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A National Report of Nursing Home Quality and Information Technology: 2-Year Trends

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Abstract

Health Information Technology is transforming healthcare delivery. This research report describes 2 year trends in technology adoption, called information technology sophistication, defined as capabilities, extent of use, and integration of technology. Trends are identified using a validated annual survey. In Year 1, 815 facilities participated in the survey; in Year 2, 484 nursing homes repeated the survey representing every US state. Statistically significant increases in information technology sophistication were found in resident care and total scores. Sample homes tended to be smaller and from small town/rural areas. There were more information technology gains than losses in technology sophistication over the 2 years in the sample. Significant correlations were identified between differences in information technology sophistication and 12 different quality measures.

Keywords

Health Information Technology; Long Term Care; Informatics; Quality Measures; Nursing Home

INTRODUCTION

A remarkable transformation is occurring in the nation's use of health information technology (HIT). HIT adoption has been spurred on by federal legislation in the past few years, which provided financial incentives for HIT adoption, mostly in acute care.(1) Federal strategies continue to promote goals that support research, scientific knowledge, and innovations that show how HIT improves health and healthcare delivery across all sectors.(2) A growing area of evidence concerns the widening gap of HIT adoption across healthcare organizations, such as varied trend rates of electronic health record adoption in long term care facilities (LTC), such as nursing homes.(3) Despite recognized values HIT provides to LTC providers, such as error reduction, clinical efficiencies, cost savings, and improved patient outcomes some LTC providers continue to lag behind in their choice to adopt HIT.(4) Furthermore, there is a scantiness of evidence focused on HIT adoption and trends in quality

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measures (QMs). In fact, QMs, which LTC leaders have collected nationally for years, are used in few studies reporting associations with technology adoption trends. Again, this deficiency in reporting further widens our understanding of how LTC IT is improving care delivery in these settings. Research explained in this paper was undertaken to explore this evidence gap by answering the following research questions: 1) What are trends in IT adoption in US nursing home facilities over two years? 2) How are two year trends in IT adoption in US nursing homes related to nationally reported QMs?

BACKGROUND

This research is innovative because it includes the first national assessment of nursing home QMs and trends in IT adoption, called IT sophistication. IT sophistication reflects three domains of IT adoption that can be measured: IT capabilities, extent of IT use, degree of IT integration between internal and external stakeholders (see Table 1). These domains are further classified into three healthcare dimensions, including resident care, clinical support, and administrative activities(5). Combining the nine domains and dimensions into one cumulative score, Total IT Sophistication, can be determined for a facility, representing ten measurable scales total. The measure for nursing homes, developed by the corresponding author, has been extensively tested in nursing homes since 2007(5).

IT Sophistication Domains and Content Areas

In preliminary research, examining the 3X3 dimensional IT Sophistication model ((IT capabilities, extent of IT use, IT integration)X(Resident Care, Clinical Support, Administrative Activities)) 27 Content Areas have been identified and provide a cumulative measure called Total IT Sophistication for a nursing home. Table 1 illustrates each of the 27 content areas by IT sophistication domain. Not shown in Table 1 are the content items that describe each of the content areas which make up Total IT Sophistication. As an example of the content items, under the domain of *IT Capabilities* is the Content Area called *Nursing Processes or Documents that are Computerized*. Content Items associated with this Content Area include staff scheduling, vital signs recording (from monitoring equipment), medication administration, staff workload management, physician orders transcription, care planning/care area assessments, historical record keeping, resident acuity/condition reporting, quality assurance, nursing flowsheet, incident reporting, real time or continuous minimum data set/resident assessment instrument, and clinical reporting (e.g. treatments). Content Items associated with each of the Content Areas are able to be scored and cumulatively provide an overall estimate of Total IT Sophistication for a facility that can be trended over time(6).

Nursing Home Characteristics and QMs

To answer research questions, primary outcomes are measured using nursing home characteristics and QMs found in a publicly available Minimum Data Set known as Nursing Home Compare(7). Using this information to analyze quality of care is of interest because nursing homes are federally mandated to obtain data for all residents upon admission, at times of significant change in condition, quarterly for selected items, and annually for all facilities participating in Medicare and Medicaid across the US(8). In 2000, QMs were

developed by researchers and reviewed by a Technical Expert Panel sponsored by the CMS. Out of this work came a national set of QMs recommended for public reporting. Currently, the data set contains 15 Long-Stay QMs and 9 Short-Stay measures, of which 5 are new publicly reported measures since 2016. Long-stay measures are obtained for patients admitted to a nursing home for stays that range from months to years because they are not able to care for themselves at home. Short-stay measures are obtained for patients admitted for stays of less than 100 days. Short-stay residents typically are acute-care patients released from a hospital or patients requiring high-intensity care and short term rehabilitation stays.

METHODS

Design

This study used a longitudinal survey design conducted by nursing home administrators each year for two years. Two data sources were used in this report including: (1) an annual survey used to identify trends in Total IT Sophistication and (2) nationally reported nursing home QMs and organizational data from Nursing Home Compare. The team recruited administrators for Year 1 (Jan 2014-July 2015), the same administrators completing Year 1 surveys were recruited for Year 2 (Jan 2015-July 2016). The University's Institutional Review Board approved all research procedures.

Sample

During the first year of this study, 815 nursing home administrators completed the IT Sophistication survey. During the second year of this study, researchers asked each of the 815 administrators completing Year 1 surveys to complete a Year 2 survey. Researchers incorporated the same recruitment strategy for both years, previously described in the Year 1 report(9). The nursing homes from the Year 1 sample were from each US state and had similar characteristics in ownership, bed-size, and location to other nursing homes around the US, not participating in the survey research(10). The majority of Year 1 facilities had corporate ownership that were for-profit (55%). Year 1 representation was lower for county owned facilities and non-profit corporations compared to national statistics. Most of the facilities in the sample were located in metropolitan locations with >50000 population. Approximately 12% were located in rural locations with <2500 population.

Measures

Total IT Sophistication—Total IT Sophistication is a cumulative measure including a total score obtained from adding the nine dimension and domain scales within the survey. Each weighted dimension and domain has a minimum score of 0 and maximum score of 100. A maximum cumulative Total IT sophistication score, used in this analysis, equals 900. Investigators calculated the Total IT Sophistication measure used in this analysis by subtracting Year 2 from Year 1 Total IT Sophistication scores.

Nursing Home QMs—Using Nursing Home Compare data investigators calculated the mean of the four quarters of QM values going back from the quarter in which each administrator returned their Year 1 IT survey. The cutoff for recruitment of Year 1 homes was in July 2015 (Q3 2015). The cutoff for recruitment of Year 2 homes was in July 2016

(Q3 2016). Measures used in this analysis are Year 2 minus Year 1 differences in means of the four quarters for each QM reported in Nursing Home Compare data.

Analysis

Researchers looked at characteristics of the nursing homes in the Year 2 sample and compared them to the remaining (15197) homes not in the sample relative to the variables ownership, bed-size, and location. Before further analysis, researchers incorporated post-stratification weighting procedures to re-weight the homes to national proportions with regard to these variables. Using post-stratified weights, the team looked at differences in Total IT Sophistication scores (Year 2-Year 1) relative to nursing home characteristics.

Using post-stratification weights, investigators estimated correlations between differences in mean averages of QMs and difference in Total IT Sophistication. Regression analysis was conducted on independent variables where the IT differences showed the highest correlations ($r > .10$). In the analysis, the QM difference was the dependent variable and the independent variables included change in IT sophistication from Year 1 to Year 2, size, location, and ownership. These variables were kept in the model as explanatory variables even if they were not significant. The basic idea was to see if the relationship held up when accounting for characteristics of the homes. Also, where there were multiple IT scales that showed a relationship, investigators wanted to see if the relationship was maintained when other IT variables were included. To that end the team used a backward elimination approach dropping IT variables that were not significant at the 0.05 level with the home variables in the model.

RESULTS

In looking at differences between year 1 and year 2, there are 484/815 homes with data at both times (59% response rate). In Year 2, participating homes were from every US state. There were some differences in the homes that responded (in the sample) and those that did not (all other homes in the US) with regard to ownership, bed-size and location. The sample homes tend to be smaller (more in the 60–120 range and fewer in the >120 range) and more from small town/rural areas. For this reason, post-stratification to re-weight the homes is appropriate.

Our team calculated estimated median differences between Year 1 and Year 2 for each subscale and total IT Sophistication (See Figure 1). The differences that are significantly different from 0 (at the 0.01 level, based on 0 being included in a 99% confidence interval estimate) are resident care IT capabilities (rfun), resident care extent of IT use (rtech), resident care IT integration (rint), and total IT sophistication (not shown). Median differences in resident care IT capabilities from Year 1 to Year 2 was +3.39, differences in extent IT use in resident care of +1.91, and differences in degree of IT integration in resident care was +4.02. As illustrated in Figure 1, all other IT sophistication dimensions in clinical support and administrative activities also increased, but did not reach significance. Overall total IT sophistication increased by +28.1 from Year 1 to Year 2 and was significant.

A scatter plot was created in Figure 2 to further examine differences in total IT sophistication scores. The scatter plot illustrates change in Total IT Sophistication scores for each facility between Year 1 and Year 2. Extreme changes correspond to points beyond the outer lines in the plot, some extreme changes are positive indicating a drastic increase in total IT sophistication in Year 2. Some extreme changes are negative indicating a major loss in total IT sophistication in Year 2 in some of the sample facilities.

Next, the team looked at differences in Total IT Sophistication score relative to nursing home characteristics. In the sample, there were no differences in Total IT Sophistication based on ownership. Estimated mean differences in Total IT Sophistication scores in for-profit facilities (29.1) were similar to non-profit facilities (31.1) and not significant ($p=.89$). No significant differences in Total IT sophistication were found due to location ($p=.66$). Mean differences in Total IT Sophistication relative to location ranged from 25.5 in metropolitan locales to 48.4 in rural locales. There are differences in Total IT Sophistication due to bed-size ($p=.02$). Small (<60 beds) had a mean difference of only 8.4 while mid-sized (60–120 beds) had a mean difference of 45.6.

The team estimated correlations (using weights) between each of the QM differences and each of the IT sophistication subscale differences. There were 26 estimated correlations that were at least .10 (in absolute value), including 12 different QMs (see Table 2). Some QMs were only correlated with one IT sophistication scale, while the QM for % Long Stay Residents Received an Antipsychotic Medication correlated with 6 different IT scales. The team then looked at each of the 12 QM's (Table 2) separately using regression models. There were three where the IT scales were *not* significant predictors of QM change after adjusting for home characteristics: % Long Stay Residents Assessed/Given Seasonal Flu Vaccine, % Short Stay with New or Worsened Pressure Ulcers, and % Short Stay Assessed/Given Pneumococcal Vaccine. In most where there were multiple IT scales showing a relationship to QM differences, after backward elimination only one QM scale was ultimately significant. The exception was % Long Stay with Urinary Tract Infection where differences in IT capabilities in Administrative Activities ($p<.02$) and differences in Clinical Support Extent of IT Use ($p<.04$) were both significant at the 0.05 level.

DISCUSSION

Increasing IT sophistication in healthcare is thought to be a grand solution toward improvements in quality of care, maximizing efficiencies, and increasing confidence in safe care(11). Therefore, trending both IT sophistication and quality of care concurrently to establish the validity of this claim is paramount. However, gaps continue in our understanding of trends in IT sophistication and quality, at least in long term care. This research addresses this gap by specifically reporting on IT sophistication trends in nursing home care and quality measures over two years. Trending IT sophistication provides a new measure of how work processes are changing through gains/losses in IT capabilities, extent of IT use, and degree of integration. Trends in IT sophistication then become important indicators for change in quality measures, two variables which have not been studied and reported together on a consistent basis. This study found over a two year period, participating facilities have increased IT sophistication in each dimension and domain of

healthcare. Significant relationships were discovered in resident care in every dimension of IT sophistication and Total IT sophistication.

One important finding is that significantly more facilities had gains than losses in IT sophistication over two years. This finding supports preliminary work describing significant gains in clinical support technologies in nursing homes (12). In the current study, change in extent of use of clinical support technologies (e.g. IT used for laboratory systems) is an important predictor of the % of residents with urinary tract infections. Another finding, rapid two-year IT fluctuation, indicates some facilities are experiencing significant instability in their adoption process, either through IT implementation (gains) or abandoning IT systems (losses); this finding also supports preliminary work (12). IT implementation certainly creates disruptive forces possibly augmenting provider workflows, clinical processes, or access to key information. Disruptive experiences can influence user satisfaction and perceptions of the effectiveness of technologies which can impact adoption, having impacts on quality and safety measures. Abandonment of IT systems can occur due to unmanageable pain points encountered by leadership and staff, also leading to potential quality and safety risks. Important pain points identified by long term care administrators include, health IT design, fit to workflow, lack of information to support the process of care, excessive documentation and handoffs, and interoperability(13).

Ultimately, this study demonstrates that increasing IT sophistication in every health domain seems to influence QMs in these facilities. For example, QMs significantly correlate with multiple IT sophistication scales, indicating that IT may have broader impacts across an organization. Continuing to trend IT capabilities, extent of IT use, and degree of integration beyond this two-year period provides an opportunity to see future impacts of federal legislation driving IT adoption to improve quality. Without trends in *all* healthcare sectors, including long term care, impacts of federal legislation and policy driving IT adoption and quality improvement strategies are only partially known.

LIMITATIONS

This study is a two-wave longitudinal design that takes into account changes of IT sophistication measures over 2 years and effects of IT use on quality of care and resident outcomes. To reduce the potential effect of history on this study we limited the IT sophistication data collection to 2 annual waves. Each wave was completed over 6 quarters. There could be response bias for the facilities that chose not to participate, although our response rate is high compared to most survey mechanisms in these settings. Some facilities may not participate because they have no technology, which could result in an overall higher level of IT sophistication than actually exists. Some nursing homes may not join the study because administrators don't have requisite knowledge to complete the survey. We offered help to overcome these barriers by providing our contact information and helping administrators when called upon.

CONCLUSION

Healthcare leaders believe, “*Health IT creates patient safety issues, work-arounds, sentinel events*,” furthermore, the significance of this problem is, “*across all sites, patient populations and health IT vendors*.”(14). This belief provides evidence that trends in IT sophistication have implications for all professionals who influence practice. Some of those implications, such as IT sophistication gains/losses, in short periods of time, have impacts on care delivery and stakeholders, such as IT developers, who are building systems for care delivery and nurses who use them. In this study, what is learned from episodes of IT gains/losses could help in building better IT systems that are friendlier to end users. Finally, the realization that multiple dimensions of IT sophistication do influence quality measures in every healthcare domain provides an opportunity to design a reporting system that joins these important variables, to be assessed on a national scale, which can help to define greatest areas of need for better IT systems to improve care quality for all.

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Figure 1:
Median IT Sophistication Scores Year 1 (Solid) and Year 2 (Dashed) Poststratified

Figure 2: Total IT Sophistication Differences Year 1-Year 2

Points above top line Year 2 Total IT Score higher

Points beyond outer reference lines Total IT Score differs by 150

Table 1:**IT Sophistication Model Domains and Content Areas**

IT Capabilities (12 Content Areas)	
Resident management processes that are computerized	
Documents in resident care that are computerized.	
Clinical processes or documents that are computerized	
PT/OT processes that are computerized	
Technology that is available for patients or patient representatives	
Processes that are computerized in the laboratory systems	
Processes that are computerized in radiology systems	
Processes that are computerized in pharmacy systems	
Processes for managing IT issues	
Connectivity technologies used in the nursing home	
Internet based applications used in the nursing home	
IT activities currently outsourced to external providers	
Extent of IT Use (8 Content Areas)	
The extent of use of technologies in resident activities.	
The extent of use of technology in nursing care	
The extent of use of technology in PT/OT	
The extent of use of resident or resident representatives' technology	
The extent of use of laboratory technology	
The extent of radiology technology	
The extent of use of technology for pharmacy management	
The extent of use of office automation applications in your nursing home	
Degree of IT Integration Internally and Externally (7 Content Areas)	
Resident Care Systems are integrated (electronic and automatic transfer of information) with other systems in your nursing home	
Nursing information systems are integrated (electronic and automatic transfer of information) to each other in your nursing home	
PT/OT system are integrated (electronic and automatic transfer of information) to each other in you nursing home	
Laboratory systems are integrated	
Radiology systems are integrated with other information systems	
Pharmacy systems are integrated with other information systems	
Total number of IT personnel in your nursing home excluding long-term consultants or sub-contractors	

Table 2:

Estimated Correlations (using weights) between IT Sophistication and Quality Measures

Health Domain	IT Sophistication Dimension	Quality Measure (% Residents)	r	p
Resident Care	IT Capabilities	Received an Antipsychotic Med	0.17	0.02
		Risk LS Bowel or Bladder Incontinent	-0.18	0.09
	Extent of IT Use	Received an Antipsychotic Med	0.12	0.13
		With New or Worsened Pressure Ulcers	-0.10	0.23
		Received an Antipsychotic Med	0.11	0.14
		Assessed/Given Pneumococcal Vaccine	0.11	0.09
Clinical Support	IT Capabilities	ADL Needs Increased	-0.11	0.05
		Who Were Physically Restrained	0.11	0.05
	Extent of IT Use	Assessed/Given Seasonal Flu Vaccine	0.11	0.13
		Assessed/Given Pneumococcal Vaccine	0.14	0.09
		Received an Antipsychotic Med	0.22	0.00
		With a Urinary Tract Infection	0.12	0.05
	IT Integration	Who Were Physically Restrained	0.10	0.05
		Assessed/Given Pneumococcal Vaccine	0.20	0.03
		Who Were Physically Restrained	0.13	0.01
		Assessed/Given Pneumococcal Vaccine	0.14	0.13
	Total IT Sophistication	Received an Antipsychotic Med	0.11	0.09
		Who Report Mod to Severe Pain	-0.18	0.00
Administrative Activities	IT Capabilities	Who Lose Too Much Weight	0.10	0.06
		with Cath Inserted and Left in Bladder	-0.12	0.02
		With a Urinary Tract Infection	-0.14	0.01
		ADL Needs Increased	-0.14	0.02
	Extent of IT Use	Assessed/Given Pneumococcal Vaccine	0.14	0.13
		Who Were Physically Restrained	0.11	0.02
	IT Integration	Assessed/Given Pneumococcal Vaccine	0.11	0.26
		Received an Antipsychotic Med	0.18	0.02