

Delivery of Smoking Cessation Services and Cessation Attempts Across a Public, Safety-Net Primary Care System

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Abstract

Background: Smoking cessation rates are low in safety-net settings, contributing to high smoking-related morbidity and mortality. Understanding factors associated with cessation attempts can inform interventions.

Objective: To evaluate factors associated with smoking cessation attempts.

Design: Retrospective analysis using electronic health record (EHR) data on individuals with at least three primary care encounters from 2016 to 2019 in the San Francisco Health Network (SFHN), a network of clinics serving publicly insured and uninsured residents in San Francisco.

Participants: Patients engaged in primary care in the San Francisco Health Network.

Main Measures: The outcome was recent cessation attempt, defined as change in smoking status from “current smoker” at the index visit to “former smoker” at visit 2 or 3. We measured demographics, tobacco-related comorbidities, and cessation treatment characteristics (i.e., counseling and pharmacotherapy). To better characterize subpopulations that may benefit from targeted interventions, we described characteristics of smokers with hypertension, depression, diabetes, or HIV.

Key Results: Of the 51,554 adults identified across 15 SFHN primary care clinics, 11,622 (22.7%) were current smokers. Approximately 26% of smokers made a recent cessation attempt. Medical assistant (90%) and provider counseling (73%) rates were high, while behavioral assistant counseling rate (17%) was low. All counseling types had lower odds of cessation attempts in multivariable analysis. Smokers with depression (AOR 1.18, 95%CI 1.05-1.33) and ischemic heart disease (AOR 1.36, 95%CI 1.06-1.74) had higher odds of attempts. Among comorbidity groups, cessation attempts ranged from 21-26%, and smokers with HIV received the lowest rates of cessation counseling.

Conclusions: Although rates of basic cessation counseling were high, efforts were associated with lower odds of making a cessation attempt. Using intensive interventions to target populations with comorbidities could be opportunities to increase cessation engagement.

Introduction

Despite decades of efforts to reduce tobacco use in the United States (US), cigarette smoking accounts for one in five deaths annually and remains a leading cause of preventable death.¹ The prevalence of smoking and burden of tobacco-caused diseases further remain disproportionately high in individuals with low socioeconomic status, mental illness, substance use disorders, and communities of color.^{2,3} Safety-net health systems that provide care for populations with high smoking rates are therefore uniquely poised to provide smoking cessation services, though many competing priorities and limited resources make providing cessation care challenging.

Our prior work, using a PRECEDE-PROCEED evaluation framework, explored enabling factors and barriers to delivery of cessation services within a subset of safety-net clinics.⁷ We found that due to competing priorities, clinic staff trained in offering cessation counseling (e.g., behavioral assistants) were not able to meet the demands of “warm hand offs” for counseling during encounters, requiring rescheduling visits that resulted in low follow up. Lack of both coordination of cessation services and ownership of counseling by clinical workforces also posed barriers to successful delivery of cessation services.⁷ Less is known about patient-level factors associated with smoking cessation attempts and receipt of cessation services within safety-net populations who have comorbid chronic physical and mental health conditions.

This study expands on prior work by using the electronic health record (EHR) to identify factors associated with smoking cessation attempts among all primary care clinics in the San Francisco Health Network (SFHN), the largest network of primary care clinics, specialty clinics, acute care hospitals, and behavioral health clinics serving publicly insured and uninsured patients in San Francisco. In recent years, the SFHN has undertaken various quality improvement initiatives to improve smoking cessation care across the entire health system. Understanding patient-level characteristics and factors associated with cessation attempts can enable opportunities to develop future interventions within SFHN and other urban safety-net systems. We hypothesized that delivery of cessation services, including any counseling from medical assistants, providers, and behavioral assistants, as well as pharmacotherapy, would be associated with cessation attempts.

Methods

Study setting and population

We extracted patient-level EHR data on smoking status and delivery of smoking cessation services from 15 primary care clinics across SFHN (Appendix 1). Four of the 15 clinics (Clinics 2–6) are academic primary care practices housed within a university-affiliated public hospital, with three general primary care clinics and one clinic focusing on care for patients living with HIV. The remaining 11 clinics are community-based clinics dispersed across San Francisco with varying patient demographics. Clinic 1 is located in the downtown area and provides care predominantly to people experiencing homelessness, whereas other clinics serve a higher proportion of Black, Latinx, Asian, and other racial/ethnic communities.

At each clinic visit, medical assistants (i.e., frontline medical staff) screen patients for smoking status as “current smoker,” “past smoker,” or “never smoker” and input their status into the EHR. To be consistent with prior literature and clinical practice, we refer to “past smokers” as “former smokers” for the remainder of the study.⁷ For current smokers, medical assistants can refer to one or more cessation resources including those specific to the clinic (e.g., on-site smoking cessation groups or counseling by the behavioral assistants) and/or general resources (e.g., the California Smoker’s Helpline).¹⁴ Providers and medical assistants during the encounter may also refer to behavioral assistants for counseling. Behavioral assistants are ancillary staff trained to offer smoking

cessation coaching, and they offer on-site or telephone counseling to patients. Patients can also receive counseling from their provider and/or initiate smoking cessation pharmacotherapy through a prescription from their provider or a pharmacist during the clinical encounter. This study was approved by the University of California, San Francisco Committee on Human Research (#18-26398).

Study Design

The study utilized the PRECEDE-PROCEED model as its theoretical framework, an implementation science model used for assessing the health needs within a public health program, and for designing, implementing, and evaluating programs to meet these needs.¹⁵ In our prior work, we conducted social, epidemiological, and ecological assessments to identify predisposing and reinforcing factors (PRECEDE) to increase delivery of cessation services.⁷ We found that provision of medical services using team-based care models is feasible, and that the EHR could be a useful tool to facilitate delivery of cessation care. Here, we explore potential Policy, Regulatory, and Organizational (PROCEED) factors in order to facilitate the implementation of system-level interventions to increase delivery of cessation services and evaluation of such interventions.

We extracted data from the EHR on any patient of the 15 clinic sites who had at least one recorded smoking status and at least three unique primary care encounters between May 2016 to May 2019. The index visit was the first encounter closest to the study's start date. Current smokers reported smoking at the index visit, whereas non-smokers were either former smokers or never smokers. We extracted data from the EHR using i2i Tracks (<http://www.i2isys.com/p/i2itracks>) software and Structured Query Language (SQL).

We extracted patient level factors including age, gender, primary language, race/ethnicity, health insurance type, and smoking-related comorbidities from the EHR. Health insurance was categorized as either Medicare, Medicaid (named "Medi-Cal" in California), Healthy San Francisco/Healthy Workers (a county-based program providing medical care to low-income adults), private, other coverage, or uninsured. Smoking-related health comorbidities were identified using ICD-9 and ICD-10 codes listed as diagnoses within the patient's medical record (Appendix 2).

Data Analysis

We used descriptive statistics to summarize the data, with frequencies and percentages for categorical variables and means with standard deviations (SD) for continuous variables. We compared current smokers and non-smokers based on smoking status at the index visit. We used Pearson's chi-square test for categorical variables and the t-test for continuous variables when comparing demographic characteristics, health insurance type, comorbidities, clinic, and referral characteristics.

We evaluated factors associated with making a recent smoking cessation attempt. Recent smoking cessation attempt was defined as a transition in smoking status from current smoker at the index to former smoker either at visit 2 or 3. We chose independent variables previously shown to be associated with smoking cessation attempts, including demographics, health insurance type, clinic, visit number, comorbidities, and receipt of cessation services including counseling (medical assistant counseling, provider counseling, behavioral assistant counseling) and pharmacotherapy.⁷ We examined the multivariable association between recent cessation attempts and covariates using generalized estimating equations (GEE), accounting for nesting patients within clinics with an exchangeable correlation structure. We further characterized rates of recent cessation attempts as well as the relapse rates by clinic. We defined a relapse as a change in smoking status from former smoker at visit 2 to current smoker at visit 3.

To better understand disparities in delivery of smoking cessation services and delineate which subpopulations may benefit from more intensive efforts, we described characteristics within patient groups with various comorbidities (*i.e.*, hypertension, diabetes, depression, and/or HIV), including their demographics, health insurance type, clinic, receipts of smoking cessation counseling and pharmacotherapy, and cessation attempts. All analyses were completed using SAS version 9.4.

Results

Individual Characteristics among Smokers and Non-Smokers

The sample included 51,554 individuals from 15 clinics, of whom 11,622 (23%) were current smokers (Table 1). Approximately 37% of current smokers and 43% of non-smokers came from the four academic, hospital-based clinics. Compared to non-smokers, current smokers were more likely to be younger (mean age 50.3 years +/- SD 13.9 vs 52.2 years +/- SD 16.5), male (68% vs 42%), and White (27% vs 16%) or Black/African American (32% vs 10%). Current smokers were also more likely to be English-speaking (81% vs 51%) and had higher prevalence of asthma (10% vs 8%), COPD (14% vs 4%), depression (32% vs 25%), HIV (12% vs 4%), and heart failure (4% vs 3%).

Table 1
Demographic, Comorbidities and Referral Characteristics among Smokers and Non-smokers in San Francisco Health Network clinics (N = 51,203)

	Mean (SD) or n (%)		p-value
	Current smokers (N = 11,622)	Non-smokers (N = 39,581)	
Age	50.3 (13.9)	52.2 (16.5)	< .0001
Gender			< .0001
Male	7,921 (68.2%)	16,516 (42%)	
Female	3,701 (32%)	23,065 (58%)	
Race/ethnicity			< .0001
Hispanic	2,034 (18%)	12,965 (33%)	
American Indian/Alaska Native	119 (1%)	187 (0.5%)	
Asian	1,859 (16%)	13,119 (34%)	
Black/African American	3,622 (32%)	3,973 (10%)	
Native Hawaiian/Pacific Islander	150 (1%)	352 (0.9%)	
White	3,096 (27%)	6,236 (16%)	
Other	564 (5%)	2,184 (6%)	
Language			< .0001
English	9,340 (81%)	20,179 (51%)	
Spanish	958 (8%)	9,526 (24%)	
Cantonese/Mandarin/Chinese	884 (8%)	7,283 (18%)	
Vietnamese	80 (0.7%)	634 (2%)	
Russian	125 (1%)	585 (1%)	
Tagalog	43 (0.4%)	353 (0.9%)	
Korean	24 (0.2%)	213 (0.5%)	
Arabic	24 (0.2%)	121 (0.3%)	
Other	58 (0.5%)	499 (1%)	
Insurance			< .0001
Healthy San Francisco	499 (5%)	3,198 (9%)	
Medi-Cal	6,177 (59%)	16,552 (47%)	
Medicare	2,101 (20%)	7,060 (20%)	
Private	112 (1%)	479 (1%)	
Other coverage	1,190 (11%)	6,967 (20%)	
Uninsured	335 (3%)	816 (2%)	
Comorbidities			
Asthma	1,102 (9%)	3,126 (8%)	< .0001
Chronic obstructive lung disease	1,567 (13%)	1,572 (4%)	< .0001
Depression	3,737 (32%)	9,924 (25%)	< .0001
Diabetes	1,863 (16%)	8,341 (21%)	< .0001
HIV	1,424 (12%)	1,715 (4%)	< .0001
Hyperlipidemia	2,448 (21%)	11,843 (30%)	< .0001
Hypertension	4,309 (37%)	15,197 (38%)	0.01
Ischemic heart disease	627 (5%)	2,206 (6%)	0.46
Heart failure	491 (4%)	1,286 (3%)	< .0001

	Mean (SD) or n (%)		p-value
	Current smokers (N = 11,622)	Non-smokers (N = 39,581)	
Kidney disease	1,114 (10%)	4,242 (11%)	< .001
Clinic			< .0001
Clinic 1	1,949 (17%)	1,512 (4%)	
Clinic 2	52 (0.5%)	413 (1%)	
Clinic 3	1,562 (13%)	8,385 (21%)	
Clinic 4	1,006 (9%)	1,281 (3%)	
Clinic 5	1,637 (14%)	6,892 (17%)	
Clinic 6	712 (6%)	2,910 (7%)	
Clinic 7	28 (0.2%)	14 (0.04%)	
Clinic 8	645 (6%)	4,413 (11%)	
Clinic 9	380 (3%)	764 (2%)	
Clinic 10	24 (0.2%)	12 (0.03%)	
Clinic 11	732 (6%)	2,570 (6%)	
Clinic 12	592 (5%)	3,244 (8%)	
Clinic 13	487 (4%)	1,531 (4%)	
Clinic 14	634 (5%)	3,489 (9%)	
Clinic 15	1,182 (10%)	2,149 (5%)	
Referral characteristics			
Medical assistant counseling	10,426 (90%)	—	
Provider counseling	8,467 (73%)	—	
Behavioral assistant counseling	2,031 (17%)	—	
Pharmacotherapy	1,419 (12%)	—	

Table 2
 Logistic regression model of factors associated with making a recent smoking cessation attempt
 among Smokers in San Francisco Health Network clinics

	Unadjusted OR		Adjusted OR	
	OR (95%CI)	p value	AOR (95%CI)	p value
Age	0.98 (0.97, 0.98)	<0.001	0.99 (0.98, 0.99)	<0.001
Gender				
Male (ref.)	—	—	—	—
Female	1.21 (1.09, 1.34)	<0.001	1.25 (1.10, 1.41)	<0.001
Race/ethnicity				
White (ref.)	—	—	—	—
American Indian/Alaska Native	1.30 (0.83, 2.05)	0.25	1.82 (1.10, 3.02)	0.02
Asian	0.88 (0.74, 1.03)	0.11	1.02 (0.82, 1.28)	0.85
Black/African American	1.00 (0.87, 1.14)	0.99	1.03 (0.88, 1.21)	0.70
Hispanic	1.90 (1.64, 2.20)	<0.001	1.31 (1.08, 1.60)	0.006
Native Hawaiian/Pacific Islander	1.28 (0.83, 1.98)	0.27	0.98 (0.59, 1.65)	0.95
Other	1.50 (1.18, 1.91)	<0.001	1.05 (0.80, 1.38)	0.71
Language				
English (ref.)	—	—	—	—
Arabic	1.97 (0.71, 5.44)	0.19	1.29 (0.41, 4.03)	0.66
Cantonese/Mandarin/Chinese	0.53 (0.42, 0.66)	<0.001	0.72 (0.52, 1.01)	0.06
Korean	0.20 (0.03, 1.50)	0.12	0.27 (0.03, 2.21)	0.22
Other	1.11 (0.28, 1.60)	0.36	0.67 (0.28, 1.60)	0.36
Russian	0.98 (0.55, 2.23)	0.78	0.98 (0.55, 1.76)	0.95
Spanish	2.30 (1.96, 2.69)	<0.001	1.44 (1.15, 1.81)	0.001
Tagalog	0.66 (0.24, 1.85)	0.43	0.86 (0.24, 3.10)	0.82
Vietnamese	1.00 (0.58, 1.72)	0.99	0.78 (0.43, 1.43)	0.42
Insurance type				
Medicare (ref.)	—	—	—	—
Healthy San Francisco	2.18 (1.71, 2.79)	<0.001	0.81 (0.60, 1.09)	0.16
Medi-Cal	1.28 (1.12, 1.46)	<0.001	0.86 (0.73, 1.01)	0.06
Private	1.23 (0.72, 2.13)	0.45	0.62 (0.33, 1.17)	0.14
Other	1.02 (0.84, 1.24)	0.86	0.87 (0.69, 1.09)	0.22
Uninsured	1.08 (0.77, 1.52)	0.65	0.75 (0.52, 1.09)	0.13
Clinic				
Clinic 1 (ref.)	—	—	—	—
Clinic 2	8.52 (3.13, 23.19)	<0.001	4.82 (1.58, 14.73)	0.006
Clinic 3	2.78 (2.31, 3.34)	<0.001	2.43 (1.96, 3.02)	<0.001
Clinic 4	1.38 (1.11, 1.73)	0.005	1.14 (0.79, 1.63)	0.49
Clinic 5	2.85 (2.37, 3.42)	<0.001	2.58 (2.08, 3.20)	<0.001
Clinic 6	2.55 (2.01, 3.22)	<0.001	2.90 (2.22, 3.77)	<0.001
Clinic 7	0.87 (0.65, 1.16)	0.33	1.57 (1.08, 2.28)	0.02
Clinic 8	0.89 (0.20, 4.02)	0.88	0.64 (0.12, 3.35)	0.59
Clinic 9	0.88 (0.61, 1.25)	0.47	1.19 (0.78, 1.81)	0.41
Clinic 10	1.29 (0.44, 3.78)	0.64	1.25 (0.43, 3.66)	0.68

	Unadjusted OR		Adjusted OR	
	OR (95%CI)	p value	AOR (95%CI)	p value
Clinic 11	1.63 (1.28, 2.07)	< 0.001	2.03 (1.55, 2.65)	< 0.001
Clinic 12	1.57 (1.21, 2.05)	< 0.001	2.38 (1.74, 3.26)	< 0.001
Clinic 13	1.61 (1.20, 2.16)	0.002	1.76 (1.27, 2.43)	< 0.001
Clinic 14	2.02 (1.57, 2.61)	< 0.001	1.89 (1.41, 2.54)	< 0.001
Clinic 15	1.48 (1.19, 1.85)	< 0.001	1.30 (1.01, 1.68)	0.04
Visit				
Visit 2 (ref.)	—	—	—	—
Visit 3	0.69 (0.62, 0.76)	< 0.001	0.77 (0.69, 0.86)	< 0.001
Comorbidities				
Asthma	0.99 (0.84, 1.17)	0.91	1.03 (0.85, 1.24)	0.78
Chronic obstructive lung disease	0.68 (0.58, 0.78)	< 0.001	1.02 (0.85, 1.23)	0.82
Depression	1.02 (0.92, 1.13)	0.70	1.18 (1.05, 1.33)	0.006
Diabetes	0.98 (0.86, 1.12)	0.75	1.00 (0.85, 1.18)	0.97
HIV	0.76 (0.65, 0.89)	< 0.001	1.21 (0.90, 1.64)	0.21
Hyperlipidemia	0.85 (0.75, 0.96)	0.007	1.17 (1.00, 1.36)	0.05
Hypertension	0.77 (0.70, 0.86)	< 0.001	1.03 (0.90, 1.18)	0.62
Ischemic heart disease	1.00 (0.81, 1.23)	0.98	1.36 (1.06, 1.74)	0.02
Heart failure	1.03 (0.82, 1.30)	0.79	1.26 (0.96, 1.64)	0.10
Kidney disease	0.90 (0.77, 1.06)	0.22	1.06 (0.87, 1.29)	0.58
Counseling and pharmacotherapy				
Medical assistant counseling	0.36 (0.32, 0.40)	< 0.001	0.35 (0.31, 0.40)	< 0.001
Provider counseling	0.44 (0.40, 0.49)	< 0.001	0.66 (0.58, 0.76)	< 0.001
Behavioral assistant counseling	0.63 (0.55, 0.72)	< 0.001	0.83 (0.71, 0.98)	0.03
Pharmacotherapy	0.72 (0.62, 0.83)	< 0.001	0.85 (0.71, 1.02)	0.08

Receipt of counseling and pharmacotherapy

Among current smokers, 90% received medical assistant counseling during the study period, 73% received provider counseling, 17% received behavioral assistant counseling, and 12% received pharmacotherapy.

Rates of Cessation Attempts

Within the cohort of current smokers at the index visit, 26% made a recent smoking cessation attempt at either visit 2 or 3 (Fig. 1). Academic, hospital-based clinics had some of the highest cessation attempt rates. Among those who had made a cessation attempt at visit 2, on average 45% relapsed at visit 3 (range 0–50%) (Appendix 3).

Factors Associated with Recent Smoking Cessation Attempts

All forms of smoking cessation counseling were significantly associated with lower odds of making a cessation attempt. Receipt of smoking cessation pharmacotherapy did not reach statistical significance. Among patient factors, only older age was associated with lower odds of making a cessation attempt (Adjusted Odds Ratio [AOR] 0.99, 95% CI 0.98–0.99). Factors associated with higher odds of making a cessation attempt included female gender (AOR 1.25, 95% CI 1.10–1.41), American Indian/Alaskan Native (AOR 1.82, 95% CI 1.10–3.02) and Latinx/Hispanic ethnicity compared to Non-Hispanic White (AOR 1.31, 95% CI 1.08–1.60), or Spanish as the primary language (AOR 1.44, 95% CI 1.14–1.81). Those with depression (AOR 1.18, 95% CI 1.05–1.33) and ischemic heart disease (AOR 1.36, 95% CI 1.06–1.74) also had higher odds of making a cessation attempt.

Across clinics, compared to Clinic 1 (a downtown clinic predominantly serving those experiencing homelessness), all academic, hospital-based clinics except Clinic 4 were associated with making recent cessation attempts and had some of the highest odds ratios across all 15 clinics.

Demographic and Referral Characteristics among Smokers with Specific Comorbidities

Among current smokers with available EHR comorbidity data, we stratified patients based on the presence of comorbidities of hypertension (N = 3,441), diabetes (N = 1,446), depression (N = 2,903), and HIV (N = 1,140) (Table 3). Current smokers in all comorbidity groups were on average middle aged (though those with HIV were slightly younger) and predominantly male.

Table 3

Demographic and Referral Characteristics among Smokers with Hypertension, Diabetes, Depression, HIV in San Francisco Health Network clinics

	Mean (SD) or n (%)			
	Smokers with Hypertension (N = 3,441)	Smokers with Diabetes (N = 1,446)	Smokers with Depression (N = 2,903)	Smokers with HIV (N = 1,140)
Age	58.5 (10.3)	57.6 (10.5)	51.5 (13.0)	48.0 (11.7)
Gender				
Male	2,342 (68%)	1,025 (71%)	1,793 (62%)	975 (86%)
Female	1,099 (32%)	421 (29%)	1,110 (38%)	165 (14%)
Race/ethnicity				
Hispanic	384 (11%)	249 (17%)	472 (16%)	201 (18%)
American Indian or Alaska Native	28 (1%)	6 (0.4%)	39 (1%)	30 (3%)
Asian	551 (16%)	316 (22%)	283 (10%)	58 (5%)
Black/African American	1,501 (44%)	533 (37%)	982 (34%)	346 (31%)
Native Hawaiian or other Pacific Island	44 (1%)	33 (2%)	30 (1%)	3 (0.3%)
White	761 (22%)	238 (17%)	935 (33%)	428 (38%)
Other	148 (4%)	62 (4%)	123 (4%)	57 (5%)
Insurance				
Healthy San Francisco	84 (3^)	70 (6%)	78 (3%)	21 (2%)
Medi-Cal	1,494 (50%)	626 (50%)	1,582 (63%)	620 (65%)
Medicare	977 (33%)	359 (29%)	608 (24%)	235 (24%)
Private	20 (1%)	11 (1%)	26 (1%)	15 (2%)
Other coverage	329 (11%)	144 (12%)	161 (6%)	34 (4%)
Uninsured	89 (3%)	30 (2%)	54 (2%)	30 (3%)
Clinic				
Clinic 1	705 (20%)	257 (18%)	628 (22%)	206 (18%)
Clinic 2	3 (0.1%)	0	9 (0.3%)	0
Clinic 3	399 (12%)	170 (12%)	327 (11%)	12 (1%)
Clinic 4	187 (5%)	46 (3%)	322 (11%)	783 (69%)
Clinic 5	465 (14%)	253 (18%)	352 (12%)	9 (1%)
Clinic 6	163 (5%)	72 (5%)	166 (6%)	46 (4%)
Clinic 7	0	0	4 (0.1%)	1 (0.09%)
Clinic 8	174 (5%)	100 (7%)	77 (3%)	0
Clinic 9	192 (6%)	61 (4%)	117 (4%)	10 (1%)
Clinic 10	0	0	4 (0.1%)	7 (1%)
Clinic 11	231 (7%)	93 (6%)	234 (8%)	17 (1%)
Clinic 12	155 (5%)	70 (5%)	116 (4%)	0
Clinic 13	157 (5%)	62 (4%)	150 (5%)	3 (0.3%)
Clinic 14	189 (5%)	100 (7%)	139 (5%)	1 (0.1%)
Clinic 15	421 (12%)	162 (11%)	258 (9%)	45 (4%)
Referral characteristics				
Medical assistant counseling	3,266 (95%)	1,383 (96%)	2,750 (95%)	1,049 (92%)
Provider counseling	2,753 (80%)	1,154 (80%)	2,297 (79%)	843 (74%)
Behavioral assistant counseling	814 (24%)	328 (23%)	663 (23%)	82 (7%)

	Mean (SD) or n (%)			
	Smokers with Hypertension (N = 3,441)	Smokers with Diabetes (N = 1,446)	Smokers with Depression (N = 2,903)	Smokers with HIV (N = 1,140)
Pharmacotherapy	595 (17%)	272 (19%)	519 (18%)	202 (18%)
Smoking Cessation Attempts	683 (23%)	323 (26%)	659 (26%)	208 (21%)

Asian smokers were more represented among populations with hypertension (16%) and diabetes (22%) and less so among those with depression (10%) or HIV (5%). Latinx smokers were more represented among groups with diabetes (17%), depression (17%), and HIV (18%). Black/African American smokers were well represented in all comorbidity groups, especially among those with hypertension (44%). White smokers were well represented in all groups, especially among those with depression (33%) and HIV (38%).

There were high rates of current smokers across comorbidity groups receiving medical assistant (range 92–96%) and provider counseling (74–80%). There was much lower delivery of behavioral assistant counseling (range 7–24%), especially among current smokers with HIV. Notably, those with HIV had consistently the lowest rates of receiving any type of cessation counseling. All comorbidity groups had similar low percentages of receiving cessation pharmacotherapy (17–19%). Cessation rates across comorbidity groups were also similar (21–26%).

Discussion

Among 51,554 individuals across 15 safety-net primary care clinics, we found 23% were current smokers, and 26% made a recent cessation attempt. Safety-net clinics delivered medical assistant and provider counseling at high rates, though rates were much lower for behavioral assistant counseling and pharmacotherapy. Contrary to our hypothesis, individuals receiving any type of cessation counseling were less likely to make a cessation attempt. This was dissimilar to our prior work, which found higher odds of making a cessation attempt in those who received medical assistant counseling and provider counseling, albeit the prior study was limited to only four clinic sites with a much smaller study sample.⁷

Our results highlight how safety-net clinics are able to adequately deliver basic cessation interventions such as provider and medical assistant counseling, and that enhancements in EHR functions allowed demonstration of cessation service delivery. However, delivery of cessation services may not always correlate with cessation attempts, especially in the context of large health systems with diverse subpopulations. For subpopulations with high burden of comorbidities, basic cessation services may be insufficient, highlighting a need for more intensive efforts.^{8,16} Such efforts may include counseling from care providers of multiple disciplines, combining referrals from different encounters or providers, and streamlined infrastructure to ensure efficient delivery of cessation resources.

Several opportunities for interventions among subgroups exist. Although members of Black/African American, Latinx, and Asian communities are less likely to ever smoke and are more likely to be lighter smokers than their White counterparts, they also face disproportionately worse smoking-related health outcomes.^{17–19} And despite higher interest in quitting than White individuals and past-year quit attempts, Black/African American individuals have lower rates of sustained cessation. These racial disparities can be attributed to structures of systemic racism, including barriers to accessing care, lower receipt of cessation counseling and pharmacotherapy, and increased targeted marketing of tobacco products to racial/ethnic minorities, making sustained cessation more challenging among these communities.^{20–23}

We found communities of color were well represented across comorbidity groups, with Asian smokers well represented among groups with hypertension and diabetes, Latinx smokers represented among those with diabetes, depression, and HIV, and Black/African American represented across all comorbidity groups, especially hypertension. As efforts in addressing diabetes, hypertension, depression, and HIV have all displayed success in improving health outcomes by using a chronic disease management framework, pairing smoking cessation with other chronic disease management efforts may help address racial/ethnic disparities in smoking outcomes.^{20,24,25} Such interventions include telephone or in-person outreach to targeted populations, linking cessation counseling with efforts to improve blood pressure or diabetes care targets, or community engagement practices to inform cessation interventions. Latinx and Non-English speaking patients also had higher odds of recent cessation attempts, highlighting the importance of culturally informed and language concordant cessation counseling and resources.²⁶ More intensive efforts would align with equity goals to reduce racial disparities across health systems.

Our findings demonstrate how EHRs can be an effective tool for identifying smokers and delivering basic smoking cessation services within the context of rapid cycle quality improvement work. In the past decade, financial incentive programs for meaningful use of EHRs have increased tobacco screening, documentation of smoking status, and delivery of cessation services in safety-net settings.^{11,27–29} Additionally, the EHR has shown to be effective in rapidly identifying factors associated with cessation attempts and the receipt of referral services, which could be used to drive quality improvement activities to improve health outcomes.^{7,13}

In the face of many competing priorities, health systems are required to meet minimum criteria to obtain reimbursement and incentives from public insurers. For example, The Public Hospital Redesign and Incentives in Medi-Cal program (PRIME) requires evidence-based quality improvement goals for clinics, including screening for smoking status and counseling every two years.³⁰ However best practices guidelines recommend assessments at every clinical encounter to optimize chances of cessation,³¹ highlighting how more intensive interventions than those required by public insurers may be needed to improve patient outcomes. Therefore, clinics should acknowledge the need to meet minimum requirements for reimbursement, but also to take measures to strive for best practice recommendations. Health systems can do so by streamlining efforts, including assigning responsibilities to each health team member for

providing smoking cessation services or providing guidance on how frequently these services should be provided to avoid redundancy and waste of resources. The EHR is also advantageous in identifying populations that need these intensive interventions, and the PRECEDE-PROCEED model can be used to develop interventions in these contexts. For example, the SFHN implemented an EPIC Enterprise EHR in August 2020. Our evaluation using the PRECEDE-PROCEED is therefore timely in providing critical information to developing system-level approaches to support cessation efforts throughout the network. Already, efforts from this work have led to creation of a tobacco registry that includes a better screening tool for tobacco use embedded within the new EHR and templates to document counseling interventions. The registry can be used to track receipt of cessation services and drive practice changes in delivery of cessation care.

In our study, we found that only a quarter of current smokers made a recent cessation attempt, and of those who made a smoking cessation attempt at visit 2, about half of them relapsed by visit 3. These rates of cessation attempts were lower than the estimated 44% of smoking cessation attempts in the past year made by the general US population.³² Little is known about the rates of cessation attempts in primary care settings, with few studies estimating roughly 36–39% of patients making a recent cessation attempt and 15–20% of patients maintain cessation at one year.^{24,25,33,34} Ours was one of the few studies evaluating cessation attempts and relapse rates at clinic or system levels within a safety-net system. Because most smokers who attempt cessation are likely to relapse with high average lifetime number of quit attempts before sustained cessation,^{35,36} program initiatives should pay increasing attention toward sustaining cessation attempts and streamlining interventions to determine which groups require more intensive efforts.

There are several limitations to our study. EHR data relied on patient self-report, and smoking status was not biochemically verified, leading to a potential misclassification bias. However, our repeated assessments of smoking status over time may have reduced potential misclassifications. By excluding people with missing smoking status in the analysis, we may have also introduced some bias.⁷ Still, our large sample size may have protected against this and allows our data to be generalizable, as the inclusion of a diverse array of patients and clinics may be representative of other safety-net settings. The quality of smoking status data collection could have varied across clinic sites, though all clinics had the same EHR with a structured format for data collection.²⁸ Finally, for some clinics especially those serving young adult populations, the actual numbers of patients who attempted recent cessation were small, leading to inflated percentages of relapse in these clinics.

In conclusion, the EHR can be used to efficiently understand and identify opportunities for improvement in delivering smoking cessation services, especially in subpopulations that may require more intensive, directed efforts to achieve sustained cessation.^{37–39} Safety-net providers and clinic leaders could consider using the EHR to enhance the reach and efficacy of smoking cessation services, and target subpopulations with high needs in order to reduce racial and health disparities in safety-net settings.

Declarations

1. **Ethics approval and consent to participate:** This study was approved by the University of California, San Francisco Committee on Human Research (#18-26398).
2. **Consent for publication:** Not applicable.
3. **Competing interests:** The authors declare that they have no competing interests.
4. **Funding:** This study was supported by the National Heart, Lung and Blood Institute (R38 HL143581) and the Tobacco-Related Disease Research Program (28CP-0038). The funding agencies had no role in study design, data collection, analysis, the decision to publish, or the preparation of the manuscript.
5. **Data availability:** The datasets generated during and/or analyzed during the current study are not publicly available due to ongoing data collection and analysis but are available from the corresponding author on reasonable request.
6. **Authors contributions:** V., H.R., and E.C. conceptualized the design of the study. T.L. performed data analysis with guidance from M.V. and L.S. L.S. and M.V. wrote the manuscript with support from K.C., E.S., T.L., E.C., and H.R. All authors contributed to the final version of the manuscript.
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8. **Prior presentations:** This work was presented as a poster presentation at the San Francisco Bay Area Collaborative Research Network 2020 Annual Meeting.

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Appendix

Appendix Table 1. Demographics by type of clinics

	Academic clinics (N = 21314)	Community clinics (N = 30240)
Age	50.2 (16.5)	52.8 (15.5)
Gender		
Male	10347 (49%)	14300 (47%)
Female	10967 (51%)	15940 (53%)
Race/ethnicity		
Hispanic	8701 (41%)	6388 (21%)
American Indian or Alaska Native	164 (1%)	144 (0.5%)
Asian	4337 (21%)	10686 (36%)
Black/African American	2558 (12%)	5133 (17%)
Native Hawaiian or other Pacific Island	171 (1%)	338 (1%)
White	3358 (16%)	6029 (20%)
Other	1740 (8%)	1057 (4%)
Language		
English	12359 (58%)	17406 (58%)
Spanish	6200 (29%)	4360 (14%)
Cantonese/Mandarin/Chinese	1374 (7%)	6804 (23%)
Vietnamese	448 (2%)	271 (1%)
Russian	192 (1%)	519 (2%)
Tagalog	205 (1%)	192 (1%)
Korean	18 (0.1%)	221 (1%)
Arabic	94 (0.4%)	51 (0.2%)
Other	263 (1%)	300 (1%)
Insurance		
Healthy San Francisco	1910 (10%)	1809 (7%)
Medi-Cal	10262 (54%)	12677 (47%)
Medicare	3784 (20%)	5417 (20%)
Private	304 (2%)	295 (1%)
Other coverage	2092 (11%)	6094 (23%)
Uninsured	551 (3%)	624 (2%)
Recent Smoking Cessation Attempt*	891 (33%)	1017 (22%)
*For recent cessation attempts, only individuals with at least three primary care encounters with smoking status were included in this measure, leading to N = 2664 for academic clinics and N = 4724 for community clinics.		

Appendix Table 2. International Classification of Diseases 9 or 10 Diagnoses Extracted to Characterize Presence of Comorbidities

Diagnosis	ICD9 code	ICD10 code
Asthma	493	J45
Chronic Obstructive Pulmonary Disease	491–494, 496	J41-44, J47
Depression	290, 296, 298, 300, 301, 309, 311	F01, F32-F34, F43
Diabetes	250, 357, 362, 366, 648	E10, E11, E13, Q24
HIV	042, V08	B20, Z21
Hyperlipidemia		E78
Hypertension	401–404	I10-13
Ischemic vascular disease	411, 413, 414, 429, 433, 434, 437, 440, 444, 445	I20, I24, I25, I63, I65-67, I70, I75, T82
Heart failure	398, 402, 404, 428	I09, I11, I13, I50
Kidney disease		A18, A52, B52, C64, C68, D30, D41, D59, E08-E11, E13, E74, I12, I13, I70, I72, K76, M10, M32, M35, N00-08, N13-19, N25, N26, Q61, Q62, R94

Appendix Table 3. The relapse rate at visit 3 among smokers who made recent quit attempts in visit 2

	n (%)
Overall	536 (45%)
By clinic	
Clinic 1	62 (50%)
Clinic 2	3 (50%)
Clinic 3	105 (45%)
Clinic 4	37 (45%)
Clinic 5	112 (50%)
Clinic 6	31 (33%)
Clinic 7	1 (50%)
Clinic 8	22 (50%)
Clinic 9	10 (37%)
Clinic 10	0 (0%)
Clinic 11	32 (45%)
Clinic 12	29 (47%)
Clinic 13	21 (48%)
Clinic 14	30 (45%)
Clinic 15	41 (39%)

Figures

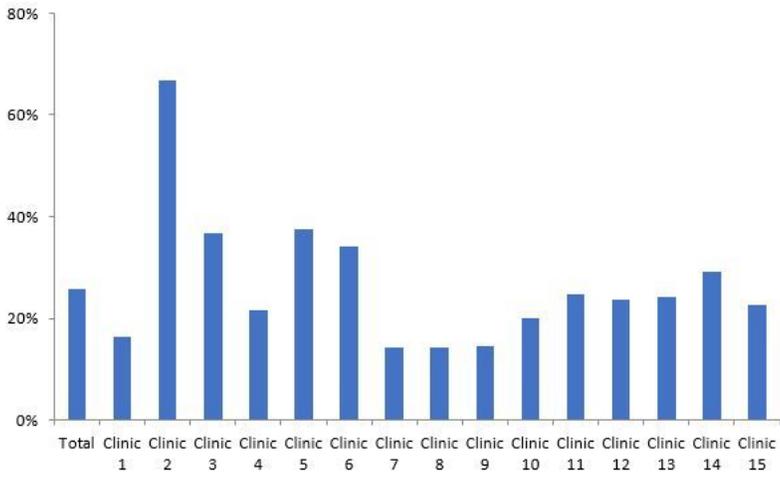


Figure 1

Cumulative rate of a recent cessation attempt across San Francisco Health Network clinics from May 2016 to May 2019 (N= 7,388)