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# Case studies of IT sophistication in nursing homes: A mixed method approach to examine communication strategies about pressure ulcer prevention practices

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ABSTRACT

Most nursing homes lack information technology (IT) for supporting clinical work in spite of its potential to improve the safety, quality, and efficiency of nursing home care in the United States. Increased attention to medical error and concern for patient safety have prompted general recommendations to develop sophisticated technologies to support clinical decision making at the point of care, to promote data standards in electronic records, and to develop systems that communicate with each other. However, little is known about what IT applications best support communication and risk assessment practices to improve resident outcomes in nursing homes. Thus, the overall aim of this study was to evaluate how differences in IT sophistication in nursing homes impact communication and use of technology related to skin care and pressure ulcers. We used a mixed method approach to conduct case studies on two nursing homes – one with high IT sophistication and one with low IT sophistication. Observational analysis and social network analysis were used to identify patterns in communication types and locations; also, focus groups were conducted to explore communication strategies used by Certified Nursing Assistants (CNAs) to support pressure ulcer prevention practices. Overall, results from social network analysis of observational data indicate that direct interactions between CNAs and registered nurses (RNs) or licensed practical nurses (LPNs) were more frequent in the low IT sophistication home and occurred in more centralized locations (e.g. the nursing station) compared to the high IT sophistication home. Moreover, these findings are supported by focus group results, which indicate that the high IT sophistication home had more robust and integrated communication strategies (both IT and non IT) that may allow for interactions throughout the facility and require less frequent face to face interactions between CNAs and RNs or LPNs to verify orders or report patient status. Results from this study provide insight into the design and assessment of different forms of communication to support clinical work in NHs.

*Relevance to industry:* Nurses bear great burdens for nursing home care; yet, issues persist with poor quality, variable performance of caregiving, and lack of implementation of proven care interventions. One new hope for improvement in nursing home care is the introduction of IT to improve communication, clinical decision-making, and quality of care.



## 1. Introduction

Healthcare delivery reached a tipping point in 2009 with the passage of the American Reinvestment and Recovery Act (Valdez et al., 2010). The federal government invested $25.8 billion in health information technology (IT) (Department of Health and Human Services, 2010), which is a high priority for long-term care (LTPAC Health IT Collaborative, 2010). Current national priorities for Long Term and Post-Acute Care settings, including nursing homes (NHs), are adoption and use of health IT and electronic health records (LTPAC Health IT Collaborative, 2010). Rationale for these national priorities emphasizes importance of adoption to improve quality and continuity of care for 1.5 million chronically ill

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residents' living in U.S. NHs (Committee on Data Standards for Patient Safety, 2003). Better quality and continuity will prevent chronic illness exacerbations resulting in health status changes, hospitalization, complex treatments, and high cost (Kane, 1999). Annual costs for long term care in the U.S. have reached over 200 billion dollars with 69% being paid by Medicare and Medicaid (U.S.Department of Health and Human Services, 2010).

Currently, we do not know which IT applications or capabilities are best suited to improve NH residents' outcomes (U.S.Department of Health and Human Services, 2010). However, results of our prior research confirms that increasing IT Sophistication (ITS) in NH resident care does correlate positively with nationally reported NH Quality Measures, including residents with declining activities of daily living and those with incontinence, which contribute to more positive outcomes associated with skin integrity and pressure ulcers (Alexander and Madsen, 2009). The purpose of this manuscript is to provide results of two case studies of two NHs with diverse ITS. Our overall goal was to evaluate how differences in ITS in NHs impact communication and use of technology related to skin care and pressure ulcers. In each NH, we explored what communication strategies were used by NH staff to provide care to residents at risk of skin breakdown and pressure ulcers. Furthermore, we explored what evidence based pressure ulcer preventions associated with risk assessment and skin care were used by staff in NHs with diverse ITS. Finally, we used a social network analysis tool called ORA developed by the Center for Computational Analysis of Social and Organizational Systems (CASOS) at Carnegie Mellon to illustrate social networks surrounding Certified Nurse Assistants (CNAs) who were observed in the two facilities during the study. Metrics used to evaluate social networks provide valuable insights into workflow enhancements or interruptions that can have positive or deleterious effects on quality of nursing work (Carayon et al., 2010). Based on our results, we offer some design implications related to ITS.

## 2. Conceptual model

Human-factors principles relate to how humans accomplish work-related tasks in the context of human-machine systems (Meister, 1989; Salvendy, 1997). These systems can be used to determine how NHs reporting greater levels of ITS improve communication about pressure ulcer prevention measures. Human-factors models incorporate a strategic focus on operators, machines, and environments (Czaja, 1997; Helander, 1997; McCormick and Sanders, 1982). Building on this human-machine system model, a conceptual model relating current and ideal states of NH ITS was developed for this work. Fig. 1 illustrates the model and how IT capabilities, such as clinical decision support systems found in NHs with high ITS, aide in problem recognition and lead to clinical actions resulting in improved resident outcomes. We believe that resident outcomes will improve as NHs implement these functionalities into bedside care, as providers use them more, and as they are integrated with other systems, such as electronic nursing documentation systems. This conceptual model guided our mixed-method examination of associations between overall ITS and NH communication strategies.

The conceptual model in Fig. 1 contrasts NHs that do not have (Current State) the capability to enter resident assessment data into an IT system with NHs that do have such systems (Ideal State)(-Alexander et al., 2010; Liu et al., 2009). In the Ideal State, any type of healthcare provider can enter data. The IT algorithms used in ideal states have predetermined clinical criteria that link to assessment data, such as "no incontinence" that are compared to data providers enter, such as "resident has increasing incontinence". When preset criteria are not met by resident data entered into an assessment, the clinical decision support system generates electronic alerts, such as a "skin integrity alert", which can be sent to healthcare providers. The scenario in Fig. 1 includes a skin integrity alert that can be turned on for a number of reasons, including when an RN/LPN or CNA documents that a resident is comatose, has increased edema, is experiencing increasing incontinent episodes, or when turning repositioning has not been documented. The predetermined criteria can be set by vendors and can often be manipulated by the administrator of the decision support system (Alexander et al., 2007). When an alert is issued, the system automatically sends a message to the user (RN/LPN/CNA) that a potential problem has been identified. This is a prompt for the staff to investigate the problem. Previous work has established that NHs that implement IT with these capabilities demonstrated sustained improvements in quality measures three years after implementation, however costs for maintaining these systems were not neutral (Rantz et al., 2010).

IT innovations have the potential to change the clinical practice paradigm in NHs by changing the way providers monitor and communicate patient needs and care processes. This is demonstrated

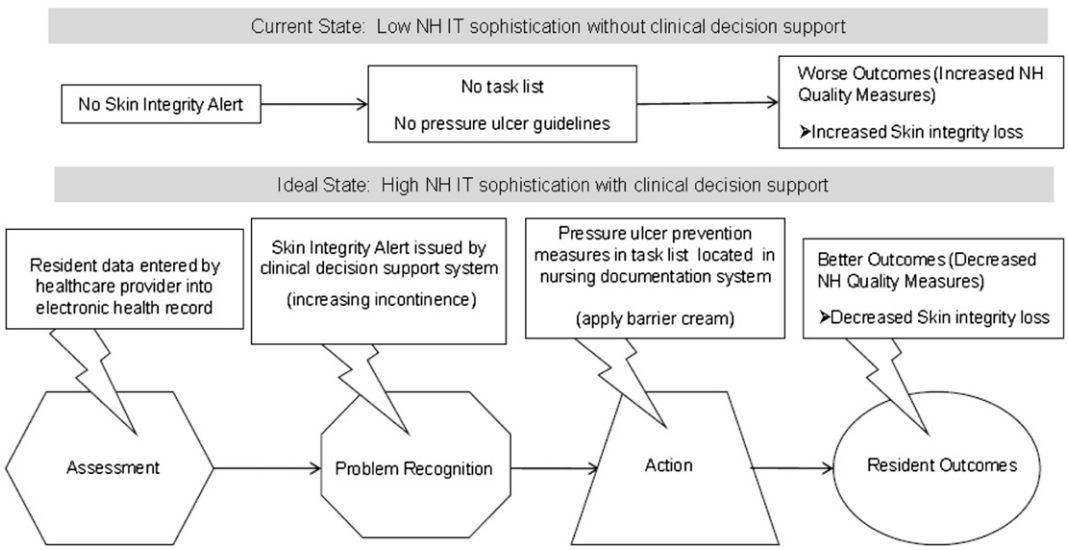


**Fig. 1.** Current and ideal state models for low and high IT sophistication in NHs.

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for skin integrity in Fig. 1. NH IT administrators should integrate recommended evidence based guidelines for pressure ulcer prevention (ex. apply barrier cream for incontinence) into the IT system using automated task lists to remind RNs/LPNs/CNAs to practice appropriate resident care. Based on messages staff receive, they can exercise their own clinical decisions enhanced by electronic messages, guidelines, or their own observations; then, staff can choose whether to take clinical action and administrators can monitor these actions. The alert turns off when it is resolved through appropriate documentation. The majority of NHs operates without alerts and staff is responsible for making care decisions based upon their own recall and synthesis of vital information. Considering that NH quality problems have been consistent over time and place, it appears the current state of low ITS is not working well. It is our belief that higher levels of IT sophistication provides the infrastructure for "better" communication thorough decision support systems based on evidence, and reducing the need for face-to-face communication. Further, following such guidelines through decision support systems also documents the tasks and enables tracking without face to face interactions.

## 3. Measures and methods

To assess how NH IT improves resident care and provider communication, we conducted two case studies in two NHs, one with high ITS and one with low ITS. In these two NHs we explored strategies staff use to communicate evidence based pressure ulcer preventions. In this paper we will report communication patterns of Certified Nursing Assistant's (CNA), which were documented using a structured observational field note guide of recommended evidence-based guidelines for pressure ulcer management. Data from these mappings were used to create visualizations of the social networks that CNAs were collaborating with to provide care. Finally, we conducted focus groups including CNA staff from each facility to further interpret how communication strategies for pressure ulcer prevention are implemented to provide better care. In this paper, we'll focus primarily on the work conducted by CNAs because they are primarily responsible for implementing good skin care practices, while nurses conducted advanced assessment.

### 3.1. Information technology sophistication

ITS describes the information technology and software that support three domains of NH care: Resident Care, Clinical Support, and Administrative Activities. The three dimensions of ITS are: (1) Functional Sophistication, which includes healthcare delivery processes or activities supported by technology; (2) Technological Sophistication, or the extent of use of hardware/software devices; and (3) Integration Sophistication, which represents the level of internal and external integration among departments and clinical settings inside and outside a facility (Jaana et al., 2005; Pare and Sicotte, 2001; Cheney and Dickson, 1982). Early development of ITS measures arose as researchers evaluated IT frameworks in manufacturing environments (Nolan, 1973). The measures were adapted to acute care hospital settings and demonstrated excellent reliability (Cronbach's Alpha) in each dimension mentioned above (Functional, .81–.86; Technological, .71–.83; Integration, .67–.86) (Pare and Sicotte, 2001). The measures also proved reliable for the domains of care (Patient Care, .79–.86; Clinical Support, .82–.86; Administrative Activities, .67–.81) (Pare and Sicotte, 2001).

Our interdisciplinary team's preliminary work (Alexander and Wakefield, 2009) adapted the acute care ITS instrument for use in NHs. To accomplish this, we interviewed 12 IT stakeholders from 4 high-ITS NHs in 2 states. These interviews included key informants as well as focus groups to explicate the dimensions of the ITS measure among three clinical domains (Alexander and Wakefield, 2009). We further tested the survey instrument in a statewide census of 491 NHs (Alexander et al., 2010); we estimated internal consistency using Cronbach's Alpha for each subscale of the NH ITS instrument. Cronbach's Alpha values for the ITS dimensions among three clinical domains were: Resident Care, .87–.88; Clinical Support, .86–.91; and Administrative Activities, .69–.80. Values between these ranges have been found suitable for research purposes (Pedhazur and Pedhazur-Schmelkin, 1991).

#### 3.1.1. Selection of NHs for case studies

The statewide ITS survey completed in Missouri resulted in a 41% response rate (199 NHs). The current study includes a comparison of NHs with the highest and the lowest ITS from the statewide census completed in 2007 (Alexander et al., 2010). In preliminary work, the ITS scoring mechanism was standardized across dimensions and domains to enable comparisons to be made between groups, including 9 dimensions and domains and a total ITS score. After standardization procedures were applied each combined dimension and domain ITS score ranged between 0 and 100; also, the maximum Total ITS score was 900. The highest ITS NH in this study, which would reflect the Ideal State in our model, had a total ITS score of 661; in comparison, the lowest ITS NH in our study had a Total ITS score of 50 (See Table 1). In the high ITS NH the range of ITS scores was 47–100 across dimensions and domains with the extent of use of administrative systems (administrative technological) scoring lowest and IT integration in resident care scoring the highest, respectively. In the low ITS NH representing the current state of NH ITS, ITS scores ranged from 0 to 26. The lowest ITS was reported across all clinical support domains in each dimension of ITS and the highest ITS score was in extent of use and integration of ITS for administrative activities, accordingly. Examples of ITS in each of these facilities are described in the sections that follow.

The high ITS NH was a not for profit facility located in a metropolitan area with a bed size of 60–120. The low ITS NH was a for

**Table 1**
Demographics of nursing homes participating in case studies.

| | Facilities by total ITS score | |
|---|---|---|
| | High ITS NH | Low ITS NH |
| *Facility demographics* | | |
| Ownership | Not for profit | For profit |
| Bed size | 60–120 | 60–120 |
| Setting | Metropolitan | Metropolitan |
| *Quality measures (percentage residents) (possible residents)* | | |
| Low risk residents who lost control of bowel/bladder | 27%(41) | 36%(45) |
| Residents whose need for help with ADLs increased[a] | 10%(49) | 24%(74) |
| Residents whose ability to move in and around room got worse | 7%(44) | 29%(48) |
| Residents who spend most of their time in bed or chair | 0%(55) | 3%(93) |
| High risk residents with pressure ulcers | 3%(30) | 3%(74) |
| Low risk residents with pressure ulcers | 0%(25) | 0%(19) |
| *ITS by domain and dimension (range 0–100)* | | |
| Residential Care Functional ITS | 93 | 6 |
| Technological ITS | 62 | 0 |
| Integration ITS | 100 | 0 |
| Clinical Support Functional ITS | 81 | 0 |
| Technological ITS | 66 | 0 |
| Integration ITS | 83 | 0 |
| Administrative Functional ITS | 50 | 0 |
| Technological ITS | 47 | 26 |
| Integration ITS | 79 | 18 |

[a] ADL = Activities of Daily Living.

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profit facility located in a metropolitan area also with 60–120 beds. In preliminary work via the statewide survey we found that differences in ownership are moderately correlated with increasing ITS, not for profit facilities were more likely to have high ITS (Alexander et al., 2008), which is seen in this case study sample. As a measure of patient acuity or difficulty of care for residents in each NH at the time we were conducting our observations we collected nationally reported Quality Measures from each facility administrator during our visit (See Table 1). NH Quality Measures come from resident assessment data that NHs routinely collect on the residents at specified intervals during their stay; Quality Measures are a valid source of information for comparing care across NHs (CMS, 2012). Quality Measures related to this study including the percentage of residents with elimination and incontinence issues, percentage of residents with physical functioning issues, such as mobility, and percentage of residents with skin care issues, specifically pressure ulcers were assessed. Elimination and incontinence issues for residents appear to be a problem in these facilities, which would require frequent, and accurate risk assessments, as well as a diligent skin care regimen to prevent pressure ulcers from occurring. For example in the low ITS NH 36% (16/45) and in high ITS NH 27% (11/41) of residents were low risk but had incontinence of bowel or bladder. Both facilities had approximately 3% of high risk residents with pressure ulcers; high ITS NH with 1/30 and low ITS NH with 3/74.

In addition to patient level factors we considered facility level factors that could have affected observed communication strategies. We conducted windshield surveys of each facility to get acquainted with their floor plans. We collected floor plan documents to analyze after conducting observations. Both facilities had a centralized core area that was surrounded by patient rooms with similar bed size. Oftentimes residents were found in core areas that included nursing stations, day rooms, baths, or courtyards located adjacent to the resident's rooms. Observations of communication between CNAs, staff and residents occurred in all of these areas. To minimize the bias introduced by facility architecture and structural characteristics we elected to conduct observations on a single nursing unit within a facility, selected by the administrator, which had the residents with the highest skin care needs, usually the Medicare unit.

### 3.2. Prevention and treatment strategies for pressure ulcers in nursing homes

Skin care experts developed clinical practice guidelines for predicting, preventing and treating pressure ulcers, and AHRQ disseminated them in 1992 and 1994 (Agency for Healthcare Research and Quality ((AHRQ) formerly AHCPR), 1992; Agency for Healthcare Policy and Research, 1994). Clinical practice guidelines, which describe best practices, are systematically developed recommendations that guide practitioners and patients in making appropriate healthcare decisions in specific circumstances (Berlowitz et al., 2001). The purpose of the pressure ulcer guidelines was to assist nursing home staff in identifying residents who are at risk of developing pressure ulcers and to carry out early interventions prevention and treatment. AHRQ guidelines remain a valid method to assess prevention and treatment of pressure ulcers in NH (Shekelle et al., 2001). AHRQ guidelines are still recognized as some of the best strategies for lowering the prevalence and incidence of pressure ulcers in NHs.

#### 3.2.1. Implementation of clinical guidelines for pressure ulcers

The AHRQ clinical practice guideline and skin-care experts recommend the following for the prediction, prevention and early treatment of pressure ulcers in adults: (1) use risk-assessment tools to identify adults who are at risk of developing pressure ulcers; (2) suggest skin-care and treatment options to maintain and improve tissue tolerance to pressure; (3) promote the use of support surfaces that reduce pressure, friction, and shear on skin surfaces; and (4) address the need for educational programs on pressure ulcer prevention for all levels of providers (Agency for Healthcare Research and Quality ((AHRQ) formerly AHCPR), 1992). A second guideline released in 1994 provided scientific evidence and recommendations for treatments focused on: (1) assessment of residents and pressure ulcers; (2) tissue load; (3) ulcer care; (4) infection and colonization of bacteria; (5) operative repair, and (6) education and quality improvement (Agency for Healthcare Policy and Research, 1994). Research using these guidelines has been widely disseminated. For example, the National Pressure Ulcer Long Term Care Study (Horn et al., 2004) reported that most preventive strategies initiated for pressure ulcer management in participating NHs were related to incontinence interventions (86%), repositioning schedules (79.3%), pressure-relieving devices (64.9%), protective devices (52.2%), friction and shear treatments (39.8%), and seating devices (31.9%). Bergstrom et al. emphasized that clinical judgments regarding which types of prevention practices to implement must be based on patient factors, characteristics of pressure ulcers found during assessments, knowledge of pressure ulcer appearance, and knowledge of the efficacy of treatments (Bergstrom et al., 2005). One of the surprising findings in the Bergstrom study was the large variation in pressure ulcer treatment practices (Bergstrom et al., 2005); standard protocols were not in place, which permitted greater than expected variation in pressure ulcer management (Bergstrom et al., 2005).

#### 3.2.2. Structured observational field notes of pressure ulcer preventions

To conduct this study, we developed a structured observational field note guide with four categories of pressure ulcer prevention practices recommended for at risk residents. The four categories in the field note guide included Risk Assessment, Skin Care, Mechanical Loading and Support Surfaces, and Education. Each category included subcategories, which provided specific prevention practices that could be observed in the clinical setting. For this analysis of CNAs we included the categories Risk Assessment and Skin Care (See Table 2), specifically *risk reassessment at periodic intervals* and *systematic skin care inspection*. Our rationale for this decision was that in NHs CNAs are mostly responsible for providing good skin care, for example skin care associated with toileting and positioning. As indicated previously, both NHs had similar numbers of patients identified as low risk who had lost control of their bowel or bladder; conversely, these NHs had a wide range of residents at high risk of pressure ulcer, but very few with actual pressure ulcers. Fluctuations in these risks could account for differences in observations of communication in High and Low ITS NHs. For example, one would expect that the low ITS NH with greater numbers of high risk pressure ulcer patients would have greater face to face communication observed because of the greater number of skin care needs. However, if face to face communication is not effective, subsequent risk reassessments and/or follow up interventions could be decreased. CNAs are responsible for monitoring and communicating changes in skin condition for any patients with these risks, and for reporting to RNs/LPNs if skin conditions appear to be deteriorating, which would require a higher level of risk assessment conducted by RNs.

Our observational plan included a windshield survey of each facility to map unique communication strategies used. Two research team members, including a PhD prepared RN with expertise in gerontology and informatics and a research assistant with a healthcare background, conducted structured participant observations of RN/LPN-CNA dyads while they were performing clinical

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**Table 2**
Observations of pressure ulcer preventions communicated by nursing home staff.

| | High ITS NH | Low ITS NH |
|---|---|---|
| Total observations per Facility | 675 | 711 |
| 1. Risk assessment | | |
| Use of validated risk assessment tool (Braden or Norton Scale) | 1 | 0 |
| Risk reassessed at periodic intervals | 255 | 232 |
| Risk assessments documented | 77 | 67 |
| 2. Skin care | | |
| Systematic skin inspection including bony prominences | 222 | 215 |
| Skin inspection documented | 67 | 79 |
| Skin cleansing (at time of soiling and at routine intervals) | 64 | 52 |
| Frequency of skin cleansing individualized | 7 | 38 |
| Avoid hot water | 4 | 30 |
| Use of mild cleansing agents | 29 | 17 |
| Minimization of force and friction applied to skin | 49 | 38 |
| Minimize environmental factors (low humidity, exposure to cold) | 6 | 12 |
| Treat dry skin with moisturizers | 15 | 9 |
| Protect bony prominences | 94 | 92 |
| Minimize exposure to moisture | 48 | 53 |
| If moisture uncontrollable, use underpads or briefs to absorb moisture | 14 | 32 |
| Apply proper positioning, transferring, and turning techniques | 72 | 129 |
| Apply lubricants, protective films, dressings, and/or paddings | 76 | 54 |
| Support nutritional intake | 61 | 80 |
| Institute rehabilitation | 5 | 5 |

work. To improve inter-observer agreements at each facility the two observers simultaneously watched different events occurring on the clinical unit, while independently recording data using the observational field note guide. Following observations, observers reviewed the percentage of agreement determined by a function of their disagreements and agreements (Polit and Tatano-Beck, 2004). Any disagreements were discussed among the observers until a 90% index of agreement was reached. Inter-observer reliability was assessed periodically in both facilities to assess potential observer drift. The research team worked with administrators of each NH to select specific nursing units with residents at high risk of skin breakdown, typically the unit where Medicare patients were cared for. Observations were performed on each shift in each facility with different dyads. Data collected during observations focused on identifying activities that the dyads performed during the shift, duration of activities, and physical interactions within the environment as each member of the dyad performed patient care. Additionally, observations focused on specific behaviors associated with communication strategies that direct staff used for risk assessment and skin care provided to residents. Individual observations were conducted at approximately 2–4 min intervals. Total observational periods ranged from 2 to 3 h in length on each shift spread over two days in each NH. Even though evening and night shifts were also observed, in order to avoid any bias, only observations during the day shifts are included in this study.

#### 3.2.3. Coding and reliability measures of structured observations

After observations were finalized for each NH, observational data was transcribed into Excel 2010 for coding. Each observation was coded into a category of recommended pressure ulcer prevention practices derived from the observational field note guide. Each observation made by the research team was evaluated to determine which category or categories in the structured observational field note guide that the observation occurred. Each observation was coded by researchers who conducted observations. A set of coding rules was established and used by the researchers to ensure consistent coding of the observations. Each observation was coded as a "1" if it was determined to fit within a specific pressure ulcer prevention category and it met coding rules definitions; observations were coded as a "0" if it did not meet criteria. To estimate inter-rater agreement between the researchers, 220 of the observations were coded independently and two way tables were created using McNemar's test. All observations where there was disagreement between researchers on specific categories were discussed until a consensus was reached.

#### 3.2.4. Communication network analysis

After the data was coded for these NH case studies we used ORA social networking open source software created by CASOS at Carnegie Mellon to examine the communication networks within the NHs, with a focus on communication between RNs/LPNs and CNAs. ORA is a robust software tool that has been used in many settings for organizational risk analysis, global positioning of marine merchants, and to destabilize terrorist networks (Carley, 2012). Recently, ORA has been used in healthcare settings for multiple purposes, for instance to analyze communication patterns on nursing units and impact of communication on patient safety and outcomes (Effken et al., 2011).

Our interest in using this software was to begin to explore the interactions that occurred between CNAs and RNs/LPNs in each NH related to risk assessment and skin care pressure ulcer prevention categories. To our knowledge, social networking software such as ORA has not been used before to explore how networks change across space and time in NHs for this purpose.

### 3.3. Qualitative focus groups: communication strategies used by CNAs

To explore CNA strategies to communicate pressure ulcer preventions in each NH our research team conducted focus groups on each shift. Focus groups included 4–6 voluntary participants. Food and drink were provided to participants as incentive and to show appreciation for their time. Guided questionnaires were developed to elicit voluntary responses about the following: 1) experience with different types of communication strategies (IT versus non-IT) in their facilities, 2) their knowledge of how evidence based pressure ulcer prevention practices are introduced into their communication systems, and 3) how care is prioritized through their communication systems.

All focus groups were recorded and transcribed. The analysis of focus group data included identifying attributes that emerged across all focus groups. NVivo 9.0 was used to code focus group data. We applied an axial coding method (Krueger, 1994) to create a matrix of attributes using overriding common themes regarding communication about standard practices used for pressure ulcer prevention as well as concepts from human factors theory. Our goal was to identify recurring ideas in each NH that would allow us to describe the range of experiences and perceptions about how communication regarding pressure ulcer prevention differs between high and low ITS NHs.

## 4. Results

For this analysis a combined total of 1386 total observations were conducted within the two NH case studies. Agreement range for two independent coders was 83–100% under *Risk Assessment* within the category *Reassessed at periodic intervals* and *Use of validated risk assessment tool*, respectively (see Table 2). Agreement range under *Skin Care* was 86–100% within the categories of *Protect bony prominences* and *If moisture uncontrollable, use*

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*underpads or briefs to absorb moisture*, accordingly (see Table 2). Our goal was to maintain inter-rater reliability above 80%.

The most frequent observations in both facilities were coded under *Risk Assessment* within the category *Risk reassessed at periodic intervals.* Interestingly, the *Use of validated risk assessment tool (Braden or Norton Scale)* was observed being used only once for all observations of the dyads (RN/LPN-CNA). Researchers observed similar communication frequencies about pressure ulcer preventions in many categories across the two NH facilities. The widest range of variation between observed uses of pressure ulcer prevention guidelines among the two NH facilities occurred when staff was *applying proper positioning, transferring, and turning techniques* when providing skin care (see Table 2). In this category, there were 72 observations in the High ITS NH while there were 129 observations documented in the Low ITS NH.

### 4.1. Communication network analysis results

From the ORA visualizations there are some interesting findings in terms of locations where interactions are occurring and types of activities – particularly CNAs approaching RNs/LPNs. In the low ITS NH interactions are taking place only at a couple of distinct locations, such as nursing stations perhaps where there is access to documentation (See Fig. 2). In the high IT NH, CNA initiated interactions with RNs/LPNs permeate more throughout the facility which could be reflective of the more comprehensive range of communication technologies in place in the high ITS NH (See Fig. 2). These assessments were verified by staff during the focus groups.

The communication network reflected in the ORA visualizations (Figs. 2 and 3) includes observed CNAs and RNs/LPNs, which were setup in the software as agents. Agents were observed discussing the risk reassessment and/or the skin care inspections at a particular location. The agents and location are represented as nodes in the maps. For instance, when an agent1 initiates a communication with agent2 about skin care at the nurse's station, this is represented visually by six links between – agent1 and agent2, agent1 and nurse station, agent1 and skin care, agent2 and nurse station, agent2 and skin care, and skin care and nurse station. The link width is relative to the number of times two nodes are connected; hence, the higher the connection between two nodes the wider the link.

There were approximately similar CNA initiated communications in both NHs, 20 in the low IT NH compared to 21 in the high IT NH. However, this was drastically different for RN/LPN initiated communications, with 37 in the low IT NH and 14 in the high IT NH. Thus, the number of RN/LPN initiated communications was two-and-a-half times more in low IT NHs.

When the individual links were analyzed, for both RN/LPN and CNA initiated communications, low IT NH had considerably more discussion on risk reassessment and skin care inspection. Figs. 2 and 3 visually represent the communication structure. As can be seen from Figs. 2 and 3, the nurse's station is a primary communication location appearing in both CNA and RN/LPN initiated communications in the low IT NH, while not appearing in the high IT NH.

### 4.2. Focus group results

A total of 5 focus groups were held in the two NHs with 21 CNAs. Three focus groups were held in the high ITS NH including 14 CNAs and 2 were conducted in the low ITS NH including 7 CNAs. Transcribed verbatim focus group information was imported in NVivo 9.0 for coding. A PhD prepared RN and a PhD nursing graduate student coded the data independently and arrived at common themes across all focus groups that were discussed. Emerging themes derived from focus group discussions which were common to both sets of coding included Communication and Structured Messages, Computerized Reports, Non Computerized Reports, Human Factors and Usability, Keep Track of Needs, and Organization and System Structure. Each of these themes is discussed below.

*Communication and Structured Messages* among CNAs in the high ITS facility appears to be supported by a more robust mix of communication methods, which are integrated across clinical departments and specialties (skin care teams, nurses, etc.). Communication systems in the high ITS facility appear to have built in redundancies or backup systems, such as electronic status boards where interventions can be observed by everyone anytime during the shift. Additionally, these status boards enable care tracking so that staff can determine what care has been given throughout a particular shift. The high ITS facility has email systems and exhibits a "check email" culture where much information is distributed, especially from nurse to skin care team to CNA. However, several comments indicated that while nurses disseminate information to CNAs using the computer, CNAs find nurses and alert them verbally when they need to give information back. This is similar to the low ITS facility where priority is given to person to person communication followed by documentation. Finally, the high ITS facilities incorporate strong visual cues into computer and non-computerized communication systems. For example, status boards have "pinks" which are highlighted areas of the interface that indicate when some form of patient care such as turning and repositioning are not completed. Other lower tech items in the high ITS homes included laminated picture cards, such as a red sock, which indicated fall risk.

The infrastructure for *Computerized Reports* is more comprehensive for high ITS NH, as described by CNAs. For example, there are rolling laptops on every hall to support documentation practices at the point of care. As indicated much of the communication is done via email, except documentation on electronic intervention lists. One downside to this is that staff may have multiple places to check information and accuracy could be an issue. In the low ITS NH there is some charting completed by CNAs electronically, however this charting is not part of the medical record and is used primarily by care plan coordinators and not regular nursing staff. This creates duplicate systems where some inconsistencies and inefficiencies exist; for example, when a nurse needs to see all the information for a resident they might have to check both documentation systems. Furthermore, there are technical difficulties with the electronic charting used by CNAs in the low ITS home. There is no feedback system indicating that resident information being entered has been successfully submitted and staff is unaware of any backup systems for this information.

*Human Factors and Usability* in the high ITS NH are supported by sophisticated systems that incorporate reminders to reduce memory load for CNAs, provide high accessibility to computers, laptops, and clinical information via email, and use color and visual color coding that is easy to recognize and provides increased awareness of resident state of care. Many of the information cues are proximal to the patients, such as a water droplet on the wall to indicate that hydration is important for a resident. *Human Factors and Usability* are not as well supported in the low ITS NH as indicated by CNAs who indicate that much of the care they provide is "common sense" versus using a systematic approach as in the high ITS NH.

Communication that enabled CNAs to *Keep Track of Needs* while caring for their residents was critical. CNAs in the high ITS facility discussed systems that appeared to be highly integrated with patient care so care could be tracked in a variety of ways. Some of the methods were electronic, but they also discussed many creative non-computerized communication systems that supported information transfer. For example, the high ITS facility incorporated staff

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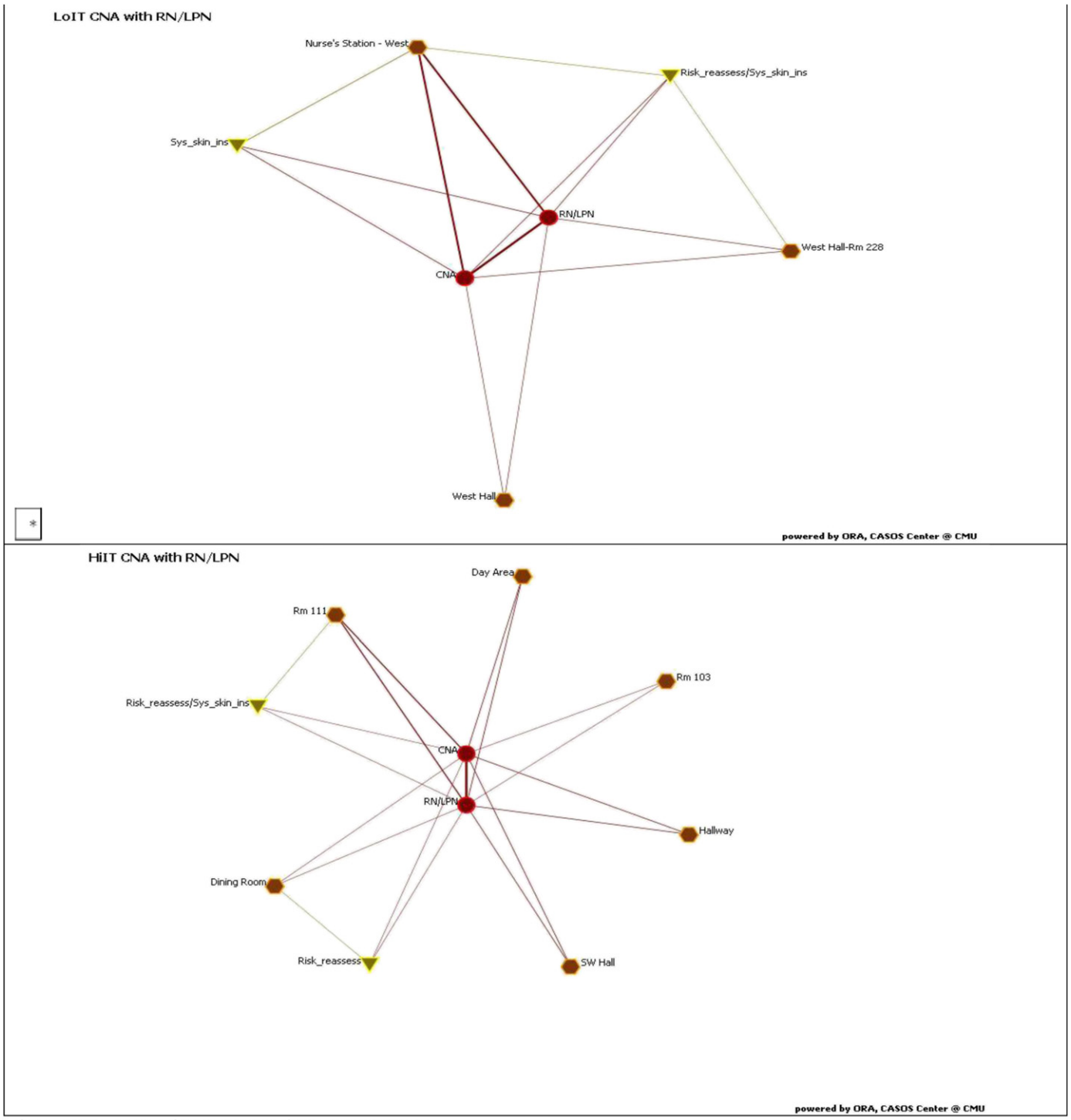


**Fig. 2.** Comparison of CNA initiated communications with RNs/LPNs in Low and High IT NHs.

huddles at the beginning of shift for every member of the team to discuss relevant issues to patient care. Conversely, to *Keep Track of Needs* in the low ITS facility staff used verbal means or documentation which included paper notes posted in patient rooms, a colored dot system that indicated to staff that a certain type of resident assistance was needed when interacting with a resident. Low ITS facility residents had bracelets on their wrists which indicated a fall risk. Bracelets could be much more difficult to track

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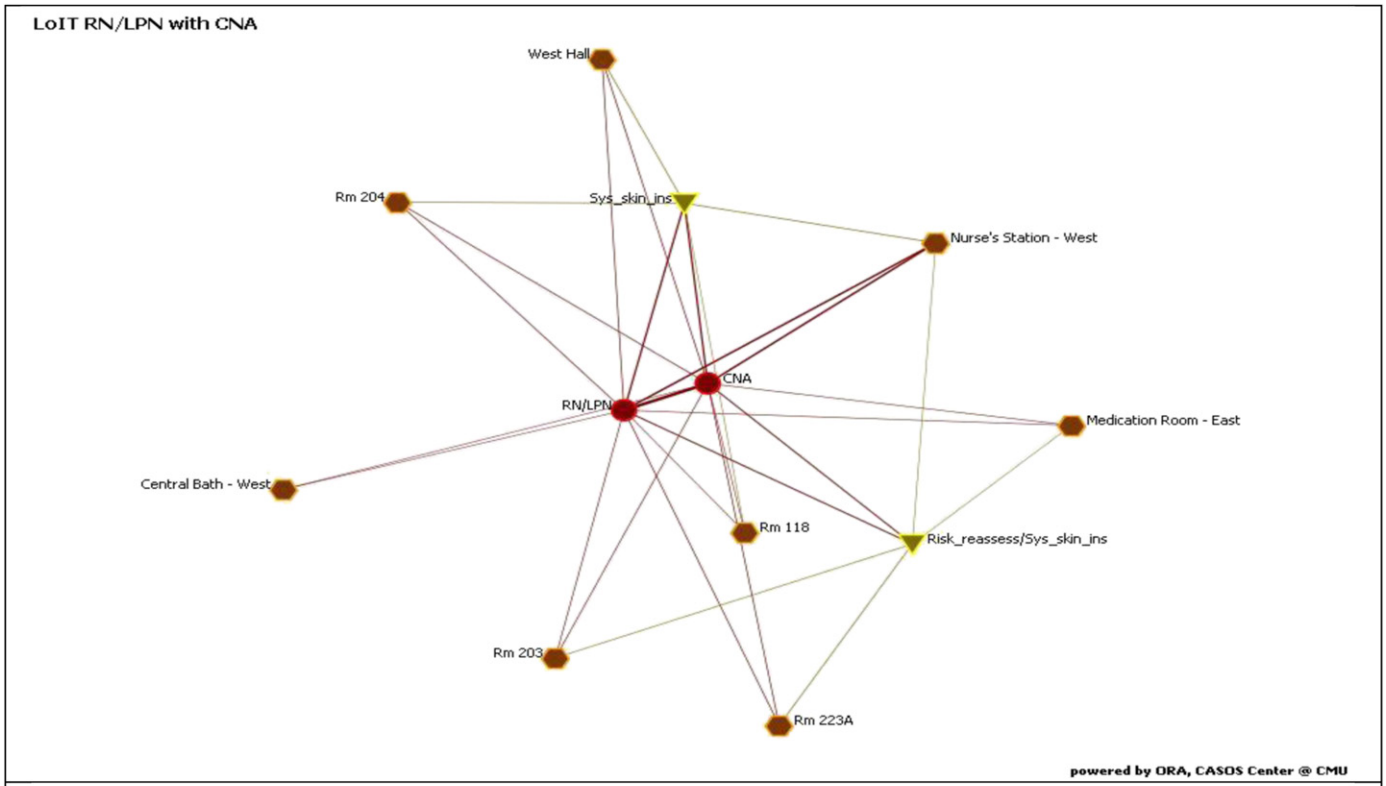


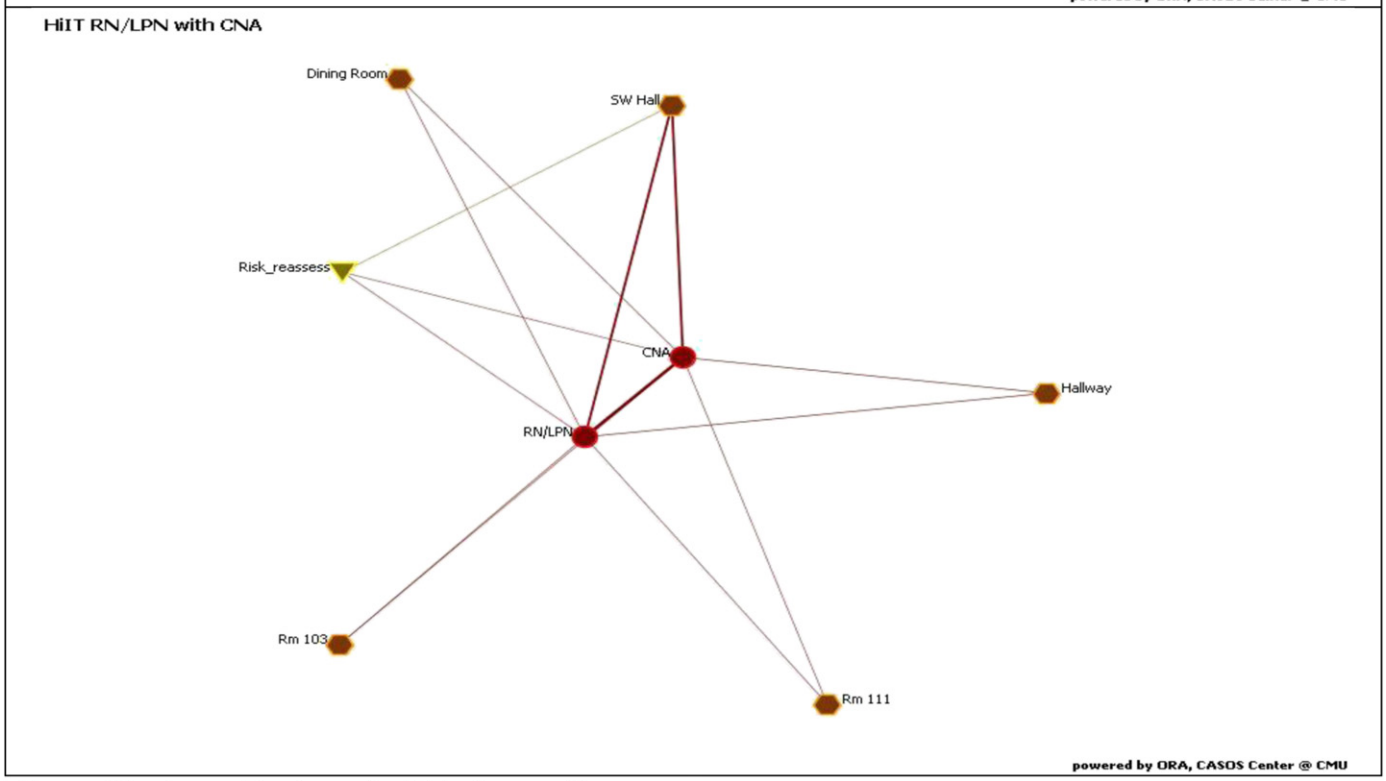


Sys_skin_ins = Systematic Skin Inspection
Risk_reassess = Risk reassessed at periodic intervals
CNA = Certified Nurse Assistant
RN/LPN = Registered Nurse/Licensed Practical Nurse
Rm = Patient room

**Fig. 3.** Comparison of RN/LPN initiated communications with CNAs in Low and High IT NHs.

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than a laminated picture of a bright red sock; although bracelets are more proximal to the resident.

The *Organization and System Structure* of the high ITS NH seems to provide greater privacy as all communication only uses resident numbers versus names for confidentiality purposes. Accessibility of patient information is available electronically and is password protected, but is readily available through widespread hardware devices. Furthermore, the high ITS system supports email access at home as well as work. In the low ITS NH paper notes with patient names and information are used throughout the facility which could contribute to breaks in confidentiality and reduce privacy.

## 5. Discussion

This study used a mixed method approach to identify communication patterns and strategies CNAs use in clinical practice; in particular, we focused on risk assessment and skin care preventions. We explored social network analysis of observational data collected during nursing staff interactions coupled with in depth discussion of communication strategies and the use of IT to support communication about evidence based skin care practices. From this work we are able to provide insight into the role of IT and other forms of communication in NHs.

As we've indicated, our preliminary work has shown moderately significant correlations for increasing ITS and NH Quality Measures measuring activities of daily living decline and incontinence (Alexander and Madsen, 2009). Additionally, significant negative correlations for incontinence in facilities with increasing ITS in clinical support areas were found. Our assumption is that better communication among staff about these types of functional status measures is one reason these correlates have significant relationships. Even though the results of the study currently being discussed are not predictive in nature, the qualitative observations and focus groups conducted here allowed us to describe more completely NH ITS and communication strategies that resulted in these correlations in case studies of the most extreme NH in the larger preliminary study.

First, as new models of nursing care coordination are implemented in NH with greater IT support information exchange between healthcare providers will become more important (American Health Information Management Association, 2011). The design of communication systems (IT and non-IT) as they are integrated into clinical environments is critical to match workflow and to keep information accessible and as close to the patient as possible; secondly, new benchmarks will be required to assess workflow (Hedg eet al., 2011). Using social network analysis visualization tools, such as ORA can facilitate more detailed organizational assessments about how patient information is communicated and reacted to during clinical workflows. These tools enable dynamic assessments of information exchange occurring proximally or distally to patients, which can become new quality benchmarks that can be linked to patient outcomes.

When considering both our social network analysis of observational data and focus group results, several design considerations emerge. First, during CNA initiated interactions with RNs and/or LPNs, there are differences in the primary locations or areas where these occur between low and high ITS NHs. In the low ITS home, a majority of these interactions take place at a nursing station or common hallway, whereas in the high ITS home, they are distributed more throughout patient rooms and other locations in the facility. Coupling this with several of the key themes from the focus groups, we find that the high ITS facility CNAs reported more distributed communication systems and strategies. For example, in the high ITS NH a large amount of communication occurs via email and there are multiple locations where documentation or work planning can occur. The EHR system in this home also allows for communication between CNAs and RNs/LPNs through task lists and color coding indicating an item has been seen or addressed. In contrast, the low ITS NH reported a stronger reliance on in-person communication and fewer electronic documentation systems throughout the facility. This difference in available technologies and features accounted for differences in interaction locations. In the high ITS facility CNAs are able to access work plans or patient information for reporting at multiple locations, while in the process of their workflow. Thus, if a question or a need for consultation with an RN/LPN emerges, they do not need to return to a specific location to access relevant information or document the discussion.

Designing clinical information systems (both IT and non IT) into nursing environments that provide reminders about clinical care at multiple points are important to keep track of needs; however, these communication strategies must be readily apparent in the environment, accessible to staff, and consistently used (Patterson et al., 2011). Additionally, these strategies must be implemented carefully to provide a maximum level of confidentiality and security of patient information. Trust has been identified as a significant concern for adoption of health information technologies (Alexander et al., 2007a); therefore, designing systems that provide maximum security and confidentiality protection for patient and staff are critical to user acceptance and successful implementation of novel communication strategies into workflows. Placing clinical information in greater proximity to providers and patients has both benefits and risks.

Successfully using organizational assessment tools that provide capabilities to benchmark clinical workflow and information exchange is another important outcome of this research. For instance, assessments in the high ITS NH indicated that fewer interactions between CNAs and RN/LPNs occurred regardless of who initiated the communication. This again relates to focus group themes where CNAs in high ITS facilities reported more electronic communication and a strong email culture that reduced there need to directly communicate with an RN/LPN. This type of communication requires trust in the communications systems and faith in people that use the system. Also, from an ergonomic perspective, it is not clear if less face to face communication as a result of savvy technology and better email introduces advantages for NHs with an Ideal state of technology implementation. This uncertainty offers opportunities for future research to investigate impacts of technology on different types of interactions. Developing a system culture that accepts these sorts of interactions will be critical in the future as more and different types of communication devices are embedded into clinical care, for example, interactive camera technologies via I-pads and I-phones; or direct email communications from patients who enter data into personal health records.

In some cases, designing direct face to face communication may be preferable in some clinical workflows, thus we don't want to eliminate it completely; however, physically moving from one position to another may increase inefficiencies and interruptions in workflow for both CNAs and RNs/LPNs. Previous research has established that these types of interruptions in clinical workflows may contribute to medical error and reduce quality of nursing work (Kowinsky et al., 2012; McGillis-Hall et al., 2010; Kalisch and Aebersold, 2010). Health systems that accept and use novel communication strategies to connect providers and patients may realize new benefits when compared to traditional methods of communication. More comprehensive and technologically advanced communication systems at high ITS facilities offer an advantage by enabling CNAs and RN/LPNs to communicate through technology indirectly and manage that communication in the context of their individual workflows with greater efficiencies and less interruptions. The low ITS facility, however, relies more extensively on in-

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person communication and paper notes in patient rooms because their electronic reporting system does not provide a means for information exchange between nursing providers.

## 6. Limitations

This study focused on communication networks in NHs and used a mixed method approach taking advantage of network analysis. However, there are two assumptions. This study focused on observations solely during the day shift (even though observations were also made during evening and night shifts). We elected this method in this initial analysis to eliminate any bias due to different shifts. Future studies will use a similar approach in this paper to focus on communication networks and how they vary across shifts. A limitation was related to how the network analysis was setup. Individual RNs/LPNs and CNAs were not uniquely identified during observations and the analysis lumped them together as RNs/LPNs and CNAs respectively. This was done because our primary focus was on the overall communication network structure between these groups, and the impact of IT sophistication for CNAs to operate in high IT environments. Future work can study individual providers and their workflow and interactions with other providers as they deliver care in nursing homes.

This study was limited on a comparison of 2 NHs with a specific degree of IT sophistication. As the study did not follow a change due to introduction of IT sophistication, it cannot be excluded that observed differences are due to many other confounding factors, for example, different "culture", different architectures, and different organizations (Nam et al., 2009; Resnick et al., 2009; Lawler et al., 2011). We recognize that other confounding variables offer an opportunity for increasing bias in our results, however, we have attempted to identify these types of bias where we could by spending significant time over several days observing staff in each facility, actively engaged with staff and residents during care, who eventually provided a rich qualitative data set that contributed to some knowledge about their culture which provides some face validity to our findings.

A final limitation relates to generalizability of findings. This study includes an in depth analysis of two NHs from one state, Missouri. Thus, generalizing findings to NHs in other states may not be appropriate. This work is important preliminary work for future research demonstrating how organization analytics about communication can be used to benchmark evidence based practices.

## 7. Conclusion

Analysis of workflow and communication paths is a necessary prerequisite to facilitate better design and implementation of clinical technologies. System design requires that we understand how people work before and after implementation of technologies; however, in many situations these activities are not carried through before clinical systems are put into place. And rarely are these processes evaluated post clinical system implementation. The design of embedded IT systems effects how clinical information is transferred between nursing staff and other patient care providers. Assessing how embedded IT systems affect the timing and placement of provider/patient interactions has important implications for clinical workflow, patient safety and quality measurement. Ethnographic methods including systematic observations of staff using various communication systems, including IT, provide a rich source of data that illuminates current clinical workflows, process change, and efficiencies that can improve care delivery. These types of organizational assessments are novel to NHs who are implementing IT systems. These evaluations can lead to better metrics in care delivery and improved healthcare system administration.

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