Review Article

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TANAFFOS

Key Data Elements and Clinical Applications of Electronic Health Records for Smoking Cessation: A Systematic Review

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Background: Healthcare systems increasingly adopt Electronic Health Records (EHRs) to support tobacco cessation and improve outcomes. Yet no integrated EHR system exists for this purpose in developing countries such as Iran. Identifying core data elements for documenting and delivering cessation care is therefore essential. Therefore, this study aimed to identify and extract key smoking cessation–related data elements to design EHR systems for smoking cessation clinics.

Materials and Methods: This systematic review was conducted in 2025 across multiple electronic databases, including PubMed, Scopus, and Web of Science. We also searched IEEE Xplore for technical and engineering perspectives on EHR design. Keywords combined smoking cessation and electronic health record with relevant synonyms. A total of 2,608 articles were retrieved. After the first phase of screening, 143 articles remained, followed by 25 articles in the second phase. Ultimately, 8 articles met the inclusion criteria.

Results: The extracted data elements were classified into clinical and demographic variables. Clinical variables such as smoking status, number of cigarettes smoked per day, smoking history and demographic information like age, education, annual household income and other variables. Finally, these elements were presented based on the 5A model components to better classify the smoking cessation process (Ask, Advise, Assess, Assist, and Arrange).

Conclusion: This review highlights the integration of smoking cessation data elements into EHRs as a key strategy to improve care quality, quit rates, and evidence-based intervention delivery. Employing the 5A framework within EHRs ensures systematic documentation of tobacco use, readiness assessment, interventions, and follow-up.

Keywords: Smoking cessation; Electronic health record; Datasets as topic; Clinical decision support systems; Smoking; Personal health records

INTRODUCTION

Globally, the consumption of tobacco products is a major contributor to illness and mortality. It is a primary risk factor for a range of chronic diseases, including cancer, cardiovascular disorders, and respiratory ailments (1). Smoking places a tremendous burden not only on global health but also on the world economy. The United States alone lost a staggering $864.5 billion in 2020 due to this issue (2,3). Also, in other countries like China, the prevalence of smoking remains a significant public health concern (4). In Iran, cigarette smoking prevalence declined

from 14.65% in 2005 to 10.63% in 2016 (5), while households averaged 85.25 cigarettes and $2.64 in monthly expenditures (6).

Tobacco use causes approximately 7 million deaths annually, with nearly half of its users ultimately dying from tobacco-related causes. If current trends remain unaddressed, annual tobacco-related deaths are projected to increase to 8.3 million by 2030. Notably, middle-income countries bear the brunt of this crisis, hosting 80% of the global smoking population of 1.1 billion (2).

Smoking cessation is essential for reducing mortality and enhancing overall quality of life. (4). It significantly lowers the risk of death and reduces the chances of developing smoking-related illnesses like cancer and lung disease over time (7). The National Commission on Prevention Priorities has designated tobacco use screening and cessation interventions as the highest-priority clinical preventive service for the general adult population in the United States (3). Consequently, identifying and implementing successful smoking cessation methods is an ongoing public health priority (8).

While counseling patients about cessation is a proven and effective approach, many healthcare providers do not offer it as often as they could. This is often due to challenges like limited time during appointments, lack of training, or doubts about how helpful cessation methods really are (9). A key barrier to effective smoking cessation counseling is that many physicians have never been trained in these approaches, resulting in significant gaps in their knowledge and clinical practice (10). Many physicians did not follow smoking cessation guidelines due to a lack of training and time constraints, despite being aware of the services available for smoking cessation (11). By providing healthcare professionals with better training and resources, we could bridge this gap and help more people cease smoking definitively (12). So, smoking cessation seems to require a structured process.

Studies have shown that the 5A method, popularized in "Treating Tobacco Use and Dependence," which was first published in 2000, is effective in various settings, including primary care and specialized clinics. For example, it has been proven to be associated with increased smoking cessation rates when combined with follow-up interventions or self-help materials (13, 14).

Healthcare systems are increasingly leveraging Electronic Health Records (EHRs) to facilitate the identification and management of tobacco dependence. Beyond merely capturing a patient's smoking status, modern EHRs can provide a suite of tools designed to assist clinicians in effectively treating smokers (15). EHRs can be configured to automate reminders for healthcare staff to perform key cessation support actions, including documenting tobacco use, providing brief advice, prescribing medications, and referring patients to counseling (16). EHR data can be leveraged to monitor the implementation and effectiveness of cessation interventions, enabling healthcare systems to adapt strategies for better outcomes (17) through documentation of smoking status and facilitate referrals to cessation counseling (18). The capabilities of EHRs could increase adherence to clinical guidelines for smoking cessation (1, 19). On the other hand, EHRs can facilitate patient engagement through automated screening tools and referral systems, which have been shown to improve treatment engagement rates among smokers (20). EHR data can be used to identify gaps in care and improve the delivery of smoking cessation interventions, ultimately leading to better patient outcomes (2, 21).

In many countries, EHRs were not implemented or had some interoperability issues (22, 23). Thus, there is a need to implement standalone systems specifically designed to support smoking cessation. Despite these benefits, challenges such as inadequate documentation and patient-level barriers persist (18, 24). Dedicated smoking cessation clinics exist in many countries, offering behavioral counseling, pharmacotherapy, and follow-up care, and their integration into health systems has been emphasized by the WHO (25-28). The development of such systems

requires consensus on essential data elements; however, standardized smoking cessation data elements have not yet been universally established (29).

Currently, there is no integrated EHR system specifically designed to support tobacco cessation in developing countries like Iran. To develop such systems, it is essential to identify the core data elements needed to document and deliver cessation care. This study aimed to identify and extract key smoking cessation–related data elements to design EHR systems for smoking cessation clinics.

MATERIALS AND METHODS

This systematic review was conducted in accordance with the PRISMA 2021 statement (30).

The study was approved by the Executive Board of the Medical Ethics Committee of Isfahan University of Medical Sciences, with the ethical approval number IR.MUI.NUREMA.REC.1403.023.

Search Strategy

A systematic search was conducted in multiple electronic databases, including PubMed, Scopus, IEEE Xplore (for technical/engineering perspectives on EHR design and capture technical implementation studies), and Web of Science, encompassing all records until August 2025. The search strategy is detailed in Appendix 1 and includes keywords such as "smoking cessation" AND "electronic health record", along with their relevant synonyms. The strategy was reviewed and refined by a medical informatics specialist to enhance accuracy and completeness. In addition to the primary database search, supplementary efforts were made to identify grey literature and perform cross-reference checks. Grey literature was identified through searches in Google, Google Scholar, institutional repositories, conference proceedings, and relevant organizational websites. All searches were limited to publications available in English.

Inclusion and Exclusion Criteria

The inclusion criteria comprised original research studies that implemented smoking cessation interventions through EHRs or their related platforms. Studies were excluded if they met any of the following conditions: 1) publication types such as review articles, letters to the editor, conference proceedings, or other non-research formats; 2) absence of EHR-based smoking cessation components; 3) insufficient methodological or intervention details; or 4) lack of relevant data necessary for electronic systems.

Study Selection

All identified studies were imported into EndNote to facilitate duplicate removal. The screening process was done in two phases: in the first phase, titles and abstracts were independently reviewed by three authors (NN, MJ, and SD). In the second phase, the full texts of potentially eligible studies were retrieved and assessed by the same authors independently to determine final inclusion. Discrepancies in study selection were resolved through discussion until consensus was reached, with a third researcher (HSH) consulted when necessary. Studies that did not meet the predefined inclusion criteria at the full-text stage were excluded, and the reasons for exclusion were documented. Data elements relevant to electronic health records for the smoking cessation process were extracted and organized in Excel. The extracted information included both bibliographic details and study-specific data pertinent to the identified elements.

Data synthesis

The data elements extracted from the included articles were first recorded in an Excel spreadsheet. During the synthesis stage, data elements reported across different studies were reviewed, compared, and grouped into broader conceptual categories. This process allowed us to organize the extracted information into meaningful groups such as clinical and demographic variables.

After the initial categorization, a deductive content analysis was conducted using the 5A smoking cessation model (Ask, Advise, Assess, Assist, and Arrange) as an analytical framework. The identified data elements were then mapped to the relevant components of the 5A model to better structure the smoking cessation process within the

context of electronic health records. This framework helped organize the data elements according to the stages of clinical smoking cessation interventions. The description of the data synthesis and analysis process has been clarified in the results.

RESULTS

A total of 2,608 articles were retrieved. After the first phase of screening, 143 articles remained, followed by 25 articles in the second phase. Studies lacking required EHR data were excluded. Ultimately, 8 articles met the inclusion criteria (Figure 1).

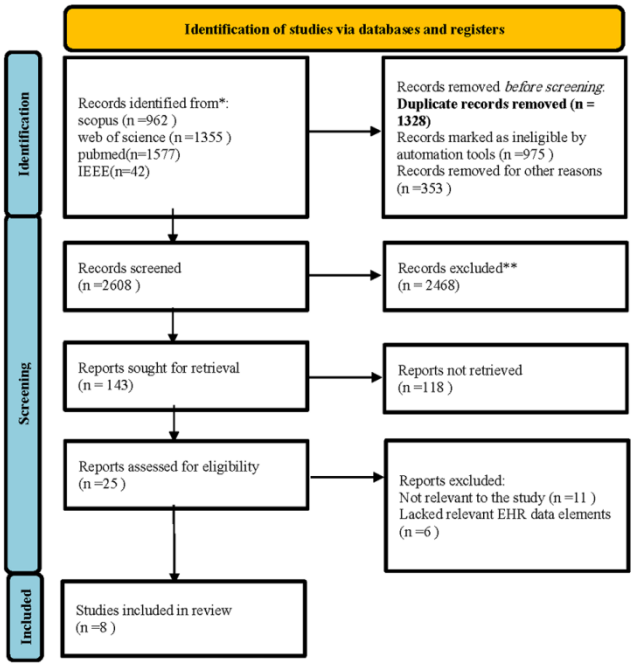


Figure 1. PRISMA Flowchart of systematic reviews

Characteristics of the Included Studies

The main characteristics of the 8 included studies, along with the bibliographic information such as author(s), study objectives, country of the study, study design, setting, participants, intervention duration, and results, are presented in Table 1.

The majority of the included studies were predominantly conducted in the United States and published between 2007 and 2022. Most of the interventions (19, 24, 31-35) were implemented in primary care settings, often integrated into electronic health records to support routine visits and facilitate smoking cessation treatment. Only one study (36) was conducted in a hospital inpatient environment, specifically in a vascular surgery unit, highlighting a distinct context compared to the predominantly outpatient primary care focus.

The studies varied widely in sample size, ranging from small cohorts of fewer than 100 participants (31, 36) to very large populations exceeding 100,000 patients (19, 34). Most other studies reported intermediate sample sizes between 500 and 6,000 smokers (24, 32, 33, 35). Intervention durations also differed, with short-term follow-ups of 3–6 months (31, 35, 36) medium-term interventions of 9–12 months (19, 24, 34) and longer evaluations extending to 18 months (33) or 3 years (32).

The objectives of the included studies were broadly aligned in seeking to improve the identification, documentation, and treatment of tobacco users through technology-enhanced interventions. Several studies emphasized EHR-based modifications to improve clinician practices, including facilitating screening, counseling, documentation, and treatment (19, 33, 34). Others focused on decision support tools or alerts aimed at increasing the provision of actionable information or pharmacotherapy for smoking cessation (24, 32). Tailored interventions to improve physician counseling practices were also examined (35), while Dahne et al. (31) tested the feasibility of a proactive e-visit model to expand access to cessation treatment. A distinct focus was observed in Smith et al. (36), which targeted hospitalized patients by enhancing cessation resources in vascular surgery inpatient settings. Overall, the studies collectively sought to leverage electronic systems and clinical decision support to enhance the delivery of evidence-based smoking cessation care.

In alignment with the study objectives, the relevant data elements were extracted and organized into two main categories: demographic and clinical information. Across the included studies, electronic smoking-cessation records were primarily designed to capture current smoking status and clinically relevant characteristics such as cigarettes per day and previous quit attempts (19, 24, 31-36).

Table 1. Characteristics of the included studies on technology-based smoking cessation interventions

Study /Year	Objective	Country	Study Design	Setting	Participants	Intervention Duration	Results
Dahne et al. 2021 (31)	The article evaluates a proactive smoking cessation electronic visit (e-visit) designed to enhance the delivery of evidence-based cessation treatment in primary care.	United States	Randomized controlled trial (RCT)	Primary care practices	51 adult smokers	3 Months	The study found that the e-visit was feasible, acceptable, and showed preliminary efficacy in improving smoking cessation outcomes compared to treatment as usual, indicating its potential for broader implementation in healthcare settings
Drake et al. 2022 (32)	The article investigates the effectiveness of a clinical decision support (CDS) tool aimed at increasing tobacco cessation rates among users by providing actionable information to clinicians.	United States	Retrospective analysis	Primary care practices	5,644 current tobacco users	3 Years	The study found that the CDS intervention significantly improved the likelihood of tobacco cessation compared to standard care, indicating its potential for enhancing clinical practices in tobacco control
Kruse, et al. 2012 (33)	The article discusses the implementation of an electronic health record (EHR)-based care management system designed to enhance tobacco treatment in primary care settings.	United States	Comparative Study	Primary care clinics	2,894 smokers	18 Months	The study found that this system successfully connected one-third of referred smokers to treatment, indicating its potential to improve the delivery and outcomes of evidence-based tobacco cessation interventions
Linder et al. 2009 (34)	The article evaluates an electronic health record (EHR)-based intervention aimed at improving tobacco treatment documentation and counseling in primary care.	United States	Cluster-randomized controlled trial	Primary care practices	132,630 patients	9 Months	The study found that the intervention significantly increased the documentation of smoking status and the number of smokers who contacted cessation counselors, although it did not affect the prescription rates of cessation medication
Lindholm et al. 2010 (19)	aimed to enhance the identification and treatment of tobacco users in primary care settings by modifying an electronic health record (EHR) system.	United States	Project demonstrated	Primary care clinics	Pre-intervention: 255,138 patient visits; Post-intervention: 247,221 patient visits	12-Months	The outcome showed a significant increase in the identification of smokers and the delivery of tobacco cessation interventions, indicating that EHR modifications can effectively improve clinical workflows and support tobacco dependence treatment in primary care
Mathias et al. 2012 (24)	The article investigates the impact of an electronic alert and linked order set on the prescription of smoking cessation medications.	United States	Pre- and post-intervention cohort study	Primary care practice	Pre-intervention cohort (2008): 1,349 smokers; post-intervention cohort (2009): 1,346 smokers	12-Months	The outcome revealed that while the intervention did not significantly increase medication prescriptions, it did lead to higher counseling referrals and a slight increase in the quit rate among smokers
Smith et al. 2015 (36)	The article evaluates the use of an electronic health record (EHR) to enhance the provision of smoking cessation resources for vascular surgery inpatients.	United States	Cohort study	Hospital and Clinics	Pre-Intervention Cohort: 52 smokers; Post-Intervention Cohort: 42 smokers	6 Months	The outcome indicated that while the prescription of nicotine replacement therapy at discharge did not significantly change, referrals for outpatient smoking cessation counseling increased following the intervention
Unrod et al. 2007 (35)	The article evaluates a computer-based, tailored intervention aimed at increasing smoking cessation counseling by primary care physicians.	United States	Randomized controlled trial	Primary care physicians' offices	518 patients	6 Months	The outcome showed that the intervention significantly improved physicians' adherence to the Smoking Cessation Clinical Guideline (5As) and had a modest positive effect on patients' smoking behaviors, although the increase in abstinence rates did not reach statistical significance

In addition, several studies incorporated patient-centered readiness and planning variables into the electronic documentation most notably motivation/ readiness to quit, and in some cases intention to quit or a chosen quit date within the next two weeks (19, 31, 32, 35).

A substantial portion of the interventions also emphasized the treatment component of the cessation record, including documentation of actions taken, provision and uptake of cessation medications (e.g., NRT, bupropion, varenicline), and patient education materials (19, 24, 31, 34).

Regarding linkage to cessation support, some studies embedded mechanisms to support follow-up and referral, such as referral to counselling services and the use of reminders and patient contact attempts, with outcomes tracked through the record system (24, 33, 34, 36).

Finally, demographic variables were included in multiple studies to contextualize implementation and outcomes, including age, gender, race/ethnicity, primary language, education, income (e.g., via ZIP code), and insurance status when available (19, 24, 31, 34, 36).

Overall, these findings indicate that electronic cessation records were constructed not only to standardize documentation of tobacco use, but also to operationalize evidence-based cessation workflows through medication, referral, education, and data-quality safeguards (19, 33, 34). A summary of these categorized findings is presented in Table 2.

Table 2. Demographic and clinical data elements for developing an electronic smoking cessation record

Article author	Clinical data required to prepare an electronic smoking cessation record	Demographic data required to prepare an electronic smoking cessation record
Dahne et al.(31)	Current smoking status/Baseline cigarettes per day/Quitting attempts in the past year/Motivation to quit in the next month/Confidence to quit in the next month/ Smoking history/ Quit duration/ Medication recommendation and uptake/ Treatment preference	Gender/ Race: White, Black, Other/ Education: Less than high school diploma, more than high school diploma/ Annual household income: <$50K, >$50K/ Health insurance status: Medicaid, Medicare, Employer-provided, Other
Drake et al. (32)	Current tobacco use status /number of cigarettes smoked per day / Type of tobacco used/ previous or current advice on quitting smoking/ Readiness to quit/ Tobacco assessment and plan	-
Kruse et al. (33)	Smoking status/ Progress notes/ lab results/ medication lists/electronic prescribing / Patient contact attempts/ Monthly performance reports/ Counseling/Referral outcome/ clinical reminders, including reminders to record smoking status. (A page to record smoking status in an encrypted field accessible to all staff)	-
Linder et al. (34)	Smoking status: Never smoker, former smoker, current smoker/Ordering of cessation medications: nicotine, bupropion hydrochloride, varenicline/ Documentation of actions/ Reminders/ Printing of educational materials to the patient/ Assessment of readiness to quit/ Referral of patients to the tobacco treatment counselor was via email or fax/ problems (blood pressure - lipids - diabetes - heart disease - lung disease (smoking related / non-smoking related) - cancer (smoking related / non-smoking related)	Age/gender/ income based on zip code/ ethnicity/ primary language /contact number
Lindholm et al.(19)	Smoking status/ Intention to quit (tobacco and medication dependence counseling): Number of cigarettes smoked per day, Past cessation medications used, Quit date chosen within next 2 weeks/ Patient education sheet: About smoking cessation, smoking cessation line referral information, and smoking cessation history review/ Order FDA-approved medications for cessation/ Billing documentation for counseling/ Percentage of patients whose smoking status was recorded	-
Unrod et al. (35)	Initial Patient Assessment: Contemplation Ladder, Fagerstrom Test for Nicotine Dependence, Pros and Cons Scale, Self-Efficacy Scale/ Smoking status, smoking quantity and duration, past quit attempt duration, and existing medical conditions exacerbated by smoking, Longest quit period, Number of 24-hour quit attempts, Main temptation to smoke, Readiness to quit smoking, Pros and cons of smoking/ Follow-up outcomes/ stage-of-change progression: precontemplation, contemplation, preparation, action	-
Smith et al. (36)	Tobacco use status/ Included were rates of prescription for nicotine replacement therapy (NRT) at discharge and referral to the Wisconsin Quitline for smoking cessation counseling	Age/ gender/ race
Mathias et al. (24)	Smoking status/ Prescription of tobacco cessation medications (nicotine replacement therapy, bupropion, varenicline)/ Patient education materials /Problem list update/Referral to smoking cessation counseling services	Age/ gender/race/ any existing health conditions

The reviewed studies were categorized according to the demographic data elements extracted from each source. Classification of the reviewed studies based on extracted demographic variables showed that gender was the most frequently reported characteristic, included in four studies (24, 31, 34, 36). Race was reported in three studies (24, 31, 36) while education, annual household income, and health insurance status were exclusively reported in Dahne et al. (31), with income also examined in Linder et al. (34) through ZIP code–based estimates. Age was documented in three studies (24, 34, 36). Additionally, ethnicity and primary language were uniquely reported in Linder et al. (34).

Finally, existing health conditions as a demographic/ clinical background variable were explicitly included only in Mathias et al. (24). Overall, demographic reporting varied considerably across studies, with gender and age being the most consistently captured variables, whereas socioeconomic and clinical background characteristics were less uniformly documented. Table 3 provides a detailed summary of this classification.

Given that one of the frameworks of smoking cessation was the 5A model, the extracted data elements were categorized according to this framework. The classification of these elements across the 5A components is presented in Table 4. The 5A framework, including questioning, advising, evaluating, assisting, and arranging, is explained below with reference to selected studies.

Ask

Across the reviewed interventions, consistent strategies were employed to ensure systematic identification of tobacco consumers. Lindholm et al. (19) integrated smoking status into the vital signs section of the EHR, requiring medical assistants to ask every patient about tobacco use. Similarly, Mathias et al. (24) designated smoking status for systematic documentation. Drake et al. (32) also relied on medical assistants, who recorded both smoking status and readiness to quit at each visit. In the study by Kruse et al. (33) EHR prompts ensured that physicians coded smoking status for all patients, improving baseline documentation rates. Linder et al. (34) employed visual icons that substantially increased the capture of smoking status. Smith et al. (36) reported that nurses documented tobacco use directly into the EHR during inpatient encounters. Likewise, Unrod et al. (35) used a computerized system to assess and record patients' tobacco status. Finally, Dahne et al. (31) identified current smokers through EHR data, inviting only active users to participate in the e-visit intervention.

Table 3. Classification of reviewed studies based on extracted demographic data elements

	Dahne et al.(31)	Drake et al.(32)	Kruse et al. (33)	Linder et al. (34)	Lindholm et al. (19)	Unrod et al. (35)	Smith et al. (36)	Mathias et al. (24)
Gender	*			*			*	*
Race	*						*	*
Education	*							
Annual household income	*			*				
Health insurance status	*							
Age				*			*	*
Ethnicity and primary language				*				
Any existing health conditions								*

Table 4. Clinical data required to prepare an electronic smoking cessation record based on the 5A model

	Dahne et al. (31)	Drake et al. (32)	Kruse et al. (33)	Linder et al. (34)	Lindholm et al. (19)	Unrod et al. (35)	Smith et al. (36)	Mathias et al. (24)
Ask	*	*	*	*	*	*	*	*
Advise	*	*		*	*	*	*	*
Assess	*	*	*	*	*	*		
Assist	*	*	*	*	*	*	*	*
Arrange	*		*	*		*	*	

Advise

Various approaches were implemented to deliver evidence-based cessation advice, ranging from automated prompts to structured discharge instructions. In Lindholm et al. (19), clinicians offered clear advice to smokers interested in cessation, while those less motivated received a brief message and the state Quit Line number in their visit summary. Mathias et al. (24) employed automated alerts with the message "Consider smoking cessation assistance" to prompt providers. Drake et al. (32) did not measure direct counseling but highlighted that reminder notes within the clinical workflow increased opportunities for brief advice. Reminder systems in Linder et al. (34) guided physicians to congratulate recent quitters and encourage current smokers to consider cessation. Smith et al. (36) embedded evidence-based discharge instructions with personalized cessation advice for inpatients. Physicians in the Unrod et al. (35) trial received tailored reports, which enhanced the specificity of their counseling. Dahne et al. (31) incorporated persuasive, evidence-based messages into the e-visit platform, ensuring that patients received structured advice to stop smoking.

Assess

Assessment practices varied across interventions. Lindholm et al. (19) explicitly asked smokers about their intent to discuss cessation within 30 days and their readiness to set a quit date within two weeks. Drake et al. (32) documented readiness during every patient encounter through medical assistants. In the study of Kruse et al. (33), tobacco treatment coordinators screened patients for contraindications to medications and gauged their motivation to quit. Linder et al.(34) integrated readiness questions into both Tobacco Smart Forms and counselor-led telephone assessments. Unrod et al. (35) demonstrated significant improvements in the frequency of readiness assessments following implementation of their tailored intervention. Dahne et al. (31) embedded a structured questionnaire within the e-visit to evaluate motivation, confidence in quitting, and smoking history.

Assist

The provision of assistance was a core feature of most interventions. Lindholm et al. (19) advised clinicians to prescribe FDA-approved cessation medications and provide information about the Quit Line. Mathias et al. (24) enabled streamlined ordering of Nicotine Replacement Therapy (NRT), bupropion, or varenicline through a linked order set, coupled with auto-generated patient education. Linder et al. (34) offered a Smart Form that supported medication prescribing, educational printouts, and rapid referral to counselors or the Quitline. Although Drake et al. (32) did not measure assistance directly, physicians were able to refer patients or prescribe medications based on the EHR reminders. Kruse et al. (33) emphasized the role of treatment coordinators, who delivered brief counseling, arranged pharmacotherapy, and connected patients to state quit line resources. Smith et al. (36) embedded cessation medications and referrals into discharge instructions for vascular surgery inpatients. Unrod et al. (35) described assistance activities that included setting quit goals, providing educational materials, and discussing pharmacotherapy. Dahne et al. (31) extended assistance through algorithm-driven recommendations for medications, electronic prescribing, and structured follow-up on adherence and side effects.

Arrange

Follow-up support was implemented unevenly across the studies. Kruse et al. (33) built a more robust system, with treatment coordinators making up to three phone calls to each referred patient and feeding outcomes back into the EHR for physicians. Similarly, Linder et al. (34) employed counselors who attempted multiple calls and documented results that were shared with providers. Smith et al. (36) used post-discharge referrals to the Quit Line as their mechanism for continuity of care. Unrod et al. (35) incorporated scheduled follow-up visits to review cessation progress and reinforce support. Dahne et al. (31) added a structured one-month e-visit follow-up to monitor quit status, medication use, and ongoing needs.

The degree of implementation of each of the 5A components varied among the eight studies included, with Ask and Assist most consistently addressed, while Arrange showed the lowest level of integration (Figure 2).

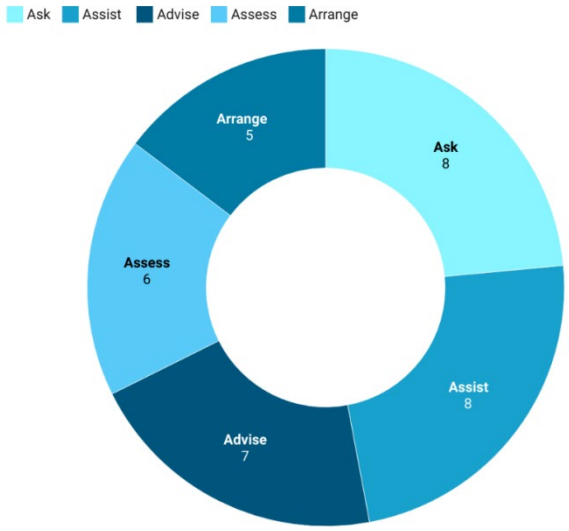


Figure 2. Extent of 5A Strategy Adoption (Ask, Advise, Assess, Assist, Arrange) in Eight Clinical Studies

DISCUSSION

This systematic review aimed to identify and synthesize the key data elements related to smoking cessation that have been integrated into EHR systems. Our analysis indicated that these elements generally fall into two primary categories: clinical and demographic. Both of these categories are essential in supporting cessation workflows. In line with previous reviews of EHR-based interventions, our results highlight that systematically capturing these data can increase the rates of pharmacotherapy, improve the provision of evidence-based treatments, and facilitate patient follow-up (37, 38).

The analysis showed that the majority of the included studies were conducted in the United States, a country widely acknowledged as a leader in the development and implementation of electronic health record (EHR) systems (1, 19, 31-36). Similar to previous reviews on digital health tools, this focus highlights the advanced infrastructure for health information technology and the strong emphasis on integrating evidence-based guidelines into everyday care (39-41).

EHR systems play a critical role in enhancing the accuracy of smoking status documentation, which is fundamental for identifying patients in need of cessation support. For instance, an EHR-based initiative in New York City demonstrated a notable improvement, with documentation of smoking status increasing from 24% to 27% and the delivery of cessation interventions rising from 23% to 54% (42). Similarly, hospital-based programs have highlighted the value of EHR prompts in guiding clinicians toward evidence-based treatment. In one such intervention, prescriptions for NRT increased dramatically from 29.9% to 78.1%, accompanied by a 5% improvement in quit rates (1). Evidence from oncology care settings further emphasizes the impact of this issue. An EHR-enabled program in cancer centers resulted in counseling referrals rising from 0.72% to 1.91% and the use of cessation medications increasing from 3% to 17% (37). Beyond specialty care, modifications to EHR systems have consistently been shown to strengthen systematic screening for tobacco use during routine medical visits. Indeed, studies have reported that such modifications significantly increase the proportion of patients assessed for tobacco use, as well as the rates of referrals for both counseling and pharmacotherapy (18, 37). Our synthesis supports these findings, indicating that incorporating structured reminders, templates, and order sets into the clinical workflow is consistently linked to increased delivery of counseling, referrals, and pharmacotherapy.

Demographic characteristics commonly assessed in public health and sociological research include a variety of variables. These typically include gender (31, 34), racial and ethnic background (e.g., White, Black, and other racial/ethnic groups) (43, 44), educational level (often operationalized as less than high school, high school diploma, or some college and above) (45, 46), and annual income (frequently dichotomized at a threshold such as $50,000) (45, 46).

Furthermore, health insurance status is a critical factor that is typically categorized into modalities such as Medicaid, Medicare, employer-sponsored insurance, and other forms of coverage (24, 31). Some systems also integrated additional socioeconomic indicators such as ZIP code–based income estimates and primary language (34). Our review found that these data elements, which provide more detailed demographic information, not only help describe the patient profile but also allow for a more in-depth exploration of the social determinants that influence tobacco use behaviors and treatment engagement. The emphasis on social determinants is becoming increasingly important in public health research.

With respect to clinical data elements, variables such as cigarettes per day, quit history, readiness to quit, self-efficacy, and type of tobacco product were the most frequently documented items. These data not only facilitate personalized treatment planning but also support evaluation of adherence to the 5A model (31, 34, 35). Our findings align with prior evidence that structured EHR systems improve performance on the 5A framework by standardizing documentation of counseling, medication orders, educational materials, and follow-up scheduling (37, 47, 48). Furthermore, studies that have integrated automated order sets have shown that treatment prescriptions can be generated in under one minute. This reduces clinician burden while supporting adherence to evidence-based care (24).

Accurate and structured documentation of tobacco use within EHR systems represents a critical foundation for cessation interventions. Information related to the type of tobacco product used, daily consumption, current or former smoker status, and whether the patient has previously received cessation counseling. These structured fields are frequently integrated with broader EHR functionalities, including clinical notes, current medication lists, electronic prescribing, and automated reminders that prompt follow-up on smoking status (34). Recent research further emphasizes the importance of expanding these documentation practices. For example, Banerjee et al. (1) showed that embedding mandatory "hard-stop" functions in the EHR significantly increased the prescription of cessation therapies during hospitalization. Similarly, Chen et al. (17) demonstrated that EHR activity data can effectively monitor clinical decision support tools for tobacco cessation, revealing gaps in documentation and referral practices, and emphasizing that accurate and consistent recording of smoking status is essential for maximizing the impact of such interventions. More recently, Kearney et al. (49) demonstrated that collecting smoking history directly from patients via online portals yields more complete and reliable data compared to SMS-based surveys. Together, these findings suggest that structured EHR fields, when combined with decision support mechanisms and patient-reported data, can substantially strengthen the integration of evidence-based tobacco cessation into routine care.

Studies show that integrating smoking cessation workflows into Electronic Health Records (EHRs) enhances care quality, follow-up, and intervention delivery (21). Structured documentation of smoking history, relapse patterns, and treatments supports personalized decision-making (50, 51), while EHR-based systems improve quit rates through real-time data access and continuous monitoring (52). EHRs also facilitate recording of cessation interventions, including prescriptions for FDA-approved medications like NRT, bupropion, and varenicline (26, 35). Additional features include educational material printing, referrals to counselors, and tracking of goals and follow-ups (24). Although early fax-based referrals modestly improved treatment uptake (53), newer EHR-enabled eReferral systems significantly boost referral completion and continuity of care (54).

In addition to data capture, EHRs are increasingly being used to evaluate clinician performance in providing evidence-based cessation care. For example, patient-completed assessment tools have been applied to evaluate adherence to the 5A model (Ask, Advise, Assess, Assist, Arrange), focusing on whether counseling, referrals, medication recommendations, educational materials, and

follow-up appointments were provided (35). Similar approaches in care settings have demonstrated that structured performance feedback improves provider adherence to guidelines and strengthens the continuity of support (55-57).

Finally, outcome-oriented data elements have been increasingly incorporated into EHR-based systems. These elements include the rates of NRT prescriptions at discharge, referrals to national quit lines like the Wisconsin Tobacco Quit Line, and patient engagement with follow-up care. Importantly, highly structured systems have demonstrated operational efficiencies, such as rapid medication ordering, automatic inclusion of cessation service contact details, and instantaneous prescription generation in less than one minute through electronic medical record platforms (19). Research corroborates these findings, demonstrating that EHR-based interventions consistently enhance medication-related outcomes, facilitate patient referrals, and improve treatment adherence. This evidence affirms the general efficacy of outcome-oriented strategies in digital health implementations (58, 59).

Limitations

While the findings provide useful insights, several limitations should be considered. First, most of the included studies originated from countries with highly developed EHR infrastructures, particularly the United States, which may limit the generalizability of findings to healthcare systems with less mature digital infrastructures. Second, considerable heterogeneity was observed across studies in terms of template designs, variable definitions, and methods of documenting interventions, which complicated cross-study comparisons and constrained the ability to establish standardized data elements. Third, because of restricted access to operational clinical systems, the analysis relied exclusively on published articles and secondary reports, without the opportunity to directly observe implementation in real-world practice. Future research should emphasize the design and implementation of smoking cessation EHR modules to validate data elements and evaluate clinical outcomes. Exploring clinician and patient experiences can support system optimization, while cross-country comparisons may uncover contextual challenges. Incorporating psychological and behavioral variables alongside clinical data could improve personalization, and standardized data elements will require coordinated efforts among public health, informatics, and policy stakeholders.

CONCLUSION

This review highlights the integration of smoking cessation data elements into EHRs as a key strategy to improve care quality, quit rates, and evidence-based intervention delivery. Employing the 5A framework within EHRs ensures systematic documentation of tobacco use, readiness assessment, interventions, and follow-up. Policymakers and digital health developers are advised to prioritize dedicated EHR modules for cessation, enabling personalized care, consistent practice, and improved population health outcomes through reduced tobacco-related disease.

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REFERENCES

1. Banerjee S, Alabaster A, Adams AS, Fogelberg R, Patel N, Young-Wolff K. Clinical impacts of an integrated electronic health record-based smoking cessation intervention during hospitalisation. ***BMJ Open*** 2023;13(12):e068629.

2. Sutha DW, Nudji B, Faida EW, Christine C. Electronic Medical Record and Smoking Cessation Activities: Literature Review. ***IJHIS***. 2024;1(3):95-105.
3. Bailey SR, Heintzman JD, Marino M, Jacob RL, Puro JE, DeVoe JE, et al. Smoking-Cessation Assistance: Before and After Stage 1 Meaningful Use Implementation. ***Am J Prev Med*** 2017;53(2):192-200.
4. Zhang X, Huang D, Zhao J, Wu J. Hypertension and burden of myocardial infarction in China: risk factors, gender differences and temporal trends from a National Chronic Disease Surveillance study (2021-2023). ***Blood Press*** 2025;34(1):2487584.
5. Shahmohamadi E, Yousefi M, Mohammadi E, Ghanbari A, Shaker E, Azadnajafabad S, et al. National and Provincial Prevalence of Cigarette Smoking in Iran; A Systematic Analysis of 12 Years of STEPS Experience. ***Arch Iran Med*** 2023;26(9):472-80.
6. Homaie Rad E, Hajizadeh M, Rezaei S, Reihanian A. Cigarette Smoking and Its Financial Burden among Iranian Households: Evidence from Household Income and Expenditures Survey. ***J Res Health Sci*** 2020;20(4):e00494.
7. Najdi J, Hawa ME, El-Achkar A, Naji N, Telvizian T, Romani M, et al. Smoking cessation counselling patterns in cancer patients - survey of Lebanese physicians. ***Ecancermedicalscience*** 2024;18:1699.
8. Fang YE, Zhang Z, Wang R, Yang B, Chen C, Nisa C, et al. Effectiveness of eHealth Smoking Cessation Interventions: Systematic Review and Meta-Analysis. ***J Med Internet Res*** 2023;25:e45111.
9. Raupach T, Merker J, Hasenfuss G, Andreas S, Pipe A. Knowledge gaps about smoking cessation in hospitalized patients and their doctors. ***Eur J Cardiovasc Prev Rehabil*** 2011;18(2):334-41.
10. Mostafa N, Momen M. Effect of physicians' smoking status on their knowledge, attitude, opinions and practices of smoking cessation in a University Hospital, in Egypt. ***J Egypt Public Health Assoc*** 2017;92(2):96-106.
11. Lina M, Mazza R, Borreani C, Brunelli C, Bianchi E, Munarini E, et al. Hospital doctors' smoking behavior and attitude towards smoking cessation interventions for patients: a survey in an Italian Comprehensive Cancer Centre. ***Tumori*** 2016;2016(3):244-51.
12. Meredith LS, Yano EM, Hickey SC, Sherman SE. Primary care provider attitudes are associated with smoking cessation counseling and referral. ***Med Care*** 2005;43(9):929-34.
13. Takahashi K, Saso H, Saka H, Saso H, Iwata M, Hashimoto I, et al. A pilot study on inducement of smoking cessation by a simple 5A (asking, advice, assess, assist, and arrange) approach at outpatient clinics. ***Asian Pac J Cancer Prev*** 2006;7(1):131-5.
14. Schauer GL, Wheaton AG, Malarcher AM, Croft JB. Health-care Provider Screening and Advice for Smoking Cessation Among Smokers With and Without COPD: 2009-2010 National Adult Tobacco Survey. ***Chest*** 2016;149(3):676-84.
15. Bernstein SL, Rosner J, DeWitt M, Tetrault J, Hsiao AL, Dziura J, et al. Design and implementation of decision support for tobacco dependence treatment in an inpatient electronic medical record: a randomized trial. ***Transl Behav Med*** 2017;7(2):185-95.
16. Boyle R, Solberg L, Fiore M. Use of electronic health records to support smoking cessation. ***Cochrane Database Syst Rev*** 2011;(12):CD008743.
17. Chen J, Cutrona SL, Dharod A, Bunch SC, Foley KL, Ostasiewski B, et al. Monitoring the Implementation of Tobacco Cessation Support Tools: Using Novel Electronic Health Record Activity Metrics. ***JMIR Med Inform*** 2023;11:e43097.
18. Boyle R, Solberg L, Fiore M. Use of electronic health records to support smoking cessation. ***Cochrane Database Syst Rev*** 2014;2014(12):CD008743.
19. Lindholm C, Adsit R, Bain P, Reber PM, Brein T, Redmond L, et al. A demonstration project for using the electronic health record to identify and treat tobacco users. ***WMJ*** 2010;109(6):335-40.
20. May JR, Klass E, Davis K, Pearman T, Rittmeyer S, Kircher S, et al. Leveraging Patient Reported Outcomes Measurement via the Electronic Health Record to Connect Patients with Cancer to Smoking Cessation Treatment. ***Int J Environ Res Public Health*** 2020;17(14):5034.
21. Silfen SL, Cha J, Wang JJ, Land TG, Shih SC. Patient Characteristics Associated With Smoking Cessation

Interventions and Quit Attempt Rates Across 10 Community Health Centers With Electronic Health Records. ***Am J Public Health*** 2015;105(10):2143-9.

22. Igwama GT, Olaboye JA, Maha CC, Ajegbile MD, Abdul S. Integrating electronic health records systems across borders: Technical challenges and policy solutions. ***International Medical Science Research Journal*** 2024;4(7):788-96.
23. Carlos Ferreira J, Elvas LB, Correia R, Mascarenhas M. Enhancing EHR Interoperability and Security through Distributed Ledger Technology: A Review. ***Healthcare (Basel)*** 2024;12(19):1967.
24. Mathias JS, Didwania AK, Baker DW. Impact of an electronic alert and order set on smoking cessation medication prescription. ***Nicotine Tob Res*** 2012;14(6):674-81.
25. England N. NHS Community Pharmacy Smoking Cessation Service 2023. Available from: https://www.england.nhs.uk/primary-care/pharmacy/pharmacy-services/nhs-community-pharmacy-smoking-cessation-service/.
26. Trust MUNF. Smoking Cessation Clinic 2023 [Available from: https://mft.nhs.uk/wythenshawe/services/smoking-cessation-clinic.
27. https://www.who.int/data/gho/data/indicators/indicator-details/GHO/gho-tobacco-offerhelp-smoking-cessation-support-is-available-in-health-clinics-or-other-primary-care-facilities.
28. Moltafet H, Arabi A. Exploring the Social Processes of Substance Abuse Relapse in Khuzestan Province, Iran. ***Journal of Social Continuity and Change (JSCC)*** 2024;3(1):131-56.
29. Shoenbill KA, Ostroff JS, Taylor KL, Jafarinia A, Minion M, Chichester LA, et al. Recommendations for Standardization of Tobacco Use Treatment Data. ***J Thorac Oncol*** 2026;21(2):258-66.
30. Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA Statement. ***Open Med*** 2009;3(3):e123-30.
31. Dahne J, Player M, Carpenter MJ, Ford DW, Diaz VA. Evaluation of a Proactive Smoking Cessation Electronic Visit to Extend the Reach of Evidence-Based Cessation Treatment via Primary Care. ***Telemed J E Health*** 2021;27(3):347-54.
32. Drake LA, Suresh K, Chrastil H, Lewis CL, Altman RL. Improving Tobacco Cessation Rates Using Inline Clinical Decision Support. ***Appl Clin Inform*** 2022;13(5):1116-22.
33. Kruse GR, Kelley JH, Linder JA, Park ER, Rigotti NA. Implementation of an electronic health record-based care management system to improve tobacco treatment. ***J Gen Intern Med*** 2012;27(12):1690-6.
34. Linder JA, Rigotti NA, Schneider LI, Kelley JH, Brawarsky P, Haas JS. 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.
35. Unrod M, Smith M, Spring B, DePue J, Redd W, Winkel G. Randomized controlled trial of a computer-based, tailored intervention to increase smoking cessation counseling by primary care physicians. ***J Gen Intern Med*** 2007 Ar;22(4):478-84.
36. Smith BK, Adsit RT, Jorenby DE, Matsumura JS, Fiore MC. Utilization of the Electronic Health Record to Improve Provision of Smoking Cessation Resources for Vascular Surgery Inpatients. ***Int J Cardiovasc Res*** 2015;4(5):10.4172/2324-8602.1000231.
37. Ramsey AT, Chiu A, Baker T, Smock N, Chen J, Lester T, et al. Care-paradigm shift promoting smoking cessation treatment among cancer center patients via a low-burden strategy, Electronic Health Record-Enabled Evidence-Based Smoking Cessation Treatment. ***Transl Behav Med*** 2020;10(6):1504-14.
38. McCarthy DE, Baker TB, Zehner ME, Adsit RT, Kim N, Zwaga D, et al. A comprehensive electronic health record-enabled smoking treatment program: Evaluating reach and effectiveness in primary care in a multiple baseline design. ***Prev Med*** 2022;165(Pt B):107101.
39. ONC A. 10-Year Vision to Achieve an Interoperable Health IT Infrastructure. Office of the National Coordinator for Health Information. 2014.
40. Bahadori S, Buckle P, Soukup Ascensao T, Ghafur S, Kierkegaard P. Evolving Digital Health Technologies: Aligning With and Enhancing the National Institute for Health and Care Excellence Evidence Standards Framework. ***JMIR Mhealth Uhealth*** 2025;13:e67435.

41. Sharma A, Harrington RA, McClellan MB, Turakhia MP, Eapen ZJ, Steinhubl S, et al. Using Digital Health Technology to Better Generate Evidence and Deliver Evidence-Based Care. ***J Am Coll Cardiol*** 2018;71(23):2680-90.
42. Silfen SL, Farley SM, Shih SC, Duquaine DC, Ricci JM, Kansagra SM, et al. Increases in smoking cessation interventions after a feedback and improvement initiative using electronic health records -- 19 community health centers, New York City, October 2010-March 2012. ***MMWR Morb Mortal Wkly Rep*** 2014;63(41):921-4.
43. Bhavsar NA, Gao A, Phelan M, Pagidipati NJ, Goldstein BA. Value of Neighborhood Socioeconomic Status in Predicting Risk of Outcomes in Studies That Use Electronic Health Record Data. ***JAMA Netw Open*** 2018;1(5):e182716.
44. Rethy LB, McCabe ME, Kershaw KN, Ahmad FS, Lagu T, Pool LR, et al. Neighborhood Poverty and Incident Heart Failure: an Analysis of Electronic Health Records from 2005 to 2018. ***J Gen Intern Med*** 2021;36(12):3719-3727.
45. Chen M, Tan X, Padman R. Social determinants of health in electronic health records and their impact on analysis and risk prediction: A systematic review. ***J Am Med Inform Assoc*** 2020;27(11):1764-1773.
46. Paccoud I, Baumann M, Le Bihan E, Pétré B, Breinbauer M, Böhme P, et al. Socioeconomic and behavioural factors associated with access to and use of Personal Health Records. ***BMC Med Inform Decis Mak*** 2021;21(1):18.
47. Hazlehurst BL, Lawrence JM, Donahoo WT, Sherwood NE, Kurtz SE, Xu S, et al. Automating assessment of lifestyle counseling in electronic health records. ***Am J Prev Med*** 2014;46(5):457-64.
48. Owens A. Tobacco Screening among Adults in Primary Care: Evaluation of the use of the 5A's Framework for Treating Tobacco Dependence.
49. Kearney LE, Jansen E, Kathuria H, Steiling K, Jones KC, Walkey A, et al. Efficacy of Digital Outreach Strategies for Collecting Smoking Data: Pragmatic Randomized Trial. ***JMIR Form Res*** 2024;8:e50465.
50. Adeniyi AO, Arowoogun JO, Chidi R, Okolo CA, Babawarun O. The impact of electronic health records on patient care and outcomes: A comprehensive review. ***World Journal of Advanced Research and Reviews*** 2024;21(2):1446-55.
51. Ho LLK, Li WHC, Cheung AT, Xia W. Effectiveness of smoking cessation interventions for smokers with chronic diseases: A systematic review. ***J Adv Nurs*** 2021;77(8):3331-42.
52. Haas JS, Linder JA, Park ER, Gonzalez I, Rigotti NA, Klinger EV, et al. Proactive tobacco cessation outreach to smokers of low socioeconomic status: a randomized clinical trial. ***JAMA Intern Med*** 2015;175(2):218-26.
53. Cantrell J, Shelley D. Implementing a fax referral program for quitline smoking cessation services in urban health centers: a qualitative study. ***BMC Fam Pract*** 2009;10:81.
54. Zehner ME, Kirsch JA, Adsit RT, Gorrilla A, Hayden K, Skora A, et al. Electronic health record closed-loop referral ("eReferral") to a state tobacco quitline: a retrospective case study of primary care implementation challenges and adaptations. ***Implement Sci Commun*** 2022;3(1):107.
55. Gesme DH, Wiseman M. Performance appraisal: a tool for practice improvement. ***J Oncol Pract*** 2011;7(2):131-4.
56. Nabeel M, Prasad RM, Kemnic T, Wang L, Khan NNS. Structured, Timely, and Individualized Patient Feedback to Residents and its Effect on HCAHPS Scores. ***J Patient Exp*** 2022;9:23743735221112583.
57. Janssen A, Nazir M. Technology-Enabled Workplace Learning Through Rethinking Electronic Health Records to Support Performance Feedback: Protocol for a Mixed Methods Study. ***JMIR Res Protoc*** 2025;14:e66824.
58. Murthi S, Martini N, Falconer N, Scahill S. Evaluating EHR-Integrated Digital Technologies for Medication-Related Outcomes and Health Equity in Hospitalised Adults: A Scoping Review. ***J Med Syst*** 2024;48(1):79.
59. Gibson B, Kramer H, Weir C, Fiol G, Borbolla D, Schlechter CR, et al. Workflow analysis for design of an electronic health record-based tobacco cessation intervention in community health centers. ***JAMIA Open*** 2021;4(3):ooaa070.