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## Adoption of health information technology among U.S. nursing facilities

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### Abstract

**Objectives:** Nursing facilities have lagged behind in the adoption interoperable health information technology (i.e. technologies that allow the sharing and use of electronic patient information between different information systems). The objective of this study was to estimate the nationwide prevalence of electronic health record (EHR) adoption among nursing facilities and to identify the factors associated with adoption.

**Design:** Cross-sectional survey.

**Setting & participants:** We surveyed members of the Society for Post-Acute & Long-Term Care Medicine (AMDA) about their organizations' health information technology usage and characteristics.

**Measurements:** Using questions adopted from existing instruments, the survey measured nursing home's EHR adoption, the ability to send, receive, search and integrate electronic information, as well as barriers to usage. Additionally, we linked survey responses to public use secondary data sources to construct measurements for eight determinants known to be associated with organizational adoption: innovativeness, functional differentiation, role specialization, administrative intensity, professionalism, complexity, technical knowledge resources and slack

resources. A series of regression models estimated the association between potential determinants and technology adoption.

**Results:** 84% of nursing facilities reported using an EHR. After controlling for all other factors, respondents who characterized their organization as more innovative had more than 6 times the odds (adjusted odds ratio = 6.39; 95%CI = 2.69, 15.21) of adopting an EHR. Organization innovativeness was also associated with an increased odds of being able to send, integrate, and search for electronic information. The most commonly identified barrier to sharing clinical information among nursing facilities with an EHR was a reported absence of interoperability (57%).

**Conclusions/Implications:** An organizational culture that fosters innovation and awareness campaigns by professional societies may facilitate further adoption and effective use of technology. This will be increasingly important as policymakers continue to emphasize the use of EHRs and interoperability to improve the quality of care in nursing facilities.

### Summary:

A majority of nursing facilities are using an electronic health record, but many respondents are unable to send, receive, integrate or search for electronic information from other organizations

### Keywords

Long-Term Care; Nursing Home; Health Information Technology; Electronic Health Records

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## INTRODUCTION<sup>1</sup>

A growing body of research suggests that interoperable health information technologies (HIT), specifically electronic health records (EHR), support effective and efficient care delivery (Jones et al., 2014). Interoperability refers to a technology's capacity to electronically share patient information between different information systems (like EHRs) and to use patient information created in different information systems while retaining the original meaning and intent (Healthcare Information & Management Systems Society, 2013). To transform the health care system, federal incentives have encouraged hospitals and ambulatory care providers' adoption of EHRs. In addition, sizable proportions of these facilities can now access and share patient information from different organizations, which may improve patient safety and care coordination while potentially leading to reduced costs (Adler-Milstein & Jha, 2017). While the health care system has made great strides towards collecting, organizing, and using electronic patient information, some providers, most notably nursing facilities lag behind this curve. Whereas current tracking surveys place the percent of hospitals and primary care providers adopting EHRs at 80% (Adler-Milstein et al., 2017) and 87% (Jamoom & Yang, 2016) respectively; a prior survey suggests around 6 out of 10 skilled nursing facilities (SNFs) have adopted an EHR (Alvarado, Zook, & Henry, 2017).

Critically, nursing facilities that provide post-acute and long-term care were not included in the federal EHR incentive programs created by the Health Information Technology for Economic and Clinical Health (HITECH) Act (AHIMA Longitudinal Coordination of Care

Practice Council E-HIM Strategy Team, 2014). As a result, nursing facilities did not have access to public funds to offset the costs of EHR adoption, unlike the vast majority of hospitals and primary care providers that qualified for federal incentive payments. The absence of funding is important as costs have been a significant barrier for EHR adoption among nursing facilities as have other resources constraints affecting training and infrastructure (Abramson, McGinnis, Moore, Kaushal, & for the HITEC Investigators, 2014; Cherry, Carter, Owen, & Lockhart, 2008; T. Wang & Biedermann, 2012).

EHRs have an important role in providing high quality care to patients in nursing facilities. Patients in these facilities frequently experience transitions in care, e.g. emergency department visits and hospitalizations/readmissions (Brownell, Wang, Smith, Stephens, & Hsia, 2014; Grabowski, O'Malley, & Barhydt, 2007; Jung, Trivedi, Grabowski, & Mor, 2016; Mor, Intrator, Feng, & Grabowski, 2010; Unruh, Grabowski, Trivedi, & Mor, 2013; Unruh, Trivedi, Grabowski, & Mor, 2013; H. E. Wang, Shah, Allman, & Kilgore, 2011). Improved interoperable information exchange is associated with more complete documentation, which could support more efficient and safer care by overcoming information sharing failures inherent during care transitions (N. Wang, Yu, & Hailey, 2013). Moreover, patients in nursing facilities tend to have complex conditions and require poly-pharmacy interventions (Dwyer, Han, Woodwell, & Rechtsteiner, 2010). The structured data of EHRs allows for rule-based decision support to encourage guideline compliance and to identify potential medication interactions or allergies (Krüger, Strand, Geitung, Eide, & Grimsmo, 2011). Additionally, EHRs can support basic reminders (Qian, Yu, & Hailey, 2015) and EHR adoption has been associated within increased vaccination rates in long term care settings (Bjarnadottir, Herzig, Travers, Castle, & Stone, 2017). Overall, the results of systematic reviews, surveys, and qualitative research have indicated that EHRs have a favorable impact on long term care largely through improvements in accuracy and accessibility of documentation (Cherry et al., 2008; Kruse et al., 2017; Meehan, 2017).

The objective of this study was two-fold. First, we sought to estimate the nationwide prevalence of EHR adoption among nursing facilities and to identify the factors associated with adoption. Second, among nursing facilities with an EHR, we sought to determine the extent of interoperability, defined as the ability to send, receive, integrate, and search for information from outside entities. This included assessing barriers to achieving interoperability with an emphasis on those that are amenable to policy- and educational-based interventions.

## METHODS

We analyzed the adoption of EHRs and the associated factors by surveying administrators and leadership from nursing facilities across the US in the winter of 2018. The survey instrument drew on existing measures to improve comparability with other studies.

### Survey sample and data sources

We surveyed members of the Society for Post-Acute & Long-Term Care Medicine (AMDA) about their organization's health information technology usage and organizational characteristics. AMDA is the professional association for long-term care administrators and

therefore respondents were in a position to answer questions about the entire organization. AMDA supplied email addresses for all members and sent an introductory email announcing the project. During the winter of 2018, the survey was delivered by email to 5,083 email addresses. We sent multiple reminders and incentivized questionnaire completion with a gift card raffle. The overall response rate for the survey questionnaire was 17% percent (n = 586 respondents representing 544 nursing facilities). Any responses from individuals not affiliated with a nursing facility (e.g. home health agencies) were excluded from the sample.

As part of the survey, respondents identified the name of their organization and its five digit zip-code. These identifiers allowed us to link responses to data from *Long-Term Care: Facts on Care in the US* (LTCFocus), the Centers for Medicare and Medicaid Services (CMS) Provider of Services Online (POS) files, and the Healthcare Cost Reporting Information System (HCRIS). LTCFocus is a publicly available dataset that includes information on the characteristics of nearly every nursing home in the nation, including patient demographics, ownership, bed count, staffing levels, presence of specialty care units (e.g. for dementia care), and quality measures. The CMS POS includes characteristics of facilities collected by CMS including location, ownership, staffing, bed counts, and types of Medicare services provided. HCRIS provided information on nursing facilities from CMS cost reports such as volume and types of services provided, provider costs, and charges.

### Survey Instrument & Measures

We drew on the exact wording of key tracking surveys, both for measures and respondent prompts, so that our results are comparable to other surveys (see Appendix for a copy of the survey instrument). EHR adoption was measured with a single item used by the Office of the National Coordinator for HIT (ONC), “Not including for accounting or billing purposes, does your facility currently use an EHR to manage your residents’ health records” (Alvarado et al., 2017)?” To assess interoperability, or the ability to seamlessly share and use electronic health information, we used the four key domains comprising ONC’s (2015) definition:

**send:** the ability to electronically transmit key information held by the organization to another organization electronically;

**receive:** the ability to take information provided by other organizations;

**integrate:** the ability to take discrete data electronic data elements and incorporate information into the EHR;

**search:** the ability to find and query relevant patient information from other organizations.

All survey questions utilized previous ONC language and anchored these information activities in the context of electronic information from outside organizations (Alvarado et al., 2017). Questions on potential barriers to interoperable HIT and EHR adoption were adapted from other surveys (Abramson et al., 2014; Kramer, Kaehny, Richard, & May, 2010).

Measures of potential factors associated with EHR and interoperability adoption were constructed from linked secondary data sources or were collected in our survey using previously published questions. The selected measures represented eight categories of

determinants known to be associated with organizational innovation adoption (Damanpour, 1996):

- *Organizational innovativeness* is the general predilection of an organization to try new technologies, ideas, procedures, tools, or ways of doing business (Wolfe, 1994). Organizations oriented towards innovation tend to be “early adopters”. A single item assessed the respondents’ perceptions of their nursing facility’s likelihood of trying an innovation (Shortell et al., 2001).
- *Functional differentiation* refers to the division of the organization into different departments or units and is therefore a structural characteristic. Functional differentiation is generally considered to be a driver of innovation adoption as the highly differentiated organizations need technology as a coordinating mechanism (Kimberly & Evanisko, 1981). Functional differentiation was measured as the binary presence of any specialty units indicated in LTCFocus.
- *Role specialization* is a construct describing the variation in employees’ training and jobs, which we measured as the count of different job classes reported in POS. In general, greater role specialization is associated with technology adoption and, in terms of HIT, the annual rate of EHR adoption in multispecialty practices outpaces adoption in single specialty outpatient practices (Hsiao, Hing, & Ashman, 2014).
- *Administrative intensity* describes the ratio of employees in administrative positions to those in non-administrative roles and was measured using the number of fulltime equivalents for each job class reported in POS. Because both the decision to adopt innovations and the process of implementation are largely driven by administration and leadership positions, increasing administrative intensity is associated with adoption (Damanpour, 1996).
- *Professionalism* was measured as the ratio of RN trained nurses to non-RN trained nurses at the facility as reported in POS and provides an indication of the relative staff education levels. In the case of innovation adoption, professionals may act as boundary spanners creating awareness of the innovation, or professionals may respond more to institutional pressures and encourage innovation adoption in order to conform to normative pressure (Zorn, Flanagin, & Shoham, 2011).
- *Complexity* was conceptualized as resident average acuity index (from LTCFocus), which reflects the extent of nursing care each resident requires. We utilized a resident-focused measure to describe care complexity since the organization’s structural complexity was already assessed through other measures.
- *Technical knowledge resources* available to each nursing facility was assessed by a single survey question about the number of IT staff employed or contracted (Menachemi et al., 2011).
- *Slack resources*, particularly financial resources, are a consistent predictor of organization IT adoption (Rogers, 2003). We determined each nursing facility’s

total profit margin (Weech-Maldonado et al., 2012) as reported in HCRIS. We then created indicators for the following categories: the lowest 25<sup>th</sup> percentile, those in the middle 50<sup>th</sup> (i.e. 25<sup>th</sup> to 75<sup>th</sup>) percentile, the highest 25 percent (i.e., 75<sup>th</sup> percentile), and those facilities for which no data were available.

Additional covariates included organizational characteristics such as bed count, ownership (i.e., for-profit or not), whether the facility was hospital-based, and whether the facility was part of a multi-facility organization (i.e. a “chain”).

## Analysis

The sample was described using percentages and means with EHR adopters compared to non-adopters using  $X^2$  and t-tests. We used a series of logistic regression models to examine the association between organizational characteristics and EHR adoption as well as engagement in each of the four domains of interoperability. The nursing facility was treated as the primary sampling unit. This was done to account for multiple respondents from the same nursing facility. Analyses were conducted using Stata 14. The project was approved by the Indiana University Institutional Review Board.

## RESULTS

84% of the nursing facilities in the sample reported using an EHR (Table 1). Adopters did not differ significantly from non-adopters in terms of size, control, hospital ownership, or percent of revenues from Medicare and Medicaid. EHR adoption was less common among nursing facilities that were part of multi-facility chains. In terms of the domains potentially influencing information technology adoption, nursing facilities with EHRs had higher levels of professionalism and were more frequently identified as innovative.

Without controlling for other characteristics (Table 2), higher professionalism was associated with adoption as was having between 1 and 5 IT staff member and having a profit margin within the middle 50<sup>th</sup> quartile. However, none of the differences in these measures were statistically significant after adjusting for all other factors. In the fully adjusted regression models, only organizational innovativeness was consistently associated with EHR adoption. After controlling for all other factors, respondents who characterized their organization as more frequently trying new technologies had more than 6 times the odds (adjusted odds ratio = 6.39; 95% CI = 2.69, 15.21) of adopting an EHR than those that did not try new technologies.

Among nursing facilities with an EHR, the overall engagement with each of ONC’s domains of interoperability was low. More than 4 in 10 respondents reported they were not able to send, receive, integrate or search for electronic information from outside organizations (Figure 1). Only 3% of respondents reported that their organization was engaged in all four interoperability domains. Respondents most frequently reported the ability to receive information (41%), followed by searching (32%) and sending (22%). Integration was the least common (12%). Few factors were associated with engagement in each of these domains. After controlling for other factors, organizational innovativeness was associated with increased odds of sending, integrating, and searching for information (Table 3). Higher

resident complexity was negatively associated with sending information and hospital-based facilities were more likely to search for information.

The most commonly identified barrier to sharing clinical information (Figure 2) among nursing facilities with an EHR was a reported absence of interoperability (57%). A lack of technical know-how (30.6%) and a lack of potential exchange partners (36.3%) were each reported by about a third of respondents. Respondent concerns over trust, security, and HIPAA were less common.

## DISCUSSION

In a nationwide sample, we estimate that more than 8 out of 10 nursing facilities have adopted an EHR. However, we note that engagement in key domains of interoperability were much lower.

In context of the current literature, these survey results indicate a continued upward trend in EHR adoption by nursing facilities. Earlier surveys suggested that the prevalence of EHR adoption among nursing facilities was well under 50% (Zhang et al., 2016). However, prior studies utilized different definitions of an EHR (Bjarnadottir et al., 2017; Zhang et al., 2016) or were reflective of nursing facilities in a single state (Abramson et al., 2014; T. Wang & Biedermann, 2012). A more recent survey from the ONC (Alvarado et al., 2017), which estimated that 64% of nursing facilities used an EHR in 2016, is a better benchmark by which to gauge progress. Both the ONC survey and the one used in this study shared item wording and were nationwide samples. While our finding that 84% of responding nursing facilities have adopted an EHR is encouraging, it still indicates that a substantial number of these facilities have not moved from paper to electronic systems. Problematically, even nursing facilities that have adopted an EHR may not be leveraging the full potential of interoperability. A minority of nursing facilities in our sample were able to send, receive, search, or integrate electronic information. Without engagement in interoperability, EHRs risk becoming just another data silo. While EHRs have many benefits, it is through HIT interoperability that patient information can be shared and used across providers and settings of care that will generate the greatest value for both individual providers and the overall health care system (Bates & Samal, 2018). Nevertheless, the low levels of engagement with interoperability was somewhat expected. ONC's 2016 survey reported even lower levels of engagement in all four domains of interoperability (Alvarado et al., 2017) and prior research suggests that nursing homes have underutilized their health information technology investments (Alexander et al., 2017).

Unfortunately, solutions to nursing facilities' barriers to greater information sharing through interoperable technology are not immediately apparent. For nursing facilities that have adopted non-interoperable EHRs, or ones with less than ideal interoperability, the only options are to wait for vendors to change the technology or to switch to a different EHR. Such changes to EHR functionality and capabilities may take time and be a low priority since, unlike providers participating in Meaningful Use, EHR products for post-acute and long-term care do not require certification. The latter option of adopting a new EHR from a different vendor may not be practical given that switching costs are very high. Additionally,

a lack of providers who are exchange capable partners is a barrier that nursing facilities cannot directly address. While technical know-how can be increased, issues related to technology - ranging from costs, infrastructure, staff, and lack of knowledge - have been longstanding issues for nursing facilities' adoption of EHRs (Abramson et al., 2014; T. Wang & Biedermann, 2012).

Prior studies have found a variety of structural characteristics associated with adoption, such as size and availability of resources (Abramson et al., 2014; T. Wang & Biedermann, 2012; Zhang et al., 2016) and pre-adoption assessment tools (e.g. LeadingAge, 2018) can help determine the need for sufficient information technology resources and staff. In our sample of nursing facilities, the only factor consistently associated with EHR adoption and engagement in interoperability was organizational innovativeness. Because innovativeness is reflective of organizations' behavior, intentions, and strategic assessments (Subramanian & Nilakanta, 1996), we suggest this provides more informative insights than structural factors. Understanding levels of EHR adoption through structural factors, such as size or rural location, is important for tracking and equity in care. However, if innovativeness is the primary factor, further gains in EHR adoption may be realized by nursing facilities' examining their own organizational culture or through increased education and awareness campaigns by professional societies.

### Limitations

Our findings are subject to several limitations. First, all survey responses were self-reported and EHR status in nursing facilities was not independently validated. Second, by the very nature of the survey (i.e. technology), the sample may be biased towards respondents from organizations with an EHR. Third, findings may have limited generalizability given the low response rates. Lastly, we can report associations only and cannot establish causality for factors leading to EHR adoption among nursing facilities. For example, it is both equally possible that (1) respondents from more innovative nursing facilities adopted EHRs or (2) having adopted an EHR made respondents view their nursing facilities as being more innovative.

### CONCLUSIONS / RELEVANCE

EHRs are becoming a near ubiquitous technology across nursing facilities. However, simply focusing on the rapid adoption over time and increased prevalence of EHRs masks important issues of capabilities and barriers to further adoption and effective usage. Importantly, only a minority of nursing facilities are leveraging the interoperable capabilities of their technology to electronically exchange patient information with other providers. In order to improve care for patients experiencing transitions across settings and foster better health, nursing facilities will have to use their EHRs to send, receive, search, and integrate information. Additionally, our findings suggest that embracing a purposeful and innovative organizational culture is a path to increasing adoption and enhancing effective use of EHRs and information exchange. Organizational culture, as a potential barrier, is amenable to change. Professional societies, trade associations, and advocacy groups may be in a position to facilitate further adoption of EHR technologies by fostering and supporting a culture of innovation and awareness among



their members. This has become increasingly important with the introduction of Medicare's Meaningful Measures Initiative, which includes EHR-based clinical quality measures for skilled nursing care, and the advancement of HIE capabilities as part of the 21<sup>st</sup> Century Cures Act. As policymakers continue to emphasize the use of HIT to improve the quality of care it will be important to build a culture that facilitates the effective use of EHRs and HIE among nursing facilities.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

## Acknowledgments

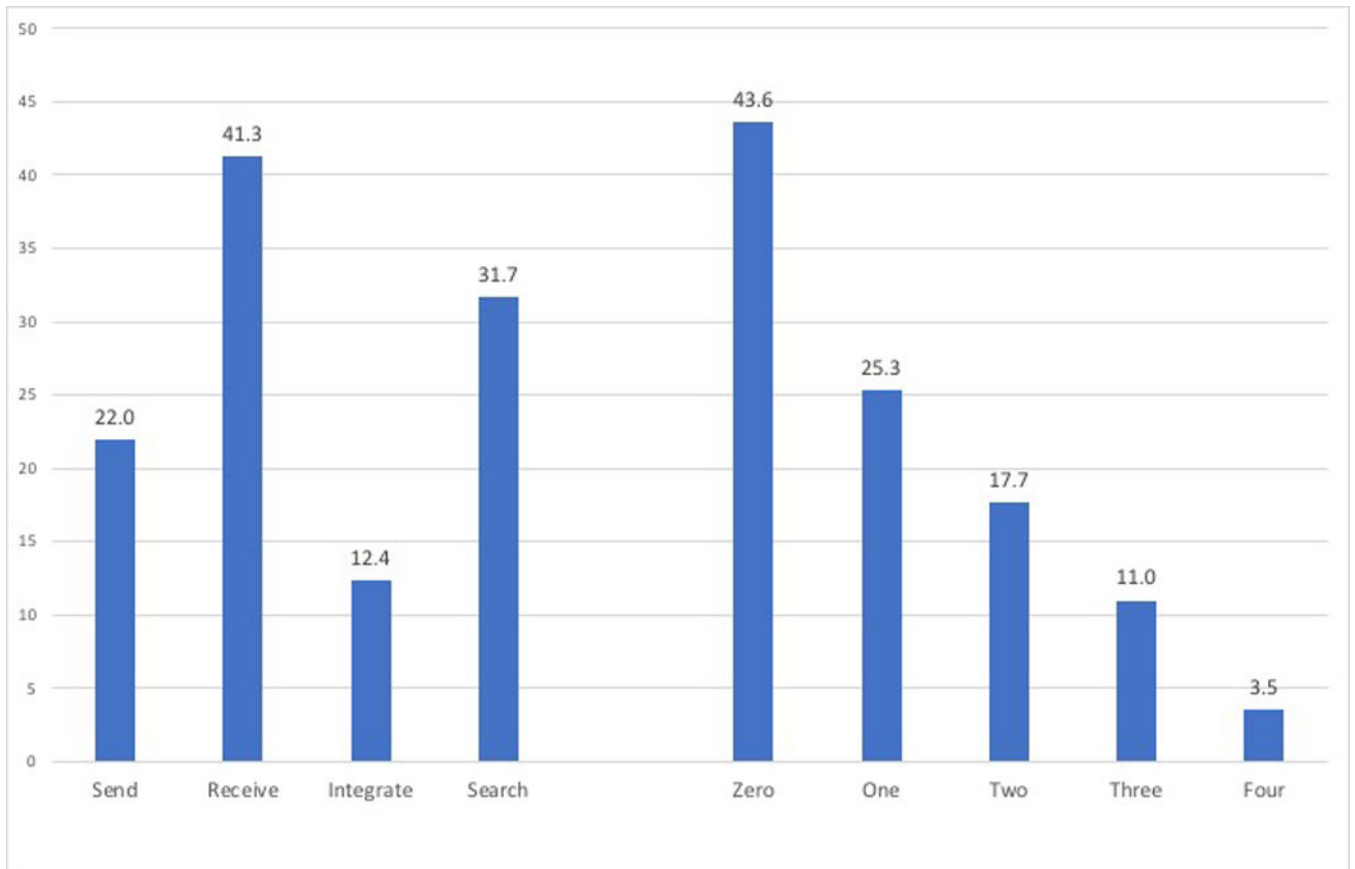
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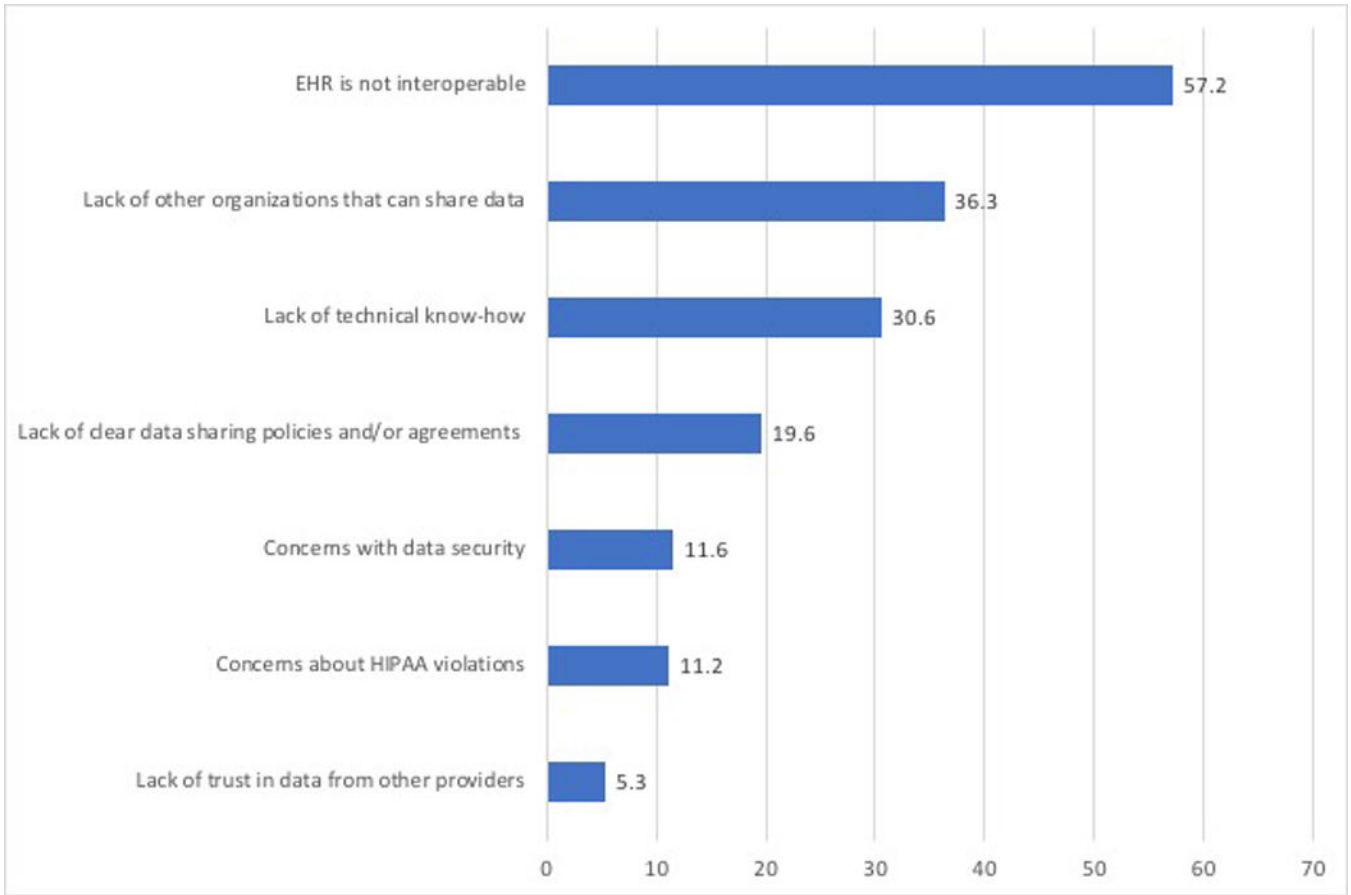
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**Figure 1.** Among nursing facilities with EHRs, the percent engaging in each of the core domains of interoperability and the distribution of facilities by the total number of domains.



**Figure 2.** Percentage of nursing facilities reporting significant barriers to sharing clinical information with other health care providers.

**Table 1.**

Skilled nursing facility's electronic health record adoption by organizational characteristics.

LTC Characteristics	Total (n=586)	EHR (n=491)	No EHR (n=95)	p
<b>Facility characteristics</b>				
<b>Bed size</b>				
Small ( 50)	6.1	6.9	2.1	0.186
Medium (50–99)	25.6	25.1	28.4	
Large ( 100)	68.3	68.9	69.5	
For-Profit	53.7	52.3	61.1	0.121
Multi-facility	57.0	55.0	67.4	0.026
Hospital-based	3.4	3.3	4.2	0.614
Percent Medicare (mean)	16.2	16.3	15.9	0.814
Percent Medicaid (mean)	54.0	53.6	56.2	0.310
<b>Domains of IT adoption</b>				
Organizational innovativeness	28.0	32.2	6.3	<0.001
Specialization (mean)	16.2	16.3	15.8	0.319
Differentiation	28.3	28.1	29.5	0.787
Professionalism (mean)	40.2	41.3	34.5	0.001
Complexity (mean)	12.2	12.2	12.4	0.091
<b>Technical knowledge</b>				
No IT staff	20.2	18.5	29.4	0.071
1–5 staff	33.0	34.6	25.0	
>5 staff	5.4	5.1	6.5	
Don't know	41.4	41.8	39.1	
Administrative intensity (mean)	9.91	9.9	9.8	0.700
<b>Slack resources</b>				
Bottom 25% profit margin	15.2	14.5	19.0	0.113
Middle 50% profit margin	30.4	32.4	20.0	
Top 25% profit margin	15.2	14.9	16.8	
Not reported	39.2	28.3	44.2	

**Table 2.**

Unadjusted and adjusted factors associated with nursing facilities' adoption of electronic health records.

LTC Characteristics	Odds Ratio (95%CI)	Adjusted Odds Ratio (95%CI)
<b>Facility characteristics</b>		
<b>Bed size</b>		
Small ( 50)	1.00	1.00
Medium (50–99)	0.27 (0.06, 1.90)	0.26 (0.06, 1.11)
Large ( 100)	0.30 (0.07, 1.28)	0.23 (0.05, 1.10)
For-Profit	0.70 (0.45, 1.10)	0.80 (0.46, 1.37)
Multi-facility	0.59 (0.37, 0.94)	0.60 (0.35, 1.03)
Hospital-based	0.77 (0.27, 2.16)	0.52 (0.14, 1.03)
Percent Medicare	1.00 (0.99, 1.02)	0.99 (0.97, 1.02)
Percent Medicaid	0.99 (0.98, 1.01)	1.00 (0.99, 1.02)
<b>Domains of IT adoption</b>		
Organizational innovativeness	7.04 (3.00, 16.48) ***	6.39 (2.69, 15.21) ***
Specialization	1.04 (0.97, 1.10)	1.08 (0.97, 1.19)
Differentiation	0.94 (0.58, 1.52)	0.88 (0.50, 1.55)
Professionalism	6.95 (2.01, 23.97) **	7.64 (1.94, 30.03)
Complexity	0.84 (0.68, 1.04)	0.86 (0.68, 1.08)
<b>Technical knowledge</b>		
No IT staff	1.00	1.00
1–5 staff	2.19 (1.19, 4.05) *	1.54 (0.77, 3.07)
>5 staff	1.25 (0.46, 3.41)	1.13 (0.38, 3.35)
Don't know	1.69 (0.97, 2.94)	1.47 (0.82, 2.66)
Administrative intensity	1.01 (0.95, 1.08)	1.03 (0.97, 1.10)
<b>Slack resources</b>		
Bottom 25% profit margin	1.00	1.00
Middle 50% profit margin	2.12 (1.06, 4.24) *	2.45 (1.16, 5.17) *
Top 25% profit margin	1.16 (0.55, 2.45)	1.20 (0.54, 2.66)
Not reported	1.13 (0.61, 2.10)	1.45 (0.76, 2.75)

\* p&lt;0.05

\*\* p&lt;0.01

\*\*\* p&lt;0.001

Factors associated with skilled nursing facilities engagement in each domain of interoperability

Table 3.

Facility characteristics	Domain of interoperability			
	Send information Adjusted Odds Ratio (95%CI)	Receive information Adjusted Odds Ratio (95%CI)	Integrate information Adjusted Odds Ratio (95%CI)	Search for information Adjusted Odds Ratio (95%CI)
Hospital-based	0.27 (0.04, 1.78)	2.41 (0.68, 8.49)	0.56 (0.59, 5.33)	5.99 (1.43, 25.01)*
Organizational innovativeness	3.87 (2.03, 7.39)***	1.08 (0.58, 2.00)	2.47 (1.20, 5.10)*	2.34 (1.40, 3.92)**
Complexity	0.73 (0.58, 0.93)*	1.27 (0.93, 1.73)	1.08 (0.78, 1.51)	0.89 (0.74, 1.07)
<b>Domains of interoperability</b>				
Send	--	29.01 (12.09, 65.59)***	1.36 (0.61, 3.00)	1.14 (0.61, 2.13)
Receive	27.54 (11.60, 65.40)***	--	9.34 (3.25, 26.90)***	2.10 (1.21, 3.64)**
Integrate	1.35 (0.64, 2.86)	8.80 (3.02, 25.63)***	--	1.58 (0.79, 3.18)
Search	1.18 (0.61, 2.27)	2.19 (1.25, 3.82)**	1.58 (0.75, 3.33)	--

Note: Non-significant factors omitted. Regression models adjusted for bed size, control, multiple facility organization, percent Medicaid & Medicare revenues, profit margins, specialization, differentialization, professionalism, administrative intensity, and IT staff.

\* p<0.05

\*\* p<0.01

\*\*\* p<0.001