacco dependence treatment, potentially influencing the behavior of thousands of clinicians, an in-depth understanding of the range of possible modifications and their differential effects is important [17].

Building on previous content analyses of technology-related smoking cessation programs [18, 19], the goal of this study is to conduct a content analysis of published studies describing the modifications to EHRs to promote tobacco treatment. Of interest are (1) the range and prevalence of features in EHRs that are aimed at tobacco treatment and (2) the degree to which these identified features fall within the 5 A's model (Ask, Advise, Assess, Assist, Arrange) for tobacco treatment as described in the U.S. Public Health Service's 2008 Clinical Practice Guideline for Treating Tobacco Use and Dependence [20]. The Clinical Practice Guidelines recommends that providers ask patients about their tobacco status ("Ask"), advise all smokers to quit ("Advise"), assess patient's willingness to quit ("Assess"), assist them with their quitting efforts ("Assist"), and arrange follow-up as needed ("Arrange") [20]. The unique contribution of this study is to systematically catalog features of EHRs that have been modified to enhance tobacco treatment support. Such an understanding of possible modifications can advance future innovations for tobacco treatment and control that make use of the EHR.

Methods

A literature review of published studies of EHRs for tobacco treatment support was conducted on February 9, 2015. Published studies represent instances of EHRs being intentionally modified for tobacco treatment purposes, and therefore, provide a window into EHRs that have been enhanced for tobacco treatment. Published studies of EHRs were chosen as the unit of analysis rather than existing EHR vendor product offerings for tobacco treatment support because EHRs supplied by EHR vendors are very basic and contain few tobacco-related features. Therefore, published studies of EHRs that have been intentionally modified by health systems and are likely to have more tobacco-related features were chosen as the unit of analysis.

Search terms for "electronic health record" or "EHR" or "medical records" or "medical record systems, computerized" or "electronic health" and "smoking cessation" or "tobacco use cessation" were run in Scopus and Medline in the English-language literature. The results of the search were cross-listed against the most recent Cochrane review on the "Use of electronic health records to support smoking cessation" [13] in the event that some studies were missed. All studies identified in

Table 1 | Overview of trial characteristics

	All trials ($N = 14$)
Clinic type	
Outpatient clinic	11 (78.6 %)
Primary care	9 (81.8 %)
Primary and specialty	2 (18.2 %)
Dental office	1 (6.7 %)
Hospital	1 (6.7 %)
Multiple settings (inpatient and outpatient)	1 (6.7 %)
Clinic location	
Urban	11 (78.6 %)
Rural	0 (0 %)
Unspecified	3 (21.4 %)
Insurance type for patients[a]	
Private insurance	3 (21.4 %)
Public insurance[b]	4 (28.6 %)
Uninsured	3 (21.4 %)
Unknown	10 (71.4 %)
Types of clinicians accessing EHR for tobacco support[a]	
Medical doctor	10 (71.4 %)
Registered or licensed vocational nurse	4 (28.6 %)
Nurse practitioner/physician assistant	4 (28.6 %)
Medical assistant	7 (50.0 %)
Dentist	1 (7.1 %)
Trainee	1 (7.1 %)
Dental hygienist	1 (7.1 %)
Pharmacist	1 (7.1 %)
Unspecified	1 (7.1 %)
EHR platform	
Epic systems corporation	3 (21.4 %)
Logician	1 (7.1 %)
VistA	1 (7.1 %)
Practice partner	2 (14.3 %)
Brigham integrated computer system	1 (7.1 %)
Not specified	6 (42.9 %)
Type of outcome(s) measured[a]	
Documentation of smoking status	11 (78.6 %)
Use of EHR treatment features[c]	11 (78.6 %)
Abstinence/cessation	4 (28.6 %)

[a] not mutually exclusive, some studies fit into multiple categories

[b] Including Medicare, Medicaid, and VA insurance

[c] EHR treatment features defined as order set/referral

the literature review were included in the Cochrane review and one additional study was found and included. The final sample consisted of 18 studies, covering 14 distinct trials [15, 16, 21–36].

Based on the description present in each published paper, each trial was coded between February and June 2015 for a range of factors. The first set of factors coded for related to the general characteristics of the trial including the clinic setting, the patient population, and the EHR used (Table 1). Factors coded for were the clinic type, the clinic location (urban/rural), the insurance type used by patients, the types of clinicians that accessed the EHR for tobacco-related support, the EHR platform or vendor, and the types of outcomes measured by the trial.

Each trial was also coded for the EHR functionality related to smoking cessation (Table 2). Because no previous studies have been conducted to systematically identify a range of relevant categories of EHR functionality related to smoking cessation, the authors of this study used an iterative process to identify EHR functionality. First, a literature search was conducted to identify relevant general features of EHRs such as the presence of order sets and alerts [8, 37, 38]. Then, based on a preliminary coding system derived from the literature search, trials identified about EHRs for smoking cessation were coded in order to identify additional EHR categories of functionality.

In all, 21 distinct EHR features were identified which were grouped into the categories of the 5 A's framework (i.e., Ask, Advise, Assess, Assist, Arrange), based on a methodology from an earlier analysis of smartphone apps for smoking cessation [18, 19] (see Table 2). First for "Ask", EHRs were coded for the presence of

Table 2 | EHR functionality related to smoking cessation grouped by 5As

Ask	Documentation of tobacco use status	14 (100 %)
	Use of alert to prompt screening of smoking status	6 (42.9 %)
	Tobacco use characteristics and history[a]	
	Cigarettes smoked per day	4 (28.6 %)
	Tobacco type	5 (35.7 %)
	Previous quit attempts	3 (21.4 %)
	Unspecified	9 (64.3 %)
	Location of documentation[a]	
	Vitals	6 (42.9 %)
	Problem list	5 (35.7 %)
	Progress note	4 (28.6 %)
	Unspecified	3 (21.4 %)
	Automated addition of smoking to Problem List	2 (14.3 %)
Advise	Provision of advice to quit language and/or documentation of advice to quit	5 (35.7 %)
Assess	Ask about willingness to quit	8 (57.1 %)
Assist	Provision of counseling language or documentation of counseling	5 (35.7 %)
	Referral to tobacco treatment specialist	6 (42.9 %)
	Referral to quitline	7 (50.0 %)
	Medication prescribing	11 (78.6 %)
	Medication dosage decision support	1 (7.1 %)
	Provision of patient education materials	8 (57.1 %)
	Presence of tobacco treatment order set	7 (50.0 %)
	Use of alert to prompt treatment	7 (50.0 %)
Arrange	Arrange for patient follow-up	5 (35.7 %)
	Specialist "pass back" to provider	4 (28.6 %)

[a] Not mutually exclusive

functionality related to the documentation of a patient's smoking status and applicable smoking-related characteristics. This coding included documentation of a patient's tobacco use status and documentation location (i.e., in Vitals, Progress Note or Problem List), documentation of a patient's smoking characteristics and history (amount smoked, type of tobacco, previous quit attempts), and the addition of smoking to a patient's problem list automatically within the EHR. Additionally, the presence of EHR alerts was recorded. EHR alerts are typically in the form of a pop-up box and aim to prompt and remind the provider to screen and document smoking status. Second, EHRs were coded for whether they helped the provider "Advise" the user to quit, which was coded only if there was specific provision of language advising quit and/or documentation of advice to quit. Third, EHRs were coded for whether they would "Assess" willingness to quit, specifically, whether the EHR helped the provider ask and subsequently document whether the patient is willing and/or ready to quit.

Fourth, for "Assist," the provision of brief counseling was coded as present if there was EHR functionality related to the documentation that counseling was given (for any amount of time) or language in the EHR on providing counseling. Also for "Assist", assistance was coded if the EHR supported assistance by referral to a tobacco treatment specialist or counselor (in-person, not via phone), referral to a quitline, medication prescribing (and if decision support was available to assist with prescribing the appropriate dosage), and/or provision of printed patient education materials. Additionally, EHRs were coded under "Assist" for the presence of an order set for cessation treatment. An order set is typically a form in the EHR that has a list of treatment options related to a common condition. The provider can select from the list to order one or more procedures or treatments for a patient. In the case of smoking, a tobacco treatment order set may include assistance in ordering smoking cessation medications, referral to a quitline, referral to a tobacco treatment specialist, assistance by providing patient education materials, as well as other features. Finally, for "Assist", the presence of alerts related to cessation was coded if they included a proactive prompt such as a pop-up box that recommended tobacco treatment. "Arrange," was coded as present if the EHR had functionality to support a patient follow-up related to tobacco treatment, and/or for the tobacco treatment specialist to electronically "pass back" the patient notes to the primary care provider.

Using the coding scheme covering 21 features, trials were coded by two independent coders and a kappa calculated. Coders reviewed the introduction, methods, and results sections, as well as tables and figures in the published papers in order to make a determination about whether a feature was present. In the event that the paper was unclear about the presence of features, the feature was coded as "unspecified." The two coders reached a moderate level of concordance in rating the 14 trials, with 81 % agreement (kappa = 0.58) for all 21 features. All discrepancies were discussed between the two coders to determine final agreement, and a third independent coder reconciled any remaining discrepancies.

The total number and mean number of features present were calculated both across and within trials.

The total across trials was calculated by summing whether a given EHR feature was present. The total number of features present within a trial was calculated by summing the list of EHR features present within a specific trial. In calculating the within trial total, instances where features were coded as "unspecified," were not counted as part of the total.

Results

Table 1 provides an overview of study characteristics. Of the 14 trials, 11 (78.6 %) took place in an outpatient clinic and within those, the majority in a primary care clinic (81.8 %). The remainder of the studies took place in a dental office, hospital, or in multiple settings (inpatient and outpatient facilities). Most trials occurred in clinics in urban areas (78.6 %), and none were reported in rural areas. The clinicians who used the EHR-based cessation tools also varied by trial, and included a physician (71.4 %), a medical assistant (50 %), and/or a nurse, nurse practitioner and/or a physician assistant (57.2 %). These categories were not mutually exclusive; in several trials, multiple providers accessed the EHR for smoking-related information (e.g., a medical assistant would screen for smoking status and a physician would then advise on quitting and available treatments). Not all studies included information about the types of insurance coverage accepted by their practice or clinic, but those that did typically represented a range of public, private, and uninsured patients. While Epic was found to be the most used EHR (21.4 %), there was a range of EHR platforms used in the studies, and several studies did not specify the EHR platform used (42.9 %). Finally, the outcomes measured in the studies assessed the documentation of smoking status (78.6 %), the use of EHR treatment features related to smoking (78.6 %), and to a lesser extent cessation (28.6 %).

Table 2 provides an overview of features in the EHR related to smoking cessation and grouped according to the 5 A's, and Appendix Table 3 provides details for each trial included in the analysis. Across trials, for functionality related to "Ask," 100 % of EHRs provided functionality for the documentation of smoking status, in some cases, prompted by an alert (42.9 %). In addition to tobacco use status, documentation of smoking characteristics within the EHR included the number of cigarettes smoked per day (28.6 %), the type of tobacco smoked (35.7 %), and the number of previous quit attempts (21.4 %). The documentation of tobacco status occurred in various parts of the EHR. Smoking status was most often documented in the Vitals section of the chart (42.9 %), but was also noted in the Problem List (35.7 %) or Progress Note (28.6 %). In two trials (14.3 %), once documented in the Vitals, smoking was automatically added to the patient's Problem List.

For "Advise," 35.7 % of EHRs provided functionality helping a clinician provide advice to quit. In these cases, the EHR either provided specific language that the provider could use to advise the patient to quit (i.e., "It's great that you are thinking about quitting smoking because it would have a huge impact on your oral health… " [21]) or had a place in the EHR to document that advice was provided. For "Assess," more than half of EHRs included a feature to document a patient's willingness to quit (57.1 %). This generally consisted of a field to indicate the patient's willingness to try quitting. For example, in one trial, the medical assistant would ask the patient, "Are you willing to talk to your provider about quitting within the next 30 days?" [27].

For "Assist," EHRs provided several features for supporting a clinician in assisting a patient in their quit attempt. In half of the trials, an alert was present to prompt the clinician to consider tobacco treatment after a tobacco-using patient's smoking status was entered into the EHR (i.e., by asking clinicians if they would like to see the tobacco treatment order set). In a distinct group of trials (50 %), the assist features were grouped together in a tobacco treatment order set which offered multiple treatment functions (e.g., prescribing, referral to quitline) in a check-list format from which the provider could select. The most common treatment feature in the EHR for assisting was a tool for medication prescribing, which was present in 78.6 % of trials. In one of these trials, medication prescribing was supplemented with a dosage decision support tool [25]. In addition, half of all trials included a feature in the EHR to electronically refer a patient to the quitline (50.0 %) or a tobacco treatment specialist (42.9 %), or to provide the patient with cessation-related educational materials (57.1 %) that were often printed as part of the discharge paperwork. The least common "Assist" feature in the EHR was related to the provision of a brief counseling session (35.7 %). In these cases, the EHR generally contained a checkbox to document that a brief counseling session was offered to the patient.

Finally, for "Arrange", EHRs helped by arranging for follow-up visits or phone appointments (35.7 %). These follow-ups were generally made by a tobacco treatment specialist (e.g., [34]) or by a care coordinator (e.g., [32]) who followed up with patients at pre-specified intervals. EHRs also facilitated arranging for follow-up by providing functionality for the tobacco treatment specialists to "pass back" the patient and relevant notes to the primary care provider with a report on their progress quitting smoking (28.6 %).

Within a trial, the number of EHR features present for tobacco treatment purposes ranged from 2 [16] to 14 [26, 27] features, with a mean of 8.8 features present (SD = 3.4). Further, all of the trials included at least one EHR feature that addressed functionality related to both "Ask" and "Assist" and three trials provided at least one EHR feature in all of the categories of the 5 A's model [15, 21, 26, 31, 34] (see Appendix Table 3).

Discussion

This study consisted of a content analysis of published studies of EHRs that were intentionally modified to support tobacco treatment in clinical settings. Across trials, 21 distinct EHR features for tobacco treatment were identified. Features corresponded to each step in the 5 A's model, with features most frequently present to support

documenting smoking status ("Ask") and assisting with medication prescribing ("Assist") and least frequently present to support providing advice to quit ("Advise"), providing smoking cessation counseling ("Assist"), and the follow-up of patients ("Arrange"). Within trials, the mean number of EHR features present for tobacco treatment was 8.8 and ranged from 2 to 14 features.

Given the record-keeping purpose of an EHR, it is not surprising that all EHRs reviewed provided some functionality for documenting smoking status ("Ask"). Nonetheless, it was impressive to find that several EHRs included functionality to support *all* of the 5 A's. As strong evidence exists outside of the EHR context for clinician adherence to the 5 A's [20], especially for "Ask", "Advise," and "Assist" [20, 39, 40], it would be expected that greater EHR adherence to the 5 A's would be associated with increased tobacco treatment support and better cessation outcomes. However, it is possible that provider burden and other EHR-specific factors (e.g., navigation, click counts) may undermine this relationship. Future studies are needed that examine 5 A's adherence in EHRs and tobacco treatment outcomes. Such research can inform future provisions in Meaningful Use regulations and other reforms such as by specifying what would be recommended for providing a "cessation counseling intervention" in the context of the EHR.

Also noteworthy, is the variability observed in the execution of EHR features within steps of the 5 A's. For example, there was substantial variability observed in the execution of the "Assist" features, which included in some cases documenting brief counseling, providing referral to a tobacco treatment specialist, referral to a quitline, medication prescribing assistance, medication dosing decision support, and/or the provision of patient education materials. There was also significant variability around the "Ask" features. While some of the variability in documenting smoking status will be removed with new Meaningful Use regulations standards [11, 12], variability in documenting other aspects of tobacco use may remain. Our study found that EHRs vary in whether they collect information on cigarettes smoked per day, type of tobacco used, and number of previous quit attempts.

Also of interest was the presence of technical features that are specific to the EHR context. For example, the ability to automatically add smoking to the problem list, once recorded in the Vitals, was present in two trials [28, 33]. Additionally, alerts were present in almost half of trials to prompt clinicians to follow-through with activities related to "Ask" and "Assist." Also present in half of the trials was the use of an order set, which co-located a variety of behavioral and pharmacologic treatment options into one location. The effects of these on effective tobacco treatment are unclear.

Unexpectedly, some EHR features which may be important were absent, such as the documentation of secondhand smoke exposure, as recommended by the American Academy of Family Physicians [41]. Additionally, despite Community Preventive Services guidelines promoting the use of mobile-phone based smoking cessation programs [42], no EHRs analyzed referred patients to mobile-phone based programs.

The strength of the present study is that it represents the first known attempt to examine systematically the content of EHR features that have been incorporated to promote tobacco treatment. It documents how the 5 A's framework may be operationalized in the context of EHR modifications to promote tobacco dependence treatment. As health systems move towards using EHRs as a tool for providing evidence-based treatments for tobacco cessation [10], an in-depth understanding of how EHRs can be used to support smoking cessation is paramount. Our analysis offers a step towards this understanding by creating a systematic inventory of EHR features that have been used in published studies for tobacco treatment.

The analysis has several limitations. First, based on the characteristics of our sample, the results may be more generalizable to health systems in urban areas and in the context of outpatient, primary care clinics. Second, our inferences are limited to cases where EHRs have been intentionally modified to promote cessation and have been published in the peer-reviewed literature. As EHRs exist behind health system firewalls, we have no information about how representative the aforementioned modifications are of EHRs in use outside of a research context. Third, features identified should not be seen as a comprehensive list of what is possible in the EHR context for supporting tobacco treatment, and indeed, it is hoped that this research will spur the development of new features. Fourth, the analysis conducted was based on descriptions in the published literature, and the authors did not have direct access to the EHRs themselves. Thus, in some cases EHR features may have been present, but omitted in the published description and therefore and not included in the results. Finally, while inter-rater reliability was moderate, there were challenges with coding some features from their descriptions in the literature.

In an era where the use of EHRs for tobacco treatment has been incentivized by health care reform, there are new opportunities for health systems to implement changes for reducing tobacco use. This study found that even in the context of EHRs intentionally modified to promote tobacco treatment, there is significant variability in the presence of EHR features across trials. To optimize EHRs for tobacco treatment, future studies need to examine not only whether EHR modifications generally speaking are related to tobacco treatment outcomes, but also to compare the relative effect of specific EHR modifications–specific features and specific steps in the 5 A's model–on tobacco treatment outcomes. As EHR design has become the focus of national policy initiatives, understanding the prevalence and implications of such modifications can help guide future policies.

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Compliance with ethical standards This research was conducted in concordance with Helsinki standards. This analysis did not involve human subjects as it is a secondary analysis of previously published papers. The authors therefore did not seek IRB approval and the research did not require informed consent. There were no human rights issues to resolve.

Conflict of interest: The authors have no relevant conflicts of interest to disclose.

Appendix

Table 3 | 5As by trial

			Adsit [22]	Bentz [23, 24]	Frank [16]	Koplan [25]	Linder [15, 26]	Lindholm [27]	Mathias [28]
Ask	Documentation of tobacco use status		X	X	X	X	X	X	X
	Location of documentation	Vitals		X				X	X
		Problem List					X		X
		Progress Note	X						
		Unspecified			X	X			
	Alert for status		X	X	X		X	X	X
	Tobacco use characteristics and history	Cigarettes smoked per day	X					X	
		Tobacco type	X					X	
		Previous quit attempts				X			
		Unspecified		X	X		X		X
	Auto-population of smoking in problem list								X
Advise	Provision of advice to quit language and/or documentation of advice to quit			X			X	X	
Assess	Ask about willingness to quit		X	X			X	X	
Assist	Presence of tobacco treatment order set		X			X	X	X	X
	Provision of counseling language or documentation of counseling			X			X	X	
	Referral to tobacco treatment specialist					X	X		X
	Referral to quitline		X	X			X	X	
	Medication Prescribing		X	X		X	X	X	X
	Medication dosage decision support					X			
	Provision of tobacco treatment education materials			X		X	X		X
	Use of alert to prompt treatment		X	X			X	X	X
Arrange	Schedule follow-up						X		
	Specialist pass back to provider						X		
Total[1]			10	(47.6 %)	10	(47.6 %)	2 (9.5 %)	7 (33.3 %)	14 (66.7 %)
4	(19.0 %)								

McCullough [29]	Ragucci [30]	Rindal [31] Rush [21]	Sherman [32]	Spencer [33]	Szpunar [34]	Vidrine [35, 36]	Total (%)

Ask	X	X	X	X	X	X	X	14 (100 %)
	X					X	X	6 (42.9 %)
	X		X		X			5 (35.7 %)
	X	X			X			4 (28.6 %)
				X				3 (21.4)
								6 (42.9 %)
		X	X					4 (28.6 %)
		X	X			X		5 (35.7 %)
		X	X					3 (21.4 %)
	X			X	X	X	X	9 (64.3 %)
					X			2 (14.3 %)
Advise			X			X		5 (35.7 %)
Assess	X	X	X			X		8 (57.1 %)
Assist						X	X	7 (50.0 %)
			X			X		5 (35.7 %)
	X			X		X		6 (42.9 %)
			X	X			X	7 (50.0 %)
	X	X	X	X		X		11 (78.6 %)
								1 (7.1 %)
	X		X		X	X		8 (57.1 %)
				X	X			7 (50.0 %)
Arrange	X	X		X		X		5 35.7 %)
			X		X	X		4 (28.6 %)
Total[1]	9 (42.9 %)	8 (38.1 %)	12 (57.1 %)	6 (28.6 %)	7 (33.3 %)	12 (57.1 %)	4 (19.0 %)	

The total is a sum of EHR features present within a trial. Instances where a feature was coded as "unspecified" is not counted in the total

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