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# Implementation, Maintenance, and Outcomes of an Electronic Referral to a Tobacco Quitline Across Five Health Systems

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## Abstract

**Introduction:** Electronic referral (e-referral) to quitlines helps connect tobacco-using patients to free, evidence-based cessation counseling. Little has been published about the real-world implementation of e-referrals across U.S. health systems, their maintenance over time, and the outcomes of e-referred patients.

**Aims and Methods:** Beginning in 2014, the University of California (UC)-wide project called UC Quits scaled up quitline e-referrals and related modifications to clinical workflows from one to five UC health systems. Implementation strategies were used to increase site readiness. Maintenance was supported through ongoing monitoring and quality improvement programs. Data on e-referred patients (*n* = 20 709) and quitline callers (*n* = 197 377) were collected from April 2014 to March 2021. Analyses of referral trends and cessation outcomes were conducted in 2021–2022.

**Results:** Of 20 709 patients referred, the quitline contacted 47.1%, 20.6% completed intake, 15.2% requested counseling, and 10.9% received it. In the 1.5-year implementation phase, 1813 patients were referred. In the 5.5-year maintenance phase, volume was sustained, with 3436 referrals annually on average. Among referred patients completing intake (*n* = 4264), 46.2% were nonwhite, 58.8% had Medicaid, 58.7% had a chronic disease, and 48.8% had a behavioral health condition. In a sample randomly selected for follow-up, e-referred patients were as likely as general quitline callers to attempt quitting (68.5% vs. 71.4%; *p* = .23), quit for 30 days (28.3% vs. 26.9%; *p* = .52), and quit for 6 months (13.6% vs. 13.9%; *p* = .88).

**Conclusions:** With a whole-systems approach, quitline e-referrals can be established and sustained across inpatient and outpatient settings with diverse patient populations. Cessation outcomes were similar to those of general quitline callers.

**Implications:** This study supports the broad implementation of tobacco quitline e-referrals in health care. To the best of our knowledge, no other paper has described the implementation of e-referrals across multiple U.S. health systems or how they were sustained over time. Modifying electronic health records systems and clinical workflows to enable and encourage e-referrals, if implemented and maintained appropriately, can be expected to improve patient care, make it easier for clinicians to support patients in quitting, increase the proportion of patients using evidence-based treatment, provide data to assess progress on quality goals, and help meet reporting requirements for tobacco screening and prevention.

## Introduction

Tobacco use remains the leading cause of preventable disease, disability, and death in the United States.[1] Quitting significantly reduces these risks, and numerous evidence-based treatments exist to help tobacco users do just that.[1,2] Clinicians have long

been encouraged to identify their tobacco-using patients and offer them these treatments.[2] Similarly, health systems have been urged to establish processes to help clinicians consistently treat tobacco use and dependence.[1,3,4] (In the context of U.S. health care, a health system includes at least one hospital and at least one group of physicians providing comprehensive

care, connected with each other and with the hospital through common ownership or joint management.)[5] One such process is the electronic referral ("e-referral") of patients to tobacco quitlines. Quitlines are free, evidence-based programs that help tobacco users quit through individualized telephone counseling.[6]

Enabling clinicians to refer patients to quitlines via electronic health records (EHR) has benefits on several levels. For patients, it increases the likelihood of engaging with treatment, because the quitline proactively reaches out to them, often when their health concerns have increased their interest in quitting.[7,8] For providers, having an e-referral order available in the EHR makes assisting tobacco-using patients easier, and a bidirectional interface helps to keep them updated on patients' progress.[9] For health systems, e-referral can be used across multiple clinical departments, and provides useful documentation that helps to meet reporting requirements relating to screening and treating tobacco use and dependence.[1,9] As said by the U.S. Surgeon General, these connections between health systems and quitlines can "further facilitate and routinize the use and utility of quitlines."[1]

Little has been published about the real-world implementation of e-referrals across entire health systems, how they are maintained over time, and the outcomes of referred patients. This study describes EHR modifications and other strategies used to implement quitline e-referrals across five independent University of California (UC) health systems, some with multiple hospitals and clinics. One health system had already implemented the intervention in an earlier pilot study.[10] Then in 2014 a new UC-wide project called "UC Quits" began scaling up the intervention by implementing it in four additional health systems. The study examines referral trends resulting from these efforts over a 7-year period, including a 1.5-year implementation phase and a 5.5-year maintenance phase. The study also analyzes and compares patient characteristics and outcomes for e-referred patients and for a general population of quitline callers, groups that showed unequal levels of initiative about using the quitline.

## Methods

### Project Overview

The UC Center for Health Quality and Innovation funded UC Quits as one of three innovative projects to scale up across five UC health systems. The five systems—UC Davis (UCD), UC Irvine (UCI), UC Los Angeles (UCLA), UC San Diego (UCSD), and UC San Francisco (UCSF)—had independent clinical operations and separate EHR systems. All but one used the Epic EHR system. UCI used the Allscripts EHR system until 2017 when UCSD began hosting UCI on its Epic EHR.

The UC quits project was led by an internal medicine physician and tobacco control researcher (EKT) who selected site champions and partners. A UC-wide nurse champion and tobacco control researcher (LS) helped engage leadership and nursing staff. Physician champions at each site assisted with outpatient and inpatient implementation. Local informatics staff built closed-loop (i.e. bidirectional) e-referrals into each EHR and made related modifications as needed. The grant also funded a centralized project coordinator, travel for champions to attend in-person meetings, and free educational credit for brief tobacco training. Partners included the California Smokers' Helpline, a statewide quitline based at UCSD, which provided in-kind programming support and

counseling, and the Smoking Cessation Leadership Center, based at UCSF, which provided educational support and meeting facilitation.

### Intervention

E-referral was programmed into EHRs as an order for outpatients and for inpatients at the time of hospital discharge. In less than a minute, a provider obtained the patient's verbal consent to be contacted by the quitline and submitted the order. The patient's name and telephone number were automatically sent to the quitline through a bidirectional interface using standard Health Level Seven (HL7) V.2 messages. The order had options indicating: (1) preferred language (English, Spanish, Cantonese, Mandarin, Vietnamese, or Korean), (2) whether the referral was for the patient or for a smoker in the patient's household, and (3) preferred day and time to be called.

Within two business days of e-referral, the quitline attempted to contact the patient by telephone, administer an intake questionnaire, and offer telephone counseling. Up to five call attempts were made to reach each patient. Quitline service outcomes (e.g. contacted, completed intake, and received counseling) were documented in the patient's EHR under referral orders, sent to the ordering provider's inbox for lab results, or both. Patients completing intake were offered a packet of self-help materials in the mail and counseling. Counseling included up to five sessions proactively initiated by the quitline to help patients plan a quit attempt and stay tobacco-free over the first month of quitting. The quitline counseling protocol, previously shown to double quit rates,[11,12] is described elsewhere.[13] Patients incurred no charges for quitline services.

### Implementation Strategies

Five main implementation strategies were used, based mostly on the Expert Recommendations for Implementing Change (ERIC) project:[14]

#### 1. Develop Stakeholder Interrelationships

Inpatient and outpatient physician champions (e.g. medicine, family medicine, and psychiatry) were identified at all five sites, who helped to increase awareness of the program and drive local implementation. A UC-wide nursing champion engaged the chief nursing officer at each site to help prioritize the project and identify nurse leads to assist with workflows. A separately funded initiative addressed secondhand smoke exposure among pediatric patients.

#### 2. Provide Interactive Assistance

UC Quits champions and partners attended monthly teleconferences to share site updates. Semiannual meetings were conducted ancillary to the UC Center for Health Quality and Innovation annual meeting or at the quitline site to help build familiarity with the service. Informatics staff conducted calls with each site's informatics team to provide technical assistance in building the e-referral.

#### 3. Adapt and Tailor to Context

After e-referrals were established, project staff met with site champions and their teams to adapt workflows and order sets to the new locations. For example, the outpatient order set, which could also be used in inpatient settings (usually at discharge), included tobacco cessation medication orders and the

quitline e-referral order. At two sites that offered in-person cessation classes, e-referral orders to these programs were also made available. Site champions worked with their inpatient and outpatient clinical leadership (e.g. nurse managers, quality improvement staff, and EHR approval committees) to integrate the orders into workflows. The standard protocol allows only providers with access to order sets to order referrals, and in UC Quits the ability to order quitline e-referrals was similarly proscribed. Nurses and other clinical staff could pend an order for physician approval but could not directly refer patients.

### 4. Use Evaluative and Iterative Strategies

Quitline e-referrals were established at UCD in March 2013, at UCLA in November 2014, at UCSF and UCSD in December 2014, and at UCI in June 2015. Referral volumes and quitline service outcomes were reported at each monthly meeting, with comparison across sites to help identify problems and improve implementation. These reports sometimes revealed that a site either had no referrals or a surge in referrals, which could indicate technological problems between the site and the quitline.

### 5. Train and Educate Stakeholders

UC Quits developed 15–30 minute educational videos to educate clinicians about tobacco treatment and made them widely available for free educational credit. Individual UC sites also developed and disseminated materials to educate providers about the e-referral and other EHR modifications, ranging from a tip sheet from the informatics team to required online training for all clinical staff.

### Post-Implementation Activities

As the 1.5-year implementation phase ended, the five sites began participating in national quality improvement incentive programs addressing tobacco assessment and treatment quality metrics. In 2015, inpatient psychiatric hospitals at four sites began reporting on tobacco quality metrics. In 2016, all five sites began participating in a Medicaid waiver program called Public Hospital Redesign and Incentives in Medi-Cal, which included a tobacco quality metric for outpatient settings. The e-referral could be counted towards quality metric reporting.

## Data Source

Data on UC e-referrals from April 2014 to March 2021 (*n* = 20 709) and on individuals who contacted the quitline themselves during this period (*n* = 197 377) came from the quitline's database. The database automatically logged both incoming referrals and outgoing feedback messages about service outcomes. Quitline counselors recorded their attempts to reach referred patients, the service outcomes, and intake and counseling data. As part of the quitline's standard quality assurance process, a random sample of quitline callers and UC patients who engaged in quitline services was followed up 7 months post-intake to evaluate cessation outcomes. Only participants who smoked cigarettes at intake and opted for counseling were sampled for follow-up.

## Measures

Several measures were used to track referral and quitting activity and evaluate outcomes: (1) number of e-referrals by date and site, (2) quitline service outcomes (no contact, refused, or completed intake), (3) choice of service (counseling, self-help materials, or no service), (4) demographic measures, including gender, sexual orientation, age, race or ethnicity, language, educational level, and insurance status, (5) tobacco use measures, including smoking frequency and cigarettes per day, (6) health measures, including self-reported physical health conditions (hypertension, diabetes, past heart attack, past stroke, and any of the above) and self-reported behavioral health conditions (anxiety, depression, bipolar disorder, schizophrenia, other drug or alcohol problems, and any of the above), (7) counseling measures, including receipt of counseling and number of sessions completed, and (8) cessation measures, including making a serious quit attempt (an attempt lasting at least 24 hours), use of approved cessation aids (nicotine replacement therapy, bupropion, varenicline), 30-day point prevalence abstinence, and 6-month prolonged abstinence. E-cigarette use at follow-up was not considered in determining quit rates.

## Data Analysis

Descriptive statistics were generated to summarize e-referrals and quitline service outcomes. Baseline characteristics of referred patients who completed intake and general quitline callers were compared using chi-square tests. Counseling measures and cessation outcomes were compared for respective subsets of callers. A trend analysis was computed using the proc transreg procedure developed by SAS.[15] The procedure analyzes trend data to find the simplest joinpoint model that the data allow. The basic data element of this analysis was the number of e-referral orders by quarter computed for the 7-year period from April 2014 to March 2021. All analyses were conducted in 2021–2022 using SAS, version 9.4.

## Results

A total of 20 709 patients were referred to the quitline from the five UC health systems. Quitline service outcomes are shown in Figure 1. Overall, the quitline was able to contact 47.1% of referred patients, with contact rates for the various UC sites ranging from 43.3% to 50.7% (range not shown in table). Among contacted patients, 43.7% completed intake, or 20.6% of referred patients. Of those completing intake, nearly all requested some service: 74.2% requested counseling and self-help materials and 24.7% requested materials only. Everyone in these groups was sent self-help materials, and of those who requested counseling, 71.5% received it. Ultimately, 10.9% of all e-referred patients received counseling.

Figure 2 shows the volume of e-referrals by quarter, go-live dates for the five UC sites, and the results of a trend analysis over the 7-year study period. UCD implemented e-referrals prior to the beginning of the study period. By the end of the third quarter of 2015, 1.5 years into the study, the other four UC sites had done so as well. In the trend analysis, the best-fitting model had one joinpoint after six quarters, following the implementation of e-referrals at all five sites. Volume increased rapidly before the joinpoint, then was largely sustained over the remaining 5.5 years of the study. A total of 1813 patients were referred during the 1.5-year implementation phase, or an average of 1209 per year, and another 18 897 over the next 5.5 years, or 3436 per year in the maintenance phase.
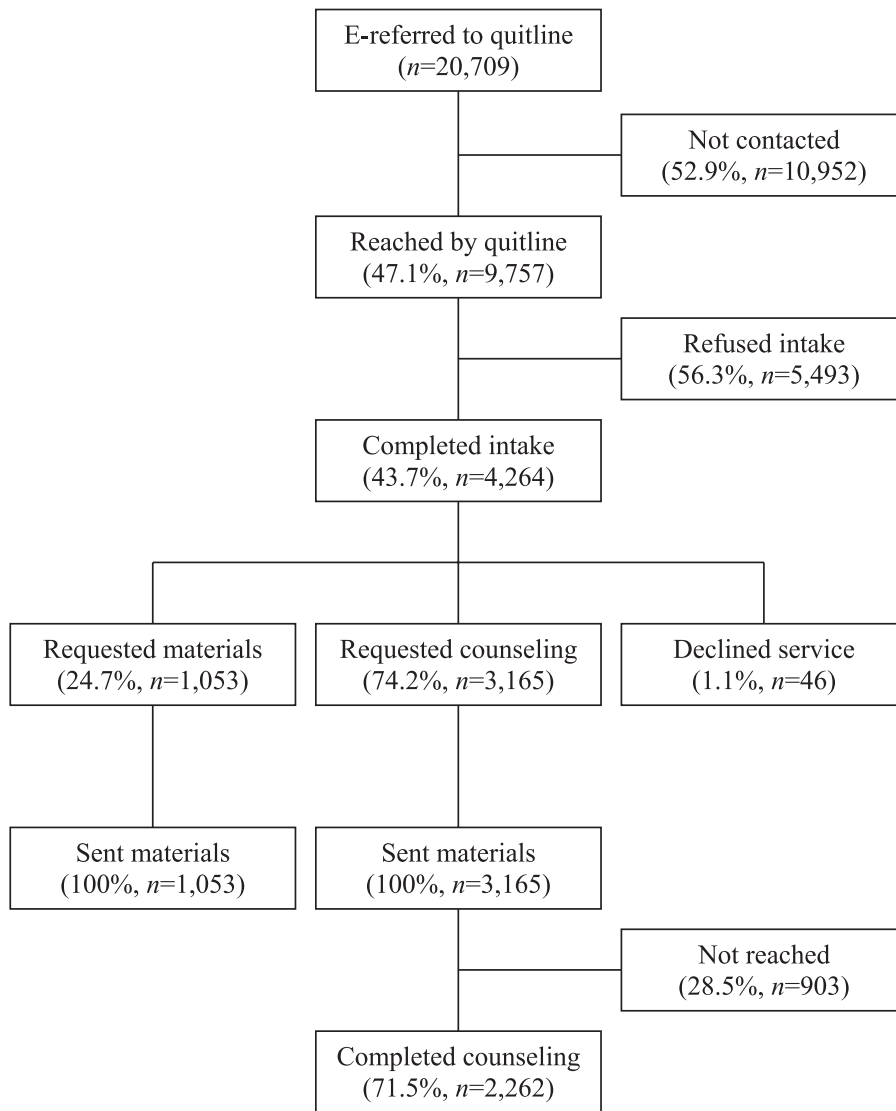
**Figure 1.** Flowchart of referrals and service outcomes of patients across five University of California health systems, April 2014–March 2021
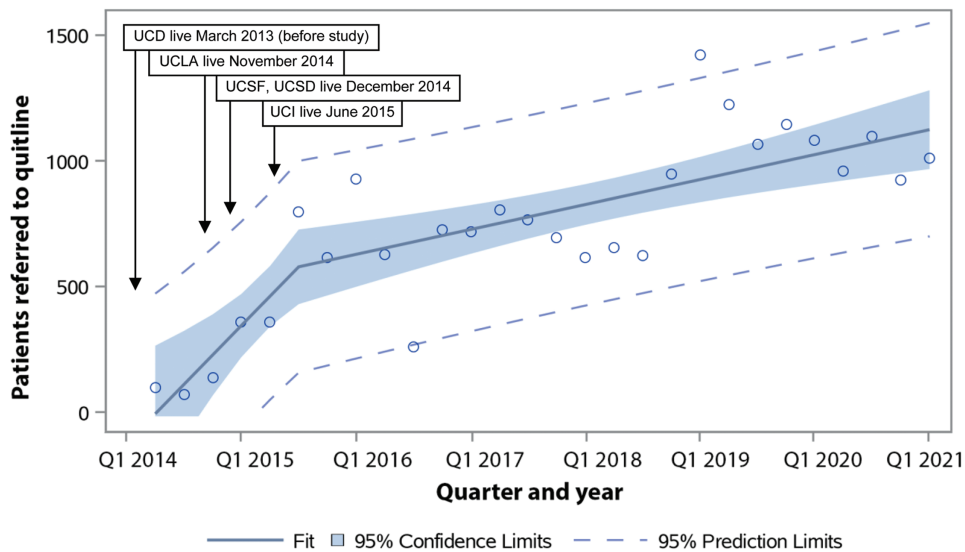


**Figure 2.** Number of University of California patients referred by quarter, April 2014–March 2021, with go-live dates and results of trend analysis

**Table 1.** Characteristics of UC Patients Completing Quitline Intake Compared to Statewide Quitline Callers, April 2014–March 2021

| Variable | UC-referred patients n = 4264 % (95% CI) | Quitline callers n = 197 377 % (95% CI) | p-Value |
|---|---|---|---|
| Gender | | | |
| Female | 47.5 (46.0 to 49.0) | 53.5 (53.3 to 53.7) | <.001 |
| Male | 52.2 (50.7 to 53.7) | 46.3 (46.1 to 46.5) | <.001 |
| Other | 0.3 (0.1 to 0.5) | 0.2 (0.2 to 0.2) | .29 |
| Sexual orientation | | | |
| Straight | 92.2 (91.3 to 93.0) | 92.4 (92.3 to 92.5) | .61 |
| Lesbian or gay | 4.3 (3.6 to 5.0) | 3.7 (3.6 to 3.8) | .05 |
| Bisexual | 2.5 (2.0 to 3.0) | 2.7 (2.7 to 2.8) | .32 |
| Other | 1.1 (0.7 to 1.4) | 1.2 (1.1 to 1.2) | .49 |
| Age | | | |
| <18 | 0.1 (0.0 to 0.2) | 0.2 (0.2 to 0.2) | .08 |
| 18–24 | 1.8 (1.4 to 2.2) | 4.1 (4.0 to 4.2) | <.001 |
| 25–44 | 23.0 (21.7 to 24.3) | 31.9 (31.7 to 32.1) | <.001 |
| 45–64 | 54.7 (53.2 to 56.2) | 51.4 (51.2 to 51.6) | <.001 |
| >64 | 20.4 (19.2 to 21.6) | 12.4 (12.3 to 12.6) | <.001 |
| Race or ethnicity | | | |
| White | 53.8 (52.3 to 55.3) | 47.2 (47.0 to 47.5) | <.001 |
| Black | 15.6 (14.5 to 16.7) | 16.2 (16.0 to 16.3) | .34 |
| Hispanic | 13.0 (12.0 to 14.0) | 17.4 (17.2 to 17.6) | <.001 |
| API | 7.7 (6.9 to 8.5) | 9.4 (9.2 to 9.5) | <.001 |
| AIAN | 1.4 (1.1 to 1.8) | 1.5 (1.5 to 1.6) | .66 |
| Multiracial | 6.1 (5.3 to 6.8) | 6.7 (6.6 to 6.8) | .14 |
| Other | 2.4 (1.9 to 2.9) | 1.6 (1.6 to 1.7) | <.001 |
| Language | | | |
| English | 93.9 (93.2 to 94.6) | 86.9 (86.7 to 87.0) | <.001 |
| Spanish | 4.3 (3.7 to 4.9) | 6.4 (6.3 to 6.5) | <.001 |
| Chinese | 0.8 (0.5 to 1.0) | 2.0 (1.9 to 2.1) | <.001 |
| Korean | 0.4 (0.2 to 0.6) | 2.4 (2.4 to 2.5) | <.001 |
| Vietnamese | 0.6 (0.4 to 0.9) | 2.3 (2.2 to 2.3) | <.001 |
| Education | | | |
| <HS | 17.9 (16.7 to 19.1) | 23.1 (22.9 to 23.3) | <.001 |
| HS | 21.7 (20.4 to 23.0) | 27.8 (27.6 to 28.0) | <.001 |
| Some college | 40.3 (38.8 to 41.8) | 37.6 (37.3 to 37.8) | <.001 |
| Bachelor+ | 20.1 (18.9 to 21.4) | 11.6 (11.4 to 11.7) | <.001 |
| Insurance | | | |
| Medicaid | 58.8 (57.3 to 60.3) | 73.9 (73.7 to 74.1) | <.001 |
| Other public | 10.4 (9.4 to 11.3) | 5.0 (4.9 to 5.1) | <.001 |
| Private | 26.8 (25.5 to 28.2) | 11.5 (11.4 to 11.6) | <.001 |
| None | 4.0 (3.4 to 4.6) | 9.6 (9.5 to 9.7) | <.001 |
| Smoking frequency | | | |
| Daily | 92.9 (92.1 to 93.7) | 96.9 (96.8 to 97.0) | <.001 |
| Nondaily | 7.1 (6.3 to 7.9) | 3.1 (3.0 to 3.2) | <.001 |
| Cigarettes per day | | | |
| ≤10 | 54.4 (52.9 to 55.9) | 40.9 (40.6 to 41.1) | <.001 |
| 11–19 | 14.4 (13.3 to 15.5) | 17.0 (16.8 to 17.2) | <.001 |
| ≥20 | 31.2 (29.8 to 32.6) | 42.1 (41.9 to 42.3) | <.001 |
| Physical health | | | |
| Hypertension | 49.4 (47.9 to 51.0) | 41.9 (41.6 to 42.1) | <.001 |
| Diabetes | 19.1 (17.9 to 20.3) | 15.0 (14.9 to 15.2) | <.001 |
| Heart attack | 10.2 (9.2 to 11.1) | 5.8 (5.7 to 5.9) | <.001 |

**Table 1.** Continued

| Variable | UC-referred patients *n* = 4264 % (95% CI) | Quitline callers *n* = 197 377 % (95% CI) | *p*-Value |
|---|---|---|---|
| Stroke | 9.9 (9.0 to 10.8) | 6.4 (6.2 to 6.5) | <.001 |
| Any of above | 58.7 (57.3 to 60.2) | 49.2 (49.0 to 49.4) | <.001 |
| Behavioral health | | | |
| Anxiety | 34.1 (32.6 to 35.6) | 37.1 (36.9 to 37.3) | <.001 |
| Depression | 37.2 (35.7 to 38.7) | 38.5 (38.3 to 38.7) | .10 |
| Bipolar | 10.9 (9.9 to 11.8) | 17.0 (16.8 to 17.2) | <.001 |
| Schizophrenia | 4.7 (4.1 to 5.4) | 8.1 (8.0 to 8.2) | <.001 |
| Drug or alcohol | 9.8 (8.9 to 10.7) | 11.5 (11.4 to 11.7) | <.001 |
| Any of above | 48.8 (47.3 to 50.3) | 52.5 (52.3 to 52.8) | <.001 |

UC = University of California; API = Asian or Pacific Islander; AIAN = American Indian or Alaska Native; all racial groups are non-Hispanic. HS = high school or general education diploma; Bachelor+ = bachelor's degree or higher. Percentages may not add up to 100.0% due to independent rounding. Physical and behavioral health conditions are self-reported.

**Table 2.** Use of Counseling, Use of Cessation Aids, and Cessation Outcomes of UC Patients Completing Quitline Intake, Compared to General Quitline Callers, April 2014–March 2021

| Counseling measure | UC-referred patients *n* = 4264 % (95% CI) | Quitline callers *n* = 197 377 % (95% CI) | *p*-Value |
|---|---|---|---|
| Requested counseling | 83.0 (81.9 to 84.2) | 83.3 (83.2 to 83.5) | .61 |
| Received counseling | 63.9 (62.3 to 65.5) | 70.1 (69.8 to 70.3) | <.001 |
| Counseling sessions (M) | 2.80 (2.72 to 2.91) | 2.83 (2.81 to 2.84) | .83 |

| Cessation measure | UC-referred patients *n*=375 % (95% CI) | Quitline callers *n*=12,994 % (95% CI) | *p*-Value |
|---|---|---|---|
| Used NRT | 41.3 (36.3 to 46.3) | 55.5 (54.7 to 56.4) | <.0001 |
| Used any quitting aid | 52.5 (47.5 to 57.6) | 60.8 (60.0 to 61.7) | <.01 |
| Made a quit attempt | 68.5 (63.8 to 73.2) | 71.4 (70.6 to 72.2) | .23 |
| Quit for 30 d | 28.3 (23.8 to 32.9) | 26.9 (26.1 to 27.6) | .52 |
| Quit for 6 mo | 13.6 (10.2 to 17.1) | 13.9 (13.3 to 14.5) | .88 |

UC = University of California; NRT = nicotine replacement therapy. NRT use refers to the use of any NRT (e.g. patches, gum, lozenges) from any source. Any cessation aid use includes medications approved by the Food and Drug Administration for tobacco cessation including NRT, bupropion, or varenicline; it does not include the use of e-cigarettes.

Table 1 compares the characteristics of referred UC patients completing intake (*n* = 4264) to general quitline callers during the same period (*n* = 197 377). UC patients were more often male (52.2% vs. 46.3%, respectively) and 45 years old or older (75.1% vs. 63.9%; both *p*'s < .001). They were somewhat less diverse, with more non-Hispanic whites (53.8% vs. 47.2%), fewer Hispanics (13.0% vs. 17.4%) or Asians and Pacific Islanders (7.7% vs. 9.4%), and fewer callers completing intake in a language other than English (6.1% vs. 13.1%; all *p*'s < .001). UC patients had higher socioeconomic status, with more college degrees (20.1% vs. 11.6%) and more private insurance (26.8% vs. 11.5%; both *p*'s < .001). They had lower tobacco consumption, with more nondaily smokers (7.1% vs. 3.1%) and more smokers using less than a pack of cigarettes per day (54.4% vs. 40.9%; both *p*'s < .001). They were more likely to report chronic disease (58.7% vs. 49.2%), but less likely to report a behavioral health condition (48.8% vs. 52.5%; both *p*'s < .001).

Table 2 compares counseling service outcomes for UC patients completing intake (*n* = 4264) and general quitline callers (*n* = 197 377). Both groups were equally likely to opt for counseling (83.0% vs. 83.3%, respectively; *p* = .61), but

UC patients were less likely to complete a session (63.9% vs. 70.1%; $p < .001$). However, those who did participate in counseling completed the same number of sessions on average (2.80 vs. 2.83; $p = .83$).

The bottom half of Table 2 compares cessation outcomes of UC patients ($n = 375$) and general quitline callers ($n = 12\ 994$) based on data gathered during the evaluation of a random sample of counseled participants. Referred patients were less likely than quitline callers to use nicotine replacement therapy (41.3% vs. 55.5%; $p < .0001$) or any cessation medication (52.5% vs. 60.8%; $p < .01$). The groups were similar in their rates of making a quit attempt (68.5% vs. 71.4%; $p = .23$), quitting for 30 days (28.3% vs. 26.9%; $p = .52$), and quitting for 6 months (13.6% vs. 13.9%; $p = .88$).

## Discussion

This study demonstrates the feasibility of implementing a tobacco quitline e-referral across multiple health systems in both inpatient and outpatient settings. It also shows that once implemented, the intervention was maintained over a period of several years, generating over 3400 referrals per year on average in the post-implementation phase, substantially higher than in the implementation phase.

The quitline contacted and completed an intake with about one in five referred patients (20.6%), and counseled about one in nine (10.9%). These results are within the range of studies reporting similar measures for inpatient and outpatient settings. For example, a study conducted in a Pennsylvania hospital reported that 10.6% of e-referred patients completed quitline intake, and 5.0% received at least one counseling session.[16] Another study in low-income primary care clinics in Ohio reported that 23.1% of e-referred patients completed intake, and 18.7% received counseling.[17] It should be noted that patients in the present study did not necessarily ask for help to quit, although they did give consent for referral. Perhaps unsurprisingly, over half, 53%, could not be contacted, although the quitline made up to five attempts per person, and 56% who were contacted declined service. A study by Albert and colleagues of patients who accepted a quitline e-referral and later were unreachable or declined service found several reasons for the change, including differing expectations of the referral, changed life circumstances and stressors, inability to find time for counseling, cell phone barriers, discomfort with quitline counseling, and simply wanting to quit on their own.[18] Patients who did not complete intake in the present study likely had a similar range of reasons. Moreover, it is important to remember that physician advice is itself a proven cessation intervention.[19] Over 20 000 patients were referred through this study, so at least that many received advice to quit. Giving clinicians a place to send their tobacco-using patients may help them broach the subject and provide this needed advice.[20,21]

Referred patients were less disadvantaged than quitline callers in general but were still very diverse. Nearly half were nonwhite and over half had Medicaid, suggesting that e-referral can help address disparities in access to cessation treatment. Nearly three in five had a chronic health condition and almost half had a behavioral health condition. In a reversal of the pattern usually seen among general quitline callers,[22–24] over half were male, indicating that e-referral may help offset men's lower likelihood of seeking treatment to quit.[25]

This study was not designed to test for efficacy, so it is not possible to determine whether UC patients and quitline callers benefitted equally from the counseling. However, given that referred patients did not themselves call the quitline to enroll in counseling, it is encouraging that their 6-month quit rate was comparable to that of quitline callers (14.2% vs. 13.9%, $p = .89$). Meta-analytic reviews have found that the evidence for quitline counseling is comparable for referred patients and for callers.[5] For additional context, in 2015 only 7.4% of recent smokers in the general population reported that they had successfully quit.[25]

The study generated lessons learned concerning the implementation and maintenance of e-referrals. First, programming could not simply be copied from one EHR to another but needed to be replicated independently in each health system. Second, operational decisions regarding when, where, and how the referral would be built, what departments would use it, and how it would fit into clinical workflows were also unique to each site. Third, most sites experienced minor programming issues, such as the intervention becoming lost during EHR upgrades or the need to troubleshoot and adjust the interface messages between the EHR and the quitline. Monitoring was needed to ensure that such issues were identified and corrected. Fourth, although e-referral was made available in both inpatient and outpatient settings, it needed to be prioritized and incorporated into workflows to be well-utilized. Initially, implementation focused on adapting workflows in medicine and family medicine. To increase utilization, e-referral should be incorporated into the workflows of other clinical areas such as pediatrics, obstetrics and gynecology, surgery, specialty care, and emergency care. For example, UCD also incorporated e-referral into its cancer center clinics[26] and a thoracic surgery clinic.[7] Finally, e-referral was initially limited to ordering physicians, although clinic staff who could not order an e-referral directly could pend an order for clinician review. Making e-referral available to other members of the care team, as suggested in the Clinical Practice Guideline,[2] could enhance utilization and maintenance. Quitline e-referral interventions have been successfully implemented by a range of personnel including physicians,[27,28] physician assistants,[28] nurse practitioners,[28] pharmacists,[29] registered nurses,[17,30] licensed vocational nurses,[31–33] and medical assistants.[31,34–36]

The systems changes implemented by UC Quits in this study were maintained across all five health systems, with over 90% of referrals occurring in the maintenance phase and nearly three-quarters occurring after grant funding ended. Maintenance was supported both by the inherent sustainability of interventions programmed into EHRs and by the onset of quality improvement programs requiring tobacco assessment and treatment. Health systems are increasingly adopting value-based care programs, and there is growing recognition that the short-term costs of implementing preventive interventions can lead to long-term gains in quality performance.[1,37] As an example of how quality improvement programs can improve tobacco treatment, in the lead-up to California's Public Hospital Redesign and Incentives in Medi-Cal (PRIME) program, the UCs and other public hospitals increased their tobacco assessment and treatment quality metric from 35% in 2012–2013 to 51% in 2014–2015.[38] Under PRIME, the UCs improved their quality metric in primary care settings from 92.6% in 2015–2016 to 97.5% in 2018–2019.[39] The

Joint Commission's voluntary inpatient tobacco quality metric could also boost performance if more health systems adopted it.[40] Maintenance of quitline e-referrals was further supported by "CA Quits," a program established in 2017 that continues the work of UC Quits in public hospital and community clinic systems across the state.[41] CA Quits hosts a Tobacco Learning Collaborative in partnership with the state Medicaid program to support shared learning among health systems on tobacco assessment and treatment integration.

The intervention achieved considerable reach within the UC health systems. Approximately 127 250 UC patients who have seen a provider in the past year are current smokers (internal data). Assuming that two-thirds are daily smokers and that 70% are interested in quitting, the target population for the intervention in this study was 59 383. The average number of patients e-referred annually in the maintenance phase was 3436, or 5.8% of the target population. The 20.6% who completed intake represent 1.2% of the target population, comparable to the approximately 1% of daily adult smokers in California who enroll in the quitline annually. In other words, the intervention succeeded in motivating smokers who did not call the quitline to participate at roughly the same rate as those who did call the quitline.

If the intervention were implemented by all providers in the state, the potential impact is considerable. With an adult smoking rate of 8.9%[42] and 31.2 million adults in California in 2021,[43] and with the same assumptions as above, the target population is approximately 972 000. If all such patients were e-referred to the quitline, it would result in about 200 000 smokers completing intake annually, or 7.2% of the state's adult smokers. If only a quarter of such patients were e-referred, it would still result in over 50 000 or 1.8% of the state's smokers completing intake annually. If replicated widely, therefore, this intervention has the potential to increase quitline utilization in the state from about 1% of smokers per year currently to between 3% and 8% per year.

Considering only those patients who receive evidence-based treatment, the e-referral intervention at a 100% referral rate would result in about 106 000 adult smokers, or 3.8%, receiving quitline counseling per year, and at a 25% referral rate would result in about 26 500 adult smokers, or 1.0%, receiving counseling per year. At the lower end of this scale, therefore, the intervention would still more than double the number of smokers receiving evidence-based quitline service.

This study has limitations. First, the study did not compare the characteristics of referred patients who did and did not complete intake, because such data were only collected at intake; the health systems themselves sent no patient data besides contact information. Second, the study did not evaluate cessation outcomes for all participants, which would have required significant additional funding. Cessation outcomes were derived from a sample randomly selected for the ongoing state-funded quitline evaluation. Third, the findings may not be generalizable to all health settings because the intervention was implemented at academic medical centers using internal funding.

As health systems increasingly engage in value-based care,[1,37] e-referral to quitlines is an evidence-based intervention that can be implemented and maintained in various practice settings and with diverse patient populations. Rapid implementation across multiple health systems is feasible with strategies to increase implementation readiness and adaptation for departmental workflows. Maintenance is enhanced with continued monitoring for technical issues and alignment with quality improvement programs. A systems approach employing multiple strategies in outpatient and inpatient settings can improve how health systems treat tobacco use and serve as a model for other quality improvement initiatives. Future research should assess how the implementation of quitline e-referrals varies across practice settings (e.g. primary care vs. specialty care), what patient characteristics are associated with e-referral acceptance and treatment compliance, and how e-referral impacts quit rates.

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## Declaration of Interests

*All authors declare no conflicts of interest for this paper.*

## Data Availability

Upon publication of this study and for at least 2 years following, aggregate data collected for the study, including a data dictionary and information about the study protocol and statistical analysis plan will be made available to other researchers upon reasonable request to the corresponding author at ektong@ucdavis.edu.

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