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Abstract

Purpose: Electronic health records (EHRs) can facilitate primary care providers' (PCPs) use of best practices in addressing tobacco dependence. It is unknown whether rural PCPs reap the same benefits as their urban counterparts when employing EHRs for this purpose. Our study examines this issue.

Methods: This cross-sectional investigation based on the 2012–2015 National Ambulatory Medical Care Survey used chi-square tests and adjusted logistic regression models to explore how rurality and use of tobacco-related EHR functions were related to smoking status documentation (SSD) and cessation treatment at adult primary care visits.

Findings: SSD rates were similar in visits to rural- and urban-based PCPs (88.2% rural-based vs 81.1% urban-based, $P = .5819$). Use of EHRs for SSD was associated with higher SSD odds at visits to both rural- and urban-based PCPs, but this increase was greater for visits to rural-based PCPs (428% vs 220% urban-based, $P = .0443$). Rates of cessation treatment at smokers' visits were low in rural and urban contexts (19.3% rural vs 19.6% urban, $P = .9430$). Odds of cessation treatment were 68% higher where EHRs were used to remind PCPs of treatment guidelines ($P = .001$), with no rural-urban difference in the size of the increase. Access to EHRs with tobacco-related functions was similar across rural and urban practices.

Conclusions: Rural-based PCPs were at least as successful as urban-based PCPs in leveraging EHRs to enhance tobacco-related services. Even where EHRs are used, opportunities exist to expand cessation treatment in rural primary care.

KEYWORDS
EHR, primary care, rural, tobacco

Tobacco smoking has been on the decline for over 50 years in the United States.[1,2] Nevertheless, tobacco use remains a leading cause of preventable death,[1,3] and tobacco imposes disproportionate health burdens on certain populations—rural communities among them.[4] Rural residents are more likely than their urban peers to report smoking,[5–7] with rural-urban disparities particularly pronounced among subpopulations such as non-Hispanic Whites, Hispanics, people with behavioral health disorders, and pregnant women.[8] Higher rural rates of smoking may contribute to the documented rural-urban gap in mortality due to tobacco-related conditions including stroke, heart disease, cancer, and chronic lower respiratory disease.[9] Given these findings, it is especially important for rural primary care providers (PCPs) to use best practices in detecting and treating tobacco dependence.

Clinical guidelines established by the US Public Health Service (USPHS) specify that at every primary care visit, patient smoking status should be evaluated and documented, and brief, evidence-based cessation treatment should be offered to every smoker.[10] Recommended

interventions include counseling and cessation medications, used independently or in combination.[11,12] Despite strong evidence that adherence to USPHS guidelines increases cessation rates,[12] not all PCPs consistently achieve these standards of care. Nationwide, tobacco-use screening is omitted in more than one-quarter of adult primary care visits.[13–16] Among primary care visits by current smokers, cessation counseling occurs in fewer than one-third of visits, and cessation medications are prescribed or provided in fewer than one-tenth.[13–15]

Few investigators have considered whether smoking screening and treatment practices differ across rural and urban primary care settings. However, one regional study found that despite higher rural smoking prevalence, rural outpatients had 70% lower odds of receiving cessation treatment than their urban peers.[17]

The literature offers reasons why rural PCPs might have greater difficulty in maintaining smoking-related standards of care. First, rural primary care workforce shortages[18] may result in increased burdens for rural PCPs, who may thus lack time to respond optimally to their patients' smoking.[19] Further, some rural cultures are characterized by pro-tobacco norms.[20,21] Where such norms prevail, rural providers may hesitate to discuss their patients' smoking because they expect the topic to elicit resistance or erode rapport.

Electronic health records (EHRs) could help rural PCPs overcome some of the obstacles they face in adhering to smoking-related guidelines. Research suggests that EHRs can improve the quality of smoking treatment in primary care.[15,22] In a study using national data on primary care visits, Bae and associates found that where EHRs were routinely used to record smoking status and deliver automated reminders of guidelines, outcomes including smoking status documentation (SSD), cessation counseling, and prescription of cessation medication were significantly higher than where EHRs were not used.[15]

Following the passage of the 2009 Health Information Technology for Economic and Clinical Health (HITECH) Act, which provided federal grant funding and incentives to promote EHR infrastructure development and meaningful use (MU) in US health care systems,[23] primary care practices across the country took advantage of the Act's provisions to acquire EHRs.[24] Rural practices sometimes faced EHR adoption barriers including difficulties in meeting incentive program requirements,[25] covering costs,[26] selecting vendors,[27] and engaging provider support for system transformation.[27] Nevertheless, 61% of noncore rural primary care practices had purchased EHR systems by 2012.[25] One study found that primary care EHR adoption rates increased with increasing rurality.[28]

While many rural primary care settings possess the technology needed to deploy EHR-supported approaches for addressing smoking, limited evidence is available to help ascertain whether rural PCPs reap the same benefits as their urban counterparts when using EHRs for this purpose. Although initiatives including rural practices have demonstrated successes in using EHR-based protocols to increase rates of SSD,[29] e-referrals to tobacco quitlines,[8,30] and patient reports of past-month abstinence from tobacco,[29] evaluations of these programs did not study rural-urban differences in outcomes. This issue warrants further exploration, as some research implies that rural practices may struggle more than urban ones to achieve desired results in employing EHRs to facilitate smoking-related care. Investigators showed that PCPs in rural counties were less likely than those in nonrural counties to meet federal MU criteria,[25,31] which specified target rates for SSD and cessation interventions.[32,33] Heisey-Grove and associates observed that SSD was one of the top 5 MU challenges reported by rural health clinics and small private practices.[27]

In the present study, we addressed gaps in the literature on use of best practices for addressing smoking in rural primary care. We examined rates of SSD and cessation treatment at adult primary care visits, comparing these outcomes in visits to rural- vs urban-based physicians and exploring their association with use of EHRs to support smoking-related services. We also sought to determine whether the relationship between study outcomes and EHR use was equally strong in visits to rural- and urban-based physicians. As context for these analyses, we considered whether rural- and urban-based physicians had equal access to EHRs with smoking-related functions.

METHODS

Data source

This study used data from the 2012–2015 National Ambulatory Medical Care Survey (NAMCS).[34] This annual survey collects data on a national probability sample of visits to nonfederally employed, office-based physicians engaged primarily in patient care. Use of survey weights in the NAMCS provides nationally representative statistics on office-based care. Although visits to community health centers (CHCs) are also sampled in the NAMCS, these data are not included in the standard NAMCS data release, and they were not available for all study years. Therefore, the current investigation excluded CHCs. For each sampled visit, NAMCS field representatives, physicians, or office staff manually abstract information from medical charts, recording patient demographics, smoking status, reason for visit, diagnoses, medications prescribed, and provision of services including cessation counseling. The NAMCS also captures data on rurality and EHR use at the physician's primary practice location (PPL). If the physician practiced at more than 1 site during the survey, the PPL is defined as the site where the physician saw the most patients.

Study population

This study examined visits to primary care physicians by patients aged 18 and older. The 2012–2015 NAMCS contained 61,686 such visits (weighted N = 372,056,465); of these, 8,098 were by current smokers (weighted N = 47,703,681). Study visits were conducted by 2,383 physicians (weighted N = 425,138).

Outcomes

SSD

The NAMCS contains a question asking physicians to indicate for each visit whether or not the patient smokes currently. We coded SSD as

present if a response was entered for this item and as absent if the response was missing or listed as unknown.

Smoking cessation treatment

Each NAMCS visit record contains a question on whether or not tobacco-use counseling was provided. The record also indicates any medications prescribed, supplied, or continued at the visit. We created a flag indicating that cessation medication had been given if the visit record listed any of the following FDA-approved agents: nicotine replacement therapies (nicotine gum, lozenge, patch, nasal spray, and inhaler); varenicline; or bupropion sustained release.[35] We then combined measures for the provision of counseling and cessation medication to construct a 3-level variable showing whether the patient had received (1) no cessation treatment, (2) counseling only, or (3) any medication, with or without counseling. Finally, we dichotomized this variable, creating an indicator for provision of any cessation treatment vs none.

Explanatory variables

Rurality

To assess rurality of a physician's PPL, we used an NAMCS item reflecting whether PPLs were in Metropolitan Statistical Areas (MSAs) or non-MSAs.[36] Physicians whose PPLs were in MSAs were classified as urban-based; those with PPLs in non-MSAs were considered rural-based. Visits to urban-based physicians were designated urban; those to rural-based physicians were described as rural. Some physicians practiced at and contributed visits from secondary sites (non-PPLs) during their NAMCS participation. The NAMCS does not assign separate geocodes to non-PPLs. Thus, PPL geocodes were used as proxies for non-PPL geocodes; visits to physicians' non-PPLs received the same rural-urban designation as visits to their PPLs.

Use of EHR for SSD

To indicate whether a physician's PPL used an EHR for SSD, we recoded a NAMCS item with 3 response options: (1) EHR was used for SSD, (2) EHR recording function was available but turned off, or (3) this EHR function was not available. We considered EHR recording function to be in use if response (1) was entered, and not in use if other responses were entered. Visits were then coded with the value assigned to the PPL of the physician who conducted them.

Use of EHR to deliver automated reminders

A similar NAMCS measure indicated that (1) EHR was used to remind providers to offer guideline-based interventions and screening, (2) automated reminder function was available but turned off, or (3) automated reminders were not available. We classified this function as present if response (1) was provided and absent if other responses were recorded. Visits were categorized based on the presence or absence of automated reminders at the PPL with which they were associated.

Covariates

Patient age, sex, and race/ethnicity were selected as covariates in multivariate models, as they have been identified as predisposing factors that may influence health service use.[37,38] We also controlled for variables shown to be related to SSD or use of cessation treatment, namely: expected source of payment for services;[15] whether the visit was for preventive care;[15] and whether the visit record documented at least 1 cardiovascular risk factor or other health condition caused or exacerbated by tobacco use.[39–41] Conditions captured by this variable included: asthma; cancer; cerebrovascular disease, stroke, or transient ischemic attack; chronic kidney disease, chronic renal failure, or end-stage renal disease; chronic obstructive pulmonary disease; congestive heart failure; coronary artery disease, ischemic heart disease, or myocardial infarction; diabetes type I, type II, or unspecified; pulmonary embolism; hyperlipidemia; hypertension; and obesity.

Analyses

In all analyses, we used weights to ensure representativeness and reduce bias from sources including NAMCS complex survey design features, physician nonresponse, and omission of eligible physicians from the sampling frame. Strata and primary sampling unit assignments were included to permit pooling across survey years. Statistical tests were conducted in SUDAAN 11.0.3 (Research Triangle Institute, 2016). Taylor series linearization was used to generate valid standard errors for the weighted data.

Bivariate analyses

Using chi-square tests, we assessed rural-urban differences in demographic characteristics associated with visits. Next, we tested differences in SSD at primary care visits by rurality and use of an EHR recording function at the physician's PPL. In addition, we considered whether the delivery of cessation treatment at current smokers' primary care visits differed depending on whether visits were to rural- or urban-based physicians and whether an automated reminder function was or was not used at the PPL. Finally, we conducted 1 physician-level analysis comparing rural-based and urban-based physicians' access to EHR systems with smoking-related functions of interest at their PPLs.

Multivariate analyses

We constructed an adjusted logistic regression model to determine how odds of SSD were related to PPL rurality, use of an EHR recording function, and the interaction between these 2 variables. A second model was fit to ascertain how odds of smoking cessation

treatment were associated with PPL rurality, use of an automated reminder function, and their interaction. Both models controlled for the covariates listed above. Contrast analyses were performed to further specify the nature of any significant interactions. Tests for multicollinearity were at acceptable levels, showing tolerance values greater than 0.40 for all explanatory variables.[42]

RESULTS

Sample characteristics

Among primary care visits by adults, 11.7% (SE = 0.9) were to rural-based physicians (unweighted N = 10,521, weighted N = 43,530,606), and the remaining 88.3% (SE = 0.9) were to urban-based physicians (unweighted N = 51,165, weighted N = 328,525,859). As shown in the first 2 columns of Table 1, rurality of physician PPL was significantly associated with patient age, patient race/ethnicity, payment source, and reason for visit (ie, preventive care, not preventive care, or not identified). A higher proportion of rural than urban visits were by patients aged 65 and older (32.8% vs 28.9%, $P = .0073$), and by those of non-Hispanic White race/ethnicity (86.3% vs 65.5%, $P < .0001$). Rural visits were less likely than urban visits to be paid for by private insurance/worker's compensation (43.0% vs 51.9%) and more likely to be covered by Medicare (34.4% vs 26.2%) ($P < .0001$). Rural visits were less likely than urban ones to be for preventive care (23.5% vs 29.1%, $P = .0048$).

Over one-tenth of adult primary care visits were made by current smokers (12.8%, SE = 0.4). Of these visits, 17.6% (SE = 1.8) were to rural-based and 82.4% (SE = 1.8) were to urban-based physicians. Visits by smokers accounted for 19.3% (SE = 1.4) of rural and 12.0% (SE = 0.4) of urban visits. As indicated in the second 2 columns of Table 1, rural smokers' visits were more likely than urban smokers' visits to be by non-Hispanic White patients (89.8% rural vs 70.6% urban, $P < .0001$). A lower percentage of rural smokers' visits were paid for by private insurance/worker's compensation (36.6% vs 48.7%) and a higher percentage were covered by Medicare (28.5% vs 21.9%) ($P = .007$).

SSD: associations with rurality and use of EHR recording function at physician PPL

Chi-square tests revealed significant bivariate associations between the use of an EHR recording function at the physician PPL and SSD, both overall and within levels of PPL rurality. Among all visits in the sample, SSD rates were 61.9% (SE = 2.0) where an EHR recording function was not used and 84.8% (SE = 0.8) where this function was used ($P < .0001$). As seen in Figure 1, SSD rates for rural visits were 58.0% (SE = 4.2) where EHR was not used, as compared to 88.2% (SE = 1.4) where EHR was used ($P < .0001$). Among urban visits, SSD rates were 62.6% (SE = 2.3) where EHR was not used, and 84.4% (SE = 0.9) where EHR was used ($P < .0001$).

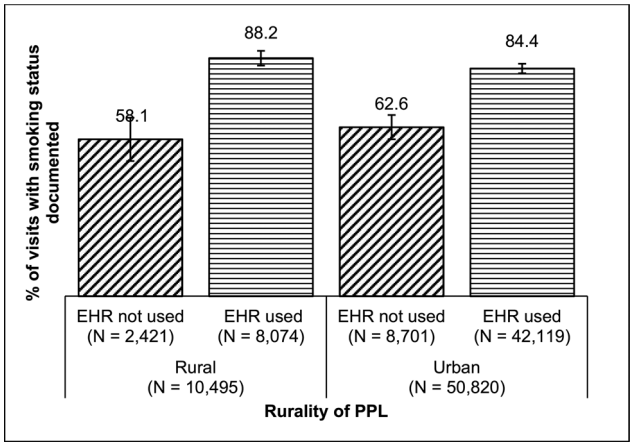

FIGURE 1 Smoking status documentation at adult primary care visits by rurality of physician primary practice location and use of electronic health record recording function[a,b].
Abbreviations: EHR, electronic health record; PPL, primary practice location.
[a]Data: 2012–2015 National Ambulatory Medical Care Survey.
[b]Unweighted N = 61,315 (excludes visits with missing EHR data).
Chi-square test of difference by EHR use among rural visits significant at $P < .0001$.
Chi-square test of difference by EHR use among urban visits significant at $P < .0001$.
Chi-square test of difference by PPL rurality where EHR was not used nonsignificant.
Chi-square test of difference by PPL rurality where EHR was used significant at $P < .05$

Overall rates of SSD were similar across rural and urban visits (88.2% [SE = 1.7] rural vs 81.1% [SE = 0.9] urban) ($P = .5819$). As Figure 1 indicates, among visits where the EHR recording function was not used at the physician PPL, there were no significant rural-urban differences in SSD rates ($P = .3488$). However, where an EHR was used to record smoking status at the PPL, SSD rates were higher for rural than for urban visits ($P = .0334$).

In multivariate analyses, SSD was regressed on PPL rurality, use of EHR recording function at the PPL, their interaction, and covariates. As shown in Table 2, the interaction between the 2 focal explanatory variables was statistically significant in this adjusted model ($P = .0443$). Contrast analyses indicated that EHR use and SSD were related for visits to both rural-based and urban-based physicians, but that the association was even greater for visits to those who were rural-based. At rural visits, the odds of SSD were 428% higher when the EHR recording function was used (95% CI: 3.43-8.13, $P < .0001$). At urban visits, EHR use was associated with a 220% increase in odds of SSD (95% CI: 2.53-4.04, $P < .0001$).

Similarly, the association between PPL rurality and SSD varied depending on whether or not the EHR recording function was used at the PPL. Where EHR was not used, rurality was unrelated to SSD (OR = 0.84, 95% CI: 0.57-1.24, $P = .3748$). Where EHR was in use, the odds of SSD were 39% higher at rural than at urban visits (95% CI: 1.02-1.88, $P = .0353$).

TABLE 1 Characteristics of adult primary care visits by rurality of physician primary practice location[a]

	All visits[b,c]		Visits by current smokers[d,e]	
	Rural PPL (N = 10,521 visits) Weighted %[f] (SE)	Urban PPL (N = 51,165 visits) Weighted %[f] (SE)	Rural PPL (N = 1,826 visits) Weighted %[f] (SE)	Urban PPL (N = 6,272 visits) Weighted %[f] (SE)
Characteristic				
Patient age**				
18-24	7.9 (0.7)	7.9 (0.4)	7.1 (1.0)	6.5 (0.5)
25-44	24.0 (1.2)	28.2 (0.8)	31.2 (2.6)	30.8 (1.0)
45-64	35.3 (1.0)	35.1 (0.6)	41.8 (2.4)	44.8 (1.2)
65+	32.8 (1.3)	28.9 (0.9)	19.9 (2.4)	18.0 (1.0)
Patient gender				
Female	63.1 (1.4)	64.6 (0.8)	57.7 (2.3)	55.0 (1.2)
Male	36.9 (1.4)	35.4 (0.8)	42.3 (2.3)	45.0 (1.2)
Patient race/ethnicity****,iv				
Non-Hispanic White	86.3 (1.8)	65.5 (1.3)	89.8 (1.4)	70.6 (1.6)
Non-Hispanic Black	6.6 (0.9)	13.0 (0.8)	5.1 (1.3)	14.7 (1.3)
Hispanic	5.5 (1.2)	15.2 (0.9)	3.8 (0.8)	10.8 (1.0)
Non-Hispanic Other	1.6 (0.3)	6.3 (0.6)	##[g]	3.9 (0.5)
Expected source of payment****,ii				
Private or workers' compensation	43.0 (1.4)	51.9 (1.0)	36.6 (2.6)	48.7 (1.6)
Medicare	34.4 (1.4)	26.2 (1.0)	28.5 (2.5)	21.9 (1.2)
Medicaid	10.8 (0.9)	10.6 (0.9)	20.4 (2.2)	15.4 (1.0)
Self-pay	4.0 (0.6)	3.6 (0.3)	5.8 (0.8)	5.2 (0.7)
Other	##[g]	1.6 (0.2)	##[g]	2.1 (0.3)
Unknown	6.1 (1.2)	6.1 (1.0)	6.5 (1.6)	6.8 (1.7)
Reason for visit*				
Preventive care	23.5 (1.7)	29.1 (0.9)	19.1 (1.8)	21.6 (1.2)
Not preventive care or not identified	76,5 (1.7)	70.9 (0.9)	80.9 (1.8)	78.4 (1.2)
Presence of smoking-related condition				
Yes	60.0 (1.7)	58.4 (1.1)	59.6 (3.0)	62.4 (1.3)
No	40.1 (1.7)	41.6 (1.1)	40.4 (3.0)	37.7 (1.3)

Abbreviations: CHIP, Children's Health Insurance Plan; PPL, physician primary practice location; SE, standard error.
[a]Data: 2012–2015 National Ambulatory Medical Care Survey.
[b]Unweighted N for all visits is 61,686.
[c]For sample including all visits: chi square test of difference by PPL rurality significant at *$P < .05$, **$P < .01$, ***>$P < .001$, ****$P < .0001$.
[d]Unweighted N for visits by adult smokers is 8,098.
[e]For sample including visits by current smokers: chi square test of difference by PPL rurality significant at [i]$P < .05$, [ii]$P < .01$, [iii]$P < .001$, [iv]$P < .0001$.
[f]Column percents may not sum to 100% due to rounding.
[g]## indicates that estimate was suppressed due to unweighted cell size less than 30.

Cessation treatment: associations with rurality and use of automated reminders at physician PPL

Chi-square tests were conducted to assess the unadjusted association of automated reminder use at physician PPL and provision of cessation treatment, among all visits and within levels of PPL rurality. Overall, rates of any cessation treatment (counseling only or any medication) were 13.2% (SE = 1.5) where automated reminders were not used and 21.0% (SE = 1.6) where reminders were used ($P < .001$). Table 3 shows rates of cessation treatment delivered at adult smokers' visits, with breakdowns by PPL rurality and use of automated reminders. Rates of any treatment at rural visits were 15.6% where reminders were absent and 20.3% where they were present. This difference was nonsignificant ($P = .4219$). Among urban visits, rates of any treatment were 12.6% when reminders were not used and 21.2% where they were used ($P < .001$).

TABLE 2 Adjusted odds of smoking status documentation at adult primary care visits[a,b]

Characteristic	OR[c,d]	95% CI
Patient age		
18-24	Reference	
25-44	0.99	0.86, 1.13
45-64	0.91	0.78, 1.07
64-84*	0.81	0.68, 0.97
Patient gender		
Female	Reference	
Male*	0.90	0.81, 0.99
Patient race/ethnicity		
Non-Hispanic White	Reference	
Non-Hispanic Black	0.84	0.68, 1.03
Hispanic	0.96	0.77, 1.20
Non-Hispanic Other	1.11	0.83, 1.48
Expected source of payment		
Private or worker's compensation	Reference	
Medicare	1.01	0.86, 1.19
Medicaid	1.00	0.82, 1.23
Self-pay**	0.70	0.54, 0.90
Other	0.86	0.55, 1.33
Unknown****	0.48	0.35, 0.67
Presence of smoking-related condition		
None	Reference	
One or more****	1.51	1.35, 1.68
Reason for visit		
Not preventive care or not identified	Reference	
Preventive care**	1.20	1.05, 1.36
Interaction of practice location by use of EHR recording function at PPL*		
Effect of EHR recording function: urban PPL		
EHR recording function not used	Reference	
EHR recording function used****	3.20	2.53, 4.04
Effect of EHR recording function: rural PPL		
EHR recording function not used	Reference	
EHR recording function used****	5.28	3.43, 8.13
Effect of PPL rurality: EHR recording function not used		
Urban	Reference	
Rural	0.84	0.57, 1.24
Effect of PP rurality: EHR recording function used		
Urban	Reference	
Rural*	1.39	1.02, 1.88

Abbreviations: CI, confidence interval; EHR, electronic medical record; OR, odds ratios; PPL, primary practice location.
[a]Data: 2012–2015 National Ambulatory Medical Care Survey.
[b]Unweighted N = 61,315 (excludes visits with missing EHR data).
[c]ORs are weighted and adjusted for all other variables in the model.
[d]ORs significant at *P <.05, **P <.01, ***P <.001, ****P <.0001.

Chi-square tests revealed no statistically significant rural-urban differences, either overall or within levels of automated reminder use (Table 3). In visits to rural- and urban-based physicians alike, about one-fifth of smokers' visits involved any type of cessation treatment (19.3% rural vs 19.6% urban, P = .9430).

When provision of any cessation treatment was regressed on PPL rurality, use of automated reminders at the PPL, the interaction of these variables, and covariates, the interaction term was nonsignificant, indicating that the relationship between reminder use and treatment was similar across rural and urban visits. Therefore, only the main-effects model is presented in Table 4. Consistent with bivariate-level results, multivariate findings showed that after adjustment for covariates, odds of treatment were 68% higher when automated reminders were used than when they were not (95% CI: 1.24-2.29, P = .001). There were no rural-urban differences in cessation treatment (OR = 0.93, 95% CI: 0.56-1.55, P = .7906).

Access to tobacco-related EHR functions at physician PPL: associations with rurality

Chi-square tests showed that at their PPLs, 76.2% (SE = 3.2) of rural-based physicians and 79.2% (SE = 1.3) of urban-based physicians had EHRs with an SSD recording function (P = .3911), while 70.4% (SE = 3.3) of rural-based physicians and 71.2% (SE = 1.5) of their urban-based peers received automated reminders (P = .8313).

DISCUSSION

Using nationwide data collected 3-6 years after the passage of the HITECH Act, this study compared the performance of rural- and urban-based primary care physicians in adhering to smoking standards of care and clarified the degree to which EHR use was associated with improved adherence to these standards in the practice of rural- vs urban-based providers. Overall rates of SSD were similar in visits to rural- and urban-based physicians. If EHRs were used to record smoking status at physicians' PPLs, odds of SSD were higher than when EHRs were not used, whether visits were conducted by rural- or urban-based physicians. However, EHR use was associated with an even greater increase in SSD odds for visits to physicians who were rural-based. Moreover, it appeared that among those using EHRs at their PPLs,

TABLE 3 Smoking cessation treatment at adult smokers' primary care visits, by rurality of physician primary practice location and use of automated reminders[a,b]

	Rural PPL			Urban PPL		
	Reminders not used[c,e] (N = 457 visits) Weighted % (SE)	Reminders used[c,f] (N = 1,324 visits) Weighted % (SE)	All Rural Visits[g] (N = 1,781 visits) Weighted % (SE)	Reminders not used[d,e] (N = 1,368 visits) Weighted % (SE)	Reminders used[d,f] (N = 4,681 visits) Weighted % (SE)	All Urban Visits[g] (N = 6,049 visits) Weighted % (SE)
Treatment type						
None	84.4 (3.5)	79.7 (4.5)	80.7 (3.6)	87.4 (1.6)	78.8 (1.7)	80.5 (1.4)
Counseling only	14.1 (3.4)	15.8 (4.1)	15.4 (3.3)	11.1 (1.6)	17.4 (1.7)	16.2 (1.4)
Any medication	##[h]	4.5 (1.1)	3.8 (0.9)	##[h]	3.8 (0.5)	3.3 (0.4)
Any treatment	15.6 (3.5)	20.3 (4.5)	19.3 (3.6)	12.6 (1.6)	21.2 (1.7)	19.6 (1.4)

Abbreviations: PPL, physician primary practice location; SE, standard error.
[a]Data: 2012–2015 National Ambulatory Medical Care Survey.
[b]Unweighted N = 7,830 (excludes visits with missing automated reminder data).
[c]Chi square test of difference by reminder use among rural visits not significant ($P > .05$).
[d]Chi square test of difference by reminder use among urban visits significant at $P < .001$.
[e]Chi square test of difference by PPL rurality where reminders were not used was not significant ($P > .05$).
[f]Chi square test of difference by PPL rurality where reminders were used was not significant ($P > .05$).
[g]Chi square test of difference for all visits by PPL rurality was not significant ($P > .05$).
[h]## indicates that estimate was suppressed due to unweighted cell size less than 30.

TABLE 4 Adjusted odds of any cessation treatment at adult smokers' primary care visits[a,b]

Characteristic	OR[c,d]	95% CI
Patient age		
18-24	Reference	
25-44	1.10	0.77, 1.58
45-64	1.26	0.83, 1.91
64-84	0.85	0.52, 1.38
Patient gender		
Female	Reference	
Male	0.99	0.81, 1.21
Patient race/ethnicity		
Non-Hispanic White	Reference	
Non-Hispanic Black	0.70	0.48, 1.04
Hispanic**	0.57	0.39, 0.85
Non-Hispanic Other	0.66	0.38, 1.13
Expected source of payment		
Private or worker's compensation	Reference	
Medicare*	1.39	1.03, 1.88
Medicaid	1.01	0.73, 1.42
Self-pay**	0.45	0.28, 0.74
Other	1.18	0.65, 2.14
Unknown	1.15	0.73, 1.79
Presence of smoking-related condition		
None	Reference	
One or more****	1.72	1.37, 2.16
Preventive care visit		
Not preventive care or not identified	Reference	
Preventive care	1.25	0.97, 1.60
PPL rurality		
Urban	Reference	
Rural	0.93	0.56, 1.55
EHR automated reminder function		
Not used	Reference	
Used**	1.68	1.24, 2.29

Abbreviations: CI, confidence interval; EHR, electronic medical record; OR, odds ratios; PPL, primary practice location.
[a]Data: 2012–2015 National Ambulatory Medical Care Survey.
[b]Unweighted N = 7,830 (excludes visits with missing EHR data).
[c]ORs are weighted and adjusted for all other variables in the model.
[d]ORs significant at $*P < .05$, $**P < .01$, $***P < .001$. $****P < .0001$.

rural-based physicians monitored smoking status more consistently than their urban-based counterparts did.

The perception of smoking as a sensitive issue may be especially relevant in influencing rural providers' screening patterns. EHR use may have had a particularly strong association with rural-based physicians'

SSD because it is effective in addressing this barrier. An EHR-generated prompt to record smoking status at every visit implicitly conveys the message that smoking discussions should be normalized and integrated into routine care. Thus, these prompts may help rural-based providers to overcome any hesitation they feel about raising the topic of smoking with their patients. Evidence indicates that, when used to facilitate identification of potentially stigmatizing problems like substance use,[43,44] mental health diagnoses,[43,45] intimate partner violence,[43] and social determinants of health such as unemployment,[46] EHRs can help primary care practices to achieve high rates of screening[43,44,46] and case detection,[45] and to exceed performance levels attained in the absence of EHR supports.[43,45]

The current investigation documented comparable rates of cessation treatment in visits to rural-based and urban-based physicians. We detected no rural-urban differences in rates of cessation counseling, prescription of cessation medication, or combined use of counseling and medication. In addition, findings showed that the odds of any cessation treatment were higher at visits to physicians whose PPLs used EHRs to deliver automated reminders supporting guideline-concordant interventions. The relationship between automated reminder use and odds of treatment was of similar magnitude whether visits were conducted by rural- or urban-based physicians. Thus, it appears that automated reminders do assist rural PCPs in their efforts to increase delivery of cessation treatment, and that the benefits they achieve through reminder use are on a par with those obtained by their urban colleagues.

Investigations based on data collected within our study period[25,27,31] and more recently[47] suggested that rural ambulatory practices ranked lower than their urban counterparts on MU of health information technology (HIT). Despite this apparent rural-urban disparity in overall HIT use, our findings showed that specific, smoking-related EHR functions were used at nearly equal rates in the PPLs of rural-based and urban-based physicians.

Limitations

Because this study was cross-sectional, findings do not support definitive conclusions about causal relationships between explanatory variables and outcomes. In addition, results are not generalizable to CHC populations, since CHC data were not included in the standard NAMCS data release on which this study was based. Further, SSD and cessation treatment could have been over- or under-reported, because NAMCS data are manually abstracted rather than electronically generated, and may be self-reported by physicians. Moreover, the outcome measures in the NAMCS may not have reflected the full scope of providers' smoking-related interactions with patients, as the survey does not flag instances when cessation interventions were offered but declined, nor does it identify referrals to other sources of cessation assistance. We have no reason to believe that there are rural-urban differences in the impact of these limitations.

Another limitation relates to rural-urban geocoding. Some physicians contributed data from both PPLs and non-PPLs. Because non-PPLs are not individually geocoded in the NAMCS, physicians' PPL geocodes were used as proxies in geocoding their non-PPL visits. Thus, some non-PPL visits to urban-based physicians might have occurred at rural sites and vice versa. As a result, the relationship between rurality and study outcomes may have been attenuated. Note, however, that differences in demographics associated with visits to rural- vs urban-based providers correspond to demographic differences usually observed between rural and urban populations: Patients visiting rural-based physicians were older,[48] more likely to be non-Hispanic White,[48] and less likely to be privately insured[49] than those visiting urban-based physicians. This observation suggests that the majority of visits to a given physician occurred at a site whose geocode matched that of the physician PPL, and that the impact of any mismatches on findings was limited.

As with geocodes, values on EHR variables were assigned to physician PPLs. The NAMCS includes no information on EHR use at any additional sites where physicians may have worked during the survey. It is, therefore, possible that some physicians contributed data from sites whose EHR status and use patterns differed from those of their PPLs. Thus, findings are best interpreted as revealing linkages between physicians' exposure to EHRs at their PPLs and the delivery of smoking-related services, rather than reflecting associations between site-specific EHR characteristics and outcomes.

CONCLUSION

Given the apparent success of rural-based physicians in using EHRs to enhance SSD, rural primary care practices might wish to leverage existing EHR capacity further to capture more specific data on patients' use of tobacco products that may be of particular concern in rural areas. For example, as rural residents are at greater risk than their urban peers for using smokeless tobacco such as chew and snuff,[5] these products might be an appropriate target for EHR-assisted screening in rural practices.[50,51] To actualize EHRs' full potential for optimizing tobacco-related services, rural practices may need financial incentives and tailored technical assistance.[47]

Although this study suggested that EHRs may play an important role in increasing rural-based providers' adherence to clinical guidelines for addressing tobacco dependence, findings also revealed that cessation treatment occurred in only about one-fifth of smokers' visits to rural-based physicians with EHR-facilitated reminder systems at their PPLs, and cessation medication was prescribed at fewer than one-twentieth of these visits. Patterns were similar for urban-based physicians. Results aligned with previous research showing low prevalence of cessation interventions in primary care.[13–15] These observations suggest that even when smoking-related EHR functions are in place, both rural and urban PCPs must take additional measures to expand their delivery of cessation interventions. Practices should support provider behavior change through evidence-based quality

improvement that includes adoption of policies prioritizing cessation treatment; delivery of standardized training on tobacco policies and procedures; development and measurement of clinic- and provider-level performance goals related to cessation treatment; and provision of individualized feedback to clinicians on their progress toward these goals.[52]

In addition to strategies targeting provider behavior, initiatives to stimulate patient demand for cessation assistance may be appropriate. Mass-reach antitobacco media campaigns, such as the Centers for Disease Control and Prevention's *Tips from Former Smokers* program (*Tips*),[53] are effective in increasing treatment uptake.[54] State comprehensive tobacco control programs (STCPs) have supported dissemination of *Tips*[55] and similar campaigns[56–59] to rural and tribal populations. Rural primary care practices should consider partnering with their STCPs to distribute antitobacco campaign materials at their sites.

Another proven approach to increasing the use of cessation assistance is to reduce patient cost barriers.[60] Research has shown that when health insurance offers comprehensive cessation coverage without cost-sharing, patients are more likely to participate in treatment[10,61–63] and succeed in quitting.[62,63] Rural PCPs could work with local stakeholders and policy makers either to extend such comprehensive coverage to rural residents or to offer no-cost cessation services to uninsured patients. Expanded coverage should be accompanied by promotion of covered services.[60] Measures focusing on both providers and patients could help rural communities realize the population health benefits and cost savings that would result from improved quit rates.[64]

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DISCLOSURES

None.

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