**Rural adoption rates of electronic medical records overtake those in urban areas; the gap is more pronounced for specialists**

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**ABSTRACT**

**Objective** To assess rural – urban differences in electronic medical record (EMR) adoption among office-based physician practices in the U.S.

**Methods** Survey data on over 270,000 office-based physician sites (representing over 1,280,000 physicians) in the U.S. collected by SK&A Information Services in 2012 was used to assess differences in EMR adoption rates between practices in rural and urban areas. Logistic regression tests for differences in the determinants of EMR adoption by geography, and a nonlinear decomposition is used to quantify how much of the rural – urban gap is due to differences in measureable characteristics (such as type of practice or affiliation with a health system).

**Results** EMR adoption rates were significantly higher for practices in rural areas (56%) versus those in urban areas (49%) in 2012 ($p<0.001$). 29 states had significantly different adoption rates between rural and urban areas, with only 2 demonstrating higher rates in urban areas. EMR adoption continues to be higher for primary care practices when compared to specialties (51% vs 49%, $p<0.001$), and state-level rural-urban differences in adoption are more pronounced for specialists. The decomposition technique finds that only 14% of the rural – urban gap can be explained by differences in measurable characteristics between practices.

**Conclusions** At the national level, rates of EMR adoption are higher for rural practices than for their urban counterparts, reversing earlier trends. This suggests that outreach efforts, namely the regional extension centers created by the Office of the National Coordinator, have been particularly effective for increasing EMR adoption in rural areas.

## INTRODUCTION

Adoption rates of Electronic Medical Record (EMR) systems have increased dramatically in the United States over the past decade, with physician-level rates moving from 18% in 2001 to 72% in 2012.[1,2] Initially, EMR adoption rates in rural areas were significantly lower than those in urban areas – a trend that held both for physicians[3] as well as hospitals.[4] Early studies hypothesized that concerns related to start-up costs, slow financial payoffs, and uncertain impacts on patient care slowed the initial adoption of EMR systems.[5,6] An important contributor to the rise in overall EMR adoption rates among office-based physicians was the Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009. This act incentivized "meaningful use" of EMR systems and also provided technical assistance to physicians who may have lacked knowledge about how to effectively implement an EMR system in their practice.[7] In addition to incentive payments from Medicare (up to $44,000 over 5 years) and Medicaid (up to $63,000 over 6 years) for physicians who adopt EMR systems, a federally funded regional extension center (REC) program set up 62 centers across the nation with personnel dedicated to assisting at least 100,000 primary care providers adopt and meaningfully use EMRs.[8,9,2] The REC program placed a particular emphasis on clinicians who work in uninsured and underserved populations (including those in rural areas), and 69% of physicians intended to participate in either the Medicare or Medicaid incentive program as of 2013.[10] These measures appear to have had a disproportionate impact on rural physicians, with recent research finding no statistical differences in EMR adoption rates between rural and urban physicians.[11,12] In fact, evidence from at least one state demonstrates that while overall EMR adoption rates were statistically the same (as of 2011), rates for some subcategories such as solo practitioners or specialties such as psychiatry were in fact significantly higher in rural areas.[13]

This paper uses a comprehensive dataset of over 1 million physicians in the U.S. to document for the first time that overall practice-level rates of EMR adoption are higher in *rural* offices than they are in urban ones (56% vs. 49%, $p<0.001$). 29 states demonstrate statistically different EMR adoption rates between offices in rural vs. urban areas; only 2 of these are situations where the urban rates are higher. Interestingly, only 20 states demonstrate significant rural – urban differences in EMR adoption rates among primary care providers, while 28 states demonstrate rural – urban differences among non-primary care specialists. In an attempt to discover the drivers of this gap, a decomposition technique is used that accounts for measurable differences between rural and urban offices (such as rural offices being more likely to be oriented towards primary care, or to accept Medicare / Medicaid). The technique demonstrates that only 14% of the gap is due to these measurable differences, implying that the majority of the gap is driven by different *relationships* between certain characteristics and EMR adoption in rural areas. One possibility for explaining these different relationships is that the REC program was much more influential for rural practices. Providing estimates of EMR adoption by specialty and geography allows for the identification of future incentive program targets – especially since current incentive programs are beginning to phase out for both Medicare and Medicaid (the last years to initiate participation are 2014 and 2016, respectively).

**METHODS**

Data regarding office-level EMR adoption were purchased from SK&A, a publicly held company specializing in health-related data. The data used were nationally representative, and included over 1,280,000 physicians working in approximately 270,000 offices as of 2012. SK&A collects their data from a compilation of corporate and company directories, state licensing information, and trade publications.  SK&A employees conduct phone surveys to supplement this data with information on organization size, practice specialty, and volume of patients seen.  The data, which is summarized by rural / urban location in Table 1, also includes whether or not the site is owned by a hospital or affiliated with a health system, and whether or not the practice accepts Medicaid and Medicare.  There are also direct questions regarding EMR adoption and how the EMR system is being used.  Any practice that had installed EMR technology was considered to have 'adopted' for the purposes of this study; however, additional questions were also asked regarding whether the EMR was used for e-prescribing or viewing labs.  Earlier versions of this dataset have been used to document low EMR adoption rates among some underserved communities[14] as well as to provide state-level evidence that for some specific physician specialties, rural adoption rates were higher.[13]

Rural is defined as non-metropolitan (i.e. at the county level) for the purposes of this paper.  Non-metropolitan counties do not contain a Metropolitan Statistical Area (MSA – typically with population greater than 50,000) and do not have more than 25% of their labor force commuting into a neighboring MSA.  If an office was located in a non-metropolitan county, it was considered rural in this analysis.

Practice-level data is used (instead of physician-level) because nearly all physicians at a practice that has adopted an EMR system will themselves be adopters.  Indeed, over 98 percent of physicians in a practice that had adopted an EMR in 2012 were using the EMR system themselves.  The data is further broken out to distinguish between primary care (family practitioner, internal medicine, obstetrics / gynecology, and pediatrician) and specialist offices.  While over 30 specialist types were included in the initial dataset, the analysis was restricted to those comprising over 2% of all specialties reported.

**Logistic Regression with Rural Shifts**

Since the adoption decision is binomial, a logistic regression was used to determine the most influential characteristics. Of particular interest is whether these characteristics have the same relationship with adoption in urban practices as they do in rural ones. Interacting a rural dummy variable with each characteristic and including them in the regression allows for documenting whether the impact of that variable is the same, regardless of geography. This type of specification can be written as:

$$y_i^* = \hat{\beta}' X_i + (\hat{\beta} + \hat{\delta})'(X_i * R) + \varepsilon_i$$

where $y_i^*$ is a measure of the benefits and costs of EMR adoption for physician office $i$, $X_i$ is a vector of characteristics that could influence EMR adoption, R is a rural dummy variable, $\hat{\beta}$ and $\hat{\delta}$ are parameter estimates, and $\varepsilon_i$ is the associated error term. Thus, the $\hat{\delta}$ parameter can be interpreted as a 'rural shift' from the basic influence seen for urban practices ($\hat{\beta}$); a statistically significant $\hat{\delta}$ estimate implies that the associated characteristic influences adoption differently in rural practices than it does in urban ones. $y_i^*$ is a latent measure and is not observed; instead only the actual adoption decision is identified (i.e. the office is seen to adopt ($y_i = 1$) if $y_i^* \geq 0$).

**Nonlinear Decomposition Technique**

This paper also seeks to explain the causes of the overall rural – urban EMR adoption gap. One popular method for examining gaps in mean outcomes (such as EMR adoption rates) between two groups is to examine how much of the gap can be explained by differences in observable characteristics. A typical approach is to conduct separate regressions on each of the groups, and then create a hypothetical outcome where *characteristics* from one group are meshed with *parameters* from the other. This technique is known as an Oaxaca-Blinder decomposition based on the seminal work of Oaxaca and Blinder.[15,16] While the original technique was applicable only to linear models, others have modified it to include non-linear specifications.[17,18]

In the context of a logistic regression, the difference in probabilities between the two groups can be expressed as:

$$\left(\hat{P}_R - \hat{P}_U\right) = \sum_{i=1}^{N_R} F\left[X_{Ri}\left(\hat{\beta} + \hat{\delta}\right)\right]/N_R - \sum_{i=1}^{N_U} F\left[X_{Ui}\hat{\beta}\right]/N_U$$

where $\hat{P}_R$ and $\hat{P}_U$ are the average probabilities of EMR adoption among rural and urban physician offices, respectively. $N_R$ and $N_U$are the sample sizes for rural and urban practices, while $X_R$ and $X_U$ are vectors of characteristics for the respective practices. Keeping in practice with the "rural shifts" used in the logistic regression described above, $\hat{\beta}$ is the estimated parameter vector for urban practices and $\hat{\delta}$ is the estimated shift for rural practices. The key component, however, is a calculation that *hypothetically* meshes urban characteristics ($X_U$) with rural parameters ($\hat{\beta} + \hat{\delta}$):

$$\hat{P}_U^0 = \sum_{i=1}^{N_U} F\left[X_{Ui}\left(\hat{\beta} + \hat{\delta}\right)\right]/N_U$$

$\hat{P}_U^0$ is then calculated for each urban practice and is interpreted as the probability of EMR adoption for urban practices if rural parameters were applied. The rural – urban gap can then be written as:

$$\left(\hat{P}_R - \hat{P}_U\right) = \left(\hat{P}_R - \hat{P}_U^0\right) + \left(\hat{P}_U^0 - \hat{P}_U\right)$$

This allows the rural - urban gap to be broken into one component associated with differences in underlying characteristics of the practices $\left(\hat{P}_R - \hat{P}_U^0\right)$ and another component which is due to differences in the underlying parameters, or behavioral differences$\left(\hat{P}_U^0 - \hat{P}_U\right)$. If the majority of the gap is driven by differences in *characteristics*, it implies that rural and urban practices have the same basic tendencies towards adopting EMRs – but that the typical rural practice is simply characterized by factors that tend towards adoption (such as ownership by a hospital or higher levels of family practitioners). However, if the gap is driven by differences in *parameters* then it is appropriate to hypothesize about the contributors to the differing relationships.

## RESULTS

Table 1 provides descriptive statistics on the practices included in the study. 31,113 of the 272,513 practices in the dataset (11%) are classified as rural. As expected, rural practices are significantly more likely to be oriented towards primary care, have only a single physician, and have lower patient volume. Notably, rural practices are also more likely to include both Nurse Practitioners (NPs) and Physician Assistants (PAs) or to be staffed only by NPs / PAs. This can have meaningful impacts on participation in EMR incentive programs since NPs and PAs are not eligible for the Medicare version of the incentive. Rural practices are also much more likely to accept both Medicaid and Medicare as a payment source, and are more likely to be owned by a hospital (though less likely to be affiliated with a health system).

**Table 1.** Characteristics of Office-based Practices, 2012

| Characteristic | Urban | Rural | |
|---|---|---|---|
| Type of Practice | | | |
| Primary Care | 32.5 | 41.8 | *** |
| Family Practitioner | 11.2 | 25.7 | *** |
| Internal Medicine | 10.3 | 8.1 | **** |
| OB / GYN | 5.8 | 4.4 | *** |
| Pediatrician | 5.3 | 3.6 | *** |
| Specialist | 67.4 | 58.1 | *** |
| Multispecialty | 10.6 | 11.9 | *** |
| Psychiatry | 6.7 | 5.7 | *** |
| Ophthalmology | 4.1 | 3.9 | ** |
| Podiatry | 3.5 | 3.0 | *** |
| Orthopedic Surgery | 3.2 | 3.5 | ** |
| Cardiology | 3.1 | 2.5 | *** |
| General Surgery | 2.6 | 3.8 | *** |
| Radiology | 2.6 | 2.5 | |
| Other Specialty | 31.1 | 21.4 | *** |
| Practice Size | | | |
| 1 | 53.2 | 58.2 | *** |
| 2-3 | 25.9 | 27.2 | *** |
| 4+ | 20.4 | 13.3 | *** |
| Daily Patient Volume | | | |
| 0-50 | 78.5 | 79.4 | *** |
| 51-100 | 15.8 | 16.1 | * |
| 100+ | 5.7 | 4.6 | *** |
| Providers | | | |
| MDs Only | 67.9 | 52.6 | *** |
| MDs and DOs | 12.0 | 16.9 | *** |
| NPs / PAs and Physicians | 15.5 | 18.4 | *** |
| NPs / PAs only | 4.7 | 12.1 | *** |
| Accepts Medicare | 82.7 | 90.8 | *** |
| Accepts Medicaid | 64.9 | 85.0 | *** |
| Affiliated with health system | 13.9 | 11.2 | *** |
| Owned by Hospital | 13.9 | 23.7 | *** |
| EMR Adoption | | | |
| EMR installed | 48.7 | 55.8 | *** |
| EMR with e-Rx capability | 36.6 | 43.0 | *** |
| EMR used to view labs | 36.4 | 42.5 | *** |
| Number of observations | 241,400 | 31,113 | |

*, **, and *** indicate statistically significant different means at the p=0.10, 0.05, and 0.01 levels, respectively

At the national level, EMR adoption rates are significantly higher for practices in rural areas when compared to their urban counterparts (56% vs. 49%, p<0.001). This pattern is repeated for more precise measures of EMR use / adoption, such as having an EMR with e-prescribe capability (43% vs. 37%, p<0.001) and using an EMR to view labs (43% vs. 36%, p<0.001). These findings represent an important shift, since previous studies of EMR adoption among ambulatory physicians found either higher rates in urban areas[3] or did not find any statistically significant differences by geographical status.

29 states exhibit statistically different EMR adoption rates between rural and urban practices, and only 2 of these are situations where urban rates are higher (Connecticut and Vermont). The gaps range from -6.5% (Vermont) to 15.5% (Alaska). One hypothesis might be that states with a higher proportion of their population living in rural areas would have higher rural – urban gaps, however a simple correlation between these variables does not uncover a meaningful relationship (Figure 1: slope = -0.19, p=0.65).

[Figure 1 about here]

**Figure 1.** Rural – urban EMR adoption gap (in percentage points) versus percentage of population residing in rural areas.
Note: States with rural-urban gaps shown as 0 did not have statistically different adoption rates between the two areas

Alternatively, we can consider state-level gaps for primary care practices (Figure 2) and specialists (Figure 3). Only 20 states have a statistically significant rural – urban gap for primary care practices, while 28 states exhibit a gap for specialty practices. Interestingly, there are no measurable spatial patterns for the general adoption gap, with Moran's I value of 0.03 (p= 0.65). This non-significant Moran's I value indicates that states with higher or lower rural – urban gaps are no more likely to be surrounded by other states with similar gaps than would be expected under a random distribution. Given that Regional Extension Centers were focused on primary care practices in underserved areas, and that the majority of the 62 RECs are state-level entities, it may be the case that state-level differences in the amount of effort expended in rural vs. urban areas impacted these varying rural – urban gaps. Indeed, recent evidence suggests that RECs have been particularly effective for physicians in rural areas, with 50 and 57% participation by physicians in large and small rural areas (compared to only 37% of urban physicians).[19,20] However, rates of physician participation varied greatly across the country, with the northeast having the highest overall enrollment rates in the REC program. Thus, rural – urban differences in REC participation could be a driving force behind the variation in state-level EMR adoption gaps identified in Figure 1.

[Figure 2 about here]

**Figure 2.** Primary care EMR adoption gaps (rural-urban) in 2012, by state

[Figure 3 about here]

**Figure 3.** Specialist EMR adoption gaps (rural-urban) in 2012, by state

Table 2 lists rural and urban EMR adoption rates by specific practice characteristics. In nearly all categories, rural adoption rates are measurably higher. The aggregate gap for specialists (8.1 percentage points) is higher than the primary care gap (6.5 percentage points). Among specialties, only cardiology and radiology do not have statistically different adoption rates; while psychiatry has a dramatic 20 percentage point gap (48.1% vs 28.0%, $p<0.001$). In terms of practice size, the rural advantage is highest among solo practitioners (49.8% vs. 40.4%, $p<0.001$) but still sizable among practices with four or more physicians (71.3% vs. 65.1%, $p<0.001$). One interesting finding is that adoption rates are highest when physicians and NPs / PAs work together in an office but are lower when an office is completely comprised of NPs and

PAs. The gap is small (but still significant) for practices that are owned by hospitals (62.7% vs. 61.3%, p=0.043).

**Table 2.** Practice-level EMR Adoption Rates by Rural / Urban Status, 2012

| | Urban | Rural | |
|---|---|---|---|
| Overall EMR Adoption Rate | 48.7 | 55.8 | *** |
| Primary Care | 50.3 | 56.8 | *** |
| Family Practice | 54.7 | 59.3 | *** |
| Internal Medicine | 48.4 | 52.3 | *** |
| OB / GYN | 45.4 | 52.6 | *** |
| Pediatrician | 49.9 | 54.7 | *** |
| Specialists | 47.9 | 55.0 | *** |
| Multispecialty | 59.7 | 65.4 | *** |
| Psychiatry | 28.0 | 48.1 | *** |
| Ophthalmology | 41.6 | 48.8 | *** |
| Podiatry | 54.7 | 56.9 | * |
| Orthopedic Surgery | 46.4 | 54.7 | *** |
| Cardiology | 56.1 | 58.0 | |
| General Surgery | 44.6 | 49.3 | ** |
| Radiology | 60.6 | 60.7 | |
| Other Specialty | 46.7 | 51.9 | *** |
| Practice Size | | | |
| Solo | 40.4 | 49.8 | *** |
| 2-3 | 53.1 | 61.5 | *** |
| 4 plus | 65.1 | 71.3 | *** |
| Daily Patient Volume | | | |
| < 50 / day | 44.6 | 52.5 | *** |
| 51- 100 | 61.2 | 66.9 | *** |
| >100 | 69.4 | 73.8 | *** |
| Providers | | | |
| MDs Only | 44.0 | 50.3 | *** |
| MDs and DOs | 58.6 | 61.7 | *** |
| NPs / PAs and Physicians | 66.7 | 70.9 | *** |
| NPs / PAs only | 52.7 | 59.9 | *** |
| Other | | | |
| Medicare (=1) | 50.4 | 56.6 | *** |
| Medicare (=0) | 40.4 | 47.4 | *** |
| Medicaid (=1) | 50.9 | 56.8 | *** |
| Medicaid (=0) | 44.6 | 49.9 | *** |
| Health System Affil (=1) | 63.5 | 69.2 | *** |
| Health System Affil (=0) | 46.2 | 54.1 | *** |
| Hospital Ownership (=1) | 61.3 | 62.7 | ** |

| | | | |
|---|---|---|---|
| Hospital Ownership (=0) | 46.6 | 53.6 | *** |
| Number of Observations | 241,400 | 31,113 | |

*, **, and *** indicate statistically significant different means at the p=0.10, 0.05, and 0.01 levels, respectively

When combined with the information in Table 1, it becomes apparent that rural practices have some characteristics that make them more likely have high levels of EMR adoption (for instance, high proportions of family practitioners, higher percentages accepting Medicare and Medicaid, and higher percentages owned by a hospital). However, they also tend towards some characteristics with lower EMR adoption rates – such as smaller practice size and daily patient volume. The decomposition technique laid out above will help to determine the extent to which these characteristics explain the aggregate rural – urban adoption gap.

**Logistic Regression Results**

The results from the logistic regression are displayed in Table 3, with practice-level EMR adoption as the dependent variable. In an attempt to determine whether the characteristics influencing EMR adoption vary between rural and urban areas, the second column presents adjusted odds ratios for urban practices, while the fourth column depicts the *shift* in adjusted odds ratios for rural practices. Statistically significant shifts indicate that there are differences in how specific characteristics impact the adoption decision across rural and urban lines.

**Table 3**. Logistic Regression of Practice-level EMR Adoption by Rural / Urban Status, 2012

| Variables | Urban | | | Rural Shift | | |
|---|---|---|---|---|---|---|
| | Odds Ratio | 95% Confidence Interval | | Odds Ratio | 95% Confidence Interval | |
| Type of Practice | | | | | | |
| Primary Care | | | | | | |
| Family Practitioner | 1.377 | (1.34-1.42) | *** | 0.870 | (0.81-0.94) | *** |
| Internal Medicine | 1.214 | (1.18-1.25) | *** | 0.862 | (0.78-0.95) | *** |
| OB / GYN | 0.880 | (0.85-0.91) | *** | 1.041 | (0.91-1.18) | |
| Pediatrician | 1.161 | (1.11-1.21) | *** | 0.983 | (1.85-1.14) | |
| Specialist | | | | | | |
| Multispecialty | 1.035 | (1.00-1.07) | ** | 0.981 | (0.89-1.08) | |
| Psychiatry | 0.485 | (0.47-0.50) | *** | 1.725 | (1.54-1.93) | *** |
| Ophthalmology | 0.787 | (0.75-0.82) | *** | 1.057 | (0.92-1.21) | |
| Podiatry | 1.697 | (1.62-1.78) | *** | 0.864 | (0.74-1.00) | * |
| Orthopedic Surgery | 0.893 | (0.85-0.94) | *** | 1.144 | (0.99-1.21) | * |
| Cardiology | 1.269 | (1.21-1.33) | *** | 0.850 | (0.72-1.00) | * |
| General Surgery | 0.969 | (0.92-1.02) | | 0.978 | (0.85-1.12) | |
| Radiology | 1.492 | (1.41-1.58) | *** | 0.847 | (0.72-1.00) | ** |
| Other Specialty | Reference | | | | | |
| Practice Size | | | | | | |
| 1 | Reference | | | | | |
| 2-3 | 1.453 | (1.42-1.49) | *** | 0.979 | (0.91-1.05) | |
| 4+ | 1.965 | (1.91-2.02) | *** | 0.969 | (0.88-1.07) | |
| Daily Patient Volume | | | *** | | | |
| 0-50 | Reference | | | | | |
| 51-100 | 1.264 | (1.23-1.30) | *** | 1.021 | (0.95-1.10) | |
| 100+ | 1.459 | (1.40-1.52) | *** | 0.948 | (0.82-1.09) | |
| Providers | | | *** | | | |
| MDs Only | Reference | | | | | |
| MDs and DOs | 1.105 | (1.08-1.13) | *** | 0.935 | (0.87-1.00) | * |
| NPs / PAs and Physicians | 1.438 | (1.39-1.52) | *** | 0.971 | (0.89-1.06) | |
| NPs / PAs only | 1.643 | (1.57-1.71) | *** | 0.941 | (0.86-1.03) | |
| Accepts Medicare | 1.301 | (1.27-1.34) | *** | 1.031 | (0.93-1.14) | |
| Accepts Medicaid | 1.013 | (0.99-1.03) | | 1.002 | (0.93-1.08) | |
| Affiliated with health system | 1.376 | (1.34-1.42) | *** | 1.095 | (0.01-1.19) | ** |
| Owned by Hospital | 1.211 | (1.18-1.25) | *** | 0.952 | (0.89-1.02) | |
| Intercept | 0.464 | | *** | 1.282 | (1.16-1.42) | *** |
| Pseudo $R^2$ | 0.051 | | | | | |
| Number of observations | 241,400 | | | 31,113 | | |

*, **, and *** indicate statistical significance at the p=0.10, 0.05, and 0.01 levels, respectively
Adjusted odds ratios reported
Rural odds ratios are shifts on urban ratios

Results from the second column generally point out that some specialties have increased odds of EMR adoption, relative to the base category of 'other specialty.' These include three of the four categories for primary care: family practitioner (aOR = 1.38, p<0.001), internal medicine (aOR = 1.21, p<0.001), and pediatrician (aOR = 1.16, p<0.001) – while obstetricians and gynecologists are significantly less likely to adopt (aOR = 0.88, p<0.001). Other specialties also notably impact the likelihood of adoption, including those that significantly reduce it such as psychiatry (aOR = 0.49, p<0.001) or ophthalmology (aOR = 0.79, p<0.001), and others that increase it such as podiatry (aOR = 1.70, p<0.001) or radiology (aOR = 1.49, p<0.001). As expected, larger practice sizes increase the likelihood of adoption, as do higher average daily patient volumes. Interestingly, the presence of NPs and PAs at a practice increases the odds of EMR adoption relative to the base category of Medical Doctors (MDs) only, and practices with *only* NPs and PAs also have higher adoption odds (despite these occupations not being able to participate in the Medicare EMR incentive program). We also find that accepting Medicare (but not Medicaid), being associated with a health system, and being owned by a hospital all increase the likelihood of EMR adoption for practices across the nation.

The rural shifts (column four) demonstrate that although family practitioner and internal medicine practices have higher likelihoods of adoption in general (column two), these likelihoods are actually *reduced* if the practice is located in a rural area (aOR = 0.87, p<0.001 and aOR = 0.86, p=0.003, respectively). Other types of primary care practices (OB/GYN and pediatricians) do not demonstrate any shift in the likelihood of EMR adoption from the relationships seen in urban areas. In terms of specialties, two specific types of practices are more likely to adopt EMRs when they are located in rural areas: psychiatry (aOR = 1.73, p<0.001) and orthopedic surgery (aOR = 1.14, p = 0.061). Other types of specialties imply reduced odds of EMR adoption if a practice is located in a rural area: podiatry (aOR = 0.86, p = 0.052), cardiology (aOR = 0.85, p = 0.051) and radiology (aOR = 0.85, p = 0.047). The cardiology and radiology results are particularly interesting since the general adoption rates for these practices were not statistically different between rural and urban areas (Table 2).

The relationships between EMR adoption and practice size or daily patient volume are not statistically different for offices in rural areas. The only type of provider that has a meaningful association with rural areas is a slight reduction in the likelihood of adoption when Doctors of Osteopathy (DOs) are present (aOR = 0.94, p = 0.061). Affiliation with a health system in rural areas results in an even stronger likelihood of EMR adoption than it does in urban locations (aOR = 1.10, p = 0.037). Finally, even after accounting for all of these characteristics, the rural intercept still demonstrates that there is something about being located in a rural area that is associated with higher EMR adoption rates (aOR = 1.28, $p<0.001$). This could be the relationships formed via the REC program or unobserved characteristics of the physicians or practices (such as age, years in practice, or relationships with other health care providers). The model correctly predicts the adoption decision in 56% of the practices that do adopt and in 67% of the practices that do not adopt. However, the pseudo $R^2$ of the model is relatively low at 0.054.

**Decomposition Results**

The decomposition technique laid out above seeks to determine how much of the documented 7.1 percentage point gap in overall rural – urban EMR adoption rates (55.8% vs. 48.7%) can be explained by differences in observable characteristics. For example, Table 1 documents that rural practices are more likely to be oriented towards family practice or internal medicine, and are also more likely to accept Medicare, have an NP or PA present, and be owned by a hospital. Table 3 then suggests that each of these 'base' characteristics is associated with an increased likelihood of EMR adoption. Thus, simply having different characteristics such as those documented above could possibly comprise a significant portion of the overall gap.

Figure 4 demonstrates, however, that only 14.1% of the overall gap is due to these differences. The remaining portion of the gap (85.9%) is then due to differing relationships associated with EMR adoption between rural and urban areas.

[Figure 4 about here]

**Figure 4.** Decomposition of 2012 rural – urban EMR adoption gap

## DISCUSSION

The overall finding that EMR adoption rates were higher for rural practices as of 2012 provides evidence that the initial advantage seen by urban practices during the early and mid-2000s has been reversed. These higher rural adoption rates are consistent across nearly all practice characteristics, including specialty, practice size, and health system / hospital affiliation. However, not all states had significant rural – urban differences in practice-level adoption rates, with only 20 showing measureable differences for primary care practices and 28 for specialists. The main finding of higher aggregate EMR adoption rates for rural practices might suggest that REC programs were particularly effective in these areas. RECs were specifically focused on primary care practices in areas with high levels of uninsured or underserved areas.[5] However, the regression results point out that although rural practices are more likely to be family practice or internal medicine, being in a rural location actually *negatively* impacts the likelihood of EMR adoption for these types of practices. This is somewhat counterintuitive since RECs have been shown to be better received by rural practices than by urban ones.[19] Thus, it still appears that, generally speaking, RECs could be more effective at helping *rural* primary care physicians increase their EMR adoption rates. With the Medicaid incentive program allowing participants as late as 2016, there is still time to engage physicians that have not participated to date.

Certain specialties are also shown to have different propensities to adopt if they practice in a rural location, including dramatically higher rates seen for psychiatrists and slightly higher rates for orthopedic surgeons. The fact that ophthalmologists, cardiologists, and radiologists have lower likelihoods of adoption in rural areas implies that RECs could reach out to these particular types of practices in rural areas, perhaps by focused webinars or specialized conferences. Similarly, the fact that urban rates are lower overall suggests that some RECs may be better off focusing their attention on urban specialties with lower likelihoods of adoption, such as obstetricians, psychiatrists, ophthalmologists, or orthopedic surgeons.

While individual REC efforts likely influence the adoption rates seen for each service area, an alternative interpretation of the wide fluctuations by specialty and geography is that some professional societies may be achieving different levels of success in reaching out to their members. For example, the American Psychiatric Association has a page on their website focused specifically on EMRs, with software listings and reviews, and the American Academy of Ophthalmology has developed reports and guidelines on EMR adoption. Assessing how useful these websites and reports have been for members in rural versus urban areas may help explain some of the adoption gaps for these particular specialties.

The dramatic gains in adoption rates seen by rural practices over the last several years warrant further inspection. The fact that only 14% of the rural – urban adoption gap can be explained by differences in observable characteristics suggests that there is something (unmeasured) about residing in a rural location that positively impacts EMR adoption. One hypothesis (as discussed above) is that RECs have already done a particularly good job of reaching rural physicians. There is evidence to support this, but additional efforts to specifically measure the impact of REC contact on the adoption decision would be justified. Alternative hypotheses are (1) that physicians in rural areas are now more aware of the benefits of EMR adoption (perhaps through a more intimate network of health care practitioners), (2) that rural physicians were more responsive to the monetary EMR incentives due to fewer financial resources being available to them, or (3) that EMR companies have successfully catered to the rural market. Data to test such hypotheses would require physician or practice-level surveys that specifically ask about their rationale for adopting (or not adopting).

**CONCLUSION**

As of 2012, practice-level EMR adoption rates across the nation were measurably higher for rural practices than they were for urban ones. This statistic held for all primary care practices, most specialties, and for all practice sizes / types of providers. Recent studies have suggested that federal EMR policies should focus on adoption among non-primary care specialists and small practices,[21] and the statistics from this analysis provides support for those steps. However, the logistic regression results show that the relationships associated with EMR adoption varied dramatically between practices in rural and urban areas. These types of discrepancies suggest that opportunities to increase future adoption rates are available for the associated government programs (including the Regional Extension Centers), EMR vendors who may consider focusing on particular specialties, or professional organizations who could reach out to members in specific geographies. The decomposition technique finds that observable practice characteristic differences between rural and urban areas are not the primary drivers of the higher adoption rates in rural areas; future research may seek to address what factors unmeasured by this study caused the dramatic increase seen across rural practices. Importantly, practice-level EMR adoption rates are still below 50% for numerous specialties - and still lag dramatically for solo practitioners - which reaffirms the need for direct research on *why* individual practices chose to adopt.

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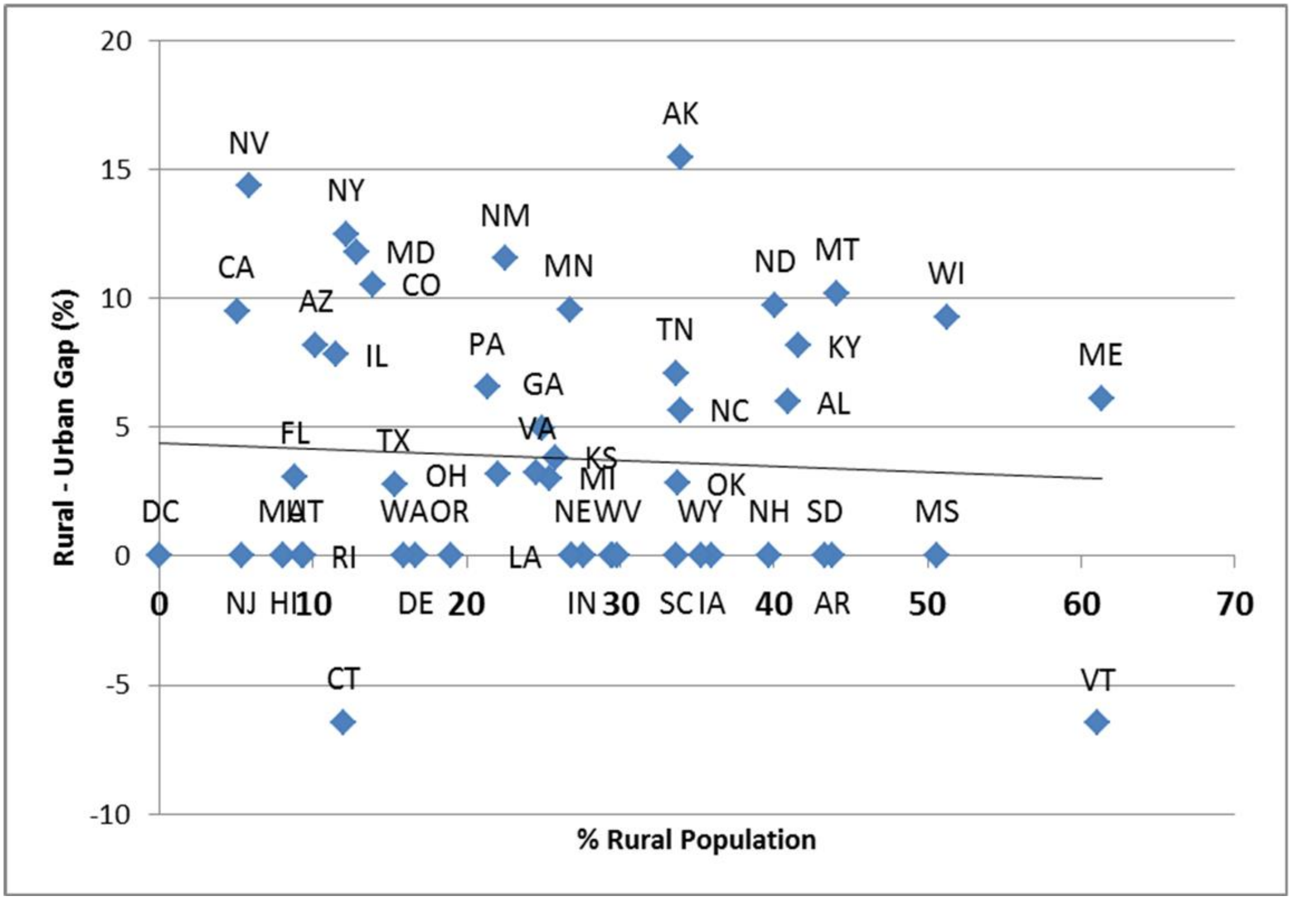


**Figure 1.** Rural – urban EMR adoption gap (in percentage points) versus percentage of population residing in rural areas

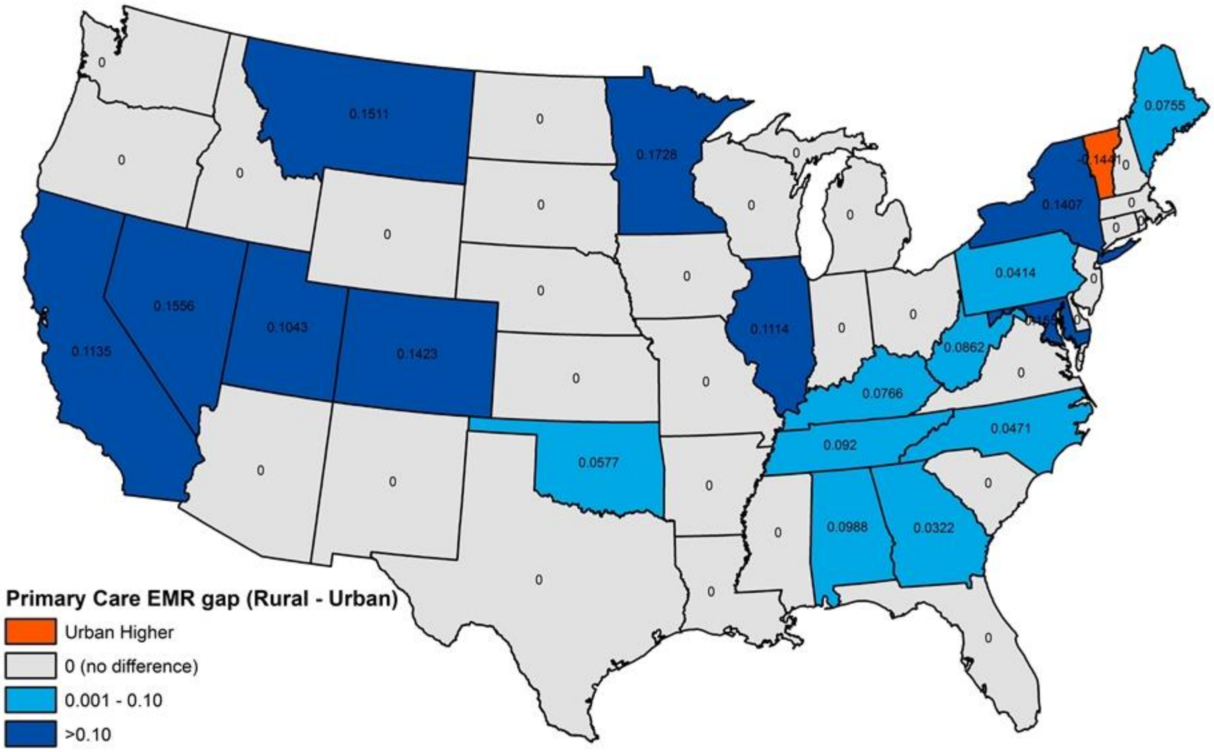


**Figure 2.** Primary care EMR adoption gaps (rural-urban) in 2012, by state

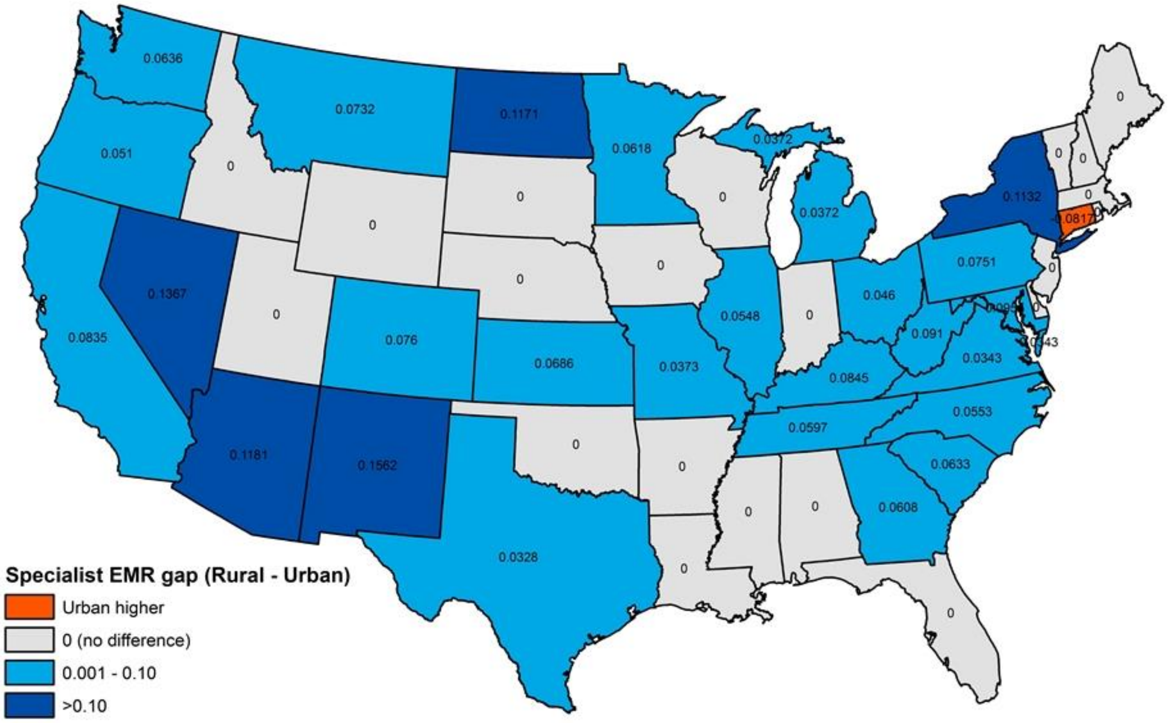


**Figure 3.** Specialist EMR adoption gaps (rural-urban) in 2012, by state

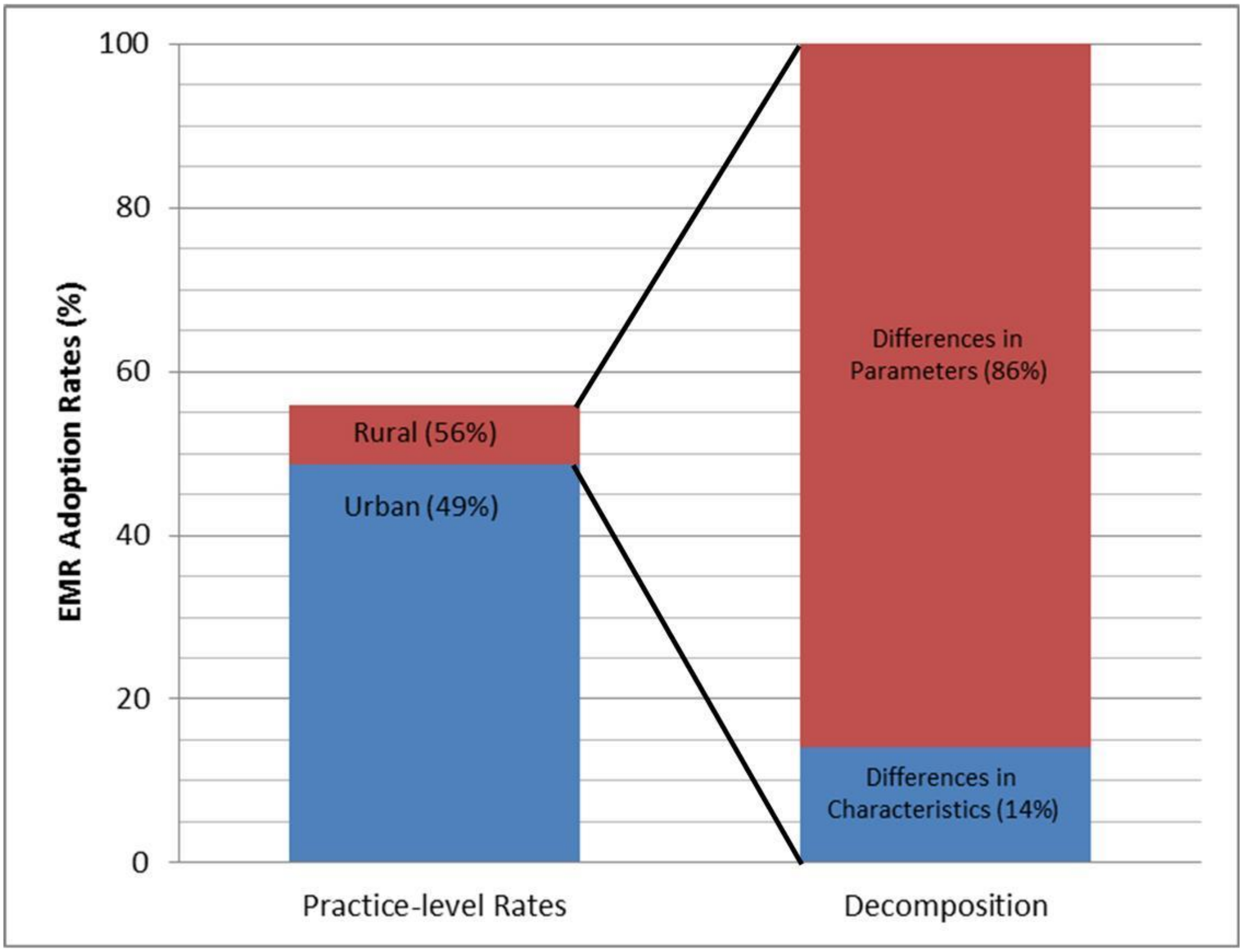


**Figure 4.** Decomposition of 2012 rural – urban EMR adoption gap