Published in final edited form as:
Policy Polit Nurs Pract. 2010 August ; 11(3): 214–225. doi:10.1177/1527154410386616.

A Regional Assessment of Information Technology Sophistication in Missouri Nursing Homes

G.L. Alexander, PhD, RN[Assistant Professor],
University of Missouri, Sinclair School of Nursing S415, Columbia MO, 65211

R. Madsen, PhD[Emeritus Professor], and
University of Missouri, School of Medicine, Office of Medical Research: Biostatistics, Columbia, MO 65212

D.S. Wakefield, PhD[Professor and Director]
Center for Healthcare Quality, University of Missouri, Columbia, MO 65212

Introduction

The adoption of health information technology (IT) by health care providers remains a critical issue in the early part of this 21st century. A sense of urgency has been created by federal initiatives which are focused on developing a national infrastructure for health IT (Presidents Information Technology Advisory Committee, 2004). Goals set by developers of this national infrastructure include the development of interoperable information systems that supports coordination and transfer of health information among organizations and systems including Long Term Care (Department of Health and Human Services, 2008). To meet these goals health systems have began adopting health information technology, albeit at a very modest pace. The purpose of this research is to explore the dimensions of IT sophistication in long term care in Missouri nursing homes. Additionally, we will determine what functionality exists in nursing home care, to what extent it is being used to support patient care, and how well integrated IT is across nursing homes in Missouri.

IT sophistication has been defined as the maturity and diversity of Technological hardware and software used to support resident care, clinical support, and administration (Pare & Sicotte, 2001). IT sophistication conceptually arose from early business systems analyses of efficiencies of computer resources being used, generally accepted guidelines for using computers, and return on investments following computer installations (Cheney & Dickson, 1982; Nolan, 1973). IT sophistication has been evaluated nationally and internationally in acute care settings, but not in nursing home care (Culler et al., 2006; Ward et al., 2006; Jaana et al., 2005). Prior studies in acute care created benchmarks including differences in levels of IT sophistication based on organizational differences including type of ownership, location and size of hospital. Given that the nation has 16,100 nursing homes (National Center for Health Statistics, 2010) it is imperative to examine current use and strategies for increasing the use of IT in these settings as part of the Federal “meaningful use” initiatives (Centers for Medicaid and Medicare Services, 2010). Conceptually, three dimensions have been identified and measured within IT sophistication studies including Technological, Functional, and Integration Sophistication. These conceptual dimensions have been refined even further into technologies that support resident care, clinical support and administrative activities. Each dimension is defined in Table 1.

Corresponding Author: Phone: 573-882-9346, Fax: 573-884-4544, alexanderg@missouri.edu.

Sophisticated information systems provide certain capabilities and functions that enhance resident care, for instance, clinical decision support systems provide automated surveillance with colored prompts and popup reminders during the medication administration process to notify providers if drugs are given at the right time, in the right dose, and to the right patient. Understanding current levels of IT sophistication in nursing homes can provide a method to benchmark best practices of information technology use by early adopters, which can be used to inform nursing home administrators who adopt much later. Our goal is to provide a state profile of IT sophistication taken from a census of nursing homes voluntarily participating in a survey, which measures IT sophistication.

Background

In nursing homes, the level of utilization for sophisticated IT systems is only now beginning to be assessed (Resnick et al., 2009). Early evidence suggests the presence of considerable diversity in technology applications in these settings and IT is being utilized for many more types of activities. Historically, nursing homes have been slow to adopt IT systems. In March 1998, when the Health Care Financing Administration (now Centers for Medicare and Medicaid Services) began requiring electronic transmission of the minimum data set, approximately 70% of the United States certified nursing homes used computerized tools to transmit data, 16% had a computer system that needed upgrading to meet requirements for transmission, and the remaining 14% had no computer at all (Fisher, 1998).

In preliminary research our team adapted an IT sophistication survey, which was used in this research, through twelve interviews with IT experts in four nursing homes that were known to use highly sophisticated IT systems in clinical care. These four nursing homes had participated in a separate study which analyzed implementation of highly sophisticated systems in nursing homes (Rantz et al., 2010; Rantz M.J. et al., 2010). Highly sophisticated IT systems were defined in preliminary work as any computer system that had specialized capabilities, such as clinical decision support with automated alerts used for early detection of problems like skin breakdown, automated messaging systems and tasks lists that supported nursing and certified nurse assistants work, and electronic documentation of nursing notes. The results of the work to develop the survey for nursing homes are published in (Alexander & Wakefield, 2009) and are not discussed here. In a separate but related study we have also assessed the relationship between IT sophistication in nursing homes and nationally reported nursing home Quality Measures (QMs) from Nursing Home Compare, these included pressure ulcers, which we have found to be moderately sensitive to variation in degree of IT sophistication (Alexander & Madsen, 2009).

Our research team has found that regional demographic variations in NH are vital to organizational success in adoption of IT in nursing homes(Alexander et al., 2008). Most nursing homes are similar to smaller hospitals in that both are challenged in terms of available capital, onsite physicians and other clinical staff who could be devoted to IT implementation issues, and IT personnel with the expertise to support implementation and ongoing support of more advanced clinical and patient care IT systems(Alexander et al., 2007; Rantz et al., 2010). Conditions in such settings make it urgent to study how IT supports recommended evidence based practices and how IT can support important resident care, clinical support and administrative activities, such as communication between certified nurse aides and nurses who work in tandem caring for nursing home residents, documentation to track resident care activities of all disciplines, and clinical decisions made by staff about patient care.

Methods

We used a descriptive, exploratory cross-sectional design to investigate the domains of IT sophistication (Technologic, Functional, and Integration) as they related to resident care, clinical support and administrative processes. After adapting the IT sophistication survey instrument, we used the survey to evaluate the dimensions of IT sophistication (Technological, Functional, and Integration) as they related to resident care, clinical support and administrative processes. The following study methods were approved by the University of Missouri Institutional Review Board prior to data collection.

Sample

The roster of nursing homes from the state of Missouri was obtained from Nursing Home Compare. All 491 nursing homes in Missouri were contacted to participate in the survey including free standing and hospital based skilled nursing home facilities. Veteran's Administration nursing homes and Missouri Veteran's homes were excluded.

Homes which elected to participate were stratified into Metro-Urban-Rural regional subgroups as determined by using Beale codes to identify three county continuum codes based on population (Cook & Mizer, 1989). Metro included total facilities with 250,000 people or more in central, fringe, and metro counties; urban status designation was given in counties with between 2,500 to 250,000 people that were adjacent and not adjacent to metro areas; finally, rural status was assigned to facilities in rural counties with less than 2,500. Nursing homes were also stratified by bedsize and ownership type; bedsize was classified into facilities with less than 60 homes, medium sized homes between 60-120 beds and larger homes greater than 120 beds. Facilities were classified into two ownership types, investor owned (IO) and non-investor owned (NIO).

Survey Methodology

A survey, which had been validated for acute care environments (Jaana et al., 2005) was adapted for nursing homes (Alexander & Wakefield, 2009) and used to create an IT sophistication profile. The survey was conducted from December 2006 to August 2007. Respondents were asked to complete four sections in the survey which provided a description of the degree of IT sophistication used in resident management, resident care activities, clinical support activities, and administrative activities in each nursing home. A fifth section provided some general information about respondents and about the nursing home. Anonymity of the respondents was maintained throughout survey period.

Recruitment

Administrators were contacted by phone and informed of the purpose of the study and how it would be conducted. Administrators were informed they could choose any respondent who had oversight of IT functions within the nursing home facility and that had knowledge of key IT stakeholders in the organization. To increase response rates, at least two follow up phone calls were made at one week intervals to the administrator's who had agreed to participate and if needed, the surveys were resent. Additionally, to increase response rates and participation respondents received a small incentive of $25.00 for taking the time to complete the survey.

Data Collection

Administrators that agreed to participate were given a choice of two separate methods to complete the IT sophistication survey, including online or paper. If the administrator wanted an online survey a web-link was sent to the administrators email address which was obtained during the recruitment process. The online survey was administered using

www.freesurveysonline.com. Administrators who preferred paper surveys were sent a survey with a cover letter describing the procedure and a self addressed envelope.

Data Analysis

Each of the dimensions of IT sophistication (Functional, Technological and Integration) was used to describe the clinical domains being investigated including resident care, clinical support, and administrative activities. To explore the range and distribution of IT sophistication a descriptive analysis of the organizational characteristics of nursing homes based upon size, ownership and regional status was conducted. Percentages for discrete IT sophistication variables were calculated by summing responses in each variable and dividing by the maximum total possible. Responses were classified and reported using dichotomous and Likert-like scales as follows:

- Functional IT Sophistication: 0 = Not Available, 1 = available
- Technological IT Sophistication: 0 = Not Used, 1-3 = Barely Used, 4-6 = Somewhat Used, 7 = Extensively Used
- Integration IT Sophistication: 0 = Not Integrated, 1-3 = Barely Integrated, 4-5 = Somewhat Integrated, 6 = Very Much Integrated

Functional IT sophistication variables were coded for respondents to select either Available or Not Available and given a score of 0 or 1. Technological sophistication variables were rated by respondents on a scale from 0-7. Zero indicating the technology was not used. The range of values from 1-7 were collapsed into three categories including Barely Used, Somewhat Used, and Extensively Used after the survey was completed to report total Functional IT sophistication scores. For example, the percentage of homes which rated their Functional IT sophistication between 1 and 3 were tallied as a percentage of homes that Barely Used the technology. Similarly, Integration IT sophistication scales were tallied in the same way; however, the scale for this variable was either 0 (Not Integrated) or 1 (Barely Integrated) through 6 (Very Much Integrated).

To explore the association of variables measuring IT sophistication with nursing home characteristics, the factors of size, ownership and regional status were used. In theory, there could be 18 combinations of the three variables (bedsize, ownership, and regional status) being considered in this evaluation. In this paper, overall findings from each dimension of IT sophistication (Functional, Technological, and Integration) and three healthcare domains including resident care, clinical support and administrative activities will be discussed.

Statistical inference was not deemed appropriate in this study since a census was taken of all the homes in the state of Missouri who were willing to respond to the survey. To assess the observed differences between variables we summarized group means for each IT sophistication variable; then, differences in mean scores were evaluated for practical significance. For example, we looked at group means for the Residential Care Management and the Technological IT Sophistication variables when stratified by Ownership. In this case, the observed mean for IO facilities was 9 and in NIO facilities 14, a difference of 5. Initially, for these variables, we set a value for mean differences to be greater than 5, which meant that this mean difference was considered to be of practical significance; however, after examining each domain individually we decided to use more conservative criteria and set mean differences of 7 or greater as reflecting practical significance. In the example described above, this more conservative criterion resulted in a difference of 5 being rated as not having practical significance; thus, the variable with the more conservative approach with a mean difference less than 7 was not included in the analysis.

For each variable, tables were developed specifying the variables present and the mean values for a given IT sophistication score. Differences in means were compared across all 18 variables and if means exceeded the more conservative level of practical significance of 7, the combined variable was assigned a value of 1, indicating a difference was at least as great as the practical significance level. Conversely, if the level of practical significance was not exceeded the assigned value for the variable combination was assigned a 0, indicating that the difference in the means was not as great as the practical significance level or less than 7. Means of factor combinations that exceeded practical significance levels were examined.

Results

A total of 71% (349/491) of the nursing home administrators initially indicated their facilities would participate in the survey when contacted. A total of 199 surveys were received (41% response rate). There was some missing information since some respondents did not identify their nursing home by name on the survey, so 14 surveys from these homes were excluded from 199 total surveys completed. There were 185 useable surveys included in this analysis, 107 of which responded online with the remaining 78 responding by paper. NIO owned homes had a higher response rate (50%) than IO facilities (34%). Few administrators (44) provided a reason for not participating, however, of these ten were too busy, four thought the survey was too long, three indicated there was too little IT at the facility to participate.

Approximately 75% of the site respondents completing the survey indicated they were an Administrator, Chief Information Officer, Vice President/Owner, or Chief Financial Officer. Just over 11% of the site respondents were RN/Administrators, Clinical Managers, Supervisors, Care Plan or Nursing Office Coordinators. Nearly 10% were classified as Executive Directors or Business/Office Managers. Three respondents indicated their job title was Director of IT, Medical Information System Manager, or IT Technician.

In Missouri, nearly 45% of IO and NIO nursing homes are located in metropolitan areas with less than 25% of each located in rural designated areas. In our sample, the distribution of ownership and licensed bedsize was very uneven, 61% representing IO and 39% representing NIO facilities. Of these homes, there are fewer larger (>120 beds) and smaller (<60 beds) homes located in rural regions with the majority of medium sized homes (60-120 beds) located in metropolitan and urban regions (see Table 2).

Nursing homes across the U.S. have similar characteristics to our sample with the majority of homes being IO (65%) vs. NIO (34%); additionally, the majority of homes (44%) in the U.S. fall into the category of medium sized and less than 30% in each class of smaller and larger size homes (Cowles Research Group, 2000). In the following results we will first discuss the IT sophistication measures across the 9 subscales, followed by the results of our analysis of the groups compared by their demographic information.

IT Sophistication Measures by Healthcare Domain Type

Functional IT sophistication—Table 3 provides data on Functional IT Sophistication which measures healthcare activities supported by the technology. In resident care management, 51% to 74% of the facilities had technology in place to facilitate admissions, discharges, and transfers of residents. For the documents assessed in the survey 82% of the facilities had the face sheet computerized; 13% had no documents computerized. The most frequent nursing processes and documents which were computerized included those related to care planning and resident assessment protocols (86%). Staff workload management and vital signs recording were not computerized very often, 5%-7% respectively. Nearly half of

all physical therapy (PT) and occupational therapy (OT) processes had no computerization; although, 42% of facilities did report having electronic progress notes for these disciplines.

Very few homes used computers for clinical support (laboratory, radiology, and pharmacy). In these settings, computers were used most frequently for recurring test management and results validation in the laboratory and for pharmacy consulting services. Little computerization was used in radiology services.

Few homes were undergoing any sort of re-engineering of current IT systems; however, resident care processes were being re-engineered in 13% of the homes. One fifth to one third of the homes outsourced some IT activities ranging from IT strategic planning processes to software and hardware development, installation, and management. Forty percent of the homes had no form of back-up power source for IT systems in place.

Technological IT sophistication—Use of IT for resident care management processes was nearly nonexistent in many variables measured on the survey such as, voice recognition for physician notes, expert systems, and scanning of medical records (see Table 4). However, there are some facilities that are beginning to use IT extensively for some activities such as electronic tracking of medical records or tracking of resident identification. Nine percent of facilities used electronic dictation for physician notes. Seventeen percent of the nursing homes somewhat used personal computers or computer workstations at the nursing station, while 83% barely used or had no IT at the nursing station. Other places that IT could be found being somewhat used to extensively used in these homes were at the bedside (4%), on medication carts (7%), and with other portable computing devices (7%). IT was being used most frequently in laboratory clinical support settings compared to radiology and pharmacy. In laboratory settings, IT was used most often for electronic reporting of laboratory results; IT was used less frequently for activities related to coding of specimens, handling specimen requisitions, and results transmissions.

Integration IT sophistication—Internal financial IT systems were very much integrated (22%), followed by human resources (10%) with resident care management processes in this sample of nursing homes (see Table 5). In contrast, 91% of the homes responding indicated resident care management processes barely integrated with external entities or were not integrated at all. Although there were few systems that were using resident management IT (Table 3 and 4) for clinical support, more systems appeared to have greater levels of Integration with other internal systems, such as dietary (15%) and PT/OT (13%) systems when compared to external entities (see Table 5). Additionally, respondents from homes which had medical or resident records computerized also indicated very much Integration in 15% of the facilities.

IT Sophistication Measures by Survey Response Type—Table 6 contains descriptive statistics for all 9 subscales of the IT sophistication measures by survey response type. Table 6 illustrates the results of the analysis of the paper vs. online groups with IT sophistication scores reported. In every case the online responders had a higher mean and in all cases the median was also as high as or higher than paper respondents. The following results will be discussed using the variables resident care, clinical support and administrative activities.

Resident care—Resident care for the homes completing the online survey method had the greatest mean for Functional and the lowest mean for Technological sophistication (see Table 3). This difference indicates that although IT functionality was present to support some healthcare activities its extent of use in clinical settings was limited. Similarly, the facilities that used paper based surveys also had higher means for Functional with the lowest

means observed in Technological Sophistication. Overall, all homes using the online survey method used higher levels of IT sophistication in resident care management (Mean range: 13-34) than homes completing paper based surveys (Mean range: 8-26).

A wide range of IT sophistication was found in both homes using online based survey methods vs. paper based survey methods in resident care. Homes using online surveys reported a range from 0-100 of resident care management Integration sophistication although the mean was low at 24. A lower range of overall sophistication was found in homes using the paper based survey with the highest level of support occurring in processes used to manage resident care.

Clinical support—Clinical support variables in our sample were highly skewed with over half of the values being 0. There is a large difference in the homes reporting the use of technology for clinical support services in our sample. The online survey homes ranged from 0 to 88 of technology use in clinical support vs. 0 to 58 in paper survey homes.

The mean values for clinical support in online homes ranged from 8 for the degree of integration of systems used to support clinical processes (laboratory, radiology, etc.) to 13 for the types of clinical activities being supported. Sophisticated IT used in clinical support was also lower in homes completing paper based surveys with mean values ranging from 4 in Clinical Support Integration to 8 in Clinical Support Functional variables. All of the median values for every clinical support variable were 0, which is evidence of the highly skewed data for this variable.

Administrative activities—As expected, IT sophistication in administrative activities was the highest for both types of survey respondents. Online paper survey respondents ranged from a high of 90 for the administrative functions supported by technology to a low of 63 for extent of use of administrative IT solutions; the medians for both these variables were very near or higher than the mean scores. Similarly, but with a smaller range, the respondents completing paper surveys indicated IT sophistication levels from 50 to 61 for Functional and Integration Sophistication of administrative activities, respectively. The mean values ranged from 11 to 31 in Integration and Functional administrative variables; medians for each of the administrative variables were very close to the means.

In view of the fact that some of our distributions were highly skewed we choose to use the Wilcoxon Rank Sum test to further analyze differences between the groups. For the administrative variables, the differences between the groups are all significant (p(administrative Functional)=.0303, p(administrative Technological)=.0005, p(administrative Integration)=.0174) (see Table 7). The clinical support scores showed the least evidence of differences, with the resident care management scores giving some indication of differences, but not as strong as the administrative IT sophistication scores.

IT Sophistication Measures by Demographic Variable—The groups were also compared on demographics including ownership (IO/NIO), bedsize (<60, 60-120, >120), and regional location (urban/metropolitan/rural). There appears to be a significant difference in the ownership variable with 54/113 (48%) of the IO homes responding online while 53/72 (74%) of the NIO homes responded online (Chi square test, p=.0005). No differences were seen with respect to location and bedsize.

Discussion

The purpose of this research was to explore the level of IT sophistication in Missouri nursing homes. This is significant because there is growing recognition that a stronger

information technology infrastructure is needed to address the complex healthcare needs of nursing home residents and quality of care delivered in these facilities (Committee on Data Standards for Patient Safety, 2003). This research helps us to describe the current level of IT sophistication in nursing homes, to recognize early adopters of IT in these settings, and will eventually be used in a larger scale study to benchmark best IT practices against the quality of care being delivered in these settings. Benchmarks of best IT practice in nursing homes should reflect: 1) implementation of recognized capabilities and measures of meaningful use in nursing home IT systems, 2) associations between health IT utilization and nationally reported quality measures, 3) competent administrators and staff who are knowledgeable about project management, implementation, and ongoing maintenance of health IT networks, standards, and interoperability within and between healthcare sites, and 4) participation in research to facilitate knowledge development about new forms of health IT.

IT capabilities and meaningful use in nursing homes

Our results indicate that some sophisticated technologies are being implemented in nursing homes in the state of Missouri. In our sample, ownership seems to be the most significant variable affecting how respondents chose to respond to the survey, electronically or via paper. Location and facility size were not factors in this analysis. Ownership could be a significant factor in the adoption of health IT in these settings. In our sample, facilities that responded electronically overall had much higher IT functionality, extent of use, and integration. This is supported in a separate analysis, reported in (Alexander et al., 2008), where we found that NIO facilities tended to have higher levels of Technologic and Integration Sophistication incorporated into resident care management processes than IO facilities with variants found in use of IT in admission, discharge, and transfer processes. One of the key meaningful use health outcome criteria recently released (Centers for Medicaid and Medicare Services, 2010) recognizes improved coordination of care including the incorporation of technologies to support key clinical information exchange among providers and authorized entities. Nursing homes should not be overlooked as these important initiatives are being implemented as staff coordinates exchanges of information during transitional and sustained care for a large number of persons residing in these facilities.

IT Utilization and Quality Measurement

Another important meaningful use measure currently being developed and adopted through federal initiatives indicates that IT systems should have the ability to improve quality, safety, and efficiencies by reporting ambulatory quality measures and generating lists of patients by specific clinical conditions and active diagnoses. This implies that important correlations should exist between the implementation of sophisticated IT systems able to capture important clinical variables and improvements in quality measures. Through our work using this survey we have already identified moderate positive correlations ($r=.26$, $p=.001$) with every IT sophistication subscale except clinical support Technological and nationally reported Center for Medicare and Medicaid Services Quality Measures for Activities of Daily Living (ADL). Furthermore, we found moderately negative correlations ($r = -0.19$, $p=0.05$; $r = -0.20$, $p=0.05$) for residents with incontinence and the clinical support Technological and Integration IT sophistication variables (Alexander & Madsen, 2009). These findings suggest that increasing IT sophistication could have a direct effect on the ability to detect residents with incontinence frequency and ADL decline. Other quality measures regularly captured in nursing home settings could also be positively or negatively affected. The relationship between IT and quality is important for patient care, and if supported by knowledgeable staff and experts in informatics, administrators in these facilities could recognize significant improvements in quality of care for their residents.

Developing Competence in Nursing Home IT

Administrators and staff who are competent in implementing and using IT effectively to meet the needs of patients are required to achieve meaningful use in any healthcare setting. One problem area for nursing home settings is that administrators and staff are not informatics professionals and in many cases do not have adequate training or resources to either implement or maintain IT systems. In our sample, respondents to our survey were selected by Administrators based on their experience and oversight with the IT systems in place. We had very few respondents who self-identified their job role. Only two of the 44 which responded to this question had the title IT director or manager, one was an IT technician. Most of the respondents completing the survey appeared to have titles which were reflective of their other types of job responsibilities such as Nurse Manager, Owner, or Office Manager. Preparation for these types of positions do not usually require knowledge of IT system development, project management or life cycles, which are important for proper oversight of these complex systems.

Administrators and staff need to be knowledgeable and to have competence necessary to lead these important initiatives and achieve meaningful use. Collaborative groups around the world are emphasizing requirements for IT leadership competence. For example, the Teaching Informatics Guiding Educational Reform (TIGER) Competencies work group in the United States has developed strategic competencies to assist IT leaders in the education of basic computer competencies, information literacy, and information management (TIGER (Technology Informatics Guiding Education Reform), 2009). Implementing these source materials in core curriculum used to train nursing home leadership and staff would assist in developing required competence to implement and maintain IT systems. Additionally, the International Medical Informatics Association has recently defined key recommendations for providing good quality health care which includes properly trained leadership in health medical informatics of all disciplines at every stage of their career (Mantas et al., 2010). Requiring some of these learning outcomes for leadership and staff of nursing homes would provide some competence to oversee advanced types of IT functionalities, knowledge of how to implement and use IT systems, and resourceful staff who understand system integration.

Research Participation and Developing Technologies

From these results, it is evident that nursing homes in this sample from Missouri are expanding use of IT for administrative and billing processes being used for patient care and clinical applications in support of activities, such as admitting, discharging and transferring residents in and out of the facility, electronic tracking of medical records, and resident identification. We also know from our previous work that the more technologically savvy administrators are exploring the potential use of expert systems and clinical decision support to assist staff to more effectively monitor residents for development of pressure ulcers, calculation of fall risk, and detection of gait abnormalities (Alexander & Wakefield, 2009). Furthermore, from the literature, other IT related technologies are on the brink of implementation, such as remote sensors for monitoring restlessness while residents are sleeping in order to detect sleeplessness, to monitor motion activities in resident apartments to determine resident activity levels during the day and night, and technologies designed to detect gait patterns and falls located on subflooring anywhere within a facility (Skubic et al., 2009). However, most of these technologies are in the research stages and do not appear to be well integrated into these settings yet.

Recently, similar assessments of nursing home IT have been made in other US states. For example, in California approximately one fifth of all long term care facilities have some form of health information technology used for clinical purposes such as charting and

medication administration (California Health Foundation, 2008). In Pennsylvania, while the adoption rates of electronic health records is largely unexamined, the use of health information technology in long term care settings is being expanded for processes like telehealth vital signs monitoring and remote medication dispensation (Peifer & Pennsylvannia Association of Nonprofit Homes for the Aging, 2008). Finally, there are numerous other examples of individual research findings exploring the use of sophisticated information technology in these settings. Nursing home facilities should be encouraged to participate in development of these new technologies through collaborative research proposals and funding opportunities. As these types of devices are developed and implemented new items will need to be added to surveys, such as the one used in this study, to monitor implementation, meaningful use, and related outcomes within these facilities.

Limitations

A limitation of this study is the bias that could be introduced because of the large number of homes that have not completed the survey. The reasons that many nursing homes did not participate in the survey process is not known. If respondents did not complete the survey because they did not have technology present the level of IT sophistication could be lower than it appears. Additionally, respondents may not have participated because of a perception of not having the requisite knowledge of IT systems to answer the questions. We attempted to overcome these obstacles by providing help to respondents, answering questions as needed, and providing ongoing contact information to assist in clarifying survey materials. In this study, we have recruited a sample that is generalizable to other facilities in Missouri based on their ownership, bedsize, and locality. A larger sample including nursing homes from other states would be necessary to generalize beyond Missouri. We have attempted to maximize external validity of our sample by taking a census of the entire state of which 41% participated. Finally, the survey was conducted between December 2006 to August 2007 so IT sophistication may have changed since the survey was conducted 3 years ago and may not reflect current levels of IT sophistication in nursing homes at the time of this publication. This is strong justification for ongoing assessment of IT implementation in nursing homes.

Conclusion

The use of sophisticated technologies to support resident care management, clinical support and administrative activities appears to be increasing in this sample of nursing homes. Nursing home technology appears to be supporting mostly administrative types of activities, however there is growing interest among Missouri nursing homes in using electronic health records for resident management processes such as admissions, discharges, and transfers of residents in and out of facilities, which may meet some meaningful use criteria. These findings are encouraging because we have demonstrated that health information technology is being adopted for a wide variety of purposes in these settings; adoption of sophisticated information systems to support resident care, clinical support and administrative processes is the first step toward building an interoperable system to support coordination and transfer of health information between these systems. However, more support is needed in the form of education and resources to assist further development of IT systems in nursing homes.

Acknowledgments

This study received support from the Gerontological Nursing Interventions Research Center NIH #P30 NR03979 (PI: Toni Tripp-Reimer, PhD, RN, FAAN, The University of Iowa College of Nursing) and the Hartford Center for Geriatric Nursing Excellence; the John A. Hartford Foundation (PI: Kathleen Backwater, PhD, RN, FAAN, The University of Iowa College of Nursing). This project was also supported by grant number K08HS016862 from the Agency for Healthcare Research and Quality (Alexander, PI). The content is solely the responsibility of the authors

and does not necessarily represent the official views of the National Institute of Nursing Research, the John A. Hartford Foundation or the Agency for Healthcare Research and Quality.

Reference List

Alexander GL, Madsen R. IT sophistication and quality measures in nursing homes. Journal of Gerontological Nursing. 2009; 35:22–27. [PubMed: 19650620]

Alexander, GL.; Madsen, R.; Herrick, S.; Russell, B. Measuring IT sophistication in nursing homes. Agency for Healthcare Research and Quality; Rockville, MD: 2008. Rep. No. 08-0034-CD

Alexander GL, Rantz MJ, Flesner MK, Diekemper M, Siem C. Clinical Information Systems in Nursing Homes: An Evaluation of Initial Implementation Strategies. CIN: Computers, Informatics, Nursing. 2007; 25:189–197.

Alexander GL, Wakefield DS. Information technology sophistication in nursing homes. Journal of the American Medical Directors Association. 2009; 10:398–407. [PubMed: 19560717]

California Health Foundation. The State of Health Information Technology in California: Use Among Hospitals and Long Term Care Facilities. California Health Foundation; Oakland, CA: 2008.

Centers for Medicaid and Medicare Services. Medicare and Medicaid Programs; Electronic Health Record Incentive Program. 42 CFR Parts 412, 413, 422, and 495. 2010. **CMS-0033-P**. 1-13-2010. Ref Type: Unenacted Bill/Resolution

Cheney PH, Dickson GW. Organizational characteristics and information systems: An exploratory investigation. Academy of Management Journal. 1982; 25:170–184.

Committee on Data Standards for Patient Safety. Key capabilities of an electronic heatlh record system. Institute of Medicine National Academies Press; Washington DC: 2003.

Cook, PJ.; Mizer, KL. The Revised ERS County Topology: An Overview. US Government Printing Office; Washington DC: 1989. Rep. No. Rural Development Report 89

Cowles Research Group. Nursing Home Statistical Yearbook, 2000. American Association of Homes and Services for the Aging; Washington DC: 2000.

Culler SD, Atherly A, Walczak S, Davis A, Hawley JN, Rask KJ, et al. Urban-rural differences in the availability of hospital information technology applications: A survey of Georgia hospitals. The Journal of Rural Health. 2006; 22:242–247. [PubMed: 16824169]

Department of Health and Human Services. AHIC Use Cases. 2008. http://hitsp.wikispaces.com/AHIC+Use+Cases [On-line]. Available: http://hitsp.wikispaces.com/AHIC+Use+Cases

Fisher C. Linking payment and quality. Provider. March.1998 :26–37. [PubMed: 10177186]

Jaana M, Ward MM, Pare G, Wakefield DS. Clinical information technology in hospitals:A comparison between the state of Iowa and two provinces in Canada. International Journal of Medical Informatics. 2005; 74:719–731. [PubMed: 15990357]

Mantas J, Ammenwerth E, Demiris G, Hasman A, Haux R, Hersh W, et al. Recommendations of the International Medical Informatics Association (IMIA) on Education in Biomedical and Health Informatics. Methods of Information in Medicine. 2010; 2:1–16.

National Center for Health Statistics. Centers for Disease Control and Prevention FastStats Homepage. 2010. http://www.cdc.gov/nchs/fastats/nursingh.htm [On-line]

Nolan RL. Managing the computer resource: A stage hypothesis. Communications of the ACM. 1973; 16:399–405.

Pare G, Sicotte C. Information technology sophistication in health care: An instrument validation study among Canadian hospitals. International Journal of Medical Informatics. 2001; 63:205–223. [PubMed: 11502433]

Peifer, S.; Pennsylvannia Association of Nonprofit Homes for the Aging. The State of Technology in Aging Services in Pennsylvannia. Center for Aging Services Technologies; Washington DC: 2008.

Presidents Information Technology Advisory Committee. Revolutionizing health care through information technology. National Coordination Office for Information Technology Research and Development; Arlington, VA: 2004.

Rantz MJ, Alexander GL, Galambos C, Flesner MK, Vogelsmeier A, Hicks L, et al. Evaluation of the Use of Beside Technology to Improve Quality of Care in Nursing Facilities: A Qualitative Analysis. CIN: Computers, Informatics, Nursing. in press.

Rantz MJ, Hicks L, Petroski GF, Madsen RW, Alexander GL, Galambos C, et al. Cost, Staffing, and Quality Impact of Bedside Electronic Medical Record (EMR) in Nursing Homes. Journal of the American Medical Directors Association. in press.

Resnick HE, Manard BB, Stone RI, Alwan M. Use of electronic information systems in nursing homes: United States, 2004. Journal of the American Medical Informatics Association. 2009; 16:179–186. [PubMed: 18952930]

Skubic M, Alexander GL, Popescu M, Rantz MJ, Keller J. A smart home application to eldercare: Current status and lessons learned. Technology and Health Care. 2009; 17:183–201. [PubMed: 19641257]

TIGER (Technology Informatics Guiding Education Reform). The TIGER Initiative: Collaborating to Integrate Evidence and Informatics into Nursing Practice and Education: An Executive Summary. 2009. http://www.tigersummit.com/uploads/TIGER_Collaborative_Exec_Summary_040509.pdf

Ward MM, Jaana M, Bahensky JA, Vartak S, Wakefield DS. Clinical information system availability and use in urban and rural hospitals. Journal of Medical Systems. 2006; 30:429–438. [PubMed: 17233155]

Table 1

Dimensions of IT Sophistication in Nursing Homes

Attributes of IT Sophistication	Domains of Health Care		
	Resident care	**Clinical support**	**Administrative activities**
Functional Sophistication	Resident care activities supported by technology	Clinical processes supported by technology	Administrative activities supported by technology
Technological Sophistication	Technology used in resident care activities	Technology used in clinical support	Technology used in administrative activities
Integration Sophistication	Degree of integration of resident care technology	Degree of integration of clinical support technology	Degree of integration of technology supporting administrative activities

Table 2

Characteristics of Respondents Based Upon Survey Response Type

	Ownership		Location			Bedsize		
Survey Response Type	**Investor Owned (IO)**	**Non Investor Owned (NIO)**	**Metro (M)**	**Rural (R)**	**Urban (U)**	**<60**	**60-120**	**>120**
Online	54	53	54	14	39	9	72	26
Paper	59	19	30	16	32	8	56	14

Table 3

Percent of Functional IT Sophistication by Health Care Domain

Resident Care		**Clinical Support**		**Administrative Processes**	
Resident Management Processes	(%)	Laboratory	(%)	IT Systems Monitoring	(%)
Admissions	74	None	53	IT Help Desk Issues	26
Discharges	63	Recurring Tests Management	26	Tracking IT Systems Issues	15
Transfers	51	Results Validation	25	IT Complaints/Requests	15
Bed Availability Estimate	31	Resident Registration/Admission	21	Backup Power Source	
Wait List Management	19	Specimen Pick-up	15	Yes	60
None	21	Results Capturing	15	No	40
Documents		Specimen Archiving	14	Current IT System Re-engineered	
Face Sheet	82	Label Generation	9	Resident Care Processes	13
Results Reporting	51	Radiology		Physician Order Entry	5
Physician Order Sheet	50	Results Capturing	9	Registration/Scheduling	5
Order Entry	22	Resident Registration	5	HIPPA	4
Discharge Summary	21	Label Generation	2	Revenue Cycle	4
Progress Notes	10	None	82	None	48
None	13	Pharmacy		Outsourced Activities	
Nursing Processes or Documents		Pharmacy Consulting Services	20	Network Administration	35
Care Planning/RAPS	86	Medication Administration	15	Hardware Management	33
Real Time Continuous MDS/RAI	62	Allergy Alerts	15	Software Development	32
Quality Assurance	34	Resident Drug Profile Look-up	14	Software Installation	30
Staff Scheduling	30	Drug Interaction Checking	14	Hardware Purchasing	27
Incident Reporting	27	Duplication Orders Checking	13	Helpdesk	21
Resident Acuity/Condition	21	Do Not Crush Alerts	13	Training	21
Physician Orders Transcription	19	Historical Information Storing	13	IT Strategic Planning	15
Medication Administration	15	Medication Purchasing	12	Change Management	9
Historical Record Keeping	14	Making Out Refill Reports	7	None	29
Clinical Reporting (e.g Treatment)	14	Crossmatch with Beer’s Criteria	6		
Nursing Flowsheet	13	Wards Stock Management	5		
Vital Signs Recording	7	IV Admixtures Management	4		
Staff Workload Management	5	None	54		

Resident Care		Clinical Support	Administrative Processes
None	6		
Physical/Occupational Therapy			
Progress Notes	42		
Care Planning	32		
Registrations/Admissions	23		
Resident data collection	20		
Physicians' Order Transcription	12		
Order Entry	12		
Staff Scheduling	11		
Results reception/reporting	10		
Notes	4		

Table 4

Percent of Technological IT Sophistication by Health Care Domain

Resident Care				
	Not Available	**Barely Used**	**Somewhat Used**	**Extensively Used**
Resident Management Processes			(%)	
Electronic Tracking of Medical Records	63	13	8	17
Electronic Tracking of Resident ID	48	14	13	25
Scanning of Medical Records	93	5	2	1
Centralized Scheduling	74	12	7	7
Dictation for Physician Notes	79	7	5	9
Voice recognition for Physician notes	96	2	2	1
Connection to External Database (e.g. Medline)	61	12	17	11
Artificial Intelligence/Expert Systems	92	6	1	1
Expert Systems Resident PHR	96	2	1	1
Telemedicine for Resident Eval	92	4	3	2
Electronic Access to Radiology Images	91	3	1	5
Transmission of Diagnostic Images or consultations	90	4	5	1
Nursing				
PCs or Workstations at Nurse Station	75	9	6	11
PCs or Workstations in Hallways	93	2	1	4
PCs or Workstations on MedCart	93	1	2	5
PCs or Workstations at Bedside	96	0	3	1
Portable computing devices (e.g. handhelds, laptops)	86	7	2	5
Touch Screens	89	4	2	5
Physical/Occupational Therapy				
PCs or Workstations at Nurse Station	84	5	4	7
PCs or Workstations in Hallways	94	1	1	4
Portable computing devices	84	3	4	9
Touch Screens	94	1	3	3

Clinical Support				
	Not Available	**Barely Used**	**Somewhat Used**	**Extensively Used**
Laboratory			(%)	
Electronic Coding for Specimen	87	4	1	8
Electronic Lab Test Requisitions	75	6	7	12
Electronic Reporting of Lab Results	65	5	10	20
Electronic Results Transmission	78	6	4	12
Radiology				

Clinical Support				
	Not Available	**Barely Used**	**Somewhat Used**	**Extensively Used**
Picture Archive Communications	95	1	4	1
Electronic Coding (e.g. films)	98	1	1	0
Electronic Test Requisitions	95	1	1	3
Voice Recognition for Transcription	99	0	1	0
Digital Radiologic Images	94	1	4	1
Electronic Access to Radiology Images	94	1	4	2
Results Capturing and Interpretation	95	1	4	1
Pharmacy				
Electronic Data Links to Medication Suppliers	90	5	3	2
Extranet Links to Suppliers	93	4	2	2
Remote OE for Medications from clinical units	91	3	1	5
Remote OE for Medications outside nursing home (e.g. clinic, home)	93	2	1	4

ID-Identification

PHR-Personal Health Record

PCs-Personal Computers

OE-Order Entry

Table 5

Extent of IT Integration (Integration Sophistication) by Health Care Domain

Resident Care				
	Not Integrated	**Barely Integrated**	**Somewhat Integrated**	**Very Much Integrated**
Resident Management Processes		(%)		
Medical/Resident Records Computerized	41	26	18	15
Resident Care Interface with External Entities (e.g Clinics, Hospitals, Clinical Laboratory, etc.)	81	10	5	4
Resident Care Systems Interface with Other Internal Information Systems				
Laboratory	81	5	6	7
Occupational/Physical Therapy	75	11	9	5
Dietary Systems	73	12	6	9
Pharmacy	78	9	6	7
Human Resources	74	8	9	10
Finance	43	13	22	22
Nursing Information Systems Integrated to Each Other Internally	63	13	12	12
Nursing Information Systems Integrated with Other Information Systems Internally				
Pharmacy	85	6	5	4
Dietary Systems	78	7	10	5
Occupational/Physical Therapy	81	6	8	5
Laboratory	81	7	5	6
Radiology	94	1	3	3
Clinical Support				
Information Systems Integrated Externally with External Entities (e.g. Hospital, Clinic, Nursing Home)				
Pharmacy	92	3	2	3
Laboratory	83	3	9	5
Radiology	93	1	2	4
Administrative Processes				
Do current computer-based applications meet current resident care, education, and research needs	18	37	37	9
Do current computer-based applications meet future resident care, education, and research needs	32	36	27	6
Do current computer-based applications meet current administrative and financial needs	11	24	56	9
Do current computer-based applications meet future administrative and financial needs	20	33	40	7

Policy Polit Nurs Pract. Author manuscript; available in PMC 2011 December 15.

Table 6

IT Sophistication Measures by Survey Response Types (Online vs. Paper)

Survey Response Type	Variable	N	Mean	Median	SD	Lower Quartile	Upper Quartile	Range Min	Range Max
Online	Resident Care								
	Functional Sophistication	107	34	29	21	**19**	**45**	0	93
	Technological Sophistication	107	13	8	15	**2**	**17**	0	62
	Integration Sophistication	107	24	15	24	**7**	**33**	0	100
	Clinical Support								
	Functional Sophistication	107	13	0	21	**0**	**22**	0	84
	Technological Sophistication	107	10	0	17	**0**	**17**	0	71
	Integration Sophistication	107	8	0	21	**0**	**6**	0	88
	Administrative Processes								
	Functional Sophistication	107	18	10	19	**0**	**20**	0	90
	Technological Sophistication	107	32	33	13	**22**	**43**	0	63
	Integration Sophistication	107	38	36	17	**24**	**50**	3	80
Paper	Resident Care								
	Functional Sophistication	78	26	25	16	**14**	**36**	0	87
	Technological Sophistication	78	8	5	9	**1**	**13**	0	40
	Integration Sophistication	78	14	11	14	**1**	**23**	0	63
	Clinical Support								
	Functional Sophistication	78	8	0	12	**0**	**16**	0	58
	Technological Sophistication	78	5	0	10	**0**	**7**	0	57
	Integration Sophistication	78	4	0	10	**0**	**0**	0	50
	Administrative Processes								
	Functional Sophistication	78	11	10	11	**0**	**10**	0	50
	Technological Sophistication	78	25	24	11	**18**	**34**	2	60
	Integration Sophistication	78	31	31	11	**23**	**39**	6	61

Table 7

Wilcoxon Rank Summed Test Paper/Online and IT Sophistication Analysis

Variable	p value
Residential care	
Functional*	0.0154
Technological*	0.0499
Integration*	0.015
Clinical Support	
Functional	0.4239
Technological*	0.0275
Integration	0.42
Administrative Processes	
Functional*	0.0303
Technological**	0.0005
Integration*	0.0174

* $p<.05$

** $p<.001$