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Long-Term Outcomes from Repeated Smoking Cessation Assistance in Routine Primary Care

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Abstract

Purpose: To test the association between repeated clinical smoking cessation support and long-term cessation.

Design: Longitudinal, observational cohort study using structured and free-text data from electronic health records.

Setting: Six diverse health systems in the United States.

Subjects: Patients aged ≥18 years who were smokers in 2007 and had ≥1 primary care visit in each of the following four years (N=33,691).

Measures: Primary exposure was a composite categorical variable (comprised of documentation of smoking cessation medication, counseling, or referral) classifying the proportions of visits for which patients received any cessation assistance (<25% (reference), 25–49%, 50–74%, ≥75% of visits). The dependent variable was long-term quit (LTQ) (yes/no), defined as no indication of being a current smoker for ≥365 days following a visit where non-smoker or former smoker was indicated.

Analysis: Mixed effects logistic regression analysis adjusted for age, sex, race, and comorbidities, with robust standard error estimation to account for within site correlation.

Results: Overall, 20% of the cohort achieved LTQ status. Patients with ≥75% of visits with any assistance had almost three times the odds of achieving LTQ status compared to those with <25%

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visits with assistance (OR=2.84; 95% CI:1.50, 5.37). Results were similar for specific assistance types.

Conclusions: These findings provide support for the importance of repeated assistance at primary care visits to increase long-term smoking cessation.

PURPOSE

Over the past 50 years, considerable progress has been made in reducing the prevalence of tobacco smoking among US adults from approximately 50% in the early 1960s to 15% in 2015.¹ Although this progress is encouraging, tobacco use remains the leading preventable cause of death in US adults, currently accounting for more than 400,000 deaths per year.²

The 2015 National Health Interview Survey reports that 68% of persons who currently smoke would like to quit and over 55% attempted to quit during the previous year.³ Healthcare providers often have multiple contacts with their patients each year; thus, primary care clinics are well positioned to identify patients who smoke and to assist with their smoking cessation efforts over time.⁴ The updated National Commission on Prevention Priorities continues to rank tobacco use screening and cessation assistance among the three highest-priority preventive services and one of the few that are cost-saving.⁵ The clinical practice guidelines for treating tobacco use and dependence in primary care settings include a brief intervention: the “5 As” (Ask, Advise, Assess, Assist, Arrange). Health care provider adherence to the first two is relatively high, but delivery of appropriate cessation services—assessment of readiness to quit, assistance in quitting, and arranging for follow-up—by healthcare providers remains low.^{6–13,14} One study using NHIS data 2000–2015 found that only 57.2% of smokers reported being advised to quit by a health professional;³ another using 2012–2013 US Medical Expenditures Panel Survey reported that less than half were advised to quit by their physician.¹¹

Advances have been made in the use of electronic health records (EHR) to increase receipt of smoking cessation services in primary care. For example, the Centers for Medicare & Medicaid Services EHR Incentive Programs¹⁵ include documentation of smoking status (“Ask”) and tobacco cessation intervention (“Assist”) as measures to demonstrate meaningful use of EHRs. Increased EHR documentation has made it possible to collect systematic, objective, longitudinal data to examine changes in receipt of the 5 A’s intervention and smoking cessation among primary care patients. In a prior study, we demonstrated the usefulness of EHRs for monitoring changes in tobacco use in patient populations in health care systems¹⁶; however, very few studies have used EHR data to examine the association between documented cessation services and quit rates among a population of primary care patients^{17,18}, and none have studied this relationship over time.

The current study is based on the transtheoretical model, which recognizes that responsiveness to behavior change interventions (readiness to change) may vary considerably from time to time, and that an individual’s readiness to change may be difficult for health care providers to predict.^{19,20} Therefore, offering the option of smoking cessation assistance at most or all outpatient visits will substantially improve the odds of reaching a patient at a time when their readiness to change is high. Based on this premise, it is

hypothesized that patients who receive repeated assistance over time to support their quit efforts will have higher odds of quitting smoking than those who are assisted less often. To test this hypothesis and to build on previous analyses^{16,21} by examining the association between the amount of smoking cessation services delivered over time and long-term tobacco cessation in six health care systems across the US. The primary objective was to assess the relationship between the repeated provision of smoking cessation assistance in primary care and long-term “quitting”. If repeated assistance efforts are associated with long-term cessation, this could encourage providers to persevere in continued assistance efforts, especially among patients who might have been resistant to change in the past.

METHODS

Design

This retrospective, observational cohort study used EHR data from six diverse health care systems: The VA Puget Sound Health Care System (VAPSHCS, VA), Kaiser Permanente Northwest (KPNW), Kaiser Permanente Hawaii (KPHI), Kaiser Permanente Georgia (KPGA), Baylor Health Care System (BHCS, Baylor), and OCHIN, Inc. Detailed descriptions of these organizations and the procedures used for assessing patient tobacco use have been published previously.^{16,22} See Table 1 for a brief description of each system.

These analyses were conducted using EHR data from primary care encounters—defined as outpatient (ambulatory) non-specialty office visits, primary in internal medicine, family practice, or pediatrics departments—during the 5 ½ year study period 1/1/2007—6/30/2012. Data used in this study did not include telephone encounters, specialty service visits, hospitalizations, emergency department or urgent care visits. Data were extracted using the comparative effectiveness research (CER) Hub common data model²³ and received extensive quality assurance reviews.²⁴ This data model is a web-based informatics platform that combines electronic clinical data from multiple health care organizations and provides standard representation of all transactional data in the EHR including vital signs, tobacco use status, medications ordered, procedures ordered or performed, diagnoses, progress notes, health maintenance care activities and written instructions for patients provided at the end of the visit.

The Institutional Review Board (IRB) at each of the participating organizations approved and monitored the use of all data and procedures for this study.

Patient Sample

The 2007 smoker cohort for this study included patients who were 18 years or older by January 1, 2007, identified as a current smoker in their medical record at any primary care visit during 2007, and subsequently seen in primary care at one of the included health care systems at least once in each of years 2008–2011.

Measures

Coding and validation of the automated 5A's.—Table 2 shows how smoking cessation services were defined for this study. Each primary care visit was coded for

documentation of smoking cessation services using the MediClass software application configured to identify the 5A's in encounter records. MediClass (Medical Classifier) applies rules to clinical concepts identified in both the free-text and coded data of encounter records,²⁵ providing automated classification of EHR records. We have previously shown that when configured with rules defining the 5A's of smoking cessation, MediClass identifies smoking cessation services on an equivalent level to human chart abstraction.^{24,26} For this study, we first refined the automated 5A's classifier using a Development dataset and then validated the classifier using a second Validation dataset. Each dataset comprised samples of primary care data records of known smokers (n=200), formatted in accord with the CER Hub common data model, obtained from each of the 6 participating health systems (total n=1200 for each dataset). Each site's records in the Development and Validation datasets were manually coded for the 5A's by a trained chart reviewer from the respective site. Classifier development processes are described in detail elsewhere.²³ Briefly, this is an iterative process conducted centrally (at the CER Hub central site) that makes changes to the classifier to minimize discordance between manual and automated coding of the Development dataset. After many iterations of refinement to the classifier, most discordance is eliminated and a final evaluation of performance was made using the Validation dataset. Because virtually every record in the Validation dataset included an "Ask" about smoking and virtually no records entailed "Arrange" for cessation follow-up, we restricted the evaluation to the remaining cessation services (Advise, Assess, and the three types of Assist). For each of these services, the mean sensitivity and specificity across the 6 samples was computed and the following obtained. Advise: Sensitivity=0.80, Specificity=0.72; Assess: Sensitivity=0.82, Specificity=0.83; Assist_Counseling: Sensitivity=0.89, Specificity=0.73; Assist_Referral: Sensitivity=0.93, Specificity=0.83; Assist_Medication: Sensitivity=0.96, Specificity=0.79. In general, we saw a trend for higher sensitivity (compared to specificity) due to services identified by the classifier that were missed or deemed not to count by the chart reviewer. In particular, the outlier low values of specificity seen above for Advise (0.72) and for Assist_Counseling (0.73) were due to data from two different sites that included a preponderance of cigar and smokeless tobacco advice and counseling assistance, which had not been included in the chart review protocol and thus not included by the chart reviewer. We subsequently decided that the classifier had coded these correctly.

Finally, the validated classifier was distributed to participating study sites to process large volumes of study data, to code the 5A's in primary care encounter records. Coded records from each study site were then shared with the central CER Hub site for analysis as HIPAA-defined limited datasets. In the current study, the focus is on the 4th A, "assistance", as the primary exposure measure.

Smoking status.—Each patient's smoking status at each visit from 2007 to 6/30/2012 was determined by a combination of last known status plus any updates to entries in the vital signs or social history portion of their records, or one or more of the following ICD-9 codes indicated current smoking at a given primary care visit: 305.1; 649.01; 649.02; 649.03; 649.04; 989.84. As is common in clinical practice, EHRs often carry forward smoking status from previous visits to inform clinical staff of prior status, which can be reviewed or

modified as necessary; thus, a patient's smoking status was assumed to persist until data from a subsequent visit met the criteria for a different category.

Exposure measures.—Assistance component measures were defined by the existence of documentation for care that was provided or ordered for any of the three assistance components: counseling, medications or referrals (See Assistance “A” in Table 2). The primary exposure measure was a composite variable incorporating these three components and classifying the proportion of total primary care visits during which each patient received any smoking cessation assistance component (ANY). For analysis, we classified the data into four categories: assistance delivered in less than 25% of visits (this was considered the reference group), at least 25% of visits but less than 50%, at least 50% of visits but less than 75%, and at least 75% of visits. Each of the individual assist components were considered secondary exposure measures: counseling, medications, and referrals.

Primary outcome.—The primary outcome for this study was attainment of long-term quitter (LTQ) status (y/n). A patient was classified as a LTQ if there was an indication of quitting smoking (current smoker to former or non-smoker) and no subsequent indication in the EHR of smoking at any visit for at least 365 days. It should be noted that because this is based on EHR documentation, we do not have specific quit dates and smoking status is self-reported. It is possible that a person may have smoked in the interim between visits and it was not captured in the EHR.

Patient characteristics.—The following characteristics were extracted from discrete fields in the EHR: age at last visit during the study period, sex (male/female), race (white, black, other/unknown), and comorbidities. Comorbidity indicator (y/n) variables were defined based on EHR documentation (or lack thereof) of ICD-9 codes for a given condition. These included: cancer (140.*- 165.*, 170.*-176.*, 179.9, 180.*- 208.*, 209.0-209.3, 209.75, 338.3, 357.3, 511.81, 789.51, V58.42, and V71.1), cardiovascular disease (CVD) (410.*-413.*, V45.81, V45.09, V45.82, and 405.*), asthma (493.*), chronic obstructive pulmonary disease (COPD) (491.*-492.*, 493.22, and 496.*), diabetes (249.* and 250.*), hypertension (401.*- 404.*), and stroke (433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91 and 436).

Analyses

Among the cohort of smokers in 2007 who were seen annually in primary care during 2007–2011, frequencies and proportions of those who achieved LTQ status were calculated overall and by age, gender, race categories, and by presence of comorbidities. Bivariate associations of patient characteristics with LTQ status were tested using mixed effects logistic regression to compute odds ratios. In these models, clustering of patients within health systems was accounted for by specifying Eicker-Huber-White-robust estimation of standard errors.²⁷ Similar multivariable mixed effects logistic regression models were used to estimate odds ratios while controlling for potential confounders, which included age, gender, race, and presence of comorbidities described above.^{1,28–31} The multivariable models also adjusted for patients' propensity scores, defined as the conditional probability of receiving assistance given a patient's baseline characteristics. Propensity scores were computed for each patient

using mixed effects logistic regression to account for within-system correlation, by modeling the probability that a patient received assistance (y/n) given their baseline characteristics (demographic and comorbidity measures, as well as health care system site and health care utilization, measured as visit counts). This propensity score method is employed to reduce potential bias in observational studies where there may be large differences on observed covariates between groups (e.g., those who did and did not receive assistance).^{32,33} An alpha level of $p < .05$ was considered statistically significant. Analyses were carried out in Stata (StataCorp. 2017).

RESULTS

Patient characteristics and associations with LTQ.

Of the 368,287 patients who were current smokers in 2007, 33,691 were seen at least annually within their same health system in years 2008–2011. Compared with those without annual visits, those with annual visits were older (mean age of 56 (standard deviation (sd): 14) vs. 44 (sd: 15), less likely to be female (46% vs. 55%), more likely to be white (65% vs. 57% white), and slightly more likely to be African American (11% vs. 9%). As expected, those with annual visits had a higher mean number of visits between 1/1/2007–6/30/2012 compared with those without annual visits (25 (sd: 26) vs. 10 (sd: 11), respectively).

Among the study cohort (those with annual visits), patients were Asked about smoking at 79% of all visits, Advised to quit at 16% of all visits, and Assessed for readiness to quit at almost 17% of visits. Assistance varied by type of service provided. Counseling was documented at 24% of all visits, smoking cessation medications at almost a third of visits, and referrals at almost 17% of visits. Any type of assistance was documented at 44% of visits during the study period. For reference, the percentages of assistance were similar for all smokers identified in 2007 ($n=368,287$): Ask 82%; Advise: 13%; Assess: 15%; Counseling: 21%; Smoking Cessation Medication: 28%; Referral: 13%; Any Assistance: 39%.

In the subset of patients with annual visits, 20% achieved long-term quit status overall. Achievement of LTQ was not statistically different by sex or by indication of cancer, CVD, asthma, COPD, hypertension, or stroke (ranged from 17% to 24%, depending on condition). Statistically significant associations were observed for age and race categories ($p<.001$). The 35–64 age group was less likely to attain LTQ status compared with the 18–34 reference group, as were African Americans compared with patients who identified as white. See Table 3.

Number of visits with assistance and LTQ.

Of the 33,691 with annual visits during the study period, a total of 32,683 (97%) patients had complete data for inclusion in the logistic models. Sixty-one percent of these had received ANY smoking assistance in 75% or more of their visits, while 19% received ANY assistance in 50–74% of their visits, 12% in 25–49% of visits and 8% received ANY assistance in 24% or less of visits (Table 4). After adjusting for covariates, the odds of achieving LTQ status among patients in the high group (i.e., assistance in 75% of visits)

were almost three-fold higher compared to patients in the lowest (reference) group, which was statistically significant. Neither of the intermediate groups were significantly different from the reference group.

When assessed individually, the percentages of visits that included assistance varied by component type (Table 4). For example, almost 40% of patients had a referral at <25% of visits and only 19% had a referral at 75–100% of visits; conversely, 41% of patients had a smoking cessation medication ordered during 75% of their visits and 23% had mention at <25% of total visits. Patients with an indication of medication or counseling at 75% of visits had over three times higher odds of achieving LTQ status compared to those with indications at <25% of visits. Those with assistance at 50–74% had odds ratios over one but did not reach statistical significance. See Table 4.

DISCUSSION

This study used five years of EHR data from 6 healthcare institutions to examine the association of smoking cessation services provided during ambulatory visits on subsequent long-term quit rates among a diverse cohort of smokers. The results are noteworthy: the odds of achieving long-term smoking cessation increased almost three-fold among patients who had smoking cessation assistance provided during at least three quarters of office visits compared with patients who did not. Although strong evidence exists that smoking cessation assistance in primary care settings is associated with higher quit rates^{34–36}, this is the first study that confirms this finding using EHR data from a population of patients in diverse healthcare settings. This study provides support for the persistent provision of smoking cessation assistance at primary care visits, even if initially unsuccessful.

The percentage of visits during which each individual assistance component was provided varied by type of assistance. Overall, any assistance was provided during at least half of all visits, with referrals and counseling only provided at around 24% and 17%, respectively. Practitioners often cite competing demands during office visits as a barrier to provision of these services, such as chronic disease management or acute symptoms, which could result in assistance not being addressed at all visits.^{37,38} It is also possible that providers feel discouraged by the low success rates of long-term smoking cessation or feel that interventions are ineffective.^{39,40} However, providing tobacco cessation counseling annually over time is estimated to be one of the three most important and cost-effective preventive services that can be provided in medical practice.⁴¹ Our findings suggest that smoking cessation should be discussed repeatedly, at the majority of primary care visits, to promote behavior change and long-term smoking cessation.

A primary strength of this study is the use of 5 years of EHR data from a large cohort of smokers from diverse health care organizations that allowed us to look at repeated smoking cessation assistance across years and long-term smoking cessation. Such longitudinal data are often difficult to obtain in randomized clinical trials due to participant attrition for a host of reasons. Unlike many EHR-based studies, we were able to include information extracted from progress notes and other text fields, a methodologic feature that increases likelihood of complete capture of all documented assistance. For example, nicotine replacement therapy

might not be captured in easily extractable fields such as medication orders, as this medication is available over the counter. Brief counseling might not be captured in a discrete code because it might not be monetarily reimbursed. This study allowed for access to structured and text data in the EHR to ensure capture of all documented smoking cessation assistance. Another strength of this study is that it is not restricted to patients who volunteer to participate in a clinical trial, increasing the generalizability of our results.

As with most observational studies, there are limitations and causal relationships cannot be demonstrated with high confidence. Given that we focused on long-term quits, we needed to have patient data on an annual basis; thus, our analyses have been restricted to those with at least one annual primary care visit in the same care organization in each year of the study. This cohort differed from those patients who receive less frequent primary care (e.g., patients included in the cohort were more often older, male, white); however, broad demographic groups were well-represented. In addition, these results apply to the large proportion of adult patients who do visit a clinician each year, although not necessarily within the same care system.³⁵ It is possible that patients identified as long-term quitters had periods of smoking between assessment points. Finally, there was variation in smoking status and smoking cessation rates between the various health organizations, as well as variation in the number of visits and time between visits for each patient, which could have impacted the completeness and quality of data. The differences in rates of smoking could be attributable to the patient-mix of the different health organizations. For example, one organization sees primarily socioeconomically disadvantaged and uninsured patients, which have significantly higher rates of smoking than patients in health organizations such as Kaiser. Differences in smoking status and cessation rates could also be due to differences in work flows for assessing and documenting smoking status in the EHR.

With recent policy changes, such as mandated smoking cessation assistance under the Affordable Care Act, and Meaningful Use of EHR, we speculate that documentation of smoking status and cessation assistance have increased in the years subsequent to this study. Future studies are warranted to determine if these policies have impacted repeated cessation assistance and long-term quit rates and thus should be continued.

Conclusions:

Our EHR-based study among diverse health care organizations provides further evidence that repeated provision of smoking cessation assistance over time is much more effective in increasing smoking cessation rates among primary care patients than is the one-time support on which much of the literature is based.

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SO WHAT? Implications for Health Promotion Practitioners and Researchers

What is already known on this topic?

Smoking cessation assistance during primary care visits can increase smoking cessation rates among patients; however, most studies have relied on patient-based surveys that are subject to recall bias and lack data on repeated assistance over time, or data from randomized clinical trials which often do not include long-term quit rates.

What does this article add?

This study demonstrates the feasibility of using comprehensive (including use of natural language processing) EHR data documenting primary care encounters to examine the association between repeated provision of cessation services and quit rates among a population of primary care patients over a period of 5 years. Overall, 20% of the cohort achieved at least 365 days of smoking cessation. This study found that, among patients seen in primary care at least once a year, those with >75% of visits with any assistance had almost three times the odds of achieving LTQ status compared to those with <25% visits with assistance (OR=2.84; 95% CI:1.50, 5.37).

What are the implications for health promotion practice or research?

These findings suggest that, in order to increase the odds of long-term quit rates among primary care patients, smoking cessation assistance should be provided at the majority of patient visits. Further, the 20% long-term quit rate over the course of four years provides evidence of the cumulative benefit of providing cessation services, even if the annual success rates are relatively low.

Table 1.

Description of the six participating health systems.

Site	Health System Type	EHR System	Location	Number of Patients Served Annually in Study Period	Smokers in Study [*] Period [*]	Race/Ethnicity
Baylor Health Care System	Nonprofit, integrated non-health maintenance organization	GE Centricity (Outpatient record only)	Texas	450,000	65,157	71% Caucasian 17% African-American 6% other race 6% unknown 15% Hispanic
OCHIN, Inc.	Non-profit network of public and private Federally Qualified Health Centers and other community health centers	EpicCare (Outpatient records only)	Oregon	335,000	99,105	74% Caucasian 4% African-American, 4% Asian/Pacific Islander 1% Alaska Native/ Native American 17% other race 35% Hispanic
VA Puget Sound Health Care System	Nonprofit, integrated health care system	VISTA	Washington	70,000	23,155	80% Caucasian 7% African-American 3% other race 10% unknown race
Kaiser Permanente Hawaii	Non-profit, group-model integrated health care system	HealthConnect (EpicCare)	Hawaii	223,000	41,231	28% Caucasian 40% Asian 30% Native Hawaiian/ Pacific Islander 2% other race
Kaiser Permanente Northwest	Non-profit, group-model integrated health care system	HealthConnect (EpicCare)	Oregon, Washington	460,000	106,122	87% Caucasian 3% African-American, 1% Native American 5% Asian American, 4% other race 6% Hispanic
Kaiser Permanente Georgia	Non-profit, group-model integrated health care system	HealthConnect (EpicCare)	Georgia	260,000	33,517	40% Caucasian 40% African American 5% other race

^{*} Distinct patients, aged 18 years and older on 1/1/2007, who had a diagnosis or social history update at a primary care visit indicating current smoker at any point during the 1/1/2007–6/30/2012 time period.

Table 2.**5As Coding Definitions**

The "A"	Definition	EHR Data Elements searched	Examples
Ask	Includes any aspect of the encounter which addresses smoking. This includes diagnosis codes applied to the visit, smoking status update to the patient's social history, or mentions of tobacco use or prevention in the text progress notes.	Visit Diagnosis, Problem List, Social History, Orders, HM Alerts, Progress Notes, Patient Instructions	"305.1ZC (TOBACCO USE)", "she smokes", "smokes 1.0 packs per day; over 25.0 years", "current smoker"
Advise	Includes generic statements advising the patient to quit. This is typically indicated by imperative, directive statements by clinician.	Problem List, Social History, Orders, HM Alerts, Progress Notes, Patient Instructions	"Continue tob cessation efforts", "stop using tobacco", "I strongly encourage you to stop smoking", "enc him to quit smoking", "advised to quit"
Assess	Includes statements reflecting a patient's readiness to quit, usually indicated by phrases that invoke the patient's current intent, motivation, or effort at quitting.	Problem List, Social History, Progress Notes	"I suggested smoking cessation and she is not so interested in that", "TOBACCO USE Note: not yet ready to quit, although is starting to plan this",
Assist	Includes statements addressing methods to achieve quitting with reference to ordering, planning, or provision of information broken out into three components as follows: Counseling: Counseling to quit smoking including in-office discussion of barriers, triggers, strategies, goals, plans etc., related to quitting Medication: Smoking cessation medications or nicotine replacement therapies discussed or ordered; Referral: Ordering, planning, or provision of information related to outside smoking cessation help including formal referral; Any Assistance: Composite of Counseling, Medication and Referral Assists.	Social History, Progress Notes, Patient Instructions, Orders, Dispenses	"At your visit today, your physician ordered medication to help you quit using tobacco", "enroll in a tobacco cessation program through Health Education Services", "(med order) BUPROPION HCL SR TAB 150MG", "REFERRAL TOBACCO ADVICE, INFORMATION PACKET ONLY", "TOBACCO USE: needs to quit, discussed plan", "counseled on stopping smoking", "Be prepared for the smoking urge to continue for a time. This is a lot to deal with, but keep at it. You will feel better", "Set a quit date and stick to it. Pick your date carefully so that it is not right in the middle of a big deadline or stressful time", "rx for chantix is avail"
Arrange	Includes statements documenting specific plans for follow-up with a patient's effort to quit.	Progress Notes, Patient Instructions	"REFERRAL TOBACCO ADVICE, HEALTH COACH CALLBACK"

Table 3.

Total number of patients identified as smokers in 2007 who had 1 visit in each of the four subsequent years (n=33,691) and proportion of those who achieved long-term quit status during the study period (n=6812; 20%), by patient characteristics.

	Total N	Achieved Long-Term Quit		P-value
Patient Characteristic		N	%	
Sex				0.65
Female	15519	3220	21%	
Male	18172	3593	20%	
Age at last visit during study period				<.001 *
18–34	2423	614	25%	ref
35–64	21940	4052	18%	<.001
65+	9328	2147	23%	0.34
Race				<.001 *
White	21714	4468	21%	ref
African American	3771	491	13%	<.001
Other/unknown	8206	1854	23%	0.33
Comorbidities				
Cancer	2760	628	23%	0.08
Cardiovascular disease	1857	440	24%	0.98
Asthma	4896	1065	22%	0.31
COPD	10211	2049	20%	0.89
Diabetes	7848	1742	22%	<.001
Hypertension	17999	3524	20%	0.10
Stroke	1024	178	17%	0.16

* Overall test for significance.

Note. Long-term quit status defined as an indication of quitting smoking (current smoker to former or non-smoker) and no subsequent indication in the EHR of smoking at any visit for 365 days; COPD: chronic obstructive pulmonary disease

Table 4.

Adjusted odds ratios for achieving long-term quit status by proportion of total number of visits for which assistance was provided, by any assistance and assistance category.

Proportion of visits assistance provided	Any Assistance				
	N	%	aOR*	95% CI	p-value
0–24%	2,703	8.27	ref (1.00)		
25–49%	3,933	12.03	0.69	(0.37, 1.26)	0.223
50–74%	6,052	18.52	0.93	(0.49, 1.78)	0.832
75–100%	19,995	61.18	2.84	(1.50, 5.37)	0.001
Proportion of visits assistance provided	Counseling				
	N	%	aOR	95% CI	p-value
0–24%	9,056	27.71	ref (1.00)		
25–49%	7,053	21.58	0.86	(0.64, 1.16)	0.333
50–74%	6,362	19.47	1.46	(0.99, 2.16)	0.059
75–100%	10,212	31.25	3.40	(1.94, 5.96)	<.0001
Proportion of visits assistance provided	Medication				
	N	%	aOR	95% CI	p-value
0–24%	7,554	23.11	ref (1.00)		
25–49%	6,164	18.86	0.78	(0.53, 1.14)	0.195
50–74%	5,566	17.03	1.18	(0.60, 2.34)	0.628
75–100%	13,399	41.00	3.05	(1.21, 7.73)	0.018
Proportion of visits assistance provided	Referral				
	N	%	aOR	95% CI	p-value
0–24%	13,016	39.82	ref (1.00)		
25–49%	6,816	20.85	0.76	(0.43, 1.35)	0.352
50–74%	6,589	20.16	1.12	(0.64, 1.96)	0.700
75–100%	6,262	19.16	2.21	(0.89, 5.51)	0.087

* Adjusted for sex, age, race, and comorbidities

Note. Long-term quit status defined as an indication of quitting smoking (current smoker to former or non-smoker) and no subsequent indication in the EHR of smoking at any visit for 365 days; aOR: adjusted odds ratio; CI: confidence interval.