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An automated program to connect adult current smokers seen in an emergency department to a stop smoking Quitline

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Abstract

This study reports on an automated system to screen, refer, and deliver smoking cessation treatments to adult patients discharged home from two Medical University of South Carolina hospital emergency departments (EDs). The data for this study are based upon 165,443 ED visit records and 85,200 unique patients seen in two EDs between February 2021-May 2025. Adult current smokers discharged home who had a working phone number received an automated interactive voice recognition (IVR) call after 7 to 14 days to connect them to the South Carolina Tobacco Quitline (SCTQ). Five outcomes are described: (1) patients who screened positive for smoking; (2) eligibility for receiving automated IVR calls; (3) reached by phone; (4) interested in getting help to quit; and (5) accepting a referral to the South Carolina Tobacco Quitline (SCTQ). In addition, results of a follow-up survey of 50 patients, 25 who accepted the SCTQ referral and 25 who opted out, contacted four weeks after being seen in the ED was done to assess smoking status and connection to the SCTQ. Among unique patients, the prevalence of cigarette smoking was 17.6%, 89.0% were eligible for the IVR call, 24.0% were reached by phone, 83.6% of those reached expressed interest in receiving help to quit or continue cessation, and 21.8% accepted a referral to the SCTQ. The follow-up study revealed 90% of patients were still smoking approximately four weeks after being seen in the ED. Among patients referred to the SCTQ, 68% reported getting connected to the SCTQ with 10/17 (59%) receiving stop smoking medications. The automated tobacco screening and referral system provides a relatively low-cost strategy for referring current smokers to a stop smoking Quitline, although response to the IVR calls was low, as was acceptance of the referral by patients reached by phone.

Keywords Smoking cessation · Emergency department · Interactive voice recognition

Background

Adult smokers, especially those from lower income households, often seek care in hospital EDs because of reduced access to primary care providers [1–5]. In addition, patients seen in EDs often present with illnesses exacerbated by or even directly caused by smoking [1]. Previous studies have tested the effectiveness of smoking cessation interventions delivered to patients seen in emergency departments (EDs) [1–7]. Screening for tobacco use is routinely conducted by the healthcare team; thus, allowing for the identification of those who might be offered help to stop smoking, which makes the ED a potentially low-cost setting for delivering smoking cessation support to patients [3, 6, 7]. However, there are important barriers that make delivery of smoking cessation interventions in an ED impractical, such as lack of space, time, and resources [1, 2].

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In 2021, the Medical University of South Carolina (MUSC) implemented a fully automated screening and referral intervention in an attempt to connect adult current smokers who were discharged home from one of two MUSC EDs to the South Carolina Tobacco Quitline (SCTQ), where patients could receive smoking cessation counseling and, if eligible, access to a free starter kit of nicotine replacement therapy. Herein, we report on the results of an implementation evaluation study to document screening, referral, reach, interest, and acceptance of the automated intervention to connect adult smokers seen in MUSC's EDs to the SCTQ. In addition, results of a small follow-up survey of 50 patients, 25 who accepted the SCTQ referral and 25 who opted out, who were contacted approximately four weeks after being seen in the ED was conducted to assess smoking status and connection to the SCTQ. The findings from this evaluation are intended to inform future efforts to broaden the delivery of evidence-based smoking cessation treatments to those who continue to smoke cigarettes.

Methodology

Intervention

The intervention involved daily screening of ED electronic health record (EHRs) to identify adult current smokers who were discharged home. People who currently smoked cigarettes were identified by nursing personnel as they asked each patient about their smoking status, alcohol, and drug use as a standard of care and entered this information into the patient's EHR. ED patients ≥ 18 years of age, who reported currently smoking cigarettes, and who had a working phone number were eligible to receive an automated interactive voice recognition (IVR) call 7 to 14 days after being discharged. To enhance the response rate to the IVR calls, the automated system populated a call display name and number associated with MUSC. If the patient missed the original call and called back the call display number, they were directed to a phone line dedicated to the MUSC tobacco treatment program. Those who responded to the IVR call were asked four questions:

1 Have you smoked any cigarettes, even a puff, in the last 7 days?
2 Do you want help to quit or stay quit?
3 Would you like to be connected to the SCTQ where you can speak with their tobacco treatment specialists and find out if you are eligible for free stop smoking medication?
4 IF NO- If now is not a good time, we can arrange to have the Quitline call you back within 72 hours. Would you like us to do that?

Responders to the IVR call who answered "YES" to the question "Do you want help to quit or stay quit" were offered the option to get an immediate transfer to the SCTQ phone queue (i.e., answer YES to Q#3) or have someone from the SCTQ call them (i.e., answer "NO" to Q#3, and "YES" to Q#4). Patients were considered "reached" by phone if they provided an answer to Q#1.

Study population

Data for this study are based on a fully automated screening of 165,433 ED visit records of adult patients seen between February 2, 2021 and May 13, 2025 to assess smoking status and connect adult smokers to the SCTQ to get help to quit or stay quit. In the analysis that follows, we describe outcomes in two ways since visit records included some patients who had multiple ED visits during the 52-month study period. First, we present study outcomes based on ED visit records. Overall, 48.3% (n = 79,904) of ED visit records were from patients seen more than one time during the 52-month study period. Second, we present results for unique patients seen in the ED. Overall, there were 85,200 unique adult ED patients who were seen during the study period. Among these unique patients, 59,775 (70.2%) had only a single ED visit during the study period while 25,425 patients (29.8%) had two or more ED visits. We also compared study outcomes for unique patients based on their first visit to the ED during the study period versus their last visit to the ED to evaluate if study outcomes differed. In addition, a small follow-up survey of 50 patients, 25 patients who accepted the referral to the SCTQ and 25 patients who opted out of the referral was conducted between October 2025 and February 2026 to assess smoking status and connection to the SCTQ approximately four weeks (range: 2.4 to 8.0 weeks) after patients were seen in the ED.

Outcome measures

Five outcomes are described in this paper: (1) patients who screened positive for current smoking; (2) patients eligible for receiving automated IVR calls; (3) reached by phone; (4) among those reached by phone interested in getting help to quit; and (5) those interested in getting help to quit accepting a referral to the South Carolina Tobacco Quitline (SCTQ).

Outcomes assessed in the follow-up survey of patients who either accepted (n = 25) or opted out of the referral (n = 25) to the SCTQ included: 1) being asked about

smoking status during their ED visit and advised to stop smoking; 2) any attempt made to stop smoking since their ED visit, and 3) current smoking status and cigarettes per day. Among patients who accepted the referral to the SCTQ we asked if they got connected to the SCTQ and if so, what services they received (i.e., counseling, sent stop smoking medications),. Among patients who opted out of the referral we asked why they opted out with the following multiple response options offered: a) not ready to quit, b) not sure what services they would get from the Quitline; c) don't believe the Quitline would be helpful; d) can't quit on my own, and e) I rather talk to my doctor than a stranger about my smoking. Patients who opted out of the referral to the SCTQ were also asked if we were to send you a free 2-week supply of NRT would you be willing to try it. All follow-up survey participants were asked if they would be willing to try an e-cigarette if it were sent to them and about ways the ED could be improved to help patients stop smoking including the following multiple response options: a) provide stop smoking medications to patients, b) provide follow-up text messages to ensure connection to the SCTQ, c) connect to a health provider at the hospital rather than the Quitline; d) recontact patients in 6-months to see if they are interested in quitting, e) send patients a website URL to get information on how to quit smoking.

Analysis methods

IVR phone call records were matched to each patient's EHR from visits to MUSC's EDs based on the patient's medical record number (MRN) and date they were discharged home. Descriptive analyses were performed using SAS 9.4 (Cary, NC) to summarize study outcomes. Among unique patients based on last ED visit, odds ratios were also computed to characterize associations between patient characteristics (i.e., age, gender, race, daily smoking status, number of visits to the ED, and year of last visit to the ED) and study outcomes over the 52-month study period. To evaluate the stability of study outcomes, results were stratified by year and Joinpoint regressions were done to test for significant changes in outcomes over the five-year study period [8–10]. In the tables that follow, we report the annual percentage change (APC) from 2021 and 2025 and 95% confidence intervals. We also report results separately for patients who had only one visit to the ED during the study period compared to those who had ≥ 2 ED visits during the study period.

Results

Figure 1a shows the study results based on the 165,433 ED visit records. Figure 1b, c show the same flow diagram based on 85,200 unique patients with Fig. 1b showing results for patients' *first* visit to the ED during the 52-month study period and Fig. 1c showing the same outcomes based on the patients' *last* visit (i.e., most recent visit to the ED) during the study period. The pattern of results were similar using ED visit records as the unit of analysis or unique patients either based on either first visit or last visit to the ED. Because results were similar, we chose to show the findings below based on unique patients' last visit to the ED. For comparison, supplemental Table 1 shows study outcomes by year based on ED visit records, and supplemental Table 2 shows the study outcomes by year based on unique patients on their first visit to the ED.

Table 1 shows the characteristics of the 82,500 unique patients seen in the ED based on last visit and the association of patient characteristics and study outcomes over the 52-month study period. Overall, 11.9% of the study group was between the ages of 18–24 years, 29.1% were 25–39 years, 21.3% were 40–54 years, and 36.3% were ≥ 55 years or older. Fifty-six percent of the patient population was female, 54.3% were white race, and 29.8% had ≥ 2 visits to the ED during the study period. The overall prevalence of cigarette smoking was 17.6% with higher rates of smoking observed among non-whites (OR = 1.2, 95% CI 1.2–1.3) compared to whites, and among those 25–39 years (OR = 1.9, 95% CI 1.8–2.0), 40–54 years (OR = 2.3, 95% CI 2.1–3.4), and ≥ 55 years (OR = 1.2, 95% CI 1.1–1.2) compared to those 18–24 years. Smoking prevalence was also greater among those with 2 visits to the ED (OR = 1.3, 95% CI 1.2–1.3), and ≥ 3 or more visits to the ED (OR = 1.5, 95% CI 1.5–1.6) compared to just 1 ED visit. Smoking prevalence also decreased over time. Among current smokers, 89.0% were deemed eligible for an IVR call with slightly higher eligibility in those ≥ 55 years and older (OR = 1.3, 95 CI 1.1–1.6) compared to those age 18–24 years, and lower rates of eligibility among non-whites (OR = 0.8, 95 CI 0.7–0.9) compared to whites. Among the 13,314 patients eligible for the IVR call, we have IVR call outcomes for 13,183 patients; 131 patients were excluded as "*Permanent Refusal*" which meant that they told us at some time prior to their last ED admission they refuse future IVR calls. Among the 13,183 patients IVR outreach calls were answered by 24.0% of those eligible with lower rates of contact among those age 25–29 years (OR = 0.7, 95% CI 0.6–0.9) and age 40–54 years (OR = 0.8, 95% CI 0.7–0.9) compared to those age 18–24 years. IVR call reach was also lower among males (OR = 0.9, 95% CI 0.8–0.9) compared to females, non-whites (OR = 0.8, 95% CI 0.8–0.9) compared to whites, and those

Figure 1a-c – Flow diagram depicting study outcome based on emergency department records (1a), unique patients based on first visit (1b) and last visit (1c) to the emergency department during the study period

Study Outcomes	Figure 1a ED visit records N=165,443		Figure 1b Unique patients, *first* ED visit N=85,200		Figure 1c Unique patients, *last* ED visit N=85,200	
Screening - to identify current cigarette smokers	**Current smokers identified** 34,433/165,443 (20.8%)	Not a current smoker 131,010/165,433 (79.2%)	**Current smokers identified** 15,006/85,200 (17.6%)	Not a current smoker 70,194/84,200 (82.4%)	**Current smokers identified** 14,959/85,200 (17.6%)	Not a current smoker 70,241/85,200 (82.4%)
Referred - Current smokers eligible for IVR calls	**Referred** 30,374/34,433 (88.2%)	Not eligible for IVR calls 4,059/34,433 (11.8%)	**Referred** 13,297/15,006 (88.6%)	Not eligible for IVR calls 1,709/15,006 (11.4%)	**Referred** 13,314/14,959 (89.0%)	Not eligible for IVR calls 1,645/14,959 (11.0%)
Reached - IVR eligible who answered the IVR call	**Reached** 5,128/30,374 (16.9%)	Did not answer IVR calls 25,246/30,374 (83.1%)	**Reached** 3,769/13,297 (28.3%)	Did not answer IVR calls 9,528/13,297 (71.7%)	**Reached*** 3,159/13,183 (24.0%)	Did not answer IVR calls 10,155/13,183 (76.3%)
Interested - Answered IVR call and had interest receiving help to quit or stay quit	**Interested** 4,262/5,128 (83.1%)	Not interested in receiving help 866/5,128 (16.9%)	**Interested** 3,182/3,769 (84.4%)	Not interested in receiving help 587/3,769 (15.6%)	**Interested** 2,642/3,159 (83.6%)	Not interested in receiving help 5,17/3,159 (16.4%)
Accepted cessation assistance - Interested in assistance, and accepted the SCTQ+ referral	**Accepted** 1,009/4,262 (23.7%)	Opted out of referral to the SCTQ 3,253/4,262 (76.3%)	**Accepted** 702/3,182 (22.1%)	Opted out of referral to the SCTQ 2,480/3,182 (77.9%)	**Accepted** 576/2,642 (21.8%)	Opted out of referral to the SCTQ 2,066/2,642 (78.2%)

* Among the 13,314 patients eligible for the IVR call, we have IVR call outcomes for 13,183 patients; 131 patients were excluded as "Permanent Refusal" which meant that they told us at some time prior to their last ED admission they refuse future IVR calls.
+SCTQ stands for South Carolina Tobacco Quitline

Fig. 1 **a-c** Flow diagram depicting study outcome based on emergency department records (**1a**), unique patients based on first visit (**1b**) and last visit (**1c**) to the emergency department during the study period

with 2 ED visits (0.4, 95% CI 0.3-0.05) and ≥ 3 or more ED visits (OR = 0.3, 95% CI 0.2–0.3) compared to those with just 1 ED visit. Non-daily smokers reported a slightly higher IVR call reach (OR = 1.1, 95% CI 1.0–1.3) compared to daily smokers. Overall, 83.6% of patients reached by phone expressed interest in receiving cessation assistance with lower rates of interest expressed by those with ≥ 3 ED visits (OR = 0.6, 95% CI 0.4–0.8) compared to patients with only 1 ED visit during the study period. Among those who expressed interest in cessation assistance, 21.8% accepted the referral to the SCTQ with higher rates of acceptance among those between the ages of 25–39 years (OR = 2.2, 95% CI 1.3–3.8), 40–54 years (OR = 4.4, 95% CI 2.7–7.4%), and those ≥ 55 years (OR = 6.9, 95% CI 4.2–11.3) compared to those ages 18–24 years, non-whites (OR = 1.7, 95% CI 1.4–2.0) compared to whites, and those with ≥ 3 ED visits (OR = 1.5, 95% CI: 1.1–2.1) compared to 1 ED visit during the study period. Lower acceptance of the SCTQ referral was observed among males (OR = 0.8, 95% CI 0.6–0.9) compared to females and non-daily smokers (OR = 0.6, 95% CI 0.5–0.7) compared to daily smokers.

The Joinpoint regression analyses displayed in Table 2 reveal that most study outcomes were stable year-to-year with the exception that smoking prevalence declined significantly over the 52-month study period which was consistent with state-wide population trends [11].

Tables 3 and 4 display study outcomes by whether patients had only one ED visit or two or more ED visits during the 52-month study period. In general, the pat-tern of results were similar to those with only one ED visit compared to two or more ED visits with two exceptions. First, the percentage of patients classified as current smokers was higher among those with two or more ED visits compared to just one ED visit. Second, the percentage of patients classified as unknown smoking status was lower in patients with two or more ED visits compared to a single ED visit during the study period.

Table 5 displays results from our follow-up survey conducted approximately four weeks after patients were seen in the ED with 25 patients who accepted and 25 patients who opted out of the referral to the SCTQ. The overall response rate for the follow-up survey was 38.8% (50/129) with

Table 1 Bi-variate associations between patient characteristics and study outcomes among unique patients based on last ED visit

Patient characteristics	Study Outcomes									
	Screened patients who were *current smokers* 14,959/85,200 (17.6%)		Current smokers *eligible for IVR call* 13,314/14,959 (89.0%)		IVR eligible patients who *answered* the IVR call* 3,159/13,183 (24.0%)		Answered IVR call and had *interest receiving cessation assistance* 2,642/3,159 (83.6%)		Interested in assistance *accepted the SCTQ+referral* 576/2,642 (21.8%)	
	N (%)	odds ratios (95% CI)	N (%)	odds ratios (95% CI)	N (%)	odds ratios (95% CI)	N (%)	odds ratios (95% CI)	N (%)	odds ratios (95% CI)
Age of patients										
• 18–24 n=11,281 (13.2%)	1345 (11.9%)	Ref	1194 (88.8%)	Ref	328 (27.5%)	Ref	272 (82.9%)	Ref	18 (6.6%)	Ref
• 25–39 n=24,815 (29.1%)	5104 (20.6%)	**1.9 (1.8–2.0)**	4456 (87.3%)	0.9 (0.7–1.0)	979 (22.1%)	**0.7 (0.6–0.9)**	801 (81.8%)	**0.9 (0.7–1.3)**	110 (13.7%)	**2.2 (1.3–3.8)**
• 40–54 n=18,185 (21.3%)	4313 (23.7%)	**2.3 (2.1–2.4)**	3827 (88.7%)	1.0 (0.8–1.2)	906 (23.9%)	**0.8 (0.7–0.9)**	744 (82.1%)	**0.9 (0.7–1.3)**	178 (23.9%)	**4.4 (2.7–7.4)**
• ≥55 n=30,919 (36.3%)	4197 (13.6%)	**1.2 (1.1–1.2)**	3837 (91.4%)	**1.3 (1.1–1.6)**	946 (25.1%)	0.9 (0.8–1.0)	825 (87.2%)	1.4 (0.9–2.0)	270 (32.7%)	**6.9 (4.2–11.3)**
Gender										
• Female n=47,740 (56.0%)	6078 (12.7%)	Ref	5382 (88.5%)	Ref	1352 (25.4%)	Ref	1,137 (84.1%)	Ref	276 (24.3%)	Ref
• Male n=37,394 (43.9%)	8865 (23.7%)	**2.1 (2.0–2.2)**	7918 (89.3%)	1.1 (0.9–1.2)	1802 (23.0%)	**0.9 (0.8–0.9)**	1501 (83.3%)	0.9 (0.8–1.1)	299 (19.9%)	**0.8 (0.6–0.9)**
• Unknown n=66 (0.1%)	16 (24.2%)	**2.2 (1.2–3.8)**	14 (87.5%)	0.9 (0.2–4.0)	5 (35.7%)	1.6 (0.5–4.9)	4 (80.0%)	0.7 (0.1–6.8)	1 (25.0%)	1.0 (0.1–10.0)
Race										
• White n=46,247 (54.3%)	7435 (16.1%)	Ref	6699 (90.1%)	Ref	1695 (25.6%)	Ref	1401 (82.6%)	Ref	246 (17.6%)	Ref
• Non-white n=38,953 (45.7%)	7524 (19.3%)	**1.2 (1.2–1.3)**	6615 (87.9%)	**0.8 (0.7–0.9)**	1464 (22.3%)	**0.8 (0.8–0.9)**	1241 (84.8%)	1.2 (0.9–1.4)	330 (26.6%)	**1.7 (1.4–2.0)**
Smoking status										
• Daily users n=11,119,74.7%	11,119 (100%)	Ref	9915 (89.2%)	Ref	2295 (23.4%)	Ref	1917 (83.5%)	Ref	463 (24.4%)	Ref
• Non-daily n=3,765, 25.3%	3,765 (100%)	—	3334 (88.5%)	0.9 (0.8–1.0)	858 (26.0%)	**1.1 (1.0–1.3)**	720 (83.9%)	1.0 (0.8–1.3)	113 (15.7%)	**0.6 (0.5–0.7)**
Visits to the ED										
• 1 visit n=59,775 (70.2%)	9572 (16.0%)	Ref	8535 (89.2%)	Ref	2565 (30.2%)	Ref	2170 (84.6%)	Ref	450 (20.7%)	Ref
• 2 visits n=13,225 (15.5%)	2597 (19.6%)	**1.3 (1.2–1.3)**	2283 (87.9%)	0.9 (0.8–1.0)	336 (14.9%)	**0.4 (0.3–0.5)**	275 (81.8%)	0.8 (0.6–1.1)	70 (25.4%)	1.3 (0.9–1.8)
• ≥3 visits n=12,200 (14.3%)	2790 (22.9%)	**1.5 (1.5–1.6)**	2496 (89.5%)	1.0 (0.9–1.2)	258 (10.6%)	**0.3 (0.2–0.3)**	197 (76.4%)	**0.6 (0.4–0.8)**	56 (28.4%)	**1.5 (1.1–2.1)**

Table 1 (continued)

Patient characteristics	Study Outcomes									
	Screened patients who were *current smokers* 14,959/85,200 (17.6%)		Current smokers *eligible for IVR call* 13,314/14,959 (89.0%)		IVR eligible patients who *answered*[*] *the IVR call* 3,159/13,183 (24.0%)		Answered IVR call and had *interest receiving cessation assistance* 2,642/3,159 (83.6%)		Interested in assistance *accepted the SCTQ*[+]*referral* 576/2,642 (21.8%)	
	N (%)	odds ratios (95% CI)	N (%)	odds ratios (95% CI)	N (%)	odds ratios (95% CI)	N (%)	odds ratios (95% CI)	N (%)	odds ratios (95% CI)
Year ED visit										
• 2021 n=14,318, 16.8%	2846 (19.9%)	Ref	2495 (87.7%)	Ref	635 (25.6%)	Ref	548 (86.3%)	Ref	139 (25.4%)	Ref
• 2022 n=17,310, 20.3%	3132 (18.1%)	**0.9 (0.8–0.9)**	2716 (86.7%)	0.9 (0.8–1.1)	652 (24.2%)	0.9 (0.8–1.0)	557 (85.4%)	0.9 (0.7–1.3)	107 (19.2%)	**0.7 (0.5–0.9)**
• 2023 n=19,530, 22.9%	3386 (17.3%)	**0.8 (0.8–0.9)**	3018 (89.1%)	1.1 (0.9–1.3)	760 (25.4%)	1.0 (0.9–1.1)	623 (82.0%)	**0.7 (0.5–0.9)**	132 (21.2%)	0.8 (0.6–1.0)
• 2024 n=23,067, 27.1%	3811 (16.5%)	**0.8 (0.7–0.8)**	3462 (90.8%)	**1.4 (1.2–1.6)**	795 (23.1%)	**0.9 (0.8–0.9)**	659 (82.9%)	0.8 (0.6–1.0)	132 (20.0%)	**0.7 (0.6–0.9)**
• 2025 n=10,975, 12.9%	1784 (16.3%)	**0.8 (0.7–0.8)**	1,623 (91.0%)	**1.4 (1.2–1.7)**	317 (19.9%)	**0.7 (0.6–0.8)**	255 (80.4%)	**0.6 (0.5–0.9)**	66 (25.9%)	1.0 (0.7–1.4)

[*] Among the 13,314 patients eligible for the IVR call, we have IVR call outcomes for 13,183 patients; 131 patients were excluded as "Permanent Refusal" which meant that they told us at some time prior to their last ED admission they refuse future IVR calls

[+]SCTQ stands for South Carolina Tobacco Quitline

Bold odds ratio indicates association was statistically significant at the p<0.05 level

most non-responders (66/129 = 51.2%) failing to respond to follow-up outreach calls, with an additional eight people who refused the interview when reached, and five people excluded because they only provided partially completed interviews. Most patients reported being asked about their smoking status (80%) and advised to quit when seen in the ED (52%). Half of the patients reported making a quit attempt since being seen in the ED; 64% among those who accepted the referral to the SCTQ compared to 36% among those who opted out of the referral. Ninety percent (45/50) of patients were still smoking approximately four weeks after being seen in the ED; 84% (21/25) in the group that accepted the referral to the SCTQ compared to 96% (24/25) in the opt out group. Among patients referred to the SCTQ, 68% reported they did get connected to the SCTQ and of those connected 10/17 (58.8%) reported receiving stop smoking medications. The majority of patients reported a willingness to try nicotine replacement medications and/or an e-cigarette to help them stop smoking.

Discussion

As has been demonstrated in other studies, having staff available to engage ED patients in smoking cessation interventions can be an effective way of promoting smoking cessation [3, 6, 7]. Unfortunately, this is not practical in most ED settings which are constrained by time, staffing, and resources [1–7]. In this implementation evaluation study, we describe results of a completely automated approach to screen, refer, and deliver smoking cessation treatments to adult patients discharged home from two hospital EDs at a large academic medical center. The results of this study reveal that the automated tobacco screening and referral system was successful in identifying and referring large numbers of current smokers to the SCTQ. The response to the IVR calls was low with only 24.0% reached by phone. Among those reached by phone, 83.6% expressed interest in receiving help to quit or continue cessation but only 21.8% accepted a referral to the SCTQ. Our follow-up survey revealed that 68% of those who accepted the referral to the SCTQ were connected to the service, with 59% of those receiving stop smoking medications.

Our findings suggest that patients who had more than one ED visit were more likely to be identified as current smokers but less likely to respond to the IVR calls. The IVR reach rate was markedly lower in patients with two or more ED visits (i.e., reach rate = 12.7%) compared to patients who had just a single ED visit (i.e., reach rate = 30.2%) during the study period. Overall, among patients reached by the IVR callback, approximately 8 in 10 expressed an interest in receiving help to quit or continue cessation, although only about 1 in 5 opted to accept the referral to the SCTQ.

Table 2 Screened, referred, reached, interested, and accepted cessation assistance based on unique patients *last* visit to the emergency department by year and overall

Year/months	2021 Feb-Dec	2022 Jan-Dec	2023 Jan-Dec	2024 Jan-Dec	2025 Jan-May	Annual percentage change (95% CI)	Total
Patients	14,318	17,310	19,530	23,067	10,975	–	85,200
Screened for smoking status							
Current smokers	2846 (19.9%)	3132 (18.1%)	3386 (17.3%)	3811 (16.5%)	1784 (16.3%)	**-4.9 (−6.4 to −3.2)**	14,959 (17.6%)
Former smokers	2543 (17.8%)	3143 (18.2%)	3493 (17.9%)	4420 (19.2%)	2317 (21.1%)	4 (−0.0 to 8.2)	15,916 (18.7%)
Never smokers	7840 (54.8%)	9688 (56.0%)	11,296 (57.8%)	13,198 (57.2%)	6106 (55.6%)	0.5 (−2.3 to 3.4)	48,128 (56.5%)
Unknown smoking status	1089 (7.6%)	1347 (7.8%)	1355 (6.9%)	1638 (7.1%)	768 (7.0%)	**-2.6 (−4.8 to −0.3)**	6,197 (7.3%)
Referred—Current smokers eligible for IVR calls	2495 (87.7%)	2716 (86.7%)	3018 (89.1%)	3462 (90.8%)	1,623 (91.0%)	**1.2 (0.1 to 2.3)**	13,314 (89.0%)
Reached*—IVR eligible patients who answered the IVR call	635 (25.4%)	652 (24.0%)	760 (25.2%)	795 (23.0%)	317 (19.5%)	-5.6 (−12.2 to 1.5)	3159 (24.0%)
Interested—Answered IVR call and had interest receiving cessation assistance	548 (86.3%)	557 (-85.4%)	623 (-82.0%)	659 (-82.9%)	255 (80.4%)	**-1.7 (−2.8 to −0.6)**	2,642 (83.6%)
Accepted cessation assistance—Interested in assistance, and accepted the SCTQ+ referral	139 (25.4%)	107 (19.2%)	132 (21.2%)	132 (20.0%)	66 (25.9%)	0.8 (−15.5 to 20.4)	576 (21.8%)

*Among the 13,314 patients eligible for the IVR call, we have IVR call outcomes for 13,183 patients; 131 patients were excluded as "Permanent Refusal" which

meant that they told us at some time prior to their last ED admission they refuse future IVR calls

+SCTQ stands for South Carolina Tobacco Quitline

Bold indicates statistically significant time trend a $p<0.05$

The relatively low response to the IVR calls was not unexpected since the typical response rate to robocalls is very low, often under 10% with the majority of consumers never answering the call. To enhance the response rate to the IVR calls in our intervention, the automated system populated a call display name and number associated with MUSC, however, this display does not work on all mobile phones. Raising awareness prior to the first call would likely help improve response to outreach efforts. For the most part we did not pre-inform patients to expect an IVR call. For a brief time during the 52-month study period we did attempt to place posters in the two EDs, warning people who smoke to expect a call. The poster stated – "If you smoke, expect to hear from us." However, we found it difficult to get the posters displayed in the EDs so this was discontinued. ED staff could also be asked to provide information cards to distribute to patients who smoke telling them to expect a call from the hospital offering help to stop smoking. However, this would require an extra task for ED staff who are already overburdened with other job demands. It is unknown if response to the IVR call could be increased by attempting IVR calls sooner or perhaps delaying calls longer than we did. Two-thirds of patients in our follow-up survey four weeks after being seen in the ED reported seeking additional medical care following their ED visit, so it is unclear if they would've been more receptive to calls timed differently than the 7 to 14 interval we employed. It is possible text messaging, emailing, and online systems like MYCHART® could be employed to boost response rates but each approach has its own limitations and costs. For example, text messaging requires patient approval in advance of sending text messages, emails are not always reliable, and many patients in the ED are not enrolled in MYCHART®. While some combination of these approaches could be tested to boost response to the outreach efforts, it remains unclear how much greater the response rates would be above the

Table 3 Screened, referred, reached, interested, and accepted cessation assistance based on patients *last* visit with only one visit to the emergency department during the study period by year and overall

Year/months	2021 Feb-Dec	2022 Jan-Dec	2023 Jan-Dec	2024 Jan-Dec	2025 Jan-May	Annual percentage change (95% CI)	Total
Patients	12,456	13,308	13,880	14,454	5690	–	59,788
Screened for smoking status							
Current smokers	2366 (19.0%)	2221 (16.7%)	2143 (15.4%)	2079 (14.4%)	764 (13.4%)	**-8.1 (−10.9 to −5.3)**	9573 (16.0%)
Former smokers	2141 (17.2%)	2231 (16.8%)	2206 (15.9%)	2275 (15.7%)	975 (17.1%)	-0.8 (−7.5 to 6.4)	9828 (16.4%)
Never smokers	6881 (55.2%)	7566 (56.8%)	8244 (59.4%)	8556 (59.2%)	3227 (56.7%)	1.0 (−2.9 to 5.0)	34474 (57.7%)
Unknown smoking status	1068 (8.6%)	1290 (9.7%)	1287 (9.3%)	1544 (10.7%)	724 (12.7%)	**9.2 (2.9 to 15.9)**	5913 (9.9%)
Referred—Current smokers eligible for IVR calls	2086 (88.2%)	1942 (87.4%)	1913 (89.3%)	1896 (91.2%)	699 (91.5%)	1.2 (−0.3 to 2.7)	8536 (89.2%)
Reached[*]—IVR eligible patients who answered the IVR call	614 (29.6%)	568 (29.3%)	596 (31.3%)	576 (30.5%)	211 (30.4%)	0.9 (−1.1 to 2.9)	2565 (30.2%)
Interested—Answered IVR call and had interest receiving cessation assistance	533 (86.8%)	489 (86.1%)	492 (82.5%)	485 (84.2%)	171 (81.0%)	**-1.6 (−2.9 to −0.3)**	2170 (84.6%)
Accepted cessation assistance—Interested in assistance, and accepted the SCTQ[+] referral	138 (25.9%)	92 (18.8%)	100 (20.3%)	79 (16.3%)	41 (24.0%)	-2.9 (-30.2 to 35.2)	450 (20.7%)

[*]Among the 8536 patients eligible for the IVR call, we have IVR call outcomes for 8,492 patients; 44 patients were excluded as "Permanent Refusal" which meant that they told us at some time prior to their last ED admission they refuse future IVR calls

+SCTQ stands for South Carolina Tobacco Quitline

Bold indicates statistically significant time trend at $p<0.05$

24.0% reach rate found using an automated IVR strategy like the one used in this study.

It is not exactly clear why there is such a large gap between expressing an interest in receiving help to quit compared to acceptance of the referral to the SCTQ. It could be lack of familiarity with the SCTQ that may cause some people to opt-out of the referral which might suggest that additional treatment options might elicit a higher acceptance rate. In one study where adult smokers were cold-called and offered a referral to a stop smoking Quitline, 41% of accepted the referral [12]. The lower acceptance rate in this study may be due in part to the use of an automated call to interact with patients, whereas the other study had live interviewers who were able to answer questions about the referral and the services provided. Other studies have found even higher acceptance of cessation assistance when stop smoking treatments such as NRT and a free e-cigarette starter kit are provided in the ED [6, 7]. In our follow-up survey 56% of patients endorsed the concept of providing stop smoking medications to patients as a way to improve the delivery of smoking cessation treatments to patients seen in the ED. Population surveys have also found that the people who smoke often are willing to express a desire to stop smoking but only a fraction actually report acting on that desire by making a subsequent quit attempt [13]. Regardless, we suspect that an expressed interest in receiving help to stop smoking does not necessarily mean the person is ready to take immediate action to stop smoking by accepting a referral to a stop smoking service. In our follow-up survey of patients who opted out of the referral, 68% said they were not ready to quit smoking at the time as the reason for opting out, a finding which is consistent with the fact that only 36% reported making a quit attempt since their visit to the ED compared to 64% among those who accepted the SCTQ referral. In another study involving a large, nationwide sample of adult smokers, 25% reported interest in a study for those who intend to quit now (i.e., within the next 30 days) while the remainder reported interest in a study but not intending to quit now [14]. This study also found that those who were ready to quit right away were more likely to express a strong desire to stop smoking and reported higher self-efficacy for quitting compared to those delaying quitting. Interestingly in this study, acceptance of the referral to the SCTQ was higher among older patients, non-whites, and those who had two or more visits to the ED (i.e., acceptance rate = 26.7%) compared to those who only had one visit to the ED (i.e., acceptance rate = 20.7%).

Table 4 Screened, referred, reached, interested, and accepted cessation assistance based on unique patients *last* visit with ≥2 visits to the emergency department during the study period by year and overall

Year/months	2021 Feb-Dec	2022 Jan-Dec	2023 Jan-Dec	2024 Jan-Dec	2025 Jan-May	Annual percentage change (95% CI)	Total
Patients	1864	4002	5650	8613	5285	–	25,412
Screened for smoking status							
Current smokers	480 (25.8%)	911 (22.8%)	1243 (22.0%)	1732 (20.1%)	1020 (19.3%)	**-6.8 (-9.5 to -4.1)**	5386 (21.2%)
Former smokers	402 (21.6%)	912 (22.8%)	1287 (22.8%)	2145 (24.9%)	1342 (25.4%)	**4.2 (2.0 to 6.4)**	6088 (24.0%)
Never smokers	959 (51.5%)	2122 (53.0%)	3052 (54.0%)	4642 (53.9%)	2879 (54.5%)	**1.3 (0.1 to 2.6)**	13,654 (53.7%)
Unknown smoking status	21 (1.1%)	57 (1.4%)	68 (1.2%)	94 (1.1%)	44 (0.8%)	-8.4 (-17.0 to 1.0)	284 (1.1%)
Referred—Current smokers eligible for IVR calls	409 (85.2%)	774 (85.0%)	1105 (88.9%)	1566 (90.4%)	924 (90.6%)	**1.9 (1.0 to 2.7)**	4778 (88.7%)
Reached[*]—IVR eligible patients who answered the IVR call	21 (5.2%)	84 (11.1%)	164 (15.1%)	219 (14.1%)	106 (11.8%)	20.7 (-20.5 to 82.2)	594 (12.7%)
Interested—Answered IVR call and had interest receiving cessation assistance	15 (71.4%)	68 (81.0%)	131 (79.9%)	174 (79.4%)	84 (79.2%)	1.9 (-2.3 to 6.2)	472 (79.5%)
Accepted cessation assistance—Interested in assistance, and accepted the SCTQ[+] referral	1 (6.7%)	15 (22.1%)	32 (24.4%)	53 (30.5%)	25 (29.8%)	39.2(-20.4 to 141.0)	126 (26.7%)

[*]Among the 4778 patients eligible for the IVR call, we have IVR call outcomes for 4691 patients; 87 patients were excluded as "Permanent Refusal" which meant that they told us at some time prior to their last ED admission they refuse future IVR calls

+SCTQ stands for South Carolina Tobacco Quitline

Bold indicates statistically significant time trend at $p<0.05$

The estimated average cost to MUSC to operate the automated ED intervention was estimated to be approximately $10,000 per year. The $10,000 annual cost is an average and may not accurately reflect costs for establishing and operating a stand-alone automated ED intervention program. At MUSC, the vendor we employed (i.e., TelASK Inc, Mount Pleasant, South Carolina, USA) operates a larger package of services for the medical center that includes screening and tracking hospitalized patients and patients seen in a statewide network of oncology clinics. In the first year of the automated ED intervention (i.e., 2021), there was a one-time $15,000 expense to install software to allow for HIPAA-compliant transfer of ED visit records allowing for daily screening of ED visits to identify current smokers. Recurring annual costs include monthly phone charges, vendor maintenance, ongoing security monitoring of the system, and quarterly reporting to ensure the system is functioning properly. At an estimated average annual cost of $10,000 the cost per patient referred was $0.75, $3.16 per patient reached by the IVR calls, and $17.36 per patient transferred to the SCTQ. Even if these costs were doubled, this represents a relatively low-cost intervention compared to other stop smoking interventions that have been tested in the ED setting [6, 7]. However, previous studies of smokers seen in EDs have found that patients were more receptive to receiving the immediate offer of free stop smoking medications or e-cigarettes, both of which have been found to be associated with higher quit rates after follow-up [3, 6, 7]. Respondents to the follow-up survey also expressed interest in receiving free stop smoking medications or e-cigarettes. Thus, if resources are available to provide onsite tobacco cessation medications, this may be an optimal strategy.

There are several limitations to this study worth noting. First, the smoking status of patients is self-reported and may not be up-to-date as it was obtained from the patient's EHR. A second limitation to the current study is the limited data available on the downstream smoking status of patients after discharge from the ED. We have no information on the large fraction of patients who failed to respond to the IVR calls. We were able to conduct a small follow-up study of

Table 5 Responses to questions in follow-up survey conducted between October 2025 and February 2026 of 25 patients who accepted a referral to the SCTQ and 25 patients who opted out of the referral

Characteristics of the follow-up sample	Accepted referral to the SCTQ N = 25	Opted out of referral to the SCTQ N = 25	Total sample N = 50
Average age in years (range)	54.2 (range: 34–79)	55.3 (range: 34–75)	Mean = 54.8 (range: 34 to 79)
Sex • % male	44.0%	40.0%	42.0%
Average number of weeks from time seen in the ED to follow-up survey completion (range)	4.0 (range: 2.4–8.0)	3.7 (range: 2.4–5.6)	3.8 (range: 2.4 to 8.0)
Responses to questions in the follow-up survey			
Were you satisfied with the services you received when you were last seen in the MUSC ED? (%, yes)	100%	100%	100%
Have you sought medical care elsewhere since you were seen in the MUSC ED? (%, yes, n)	64.0%	60.0%	62.0%
Were you currently smoking when you were last seen in the ED? (% yes)	100%	100%,	100%
Were you asked about your smoking status when seen in the ED? (% yes)	84%	76%	80.0%
Were you advised to stop smoking when seen in the ED? (% yes)	60%	44%	52.0%
Have you tried to stop smoking since being seen in the ED? (%, yes)	64%	36%	50%
Have you smoked any cigarettes today? (%, yes)	84%	96%	90.0%
Among those smoking today, how many cigarettes per day do you smoke on average? (range)	Mean = 11.1 (range: 2–20)	Mean = 12.7 (range: 3–40)	Mean = 11.9 (range: 2–40)
Among people who accepted the referral to the SCTQ, n = 25			
Did you get connected to the SCTQ (% yes)	68%	NA	34.0%
If yes, what services did you get?		NA	NA
Counseling calls (%, yes)	48%		
Stop smoking medications sent to my home (%, yes)	40%		
Educational materials sent to my home (%, yes)	8%		
Among people who opted out of the referral to the SCTQ, n = 25			
Why did you opt out (select all that apply)	NA		NA
I was not ready to quit at the time (% yes)		68%	
I was not sure what services I would get from the quitline (% yes)		32%	
I do not believe the quitline would be very helpful for me (% yes)		4%	
I can quit on my own, I do not need help (% yes)		8%	
I'd rather talk to my doctor rather than a stranger about my smoking (% yes)		8%	
If we were to send you a free 2-week supply of nicotine replacement products, would you be willing to try it to help you quit smoking? (% yes)	NA	88%	NA
If we were to send you an e-cigarette would you be willing to try it to help you quit (% yes)	76.0%	70.8%	72.0%
Which of the following things would you endorse we do to improve the delivery of stop smoking treatment to patients seen in the ED (select all that apply)			
Provide stop smoking medication to patients (% yes)	56.0%	56.0%	56.0%
Provide follow-up text to ensure connection to the SCTQ (% yes)	40.0%	12.0%	26.0%
Connect patients with an MUSC health care provider, instead of the SCTQ (% yes)	24.0%	32.0%	28.0%
Recontact patients every 6-months via text to see if they are interested in quitting (% yes)	36.0%	40.0%	38.0%
Send patients a website URL where they can get information to help them get information on stop smoking treatments (% yes)	12.0%	12.0%	12.0%

50 patients, 25 who accepted the SCTQ referral and 25 who opted out, contacted approximately four weeks after being seen in the ED to assess smoking status and connection to the SCTQ. The follow-up study revealed that 90% of patients were still smoking approximately four weeks after being seen in the ED. Among patients referred to the SCTQ, 68% reported getting they did get connected to the SCTQ with and of those connected 10/17 (59%) receiving stop smoking medications, which was reassuring. However, the follow-up survey is relatively small and is not representative of all referred patients. Among 25 patients who opted out of the referral most said they were not ready to quit although 22 or 25 said they would be willing to try using nicotine replacement medication if sent to them for free. Providing stop smoking medications or an e-cigarette to eligible patients at the time of discharge from the ED would appear to be an obvious way to engage more patients in making a future quit attempt. A future pilot study might consider testing the feasibility of providing current smokers with a voucher for a free supply of nicotine replacement therapy and/or a free e-cigarette starter kit to see if patients would redeem the voucher after being discharged from the ED.

In summary, the automated tobacco screening and referral system described represents a relatively low-cost strategy for reaching current smokers who were discharged home from an ED. Over 80% of patients reached by IVR expressed interest in receiving help to quit smoking or continue cessation. Approximately 1 in 5 opted to accept the referral to the SCTQ. This suggests a need to consider additional treatment options for patients.

Implications

The automated tobacco screening and referral system described represents a relatively low-cost strategy for reaching current smokers upon discharge from an ED. Over 80% of patients reached by IVR expressed interest in receiving help to quit smoking or continue cessation. Approximately 1 in 5 opted to accept the referral to the SCTQ. This suggests a need to consider additional treatment options for patients.

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Author contributions Conceptualization of the study – KMC; Securing funding KMC; Analysis plans and execution – AR, AAB, VT, KMC; Data collection – KMC, VT; Lead on writing of the manuscript –AR, KMC; Manuscript editing – AAB, VT, KBC, DMK, BAT

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Data availability A deidentifi ed dataset generated and/or analyzed in this study is available from the corresponding author upon reasonable request.

Declarations

Conflict of interest VT is employed by TelASK the vendor hired by MUSC to operate the Quit Plan Manager™ system used for patient tracking. KMC and BAT both have received payments as expert witnesses in litigation filed against the tobacco industry. All other authors have no conflicts to report.

Ethical approval and consent to participate This research study was reviewed and approved with respect to the study of human subjects by the Medical University of South Carolina's Institutional Review Board-I, Short title: Evaluation of an opt-out ED TTS for home-discharged patients; Study Protocol #00134703.

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