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Innovations in Quality Improvement in Long-term Care

The purpose of this column is to discuss innovations and quality improvement advancements across the various long-term care settings. This column is coordinated by Marilyn J. Rantz, PhD, RN, FAAN, NHA (rantzm@missouri.edu).

A National Report of Nursing Home Quality and Information Technology

Two-Year Trends

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A REMARKABLE transformation is occurring in the nation's use of health information technology (HIT). Health information technology 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 health care delivery across all sectors.[2] A growing area of evidence concerns the widening gap of HIT adoption across health care organizations, such as varied trend rates of electronic health record adoption in long-term care facilities (LTC).[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 scant evidence focused on HIT adoption and trends in quality measures (QMs). Quality measures, which LTC leaders have collected nationally for years, are used in few studies reporting associations with technology adoption trends. Research reported in this article was undertaken to explore this evidence gap by answering the following research questions: (1) What are the trends in information technology (IT) adoption in US nursing home facilities over 2 years? (2) How are 2-year trends in IT adoption in US nursing homes related to nationally reported QMs?

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BACKGROUND

This research is innovative because it includes the first national assessment of nursing home QMs and trends in IT adoption, called IT sophistication. The IT sophistication reflects 3 domains of IT adoption that can be measured: IT capabilities, extent of IT use, and degree of IT integration between internal and external stakeholders (Table 1). These domains are further classified into 3 health care dimensions, including resident care, clinical support, and administrative activities.[5] Combining the 9 domains and dimensions into 1 cumulative score, a Total IT Sophistication score can be determined for a facility, representing 10 measurable scales. This 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 IT Sophistication model, 27 content areas have been identified and provide a cumulative

Table 1. IT Sophistication Model Domains and Content Areas

IT Capabilities
Resident management processes that are computerized
Documents in resident care that are computerized
Nursing 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 that are currently outsourced to external providers
Internet-based applications used in the nursing home
Extent of IT use of
Technologies in resident activities
Technology in nursing care
Technology in PT/OT
Patient or patient representatives' technology
Technology for pharmacy management
Radiology technology
Laboratory technology
Office automation applications in your nursing home
Degree of IT integration internally and externally
Resident care systems are integrated (electronic and automatic transfer of information) with other systems in nursing home
Nursing information systems are integrated (electronic and automatic transfer of information) to each other in nursing home
PT/OT system is integrated (electronic and automatic transfer of information) to each other in 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 nursing home excluding long-term consultants or subcontractors

Abbreviations: IT, information technology; OT, occupational therapy; PT, physical therapy.

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 these areas that make up the 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 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 flow sheet, incident reporting, real-time or continuous minimum data set/resident assessment instrument, and clinical reporting (eg, 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, which can be trended over time.[6]

Nursing home characteristics and QMs

To answer the 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 on admission, at times of significant change in condition, quarterly for selected items, and annually for all facilities participating in Medicare and Medicaid across the United States.[8] In 2000, QMs were developed by researchers and reviewed by a Technical Expert Panel sponsored by the Centers for Medicare & Medicaid Services. 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. Nursing home administrators were asked to complete surveys each year for 2 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 (January 2014 to July 2015); the same administrators completing year 1 surveys were recruited for year 2 (January 2015 to 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 United States, not participating in the survey research.[10] The majority of year 1 facilities had corporate ownership and were for-profit (55%). Year 1 representation was lower for county-owned facilities and nonprofit corporations than national statistics. Most of the facilities in the sample were located in metropolitan locations with more than 50 000 population. Approximately 12%

were located in rural locations with less than 2500 population.

Measures

Total IT sophistication

Total IT Sophistication is a cumulative measure including a total score obtained from adding the 9 dimensions 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 4 quarters of QM values going back from the quarter in which each administrator returned his or her 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 4 quarters for each QM reported in Nursing Home Compare data.

Analysis

Our research team examined characteristics of the nursing homes in the year 2 sample and compared them with the remaining (15 197) homes not in the sample relative to the ownership, bed size, and location. Before further analysis, we incorporated poststratification weighting procedures to reweight the homes to national proportions with regard to these variables. Using poststratified weights, the team looked at differences in Total IT Sophistication scores (year 2 to year 1) relative to nursing home characteristics.

Using poststratification weights, we 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 ($r > 0.10$). 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 aim was to assess whether the relationship held up when accounting for characteristics of the homes. Also, where there were multiple IT scales that showed a relationship, we wanted to see whether 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 .05 level with the nursing home variables in the model.

RESULTS

In examining differences between years 1 and 2, there were 456 of 815 homes with data at both times (56% 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, poststratification to reweight the homes was appropriate.

Our team calculated estimated median differences between year 1 and year 2 for each subscale and Total IT Sophistication (see Supplemental Digital Content Figure 1, available at: http://links.lww.com/JNCQ/A427). The differences that were significantly different from 0 (at the 0.01 level, based on 0 being included in a 99% confidence interval estimate) were resident care IT capabilities (rfun), resident care extent of IT use (rtech), resident care IT integration (rint), and Total IT Sophistication (not shown). Median difference in resident care IT capabilities from year 1 to year 2 was +3.39, difference in extent of IT use in resident care was +1.91, and

difference in degree of IT integration in resident care was +4.02. As illustrated in the Supplemental Digital Content Figure 1, available: at http://links.lww.com/JNCQ/A427, 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 the Supplemental Digital Content Figure 2, available at: http://links.lww.com/JNCQ/A428, to further examine differences in Total IT Sophistication scores. The scatter plot illustrates change in Total IT Sophistication scores for each facility between years 1 and 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 nonprofit facilities (31.1) and not significant ($P = .89$). No significant differences in Total IT Sophistication were found because of 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 were differences in Total IT Sophistication due to bed size ($P = .03$). Small (<60 beds) had a mean difference of only 8.4, while midsized (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 0.10 (in absolute value), including 12 different QMs (Table 2). Some QMs were correlated with only 1 IT sophistication scale, while the QM for % Long Stay Residents Received an Antipsychotic Medication correlated with 6 different IT scales. The team then examined each of the 12 QMs (Table 2) separately using regression models. There were 3 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. Generally, where there were multiple IT scales showing a relationship to QM differences, after backward elimination only 1 QM scale was ultimately significant. The exception was % Long Stay With Urinary Tract Infection in which differences in IT capabilities in Administrative Activities ($P < .02$) and in Clinical Support Extent of IT Use ($P < .04$) were both significant.

DISCUSSION

Increasing IT sophistication in health care is thought to be a grand solution toward improving 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 LTC. This research addresses this gap by specifically reporting on IT sophistication trends in nursing home care and QMs over 2 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 QMs, 2 variables that have not been studied and reported together on a consistent basis. This study found over a 2-year period that participating facilities increased IT sophistication in each dimension and domain of health care. Significant relationships were discovered in resident care in every dimension of IT sophistication and Total IT Sophistication.

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	.02
	Extent of IT use	Low risk bowel or bladder incontinent	−0.18	.09
		Received an antipsychotic med	0.12	.13
		With new or worsened pressure ulcers	−0.10	.23
	IT integration	Received an antipsychotic med	0.11	.14
		Assessed/given pneumococcal vaccine	0.11	.09
Clinical support	IT capabilities	ADL needs increased	−0.11	.05
		Who were physically restrained	0.11	.05
		Assessed/given seasonal flu vaccine	0.11	.13
		Assessed/given pneumococcal vaccine	0.14	.09
		Received an antipsychotic med	0.22	.00
	Extent of IT use	With a urinary tract infection	0.12	.05
		Who were physically restrained	0.10	.05
		Assessed/given pneumococcal vaccine	0.20	.03
	IT integration	Who were physically restrained	0.13	.01
		Assessed/given pneumococcal vaccine	0.14	.13
		Received an antipsychotic med	0.11	.09
Administrative activities	IT capabilities	Who report mod to severe pain	−0.18	.00
		Who lose too much weight	0.10	.06
		With catheter inserted and left in bladder	−0.12	.02
		With a urinary tract infection	−0.14	.01
	Extent of IT use	ADL needs increased	−0.14	.02
	IT Integration	Assessed/given pneumococcal vaccine	0.14	.13
	Total IT sophistication	Who were physically restrained	0.11	.02
		Assessed/Given pneumococcal vaccine	0.11	.26
		Received an antipsychotic med	0.18	.02

Abbreviations: ADL, activities of daily living; IT, information technology.

One important finding is that significantly more facilities had gains than losses in IT sophistication over 2 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 (eg, IT used for laboratory systems) is an important predictor of the % of residents with urinary tract infections. Another finding, rapid 2-year IT fluctuation, indicates that 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] Information technology implementation 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 and quality and safety. Abandonment of IT systems can occur because of unmanageable issues encountered by leadership and staff, also leading to potential quality and safety risks. Important issues identified by LTC 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 2-year period provides an opportunity to assess the future impact of federal legislation driving IT adoption to improve quality.

Limitations

This study is a 2-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 with 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 do not have requisite knowledge to complete the survey.

CONCLUSION

Some health care leaders believe that HIT creates patient safety issues and work-arounds across all types of settings, patient populations, and 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, knowledge about episodes of IT gains/losses can help build better IT systems that are friendlier to end users. Finally, the realization that multiple dimensions of IT sophistication influence QMs in every health care domain provides an opportunity to design a reporting system that joins these important variables to be assessed on a national scale, which can help define greatest areas of need for better IT systems to improve care quality for all.

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