International Journal of Healthcare Management

ISSN: 2047-9700 (Print) 2047-9719 (Online) Journal homepage: https://www.tandfonline.com/loi/yjhm20

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To cite this article: Joe Lintz (2020): Adoption of computerized information management systems (CIMS) functions: Urban versus rural primary healthcare providers, International Journal of Healthcare Management, DOI: 10.1080/20479700.2020.1756109

To link to this article: https://doi.org/10.1080/20479700.2020.1756109

Published online: 27 May 2020.

INTERNATIONAL JOURNAL OF HEALTHCARE MANAGEMENT
https://doi.org/10.1080/20479700.2020.1756109

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Adoption of computerized information management systems (CIMS) functions: Urban versus rural primary healthcare providers

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ABSTRACT
This study examined whether there are differences in the adoption of specific Computerized Information Management Systems (CIMS) functionalities between urban and rural primary healthcare providers. A self-administered questionnaire was mailed to 1721 primary healthcare providers in both rural and urban areas in the state of Texas, with a 70 percent response rate ($n = 1204$). Chi-square goodness of fit was used to determine the frequency of adoption of specific CIMS functions and factor analyses for patterns of adoption. Findings revealed higher rates of adoption of key CIMS functions among urban primary healthcare providers compared with rural providers in the areas of clinical documentation and decision support. As such, many of the functions highlighted in the new Centers for Medicare & Medicaid Services (CMS) Promoting Interoperability (PI) seemingly are already being used by urban primary healthcare providers. Results also showed that higher rates of inadequate interoperability standards are related to clinical documentation, results viewing, and computerized order-entry functionalities by rural and urban primary healthcare providers. Accordingly, widespread technological interoperability inadequacy among rural and urban primary healthcare providers points to future challenges for federal policy makers as they seek to promote interoperability to demonstrate meaningful use of certified electronic health record technology (CEHRT).

ARTICLE HISTORY
Received 6 January 2020
Accepted 3 April 2020

KEYWORDS
Primary healthcare; functionalities; interoperability; CIMS; urban; rural

Introduction

Implementation and use of health information technology (HIT) including electronic health records (EHRs), has grown rapidly since the passage of the Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009 [1]. The benefits evolving from use of paper-based patient records toward electronic health records (EHR) are numerous [2]. Some of these uses include the increasing the speed and flexibility in access to accurate, up-to-date, and complete patient information at the point of care, and improvement in the decision-making process [2]. As part of HIT, Computerized Information Management Systems (CIMS) comprise EHR and operational and financial management systems and are a valuable tool providing more complete, timely, and sophisticated clinical information and support to providers and can, therefore, improve the quality of care delivered to patients [1]. Despite their advantages, there are gaps in the adoption of CIMS by ownership, location, and region of the country [2]. Indeed, primary care practices often under – or inefficiently use CIMS [3]. Part of the reason might be that expansion of CIMS usage in primary care practices is relatively new, and such practices may have insufficient resources to make the best use of the system, especially in rural areas where lack of adequate funding or resources is a major barrier to adoption of key CIMS functions [3]. As a result, current users of the system in primary care practices continue to report limitations in adoption of specific functions in CIMS, thus leading to medication errors and work disruptions across different geographical locations [3].

Statement of the problem

Prior research has identified underinvestment and relatively low financial margins as factors contributing to primary healthcare providers' difficulty in moving to models of care that deliver higher quality via the advanced EHRs. In particular, small and rural primary healthcare providers are less likely to have adopted two of the critical advanced EHR functions: EHR performance measurement and patient engagement [4,5]. As a result, primary healthcare facilities in rural areas are likely to lose reimbursements, and patients may not receive sufficient quality of care owing to ill-preparedness for implementation of CIMS [6,7].

A primary healthcare provider is defined as a primary specialty of general practice or family practice medicine, per the Texas Department of State Health Services (TDSHS). Urban areas constitute those counties in metropolitan areas having a population of at least 1 million. Rural areas comprise those counties

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in micropolitan areas having a population between 10,000 and 50,000, as defined by TDSHS.

Purpose of the study

The purpose of the study was to compare differences between urban and rural primary healthcare providers' adoption of specific CIMS functionalities. The research also gleaned providers' perceptions of key challenges in CIMS interoperability that affect organizational workflow.

Significance of the study

The current study involved examining patterns of adoption of individual CIMS function usage in urban versus rural primary healthcare providers. Additionally, focus was on perceptions of CIMS user groups about key challenges in CIMS interoperability that affect organizational workflow. To date, no previously published work has investigated specific differences in adoption of key EHR functionalities – such as medication lists, computerized prescribing, or clinical decision support – among primary healthcare providers in urban and rural locations. Thus, the present investigation could provide important insights for primary healthcare providers and policymakers seeking to move providers towards the provision of higher quality care. Furthermore, enhancing understanding of which specific CIMS functionalities are in use among rural versus urban primary healthcare providers should offer guidance about how rural and urban healthcare facilities might center their EHR efforts in the future.

Research question

The study was designed to answer the following research questions:

- Are there differences in the adoption of specific CIMS functionalities between rural and urban primary healthcare providers?

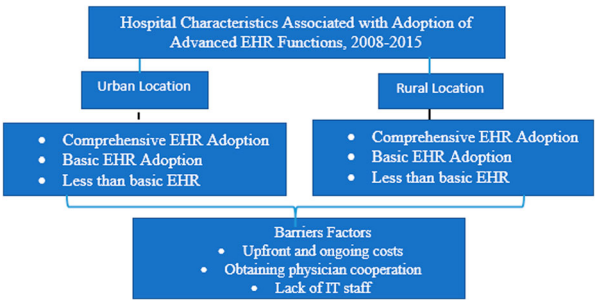

Figure 1. Theoretical framework for adoption of Electronic Health Record (EHR). Source: Adler-Milstein et al. [4], 'Electronic Health Record Adoption in US Hospitals: The Emergence of a Digital 'Advanced Use' Divide,' Journal of the American Medical Informatics Association (JAMIA). Permission granted on December 26, 2019 with License number: 4736630703825 from the Oxford University Press.

- If differences exist, which functionalities display the largest disparities in adoption between rural and urban primary healthcare providers?

The overriding hypothesis is as follows:

> *H1*: Urban primary healthcare providers are more likely to have higher rates of adoption of key CIMS functions than rural primary healthcare providers.

Support for the hypothesis is subsequently provided. The hypothesis was tested using a chi-square goodness of fit test to determine whether urban primary healthcare providers had higher rates of adoption of specific CIMS functionalities than their rural counterparts.

Literature review

The literature search employed current databases, including *PubMed* and *The Journal of American Health Information Management Association (AHIMA)*, for challenges to adoption of particular CIMS functionalities and achievement of interoperability across different geographical locations. The following keywords were used during the literature search: primary healthcare providers, EHR functionalities, interoperability, urban and rural, and adoption.

Review of research literature specific to research questions

Early studies found lower adoption rates in rural practices compared to their urban counterparts [8,9]. More recent findings further suggest that this trend continues. For example, one contemporary study revealed a significant difference in adoption rates between urban and rural providers: 82.3 percent of urban providers had adopted an EHR system compared to 78.0 percent of rural providers. Such factors as geographical location, interoperability standards, financial resources, and attainment of providers' cooperation were noted as reasons for variation between the two kinds of providers [10]. Other investigations have added support regarding increased adoption rates in urban practices across the country, thus implying that urban practices and higher rates of EHR adoption may be linked [11,9]. Notwithstanding the foregoing findings, adoption of *specific* CIMS functionalities in rural versus urban practices remains an empirical question.

This study's theoretical framework is shown in Figure 1. Predicated on the work of Adler-Milstein et al. [5], it seems especially well-suited for the current investigation for purposes of identifying whether adoption of specific CIMS functionalities differs between rural and urban healthcare providers and discerning providers' challenges in CIMS.

Variables of interest in the current study are now discussed. Summarized in the following sections are a

description of urban versus rural characteristics and experiences in EHR adoption, per the literature reviewed.

Geographical location of organization

Previous empiricism has shown that EHR adoption rates vary across geographical locations [12,9,10,13]. Although research has revealed that providers have been slow to adopt EHRs systems, implementation may vary by whether they are in an urban vs. rural locale [12]. The findings from studies exploring rural vs. urban adoption of EHRs, however, have been inconsistent. For example, one investigation examined over 261,000 ambulatory surgery centers (ASCs) about adoption and implementation of EHR systems in 2013 [9]. Results revealed that healthcare clinics in rural areas were less prepared for EHR adoption than urban providers. However, those in rural areas with the population of a small number of low-income patients had the lowest rates of EHR adoption compared with medium- to large-sized clinics in urban areas [9]. Another empirical effort ascertained that rural EHRs' adoption rates exceeded those in urban areas [5]. Specifically, EHR adoption rates were determined to vary significantly across nonmetropolitan counties, yet usage and adoption rates generally increased as a practice becomes urban [9,11].

Interoperability standards

Interoperability is the ability of two or more systems to exchange and use information. Extant empiricism has shown that exchanging patient information with a network of referring clinics can be difficult, owing to variations in system terminologies and privacy rules from state to state in both rural and urban healthcare clinics [14,15]. These challenges of functionality and interoperability thus hinder efficient and effective adoption of specific EHR functions.

In a recent study on EHR interoperability, Kruse et al. [16] concluded that rural practices – owing to their proverbial reduced level of financial and technological resources – have historically struggled to keep up with larger practices in more populated urban areas with respect to EHR interoperability. Moreover, Patel et al. [17] explored variation in interoperability among U.S. non-federal acute care clinics. Findings revealed that small rural clinics have not been able to advance as rapidly as urban facilities vis-à-vis interoperable exchange and use of health information. Specifically, rural clinics had approximately one-half the rate of engaging in all four domains of interoperability – electronically finding, sending, receiving, and integrating – compared to urban clinics (15 percent vs. 34 percent, respectively). Moreover, Huang et al. [18] explored the U.S. hospital websites to find out how they have used interactive tools to communicate with their patients and discerned that the most wired hospitals in urban areas tended to use more interactive tools, such as accessing lab result, communicating with a doctor via secure email, refilling prescriptions online than rural areas with only 3% of the most wired hospitals came from rural areas.

Financial resources

Extant empiricism has ascertained that the majority of providers in a small- to medium-sized rural facility who did not plan to adopt an EHR noted a lack of financial resources as the reason for that decision, especially those having low IT budgets [9–11,19]. Those findings are consistent with other studies: adoption rates of urban providers were higher than those of their rural peers, owing to sufficient financial resources [20–22]. Indeed, at the national level, overall practice-level adoption rates were significantly higher in urban (82.3 percent) versus those in rural (78 percent) locations [10].

Attainment of provider cooperation

Studies have shown that, compared to their urban counterparts, rural clinics were more likely to report obtaining providers' cooperation as a key barrier for adoption of EHR systems. Furthermore, small clinics in rural areas were more likely to report a cost-related barrier compared to medium and large clinics in urban areas [5]. vis-à-vis adoption of the systems. Other work has found high rates of resistance to providers' granting their cooperation for an EHR in rural healthcare facilities because of complex regulations and provider burnout associated with the technology [20,23]. Indeed, Rasmi et al. [24] determined that a key motivator to acceptance of EHRs among providers is perceived usefulness of the new system.

Review of methodological literature specific to the research question

The majority of germane literature has utilized either a qualitative or quantitative approach to explore implementation and use of EHRs from a healthcare provider's perspective [20,25–27]. The focus of the present work led the researcher to follow the approach taken by Banton and Filer [20]. They utilized a quantitative approach that employed a semi-structured open-ended questionnaire to refine further and clarify responses concerning the patterns of adoption of healthcare providers using EHRs on patient care. Those scholars averred that the mixed-question format was employed to enhance data quality and information received from participants. Accordingly, the current study applied mixed method to describe the characteristics of the selected healthcare providers in the adoption of specific CIMS functionalities between urban

and rural primary healthcare providers. Plus, using this approach is useful for generating important information about a population quickly [28].

Synthesis of research findings

The majority of literature reviewed focused on barriers to the adoption and use of new technology that vary depending on provider type and care setting [9–11,19]. Although other investigations have examined the relationship between EHR functions and adoption patterns in various healthcare settings [9–11], none has specifically explored differences in the adoption of specific EHR functionalities between rural and urban primary healthcare providers. Research investigating potential patterns of adoption of particular CIMS functionalities in rural versus urban primary healthcare providers is critically important to validate the 'Meaningful Use,' which refers to the utilization of certified EHR technology (for example, electronic prescribing) that ensures the certified EHR technology connects in a way that provides for electronic exchange of health information to improve the quality of care [9].

Method

Study measurement items were adapted from the National Electronic Health Records Survey (NEHRS) (Centers for Disease Control and Prevention [CDC]) [29] that focused on the 16 electronic functions that a federally-sanctioned expert panel identified as part of a comprehensive EHR. That major investigation asked primary healthcare providers to indicate whether they used the specific CIMS functions in their facilities, and, if so, how often. Responses were made using a four-point Likert scale with choices set ranging ranged between 1 (yes, used routinely) to 4 (not at all). The questionnaire consisted of 16 key electronic functions divided into four parts. Five questions related to the clinical documentation functions; three questions, results viewing; four questions, computerized provide order entry (CPOE); and four questions, decision support. Respondents were also asked to indicate their level of satisfaction with each of these functionalities (1 = very dissatisfied to 5 = very satisfied) and whether certain factors were major or minor barriers affecting organizational workflow (see Appendix A for the survey instrument).

Sample demographics

The population comprised the primary healthcare providers in both rural and urban areas in the state of Texas. Texas providers were selected for the sample because Texas has some of the nation's largest urban and rural primary care facilities, according to the Texas Department of State Health Services (TDSHS).

Data collection method

The survey was administered to 1721 primary healthcare providers (an estimated 90 percent of all primary healthcare providers in Texas) in both rural and urban areas. A three-step process was implemented. First, using the US postal system, the researcher mailed the questionnaire to all primary healthcare providers beginning in March and ending in December of 2017. The survey packet consisted of the instrument, a cover letter, and a confidential postage-paid return envelope addressed to the researcher. Second, a follow-up survey was mailed 30 days later to those who had not yet returned a completed survey. Third, nonresponding percipients received several phone calls and reminder letters asking them to complete the questionnaire.

Reliability and validity

The study utilized established measures from the National Electronic Health Records Survey (NEHRS) [29]. These measures have been distributed to many healthcare settings, including ambulatory healthcare milieus, and demonstrated sufficient internal consistency. In addition, they comprise items that measure EHR functionalities, process, outcomes, and satisfaction dimensions to ensure measurement validity [29].

Procedure and confidentiality

Prior to data collection, the proposal for this investigation was reviewed and approved by the Institution Review Board (IRB). In addition, the following data elements were used in the study:

- A list of all primary healthcare providers (profit/non-profit) in Texas was obtained through TDSHS.
- A list of all primary healthcare providers by location in Texas was obtained through TDSHS.
- Primary healthcare facilities included those providers who indicated that they have a primary specialty of general practice or family practice/medicine.

Efforts were taken to ensure participating providers in both rural and urban healthcare locations remained anonymous and to protect confidentiality. These endeavors included a signed consent form (provided with the survey instrument) identifying risks to participation, as well as assurances of maintenance of confidentiality.

Analysis

Chi-square goodness of fit was used to compare the proportion of primary healthcare providers who had adopted each function in rural and urban areas. Assumptions for the chi-square goodness of fit test

include that (1) data are categorical, (2) observations are independent (the same individual is not observed multiple times), (3) groups are mutually exclusive, and (4) expected frequencies have at least five for each categorical variable.

Next, using the Statistical Package for Social Science (SPSS), factor analysis was undertaken to determine the patterns of adoption in the rural and urban primary healthcare providers. Factor analysis allows the researcher to explore concepts that are not easily measured directly by reducing the number of variables into a few interpretable underlying factors [30]. Exploratory factor analysis (EFA) was utilized to identify each factor extracted; factors having eigenvalues greater or equal to 1.0 were retained. EFA afforded discovery of any latent variables that may cause observable variable to co-vary [30]. A scree plot, in combination with the eigenvalue requirement, was employed to determine the number of factors to retain [28]. After rotation, to be considered in subsequent analysis, the factor structure was determined based on the following preestablished criteria [30]: factors had to have an eigenvalue of at least 1 and contain a minimum of three variable loadings at or above the established value of .2. In addition, to determine providers' perceptions of barriers to using CIMS that affect organizational workflow, frequency counts were computed.

Results

Completed surveys totaled 1204, for a 70 percent response rate. The sample consisted of primary healthcare providers who indicated that they had a primary specialty of general practice or family practice medicine. Shown in Table 1 is the sample's demographic information. Three-quarters of respondents were male. Almost two-thirds were 40 years of age or older. In addition, 47% were urban primary healthcare providers; 53%, rural providers. Almost three-quarters had been employed 10 years or longer. Furthermore, approximately 80% were employed full-time; the remainder were part-time or contract providers.

The data revealed that, compared with rural providers, urban providers had higher rates of adoption of key CIMS functions (Table 2). Urban primary healthcare providers had significantly higher adoption levels in the clinical documentation and decision support functions. They also were more likely to use the clinical documentation functions of recording patient history/demographics (83% versus 70%, $P = 0.01$), recording patient problems list (79% versus 60%, $P < 0.01$), recording and charting vital signs (66% versus 53%, $P = 0.01$), and recording patient smoking status (39% versus 25%, $P < 0.01$). Moreover, all decision support functions had significantly higher adoption levels in the urban primary healthcare providers: clinical guidelines (55% versus 43%, $P = 0.01$), clinical reminders (46% versus 36%, $P = 0.01$), drug-to-drug interaction alerts (43% versus 33%, $P = 0.01$), and drug dosing support (89% versus 75%, $P < 0.01$).

In addition, factor analysis revealed a different pattern of adoption of key CIMS functions between urban and rural primary healthcare providers (Table 3a and 3b). Among urban providers. three factors had relatively high eigenvalues (greater than 3.0).

Table 1. Sample demographics.

	Number of participants ($n = 1204$)	Percentage
Gender		
Male	903	75
Female	301	25
Ages		
20–34	144	12
35–49	277	23
50–64	482	40
65+	301	25
Providers		
Urban	566	47
Rural	638	53
Years of Employment		
Less than 1 year	84	7
1–5 years	96	8
5–9 years	157	13
10–14 years	205	17
15–19 years	157	13
20 years or more	505	42
Employment Status		
Full-time	963	80
Part-time	157	13
Contract	84	7

Table 2. Proportion of Rural and Urban Primary Healthcare Providers with Selected CIMS Functionalities Implemented.

Functions	Urban Providers (N = 566)	Rural Providers ($N = 638$)	Difference (high-low)	*P*-value
Clinical Documentation Functions	*Percent*			
Recording patient history/ demographics	83	70	13	0.01
Recording patient problem list	79	60	19	< 0.01
Recording and charting vital signs	66	53	13	0.01
Recording patient smoking status	39	25	14	< 0.01
Recording clinical notes	59	49	10	0.01
Results Viewing				
Lab Reporting	66	59	7	0.03
Radiology Reports	78	70	8	0.04
Consultant Reports	43	35	8	0.03
Computerized Provider Order Entry (CPOE)				
Laboratory Tests	95	88	7	0.03
Radiology Tests	83	75	8	0.04
Medications	66	60	6	0.02
Consultation Requests	59	53	6	0.02
Decision Support				
Clinical Guidelines	55	43	12	0.01
Clinical Reminders	46	36	10	0.01
Drug-Drug Interaction Alerts	43	33	10	0.01
Drug Dosing Support	89	75	14	< 0.01

Factor 1 demonstrated a strong relationship between the variables and an underlying factor that associates with the adoption of key CIMS functions. Its average eigenvalue of 8.7 and nine variables load above 0.72 support this assertion. However, because there were item cross-loadings across the 3 factors, only factor 1 was used to identify the pattern of urban providers' CIMS function adoption. In particular, urban primary healthcare providers had patterns of adoption that focused on patient information, CPOE functions, and clinical- and drug related information. Factor analysis for rural providers uncovered four factors (eigenvalues were between 1.0 and 4.0). There were item-cross loadings, though, across the four factors; therefore, only the first three factors were interpreted. Rural providers emphasized patterns of functions that focused on lab reporting, certain CPOE functions, and clinical reminders.

Key challenges

Two major challenges to adoption of CIMS were identified in the study. A high percentage (90%) of respondents in both urban and rural believed the key challenges to adoption were insufficiency in interoperability standards as related to clinical documentation, results viewing, and computerized order-entry functionalities in the systems. For example, when a patient is discharged or transferred to another facility, there is no current national standard to ensure that patient data are accurately transferred between the two facilities. In addition to the interoperability issues, 10% of urban and rural respondents felt that patient data overlaying in the CIMS (when two patients are comingled within one unique identifier or MRN) is a critical element hindering organizational workflow.

Discussion

The study examined differences in the adoption of specific CIMS functionalities between urban and rural primary healthcare providers. Results showed that urban providers had higher levels of adoption of all CIMS functions, and the major differences were in the existence of clinical documentation and decision support tools available at the point of care. Urban providers also had greater availability of computerized physician order-entry (CPOE) tools, such as CPOE laboratory tests, CPOE medication, and consultation requests lists. Also, findings regarding key challenges facing providers identified the lack of data standardization in interoperability in both rural and urban areas.

Although the present research focused on primary healthcare providers in Texas, the researcher believes that this study method may be instructive to similar healthcare facilities in this country and internationally. Although the level of EHR adoption is growing

Table 3a. Factor Loadings for Urban Primary Healthcare Providers.

Variable	Factor 1 eigen = 8.7	Factor 2 eigen = 4.1	Factor 3 eigen = 3.2	Factor 4 eigen=1.0
Patient history/ demographics	0.7653	0.2456	0.1326	0.0136
Patient problem list	0.8285	0.3375	0.2540	0.1106
Recording and charting vital signs	0.8789	0.1196	0.0063	−0.0189
Patient smoking status	0.7356	−0.1569	0.0156	0.1086
Recording clinical notes	0.7228	−0.1196	0.0110	0.1118
Lab Reporting	0.0241	0.1569	0.0160	0.2156
Radiology Reports	0.2220	0.0960	0.1236	−0.2110
Consultant Reports	0.1281	−0.1163	−0.2202	0.1011
CPOE Laboratory Tests	0.3122	0.0216	0.0120	0.0104
CPOE Radiology Tests	0.3370	0.3389	0.3389	0.0800
CPOE Medications	0.4261	0.2780	0.1001	0.1201
CPOE Consultation Requests	0.5289	0.1058	−0.0190	0.1089
Clinical Guidelines	0.9323	0.1233	0.2039	0.1200
Clinical Reminders	0.8636	−0.2789	0.0410	0.0036
Drug-Drug Interaction Alerts	0.8145	0.1102	0.1164	0.0420
Drug Dosing Support	0.8236	0.2296	0.0369	0.0896

Maximum factor loadings are in bold. Factors are incorporated only for eigenvalues greater or equal to 1.0.

Table 3b. Factor Loadings for Rural Primary Healthcare Providers.

Variable	Factor 1 eigen = 4.0	Factor 2 eigen. = 3.2	Factor 3 eigen. = 2.1	Factor 4 eigen. = 1.0
Patient history/ demographics	0.0236	0.0174	0.0236	0.0456
Patient problem list	0.1196	0.1256	0.2386	0.2106
Recording and charting vital signs	−0.0456	−0.0336	0.0063	−0.1789
Patient smoking status	0.0356	0.1260	0.0156	0.0400
Recording clinical notes	0.0228	0.1823	0.0110	0.1218
Lab Reporting	0.0156	0.2156	0.0171	0.1156
Radiology Reports	0.2113	0.2460	0.0316	−0.1110
Consultant Reports	0.1280	−0.2275	−0.2030	0.1011
CPOE Laboratory Tests	0.0412	0.2216	0.0120	0.0104
CPOE Radiology Tests	0.1289	−0.1926	0.0189	0.0030
CPOE Medications	0.2261	−0.1102	0.1001	0.1201
CPOE Consultation Requests	0.4189	0.1158	−0.0190	0.1089
Clinical Guidelines	0.2189	0.1023	0.2039	0.1200
Clinical Reminders	0.0536	0.1369	0.2410	0.0036
Drug-Drug Interaction Alerts	0.2241	0.2286	0.3164	0.0420
Drug Dosing Support	0.2336	0.1378	0.2369	0.3896

Maximum factor loadings are in bold. Factors are incorporated only for eigenvalues greater than or equal to 1.0.

internationally, ability to exchange information for care coordination and patient portal adoption seemingly is low [5]. The findings of the current study may provide insight to create international benchmarks to improve adoption and use of EHRs and health IT. Therefore, the present efforts offer an opportunity to expand the research beyond the current areas of focus.

Study findings compared with the literature

Study findings are consistent with previous empiricism on the subject that has found that urban facilities are significantly more likely to adopt CIMS than rural facilities [9,12]. One potential explanation for the differences is the impact of the 'Meaningful Use' EHR Incentive Program. For example, federal incentive programs have provided billions of dollars in funding directly to hospitals and providers in rural and urban areas to help healthcare leaders and administrators implement EHRs [6]. The goals of the program were to transform the healthcare system for improved quality and efficiency by increasing adoption and use of EHRs [9,19]. In addition, the current undertaking's results suggested that the patterns of adoption of key CIMS functions were different across rural and urban providers. The dissimilarities imply that certain functions emphasized by the new Meaningful Use rules are already being utilized in urban providers. This outcome is compatible with previous work that has centered on barriers to providers' use of EHRs. Those efforts have inferred that urban healthcare providers tend to employ information technology more fully than rural area providers [9,19].

The results regarding key challenges to adoption of EHRs indicated that primary healthcare providers in both rural and urban areas have concerns about CIMS interoperability. The findings are consistent with those found in previous literature: absence of financial resources to acquire a new system and achieve interoperability between disparate EHRs, especially in the adoption of specific EHR functionalities – such as clinical documentation, results viewing, computerized order-entry functionalities, and development of a standard EHR infrastructure to achieve interoperability [9,19]. Another major hurdle identified pertains to getting CIMS to link with different health information systems for communication; this obstacle arises owing to a lack of format standardization for achieving interoperability.

Implications for healthcare providers

The current study focused on differences in the adoption of specific CIMS functionalities between urban and rural primary healthcare providers. Low usage of many key functions in CIMS among rural primary healthcare providers – especially clinical documentation and decision support functions – may prompt healthcare providers in rural areas, as well as in developing countries (with putatively reduced resources), to reassess the adoption of specific EHR functions owing to costs of patient care in such facilities. In addition, the results of the present research offer healthcare providers in the U.S. (and possibly in other nations) a foundational framework to facilitate proactive development of a strategic plan of action to address adoption of key functionalities. The findings of this investigation also offer insight into the level of awareness of the patterns of adoption from the perspective of healthcare providers and healthcare leaders. Finally, identification of issues related to adoption of key EHR functions, particularly from a primary healthcare provider perspective, should be instrumental in offering an effective response nationally and internationally.

Limitations and future research

The study has a number of limitations; consequently, the results should be interpreted with caution. First, the sample focused solely on Texas; therefore, the findings might not be indicative of other primary healthcare providers in the United States in terms of adoption of CIMS functionalities. Second, the research's outcomes may have been affected by non-responses bias. Lastly, the current effort did not seek to link adoption of specific CIMS functions with clinical or financial outcomes.

Future research should include a random sample of urban and rural primary healthcare providers from other states and in international venues. Such research should allow a researcher to validate the differences in the adoption of specific CIMS and other information system functionalities between urban and rural primary healthcare providers in the United States and beyond. Additionally, further empiricism could seek to detail barriers to health information system interoperability and the impact of CIMS training on organization performance vis-a-vis data accuracy, cost, and operational risks.

Conclusion

Low adoption rates in many key CIMS functions among rural primary healthcare providers imply the likelihood of future challenges for rural healthcare leaders as they seek to ensure that all providers and facilities achieve widespread EHR adoption while concurrently improving the quality of care. In addition, the results concerning key challenges imply that, despite increased efforts by the federal government to encourage providers and healthcare facilities to adopt and use key functions in EHR systems through the Promoting Interoperability (PI) Program, primary

healthcare providers in both rural and urban areas are still struggling with exchanging patient information between disparate EHRs when providing care to patients.

Notes on contributor

Dr. Joe Lintz is the Health Information Management (HIM) Program Director at Parker University. He has 17 years of experience in the practice of healthcare statistics, research methods, and data analytics. He received his doctoral degree in Health Administration (HA) from Central Michigan University and bachelor and master's degrees in HIM and Allied Health Management from The Ohio State University respectively.

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Table A1. Sample Survey for Providers (primary specialty of general practice, family practice/medicine) Computerized Information Management Systems (CIMS) was adapted from National Electronic Health Records Survey, Centers for Disease Control and Prevention (CDC) 2014.

CIMS Primary Healthcare Providers Survey

1. What is the reporting location? Rural ☐1 Urban ☐0
2. Gender ☐1=male ☐ 2=femaleact
3. Age____
5. Years in practice ☐1 –5 years ☐5 - 9 years ☐10 -14 years ☐15 -19 years ☐20 years or more

Providers Using CIMS for the Following Functions: CHECK NO MORE THAN ONE BOX PER ROW.	Yes, used routinely	Yes, but not used routinely	Yes,but turned off or not used	No
Clinical Documentation Functions				
a) Recording patient history and demographic Information?	☐1	☐2	☐3	☐4
b) Recording patient problem list?	☐1	☐2	☐3	☐4
c) Recording and charting vital signs?	☐1	☐2	☐3	☐4
d) Recording patient smoking status?	☐1	☐2	☐3	☐4
e) Recording clinical notes?	☐1	☐2	☐3	☐4
Results Viewing				
a) Lab Reporting	☐1	☐2	☐3	☐4
b) Radiology Reports	☐1	☐2	☐3	☐4
c) Consultant Reports	☐1	☐2	☐3	☐4
Computerized Provider Order Entry				
a) Laboratory Tests	☐1	☐2	☐3	☐4
b) Radiology Tests	☐1	☐2	☐3	☐4
c) Medications	☐1	☐2	☐3	☐4
d) Consultation Requests	☐1	☐2	☐3	☐4
Decision Support				
a) Clinical Guidelines	☐1	☐2	☐3	☐4
b) Clinical Reminders	☐1	☐2	☐3	☐4
c) Drug-Drug Interaction Alerts	☐1	☐2	☐3	☐4
d) Drug Dosing Support (e.g., renal dose guideline)	☐1	☐2	☐3	☐4

An overall level of satisfaction with each of these functionalities.	Very Dissatisfied	Somewhat Dissatisfied	Neither	Somewhat Satisfied	Very Satisfied
	☐1	☐2	☐3	☐4	☐5

What are the key challenges in CIMS that affect organizational workflow?