INFLUENCE OF NURSING UNIT LAYOUT
ON
STAFF COMMUNICATION AND INTERACTION PATTERNS

A Thesis

Presented to the Faculty of the Graduate School

of Cornell University

In Partial Fulfillment of the Requirements for the Degree of

Master of Science

by

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January 2008

ABSTRACT

This study tried to connect two separately established areas of research: 1) the importance of communication in delivering quality of care; and 2) the relationship between physical design and communication in healthcare delivery. A pre-post design intervention study was conducted to assess the impact of a decentralized vs. centralized nursing station layout of an ICCU on unplanned, opportunistic communication and interaction patterns among clinical care staff.

The study was carried out through systematic observations of communication frequencies and behaviors within the ICCU both before and after its relocation to a new space. The research design also assessed the relationship between the location of different nursing pods on the new ICCU and informal communication patterns.

Results showed a dramatic reduction in interactions in the new decentralized ICCU as compared to the old space. In the face of an increasing preference for decentralization in nursing unit layout these findings suggest a more thorough analysis of their costs and benefits for a range of valued patient and staff outcomes; and then to use this knowledge to rethink the design of nursing stations in fundamental ways.

Data also suggested that staff had a preference for a communication hub at one particular location in both the new and old ICCU. A confluence of various spatial, technological, social and other factors were found to be collectively responsible for the creation of such a communication hub. However, no clear relationship between distance from the hub and frequency of interactions was found.

Based on these findings and existing research that has established the importance of both functional efficiency as well as interaction opportunities in nursing units , a practical design approach is suggested that attempts to work at multiple levels , offering a balance between the two instead of a purely decentralized or centralized solution that offers one at the cost of the other.

BIOGRAPHICAL SKETCH

Ranojoy Dutta grew up in the culturally vibrant city of Calcutta, India. After receiving his bachelor's degree in architecture in 2004 he worked for a year with a building research firm specializing in low cost housing. During this time he also designed his family residence in Calcutta.

In order to expand his knowledge beyond his design experience he decided to pursue specialized studies and applied to master's degree programmes in India and the US. In the fall of 2005 he decided to accept admission to Cornell University based on the interdisciplinary nature of the MS programme and the reputation of the university. During his course-work at Cornell he developed an interest in health facilities planning, which led to a minor in health administration from the Sloan Programme in health administration. In keeping with his interests in facilities planning he has accepted a position as strategic planner with a design consulting firm in Seattle, Washington.

Dedicated to my Family

ACKNOWLEDGEMENTS

This thesis is a result of the guidance and support from different individuals who made many distinct contributions in their own unique capacities.

I take this opportunity to acknowledge those contributions and express my gratitude and appreciation to,

My advisor, Professor Frank Becker, for his patience, insight and constant encouragement and for being instrumental in helping me shape my understanding of research as well as instilling professional values that will remain with me long after I leave Cornell.

Professor Will White, my minor advisor, for his esteemed guidance and practical suggestions.

All my friends at Cornell, for sharing two wonderful years with me

Amitda, Bubundi, Heeya and Hillol for not letting me feel away from home.

And finally, my parents and sister who encouraged me to strive on through uncertain times and without whose love and support I would not be here today.

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CHAPTER 1 : LITERATURE REVIEW

1.1 Introduction

The American hospital has undergone radical shifts in overall goals since its earliest inception as shelters for the homeless, run by religious orders. Over the past few decades the confluence of various changes in healthcare policy, medical technology and patient demographics has led to a compete rethink of medical practice in terms of patient safety, staff effectiveness and fiscal performance (Burchfield & Battistella, 2003; IOM, 1999; Becher et al., 2001). Today health care practice in the United States is witnessing a transition from a previously provider driven care model towards a more consumer driven care model which is fueling competition between healthcare providers (Battistella & Weil,1998) to woo patients with safe and effective care in comfortable surroundings and in convenient locations. In particular, the quality and design of the built environment has acquired a very significant role in improving patient and staff satisfaction in terms of overall healthcare experience (Ulrich et al., 2004; Marberry, 2006; Joseph, 2006). In the face of an increasing need for cost reduction, new forms of service delivery, a greater number of older patients with co-morbidities, a rise in patient expectations, staff shortages and a policy shift from secondary to primary care, there has also been an increased emphasis on team working, particularly in multidisciplinary teams. (Firth-Cozens, 1998; McKee & Healey, 2002)

1.2 Multi Disciplinary Teams in Health Care

There is evidence from health care and beyond that working in teams enhances an organization's effectiveness (Kallerberg & Moody, 1994) .They have been found to produce better patient care both in terms of improving health delivery and staff motivation (Wood et al., 1994) and in superior patient outcomes (Adorian et al., 1994; Coiera, 2000).

In the context of this increasingly multidisciplinary and complex health delivery system, research in healthcare service (Campbell et al., 2001; Shortell et al., 1994) shows that good teamwork leads to

- A more responsive and patient sensitive service
- A more clinically effective and/or cost effective service
- More satisfying roles for team's members
- Increase of job satisfaction by reducing perceived alienation

Effective teams are characterized by adequate human and material resources, supportive cooperative relationships and mutual trust, effective leadership, open, honest and sensitive communications, and provision for evaluations (Kekki, 1990).

A UK study (Borill et al., 2001) found that greater team effectiveness was associated with improved health care quality. Those working in well-functioning teams reported much lower levels of stress and were less likely to leave their organization or profession. Rafferty et al. (2001) found that nurses who report a higher level of teamwork were more satisfied with their jobs, planned to stay in them, and were likely to have a lower burnout score. Team members also reported high levels of social support during times of difficulty or stress; and perceived that there was more co-operation in the organization than those not working in teams. This led to more positive work attitudes and greater propensity to co-operate with others.

Of the different factors determining team results, probably the most critical and influential factor is effective communication within and across teams (Allen et. all., 1977).

1.3 Impact of Communication on Team Working, Quality of Care and Patient Safety

Understanding how clinical staff communicate is critical given that research has found that the vast majority of hospital mishaps results from inadequate communication processes among members of health care teams or between health care teams (US Institute of Medicine, 1999; Coiera, 2000; Patient Safety and Clinical Quality Program, 2005).

The theoretical rationale linking communication and patient safety is supported by the information-sampling model of communication proposed by Stasser & Titus (1985, 1987). This model posits that when more members of a small group have information, they are more likely to share the information. Consequently, there is greater access to information for decision making. Conversely, when information is available to only one or a few members of the group, it remains unshared and inaccessible. For example, if a nurse knows that a patients' blood pressure is labile (unstable) and does not share it, the likelihood that the information is accessible for decision making to other nurses decreases thereby increasing the potential for error.

1.4 Communication under Conditions of Uncertainty

Contemporary hospital systems are environments characterized by uncertainty and complexity (Daft, 2001) that limit the attention and working memory resources of providers (Pierce & Hicks, 2001). Under such conditions, communication among diverse caregivers is critically important. Hirokawa (1990), found that when there was no single verifiable correct solution to a problem, communication served to enhance decision efficacy and performance by allowing group members to pool their individual knowledge and skills, to collectively formulate an effective procedural strategy for completing the task and to facilitate the groups understanding of the range of alternative choices as well as the strengths and limitations of those choices.

Caring for patients with increasing acuity requires an even higher quality of information to be shared. Knaus et al. (1986) compared 13 ICUs and established differences in the ratio of actual to predicted mortality, after controlling for severity of

illness, by using an instrument they developed, the Acute Physiology and Chronic Health Evaluation (Knaus et al., 1981). They concluded that staff interaction and coordination, a variable similar to collaboration, was the critical factor in accounting for these differences. Later, Shortell and colleagues (Shortell et al., 1991; 1994) joined Knaus et al. (1986) in studying 42 ICUs to measure the impact of variables such as communication and coordination, collectively termed "caregiver interaction." They were unable to distinguish ICUs with a better risk-adjusted survival, although there was a positive association of caregiver interaction with a shorter risk-adjusted length of stay. They identified organizational characteristics leading to better ICU care, including communication and collaborative problem solving.

Overall, communication is a care integrative attribute of all nursing care delivery models (Anthony, 1998). Nursing's centrality in communication processes and in addressing medical errors is also reflected in the Institute of Medicine's (IOM, 1999) mandate suggesting that one way to decrease errors is to develop models of care that improve communication systems and reduce information lapses. Towards this end, however, research on communication and conditions under which information is shared remains largely unexplored (Cooper et al., 2001). Coiera (2000) argues that in order to improve staff communication it is necessary to first understand the actual nature of communications taking place on the nursing unit. Yet relatively little research exists documenting actual communication and interaction patterns among clinical staff.

1.5 Nature of Communication in Healthcare

Studies that have examined the actual patterns of communication among clinical staff clearly show that people preferentially turn to each other for information and decision support (Coiera & Tombs, 1998; Coiera et al., 2002; Parker & Coiera, 2000; Coiera, 2000). Coiera (2000) cites a study by Covell et al. (1985) which found that about 50% of requests for information were met by talking with colleagues, rather than through searching documents. Tang et al. (1996) found that about 60 percent of clinician time in clinic is devoted to talk. Safran et al. (1999) reviewing the information transactions in a hospital with a mature computer based record system, still found that about 50 percent of information transactions occurred face to face between colleagues. In another similar study Coiera & Tombs (1998) observed the communication patterns of eight physicians and two nurses in an English district general hospital. The available channels of communication consisted of face-to-face meetings, both impromptu and planned; desktop telephones; paging; written notes for colleagues; notes at ward desks; notice boards; and pigeon holes for personal memos. The subjects in this study made little or no use of more formal sources of information, with the exception of data from the medical record. During the study, staff seemed to almost always favour face to face discussion over other methods.

These and other studies suggest that irrespective of the presence of electronic communication systems it is through the multitude of conversations throughout the day that clinicians present, examine and interpret clinical data and ultimately decide on clinical actions. In contrast to the computational view of decision support, these studies show that the dominant preference of medical staff is for informal face to face

communication with colleagues. In effect, the biggest information repository in health care lies in the people working in it, and the biggest information network is the web of conversations that link the actions of these individuals (Coiera, 2000). From this network of personal relationships come the co-operations and trust that forms the social capital that provides community (team) members with the "resources" (e.g. information , support and training) they need to learn and do their job well (Becker, 2007).

1.6 Unplanned Communication and Communities of Practice

The role of interpersonal communication in informal and opportunistic on-the-job learning can be understood in the context of the communities of practice framework which focuses on knowledge sharing across informal networks of people who share a common interest or task (Lave & Wenger, 1991). The communities of practice concept emerged from ethnographic analysis of how groups actually worked and communicated in practice. Brown & Duguid (1991) found, for example, that customer support staff learned the "tricks" of their trade not by attending formal training sessions or reading company manuals, but by drawing on the experience and insights of others with whom they worked. Knowing who to contact, and getting good information, required developing contacts among a wide range of people doing the same kind of work. In such a setting, learning through participation, rather than through more passive acquisition of knowledge, is the primary mode through which learners master the skills and knowledge needed to become competent members of a team (Lesser & Prusak, 2000). Informal communication also plays an important role in co-worker relationships that, in turn, affect work effectiveness and commitment.

Feldman (1987) found that employees had an easier time accessing information and soliciting feedback from team members once they were a trusted member of a team.

These studies from within healthcare and outside help reinforce the importance of informal face to face communications for knowledge sharing and learning.

Summarizing the literature discussed till this point the following broad statements can be established:

- There is a current transition in health care delivery that calls for multidisciplinary teams to improve quality and deal with co morbidities in an aging population
- Effective communication is critical for the successful creation and working of multidisciplinary teams
- Communication failure has a critical impact on patient care outcomes, staff effectiveness and satisfaction.
- The volume of informal face to face communications among medical staff is far greater than any other means or modes of communication and is crucial for effective team working, learning, and job satisfaction.

Having established the need for effective communication among clinical staff the next section of this review looks at the role of the physical setting in facilitating or impeding such communications.

1.7 Communication and the Physical Setting

There is a growing body of evidence showing that the quality of a hospital's patient rooms, corridors and public spaces directly influences both the health outcomes of patients and the stress levels and efficiency of hospital staff (Ulrich et al., 2004; Malkin, 1992; Carpman et. al., 2002). In addition to private patient rooms and "social spaces" for family members, new designs include decentralized nursing stations, acoustical tiles and carpet to reduce equipment noise, special filtration systems to improve air quality and neutralize odors, and access to gardens and natural light to reduce stress and combat depression that can be exacerbated by noisy, chaotic and harshly lit hospitals (Landro, 2007). Most research on the impacts of healthcare environments has been aimed at patients. Less work has focused on how the medical staff is affected by their work environments (Mroczek et al., 2005; Ulrich et al., 2004). There is evidence that a supportive physical work environment, along with other factors such as high autonomy, low work pressure, and supervisor support, positively impacts job satisfaction and burnout among nurses (Mroczek et al., 2005; Tumulty et al., 1994; Tyson et al., 2002). There is essentially no research looking at how the physical design of nursing units might affect informal and opportunistic interaction and communication patterns. Yet as hospitals move toward a patient-centered care model, the role and form of the nursing unit is being redesigned at a rapid rate with an aim of providing private rooms, family amenities and efficient layouts for staff. As discussed earlier, communication is crucial for patient safety as well as staff well being, so we need to better understand how these design decisions affect the nature and frequency of staff communication.

1.8 Evolution of the Nursing Unit

Historically, the nursing unit dealing with the housing and care of patients has been the core of the hospital. Because early hospitals were born out of the assumed responsibilities of religious orders, hospital design resembled the open bays and structures of church naves, a pattern that was repeated for centuries until the evolution of nursing care required new forms. The layout underwent few changes from the thirteenth through the nineteenth century. Wards were essentially a long, open space with beds located on exterior walls. By early nineteenth century the large open wards with their inherent limitations in terms of high noise levels, lack of privacy and the difficulty in isolating infected patients came into disfavor and were gradually replaced by smaller rooms off a double loaded central corridor (Kliment, 2000). Because the design of accommodations for fewer patients per room necessarily increased the area and corridor length generated for each patient room, nurses reconciled themselves to miles of daily walking as they went about their duties. The increase in nurses' travel raised an important design issue, still addressed in all nursing unit designs today (Joseph, 2006). The critical question faced by the architect was how to strike a balance between the need for individual privacy or for added support space, and the size of the total unit and the goal of close nurse-patient access (Kliment, 2000).

In the 1970's Canadian architect Gordon Frissen suggested innovative changes in hospital design addressing the above mentioned design challenges (Conner & Kutsuflakis, 1994; Boschen, 1978). Frissen felt that patient care would be positively impacted by keeping the nurse at the bedside and in addition having each patient's medications, treatment equipment, linen supplies and chart also located right in the

room, rather than being held at various other centralized locations. Although many modifications have been made to Friessen's basic design concept, two components are still commonly seen today. The first, the "nurservers" are closet like spaces outside each patient's room that contain a phone, entry to a pneumatic tube system, space for clean and dirty supplies, a chart holder with a pull out writing shelf and a locked drawer for storage of non-controlled medications .His second component was the decentralized nursing stations in place of the conventional centralized station; which was his way of bringing the nurse closer to the patient (Conner & Kutsuflakis, 1994). The fundamental difference between his approach and the conventional nursing station approach was the complete elimination of the central nursing station, which he felt was being used by staff for socializing at the cost of time spent with the patient.

Although, Frissen is a pioneer in hospital design and many of his ideas have been used and have shown potential for improved patient care (Boschen, 1978), his approach was predominantly guided by improved operational and functional efficiency in terms of supply and inventory management and effective staff utilization. He does not seem to take into account the need for staff communication as a team or the importance of staff socialization. Given the fact that his suggestions were made at a time when very little research was available on hospital design and staff communication or the impact of communication on patient outcomes, his design solutions were no doubt a step in the right direction for improved patient care. But as established earlier in this review, current research clearly suggests that the importance of staff communication cannot be ignored for both the sake of patient safety as well as staff well being and so any proposed design solution has to reflect that to be effective in the long run.

Many of the older existing hospital units today have centralized nursing stations with different configurations such as radial, racetrack, or single or double corridor where the nursing station is located centrally and patient rooms are located around the perimeter. As originally proposed by Frissen, more recent studies also seem to suggest that bringing staff and supplies physically and visually closer to the patients helps in reducing the time spent walking while increasing the time spent in direct patient care activities (Joseph, 2006).

Based on these views, many new designs are incorporating decentralized nurses' stations and alcoves outside patient rooms so that staff is distributed around the unit (as opposed to being in a single central location), closer to the patient.

1.9 Current Trends in Nursing Station Design: Move towards Decentralization

Much of the history of the nurses' station reveals that its evolution centered on the tasks of entering orders, notes and observations into the chart. From its inception, the workings of the nurses' station were driven by the handling of the chart. This document had to remain in close proximity to the unit clerk, who keeps the record current for use by both physicians and nurses. This concentration of people who used the same copy of information stipulated an arrangement of work spaces clustered together into what has become the centralized nurses' station. With the advent of computers and electronic data processing came the opportunity to cut the tether of the paper chart. Information could now be entered and displayed in multiple settings simultaneously. Nurses and doctors could have total access to the record right at the patient bedside. An additional rationale for the move towards decentralization is the

desire in higher acuity units to observe the patient while charting. Placing a charting alcove between two rooms with a countertop large enough for a computer, and with visual access into the rooms, serves that purpose.

Centralized nursing stations, in addition to limiting visual access to patient rooms, are also seen as chaotic and crowded areas that create high noise levels that are stressful for both patients and staff (Wade, 2006). What has not been considered in more centralized nursing stations designs, however, are the opportunities they create for frequent communication among diverse clinical staff in ways that can contribute to their informal on-the-job learning as well as providing on demand social and emotional support. Ulrich et al. (2004), while highlighting the importance of designing ward layouts and nurse stations to reduce staff walking and increase patient care time, also noted the need to facilitate staff activities such as communication and respite from stress.

1.10 Physical Layout and Staff Communication

The need for effective communication, while clearly established in its own right, has not been successfully linked to characteristics of nursing layouts. So while nursing layouts are being designed mostly with an eye on functional efficiency in terms of staff walking and fatigue (Joseph, 2006) by getting nurses closer to patients but away form each other, medical care delivery is actually calling for increased and more frequent collaboration between medical staff: two seemingly opposing forces that have not yet been successfully integrated in any one particular design solution. The previously cited research suggests that information technology, by itself, is

unlikely to bridge this gap. At this point, what is poorly understood is the way in which the design of nursing units may affect communication and interaction patterns; or, stated another way, how the design of nursing units can contribute to valued informal and opportunistic communication. With a better understanding of the role of physical design on communication patterns, there is greater potential to create solutions that work on multiple levels.

In an R&D setting, Allen (1977) found that the likelihood of communication and collaboration between team members decreases rapidly with distance. In his study of research engineers he discovered that communication reached its lowest point after the first twenty-five or thirty meters. Kraut et al. (1990) in a similar study of scientific researchers discovered that proximity played a significant role in the frequency of communication between researchers collaborating on a project, particularly in the planning and producing stages. During these stages, researchers with offices next door to each other communicated twice as much as those who were located on the same floor. Because the researchers were in different departments, the study indicated that proximity rather than common interests influenced the frequency of communication. In its simplest form, communication can often be promoted by either temporarily or permanently locating team members close to one another (Becker et al., 1995).

For nursing units that have incorporated decentralization to an extent where staff members cannot see each other at work, problems with seeking assistance and collaborations are likely to arise, as the Sutter Roseville Medical Center in Roseville, California, discovered. The horseshoe shaped decentralized stations in the med-surg and oncology units left the nurses feeling isolated and unable to effectively support each other. The clinical manger reported that the stations were so decentralized that

the staff would not even know if everyone showed up for a shift. (Flynn & Barista, 2005). There is additional research suggesting that physical distance reduces the possibilities for coordinated action (Kraut et al., 1990; Kalisch & Begeny, 2005)

Based on his research on different types of workplace settings Becker (2007) suggests that a degree of physical and visual proximity is necessary to support a culture of communication and collaboration. "Spatial transparency," as he calls it, allows employees to see and hear what others are doing from their own workspace as well as when they move around their team, unit, or department's workspace during their daily work. Seeing and hearing what others are doing provides more opportunities to model behavior, share information, and ask for and give critical feedback to team members. In a similar vein Sundstrom & Altman (1989) suggest that the most successful environments for workplace interaction are those in which personal and group boundaries can be clearly established while visibility to adjoining spaces is maintained, either through the physical arrangement of furnishings or by the ability of group members to orient themselves in a collaborative configuration.

Elements in a physical layout that can influence the establishment of informal communication and interaction process are defined by Gibson as "affordances" (Gibson, 1977). The term *affordance* refers to whatever it is about the environment that contributes to and supports the behavior that occurs in it. When the physical environment helps in developing and, more importantly, maintaining strong interpersonal relationships, it can be considered "affordable" (Gibson, 1977). In a health care context, for example, a private lounge room for nurses is "affordable" in the sense that it offers the opportunity for nurses to sit and relax, to chat with co-workers, and to build social relationships. So, too, are circulation paths, carefully

located to maximize the potential for unplanned, “opportunistic” meetings that draw people by and through magnet activity zones that increase the potential for people meeting one another (Becker, 2004).

The potential, or affordances, of a medical units’ physical design to transform the way in which a multi-disciplinary care team interacts was described by Gilleard & Tarcisius (2003) in a study of a large 1,860 bed acute general hospital in Hong Kong. In the original design, treatment was fragmented and communication among medical and allied health professionals disjointed. They found that the introduction of alternative workplace strategies on a pediatric ward of doctors and allied health professionals (e.g., clinical psychologists, physiotherapists, social workers, dietitians) significantly improved communication patterns, helped resolve conflict and increased cooperation, and resulted in higher levels of service quality from the patients’ perspective.

In the context of the hospital, Iedema et al. (2005) cite research at a new Scottish Hospital (Marcus and Cameron, 2002) where researchers found that the design of corridors, the layout of different functional areas, and the provision and design of recreational facilities had a major impact on the quality of communication between staff, patients, and visitors. The researchers observed the formation of informal interactions between medical staff during encounters on neutral spaces such as corridors and how these interactions had a bearing on the care delivery process.

Research in both the corporate workplace and hospitals suggests that the physical design of work settings, in conjunction with other social and technological factors, work processes, and employee demographics, can influence communication

and interaction patterns. Given the current view that decentralized nursing stations, which may reduce opportunities for informal and opportunistic communication are "best practice," combined with the extensive literature indicating the importance of communication among clinical staff for quality of care, this thesis seeks to further understand, specifically, how more decentralized vs. more centralized nursing unit designs affect communication and interaction patterns among clinical staff.

1.11 Research Questions and Hypotheses

How are staff communication and interaction patterns affected by a change in the physical layout of a medical ward? What are the specific changes in interaction frequencies and patterns that occur when a group of people accustomed to working in a centralized nursing station arrangement are moved into a space that has a distinctly decentralized nursing pod arrangement?

Hypothesis 1

> ***The frequency of communication between medical staff will decrease in a decentralized layout with smaller and higher number of nursing pods as compared to a centralized layout with larger and fewer nursing stations.***

Do certain physical layout design features encourage and facilitate interaction between staff? Are these specific features being used as intended or have they been modified by staff to better fit their needs? What are the aspects of the physical layout that might inhibit staff communication?

Hypothesis 2

Staff will show a tendency for congregation and hence higher frequency of communication at a certain region (communication hub) within the nursing unit

If hypothesis 2 is supported and a communication hub is found to exist then it raises a further question as to whether the physical distance of other pods from this hub has any impact on the interaction frequencies at those locations

Hypothesis 3 (conditional upon Hypothesis 2 being supported)

The frequency of staff interactions at each nursing pod will decrease with an increase in distance of that pod from a central communication hub.

CHAPTER 2 : METHODS

2.1 Research Design

This was a pre-post design intervention study assessing the influence of a new physical layout of an ICCU on unplanned, opportunistic communication and interaction patterns among clinical care staff. The study was carried out through systematic observations of communication frequencies and behaviors within the ICCU both before and after its relocation to a new space. The research design also assessed the relationship between the location of different nursing pods on the new ICCU and informal communication patterns.

2.2 Site Selection

A planned relocation of the existing ICCU at Cayuga Medical Center (CMC, Ithaca NY) to a new space within the same hospital provided the setting for a pre-post design intervention study offering a singular opportunity to compare and observe possible changes in communication patterns and frequencies in relation to different physical layouts. The new ICCU was to have a distinctly different interior layout, larger floor area, but the same number of patient rooms and same medical staff. Due to this possibility of conducting pre and post move observations in two different physical layouts involving the same staff members serving the same number of patients, this particular medical unit was chosen as a site for this study over other similar units within the hospital. The assumption was that this particular medical unit would allow the

researcher to focus on physical layout differences while reducing the variations in staff demographics, size and number of patients.

2.3 Site Description

2.3.1 Cayuga Medical Center (CMC) at Ithaca

Cayuga Medical Center at Ithaca employs 800 health-care professionals and has an affiliated medical staff of 180 physicians. It provides a 204-bed acute-care facility that offers state-of-the-art diagnosis and treatment services. Cayuga Medical Center is accredited by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO). It is a not-for-profit regional health care organization, and one of only nine rural referral centers in the state. Each year more than 150,000 patients use the acute care and outpatient services.

2.3.2 Intensive Cardiac Care Unit (ICCU) at CMC

Patients are admitted to the ICCU (Intensive Cardiac Care Unit) with serious conditions ranging from traumatic injury and heart attack to serious infection and drug overdose. They may require specialized drugs to improve heart function or to fight overwhelming infection, or invasive monitoring equipment to track cardiac, respiratory, or neurological activity. Some patients require ventilators to help them breathe, or hemodialysis in the case of kidney failure. Following major surgery, some patients are sent directly to the ICCU for intensive monitoring for signs of complications.

Till December of 2006 the ICCU was functioning in a space covering approximately 67000 gross sq.ft., with a maximum capacity of 16 single bed patient rooms. On the 18th of Dec 2006 the ICCU was relocated to a new space covering approximately 84000 gross sq.ft. but with the same maximum capacity of 16 single bed patient rooms. Apart from the floor area, the primary distinction between the two physical layouts is in the distribution and individual size of the nursing stations on the floor. While the old ICCU had only two large nursing stations serving eight rooms each, in the new ICCU there are nine small nursing pods serving 2-3 rooms each. While the former layout can be described as “centralized” the latter is distinctly “decentralized” in terms of nursing station layout.

As the name suggests, a centralized nursing station layout implies that there are one or two nursing stations that are located centrally on the entire floor or within clusters of 6-8 rooms. Each nursing station is usually large enough for 4-8 people to gather and work. In a decentralized layout each nursing station is designed and sized for a single user. These smaller nursing stations (nursing pods) are usually distributed across the medical unit floor with a spacing that allows adjacency to 2-3 patient rooms per pod. The intention of this approach is to reduce the need for staff to converge at any single nursing station (centralized) for information, charting etc, through the provision of a higher number of self sufficient and smaller nursing pods (decentralized) serving fewer number of rooms.

2.4 Old ICCU

2.4.1 Physical Layout

The old ICCU covered a gross floor area of approximately 67000 sq. ft. It had 16 single patient isolation rooms arranged in an almost linear manner separated from the service core area by a continuous hallway (Figure 1). The layout might be better described as a “multi-hub” unit with the patient rooms partially clustered in two groups of 8, with one centralized nursing station hub located at the center of each group. The larger of the two nursing stations (Nursing Station A) was actually a combination of two stations arranged about 1.5 m apart in the shape of an L, with a combined seating for 6 people. The other (Nursing Station B) had seating for 4 people including the ward clerk (Figure 1). Both the nursing stations had a working counter surface; file storage space, space for computer monitors and seating arrangements.

Right behind the Nursing station A was a dictation room for 1-2 persons and an adjacent conference room for staff discussions. The Intensivist (Intensive care doctor) had a small office right behind nursing station B. The service core, behind the nursing stations, included all the medical utility rooms like clean /soiled utilities, medical equipment, staff and patient toilets, pantry and a nurse lounge. There were two sets of adjacent clean and soiled utility rooms located near each of the two central nursing stations.

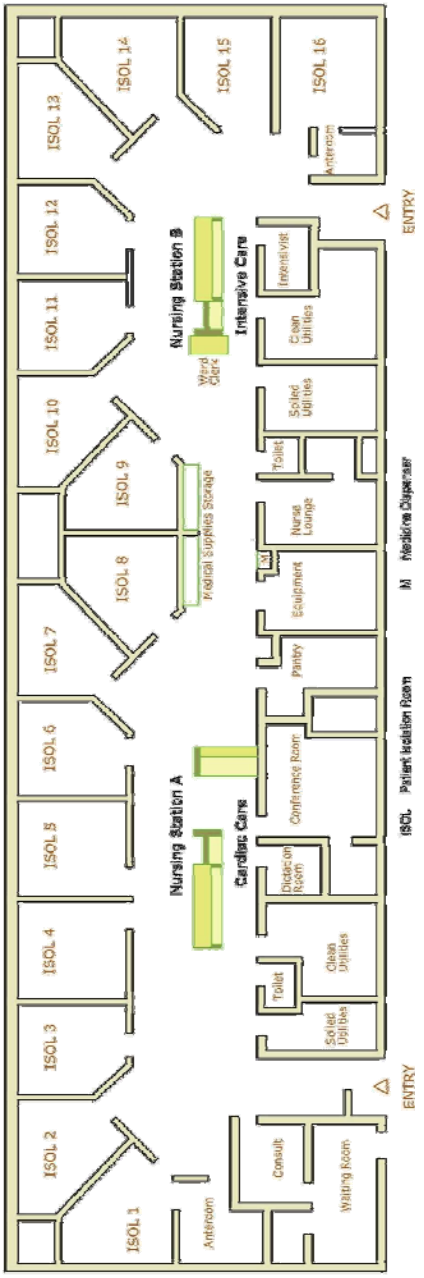

Figure 1 : Old ICCU Floor Plan

2.4.2 Sample Size and Selection

Since the focus of the study was to observe interaction patterns of medial staff in the ICCU, the sample consisted of a core group of personnel who attended the 7am to 3pm shift (*shift selected for observation*) at the ICCU.

- Regular ICCU Staff
  - Registered Nurse 5
  - Nursing Aides 2
  - Respiratory therapist 1
  - Intensivist (Intensive care doctor) 1
  - Ward Clerk 2
  - Unit Manager (Registered nurse) 1

While the number mentioned above for each category would remain the same throughout the week, the actual group of registered nurses and nursing aides would consist of different individuals on different days based on the work schedule of each person. The reparatory therapist, the Intensivist, ward clerk, and unit manger were however always the same individuals.

Due to the co-morbid nature of the medical needs of the ICCU patients, there was a constant influx of specialized medical staff who would come and go as and when required. Although it is difficult to assign a fixed number to this group, the following individuals were also included in the sample along with the regular staff whenever observed interacting on the ICCU floor.

- Visiting medical staff
    - Specialist Doctors
    - Therapists (Physical / Speech etc)
    - Dietitian/Nutritional Assistants
    - Flex Nurses
    - Nursing students

The following non-medical persons were also part of the sample but only when they were observed interacting with any of the above regular or visiting medical staff.

- Technicians
    - Medical equipment operators (X-Ray/Ultrasonography etc)
    - Utility technicians (electrical / medical gas / emergency equipment)
- Case manager
- Patient family members and other visitors
- Housekeeping Staff
- Volunteers

2.4.3 Data Collection

Systematic observations at the ICCU were simultaneously conducted by a team of three researchers and staff interactions were manually recorded according to predetermined categories for physical location, participant roles, gender and duration of interactions. (*Observation sheet provided in appendix A*)

The eight hour shift from 7am- 3pm was chosen as the daily timeframe for data collection in order to be able to observe the maximum number of on-duty staff as well as other visitors who were unlikely to come late in the night. Again, in order to control for the possible variations in terms of demographic profile associated with different staff members from the shift before or after the 7-3 shift, all daily observations would start and end with the 7-3 shift.

Only those interactions that took place within the hallway (i.e. outside any enclosed room within the ICCU) where the researchers had the permission to move about were recorded (Figure 2). The primary focus was on the two nursing stations and the corridor areas. All other interactions that took place within enclosed rooms with doors /windows accessible from the hallway - namely the conference room, dictation room, nurses' lounge etc, were noted only if and when visible to a researcher standing in the hallway outside.

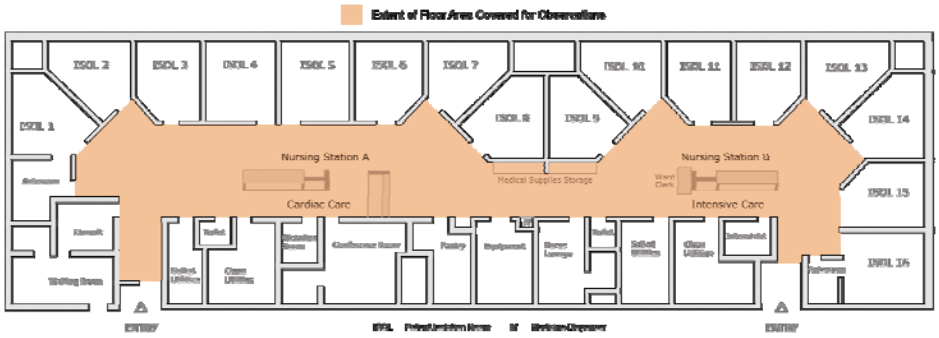

Figure 2 : Extant of Floor Area Covered for Observations in the old ICCU

Only those verbal interactions that involved at least one medical staff were deemed valid for being recorded as observations for this study. Any other interactions

solely between visitors and/or non medical staff were ignored. The researchers were visually familiar with the assigned medical staff on the shift and wherever necessary would otherwise visually determine a staff or visitor by the presence or absence of uniform and name tag.

Every morning at 9:30 am a selected group of doctors, nurses, technicians, therapists and other medical staff within the ICCU would get together outside each patient room to discuss each case. The group would start at one end of the floor and move all the way till the room with the last patient. These “Rounds” would regularly take place every day for approximately an hour, involving anywhere from 4 - 8 people. Since this type of interaction could not be called opportunistic or unplanned and also could not be assigned to any specific location, these were ignored for the purpose of this study.

Based on the predetermined guidelines, a total of 23 hours of observations were conducted on different days of the week and during different times within the 8 hr shift from 7 am to 3 pm yielding 1058 data sets.

This data set included interactions that occurred inside enclosed rooms but were visible to the researchers standing outside in the hallway. However, during the observation phase at the new ICCU, it was decided to ignore all interactions inside any enclosed room even when visible from outside. So in order to be able to make a fair comparison between the two data sets during subsequent analysis, only those interactions that were recorded at the nursing stations and the corridor area in the old ICCU were retained to create a modified old ICCU data set (***hitherto referred as pre-move data***). The new number of interactions for the 23 hrs of observations was

reduced to 994 as opposed to the original 1058. It is of interest to note that the elimination of some of the location categories made only a small difference in the total number, suggesting that the vast majority of the interactions in any case occurred either at the nursing stations or in the corridor areas. A complete analysis of the original data set is also available in the appendix. (*Appendix D)*

2.4.4 Procedure

The researchers divided up the entire floor area into three regions with predetermined boundaries in order to have manageable regions for each person to observe (Figure 3). These regions were only observational aides and had no other significance on the study. All observations recorded were reported with respect to the entire floor area of the ICCU and not by region.

The researchers chose a specific vantage point, within each region (Figure 3) that allowed for uninterrupted visibility of the chosen physical features within that region and also ensured that the staff was not inconvenienced in any manner. The researches randomly took turns to observe in each of the three regions in order to maintain inter-observer reliability. Also while observing in any one region the researcher would ignore all other visible interactions taking place in adjacent regions since those were being recorded by the other observers. An attempt was made to conduct the observations on different days and at different times within the 7am-3pm shift in order to reduce any potential bias in the data due to day or time.

The actual nature or specific content of any verbal communication was ignored for the purpose of this study. The only information recorded for each observation was the generic professional role of the participant, the gender of the participants, the physical location and the duration of the verbal interaction based on pre determined categories. Wherever required any additional notes or descriptions for a particular observation were also recorded at the time of entry.

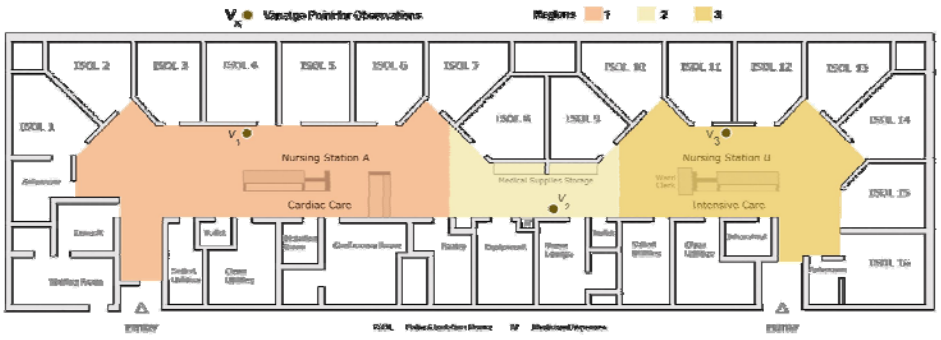

Figure 3 : Observation Regions and Researcher Vantage Points within the old ICCU

2.5 New ICCU

2.5.1 Physical Layout

The new ICCU covers a gross floor area of around 83500 square feet, about 16500 more than the old unit. It has 16 single patient isolation rooms, one of which is currently being used as a temporary staff lounge. Unlike the old ICCU, each patient room has a toilet and internal storage space. The layout resembles a semi-racetrack arrangement with the patient rooms arranged on the outside, enclosing around the

corridor and service area (Figure 4). Nine nursing stations are spread out across the floor, with a spacing that allows visual access to 2-3 rooms from each. One of these is specifically assigned to the ward clerk (NS 5; Figure 4) but is also used by other staff when available.

The service core of the new ICCU unit contains the medication room, both the medical and building utility rooms and a fax/copy room. Unlike the old ICCU, the new unit has only two centralized rooms for clean and soiled utilities for the entire 16 rooms. Additionally, there is a separate enclosed work area with seating for seven persons in a row provided for doctors/medical staff to perform writing tasks.

This space is adjacent to individual office spaces provided for the Unit manager and the Intensivist. This work area has no visual access to any of the patient rooms and is not intended to be used as a substitute for the nursing stations located adjacent to the patient rooms. All the nursing stations have a working counter top, file storage space, a computer and seating for one person.

They are similar in design and size. Among the nine nursing stations there are three which are equipped with electronic patient status monitors that track specific medical conditions of patients in each room. There are also five fixed individual alcove work stations available on the floor, which are spaced at the rate of one for every two-three patient rooms. The alcove work station is essentially a single person counter top with a computer and linen storage below, recessed into the patient rooms along the common internal wall between two rooms (*marked as WKS in Figure 4*). It is accessible only from the corridor outside the patient room but has glass windows around it that allow staff to see inside the room while working there.

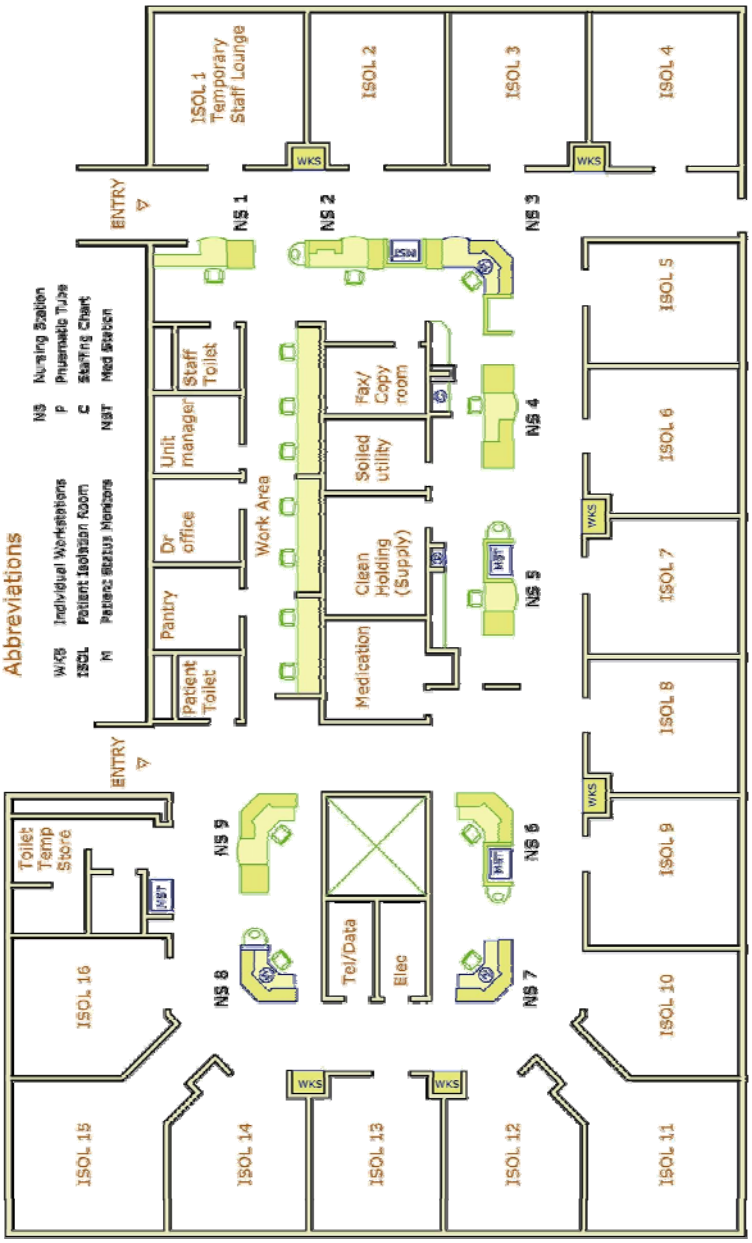

Figure 4: New ICCU Floor Plan

2.5.2 Medical Systems and Technology

The following is a brief description of some of the primary communication systems and medical equipment on the ICCU floor.

Pneumatic Tube

- There is a pneumatic (pressurized air) tube transport system present on the floor, used for the transfer and delivery of biological samples to the labs and paper documents within the hospital

Patient Monitoring systems

- These consist of a dedicated set of dual electronic screens, which display real time data on specific medical conditions (like heart rate, breathing etc) of every single admitted patient at any given time in the ICCU. There are three such systems on the entire floor.

Nurse call/patient status light system

- The nurse call system consists of a cluster of three colored light fixtures placed outside every patient room and on the ceiling above the three nursing stations equipped with the patient monitoring systems.
    - White light : general all purpose call signal activated by patient
    - Red light : activated by patient if he/she needs to go to toilet
    - Blue Light : activated by staff member from inside patient room seeking assistance from other medical staff

Medical storage systems

- There are two kinds of portable medical carts located across the ICCU floor
    - Crash cart (red in colour): contains emergency medicines and supplies
    - Procedure cart : contains only medical and surgical supplies

2.5.3 Sample Size and Selection

The Regular ICCU staff in the new space was the same as before. All other sample descriptions and details are exactly the same as mentioned earlier for the old ICCU.

2.5.4 Data Collection

Systematic observations at the ICCU were conducted by a single researcher and medical staff interactions manually recorded according to predetermined categories for physical location, participant roles, gender and duration of interactions. *(Observation sheet provided in appendix A)*

The eight hour shift from 7am- 3pm was chosen as the daily timeframe for data collection both in order to maintain parity with the pre move study and also be able to observe the maximum number of on-duty staff as well as other visitors who were unlikely to come late in the night.

Again, in order to control for the possible variations in terms of demographic profile associated with different staff members from the shift before or after the 7-3 shift, all daily observations would start and end with the 7-3 shift.

Only those interactions that took place within the effective floor area (Figure 5), where the researcher had the permission to move about were recorded. All other interactions that were otherwise visible to the researcher but took place within enclosed rooms with doors /windows accessible from the hallway; namely the patient rooms, the temporary staff lounge and the medication room were ignored.

Again, only those verbal interactions that involved at least one medical staff were deemed valid for being recorded as observations for this study. Any other interactions solely between visitors and/or non medical staff were ignored. The researcher was visually familiar with the assigned medical staff on the shift and wherever necessary would otherwise visually determine a staff or visitor by the presence or absence of uniform and name tag.

As explained earlier in the data collection section for the old ICCU, interactions during "medical rounds" in the new ICCU were also ignored for the purpose of this study.

A total of 50 hours of observations conducted on different days of the week and during different times within the 8 hr shift from 7 am to 3 pm yielded 899 data sets (***hitherto referred as post-move data***).

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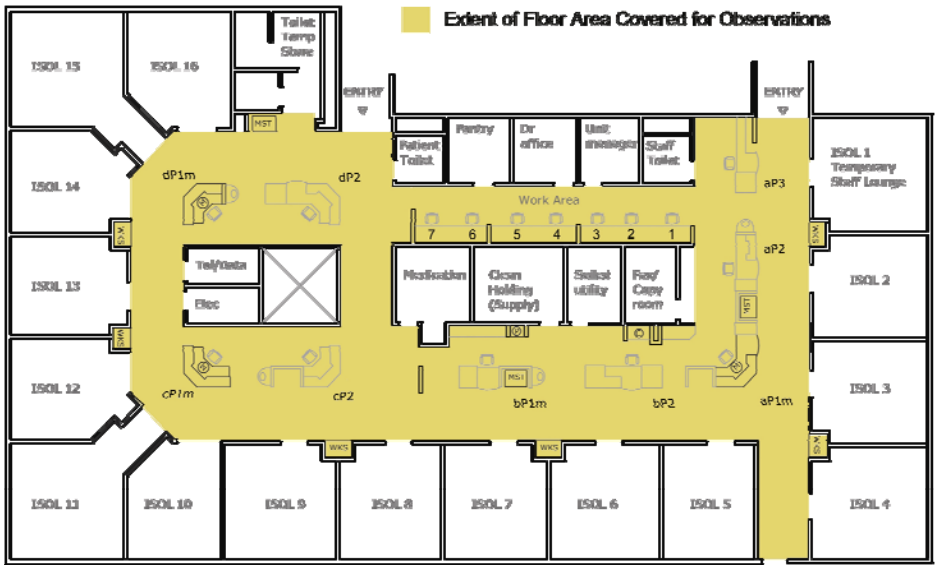


Figure 5: Extent of Floor Area Covered for Observations in new ICCU

2.5.5 Procedure

In order to allow one researcher to practically conduct the observations across the entire floor, it was divided into five distinct regions - A through E, with predetermined boundaries (Figure 6). Within each region, areas of potential interest such as chart locations, medicine storage carts, nurse-servers as well as nursing stations were identified (*Detailed Region plans and Descriptions attached in appendix B*). Apart from the obvious physical elements like the nurse stations the researchers also selected other equipment/ furniture within each region based on their perceived potential as communication hubs. The overall area left over after each specific location of potential interest had been identified was considered as the corridor space within each region.

Figure 6: ICCU Floor Plan showing Observation Regions and Pods

The researcher chose a specific vantage point (Figure 7), within each region that allowed for uninterrupted visibility of the chosen locations within that region and also ensured that the staff was not inconvenienced in any manner during their regular activities. Due to space constraints within region E the researcher decided to use a vantage point outside the region but still offering an unobstructed view of the whole region. As long as an interaction took place entirely inside the predetermined physical boundaries of a given region it was considered a valid data entry for that region. Otherwise while observing in any one region the researcher would ignore all other visible interactions taking place in adjacent regions. An exception was made only for those that occurred between someone standing inside the region being observed and others in an adjacent region. Such an interaction was coded under the location category as “between regions”.

Figure 7: ICCU Floor Plan showing Research Member Location for Each Region

In order to minimize any potential bias due to time and day, observations were carried out over different days and different times during the day in order to get a representative picture of interactions patterns. Similarly each region within the new ICCU was sampled several times over several weeks in order to develop a representative picture of hourly interactions and to counter for unequal total observation periods in each. Figure 8 presents a typical observation time table for a week. Each colored box represents a region and its height show the hours observed in that region. As far as practicable, observations were carried out in manner wherein if the first observation period began at 7:30 am on a Monday in the order of Region A-B-C-D-E, for Tuesday it would also begin at 7:30 am but in the order B-C-D-E-A and so on until each region was observed for a similar time of the day and same day of the week.

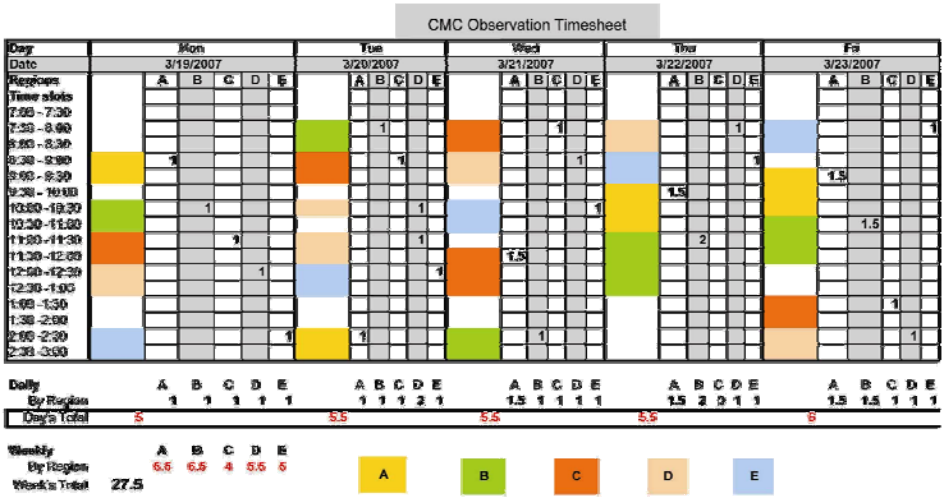


Figure 8 : Typical Time Table for Observations Conducted over Different Time and Days

The researcher would observe at any given region for at least 1 hr, upto a maximum of 3 hrs per day, before moving on to the next one. The date and start time for each set of observations at each of the five regions was noted. At the end of the observation period in one region, the stop time was noted and the researcher would move onto the next region to repeat the process till the end of the shift at 3 pm.

The actual nature or specific content of any verbal communication was ignored for the purpose of this study. The only information recorded for each observation was the generic role, the gender of the participants, the physical location and the duration of the verbal interaction based on pre determined categories. Wherever required any additional notes or descriptions for a particular observation were also recorded at the time of entry.

CHAPTER 3 : RESULTS

Hypothesis 1: The frequency of communication between medical staff will decrease in a decentralized layout with smaller and higher number of nursing pods as compared to a centralized layout with larger and fewer nursing stations.

Hypothesis 1 was supported by the findings. Pre-post analysis of the data according to all chosen parameters of location, length of conversations, role pairs and group size showed clear reductions in interactions in the new ICCU. All the pre-post comparisons presented here are made on a per hour basis to take into consideration an unequal number of observation periods before and after the move. Internal comparisons between locations in the new ICCU are also on an hourly basis to counter for different observation periods in each region.

3.1 Pre and Post-Move Comparisons

3.1.1 Analysis by Location

Comparison between the pre and post-move data (Figure 9) showed that in the new ICCU there was a 62%, decrease in the average interactions per hour taking place at the nursing pods ($X^2 = 10.8, \quad p < 0.01$), and a corresponding 35% decrease in those occurring in the corridor areas (*p value not significant*). For this comparison all the location categories listed in the new ICCU (*Appendix C)* except “Pods” were combined together and reported as “Corridor Areas” since those locations were essentially physical features within the overall corridor area of the new ICCU.

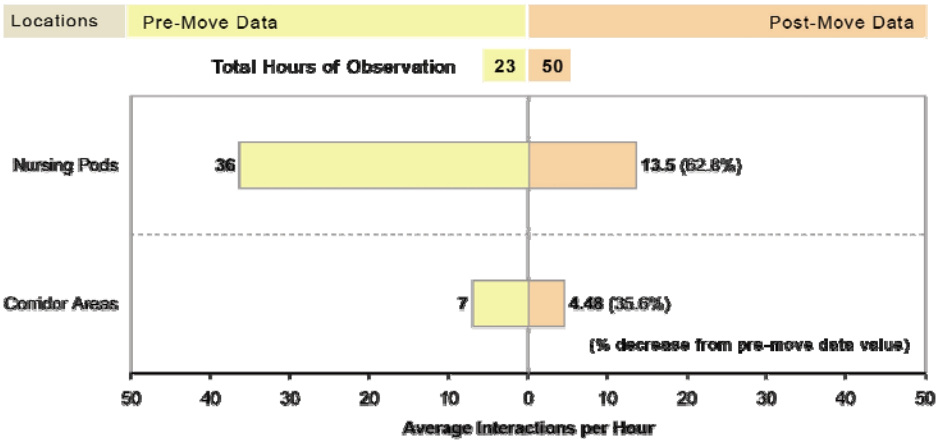


Figure 9: Comparison of Pre-Post Data by Location

3.1.2 Analysis by Length of Conversation

A comparative analysis based on length of conversation (Figure 10) revealed that in the new ICCU there were 54% fewer short interactions per hour than in the old ICCU ($X^2 = 7.08,\ p < 0.01$). There were also approximately four times more medium ($X^2 = 3.6,\ 0.1 < p < 0.05$) and long conversations per hour in the old ICCU. Finally, although a very insignificant number, there were 3 conversations longer than 10 minutes in the old ICCU while none were recorded in the new ICCU.

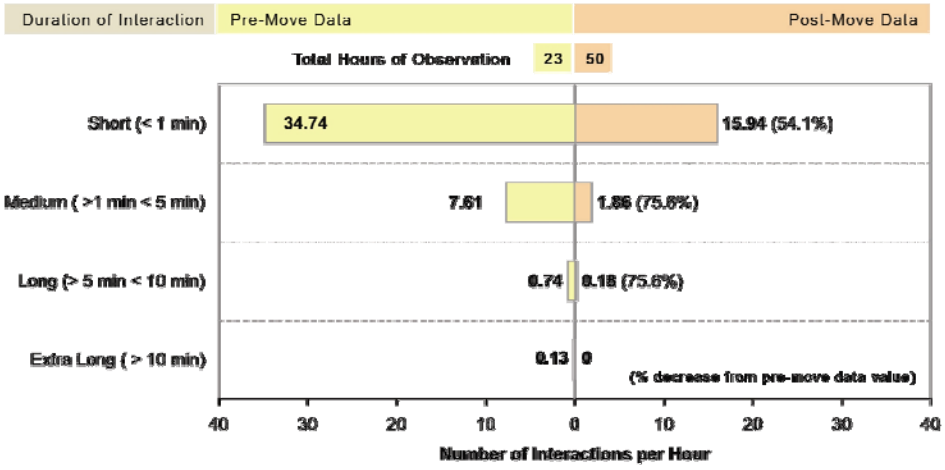


Figure 10 : Comparison of Pre and Post Move Data by Length of Conversation

3.1.3 Analysis by Number of Persons Involved in an Interaction

A comparative analysis of the total number of interactions by number of persons interacting (Figure 11), found that there were 57% fewer 2 person interactions ($X^2 = 8.96,\ p<0.01$) in the new ICCU, while even fewer 3 and 4 person interactions were observed (*p value insignificant)*

In the old ICCU there were only 5 recorded interactions involving 5 people while there were none in the new space. Interactions involving higher numbers were not observed during the course of this study except during “medical rounds”, which, as explained in the methods section were not considered for the purpose of this study.

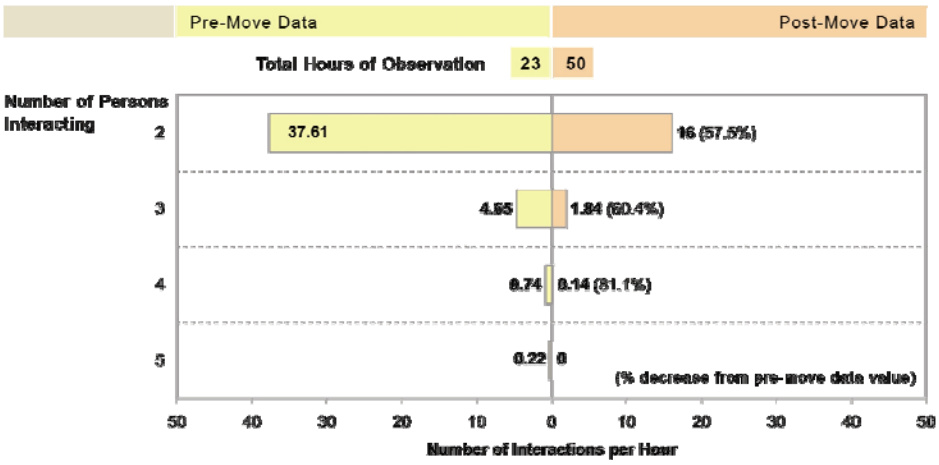


Figure 11 : Comparison of Pre and Post Move Data by Number of Persons Interacting

3.1.4 Analysis by Role Pairs

The following analysis was directed at finding out the specific professional roles of the people who were communicating the most. All two person interactions were broken down into role pairs and the ones containing at least 1 RN were categorized separately. (*Abbreviations explained in appendix E*). In order to have a more compact data set and to protect the anonymity of the Charge Nurse and Intensivist all entries for CN (Charge Nurse) and NT (Intensivist) in both data sets were converted to RN (Registered Nurse) and MD (Doctor), respectively. All other two person interactions not involving an RN were grouped together in one category.

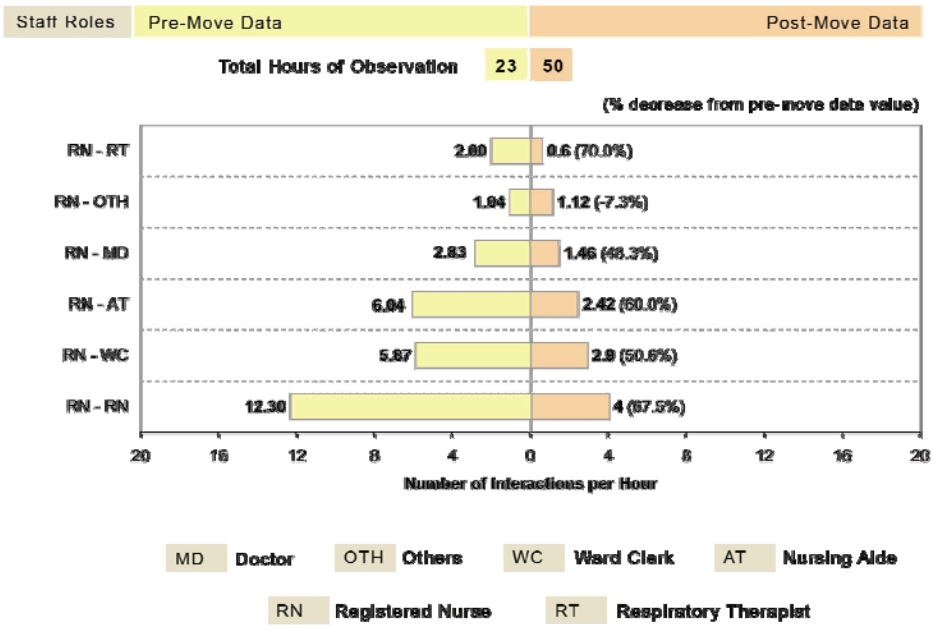


Figure 12 : Comparison of Pre and Post Move Data by Role Pairs

Figure 12 shows that on average, interactions involving a RN and all other staff had reduced by at least 50% per hour in the new ICCU with the highest reduction occurring in RN-RN interactions ($X^2 = 4$, $p < 0.05$). RN-MD hourly interactions had also decreased by slightly less than half (48%). Reductions in all the role pair interactions except RN-RN were not found to be statistically significant.

Hypothesis 2: Staff will show a tendency for congregation and hence higher frequency of communication at a certain region (communication hub) within the nursing unit

Hypothesis 2 was supported by the results. Analysis of hourly interaction data by region and sub region in the new ICCU showed the presence of a dominant communication hub. Interestingly the results also showed the existence of a communication hub in the old ICCU.

3.2 Analysis by Regions within the New ICCU

A detailed analysis of the regions and sub regions within the new ICCU was conducted with emphasis on the frequency of interactions (*Appendix F*) and the role pairs of the participants (*Appendix G*) of those interactions in order to observe inter-location variations. Table 1 shows the variations in each of the predetermined regions demarcated by the researcher at the time of observation (Figure 6).

Table 1 : Variations by Region within the New ICCU

Hours of Obs	Region	Length of Conversation							Percentage of Region total	Region Total
		S		M		L		XL		
		Total	Hourly	Total	Hourly	Total	Hourly	Total		
12.5	A	160	12.8	18	1.44	3	0.24	0	20.13%	181
12.5	B	354	28.32	35	2.8	1	0.08	0	43.38%	390
7.5	C	153	20.4	25	3.33	3	0.40	0	20.13%	181
9.5	D	102	10.74	6	0.63	2	0.21	0	12.24%	110
8	E	28	3.50	9	1.13	0		0	4.12%	37
50	Grand Totals	797	15.94	93	1.86	9	0.18	0	100.00%	899

The hourly variations presented in (Figure 13), clearly show that the highest number of short conversations per hour were in Region B; and the peak was significantly different from the other regions ($X^2 = 25.65,\ p < 0.001$). All the regions reported less than 1 long conversation per hour.

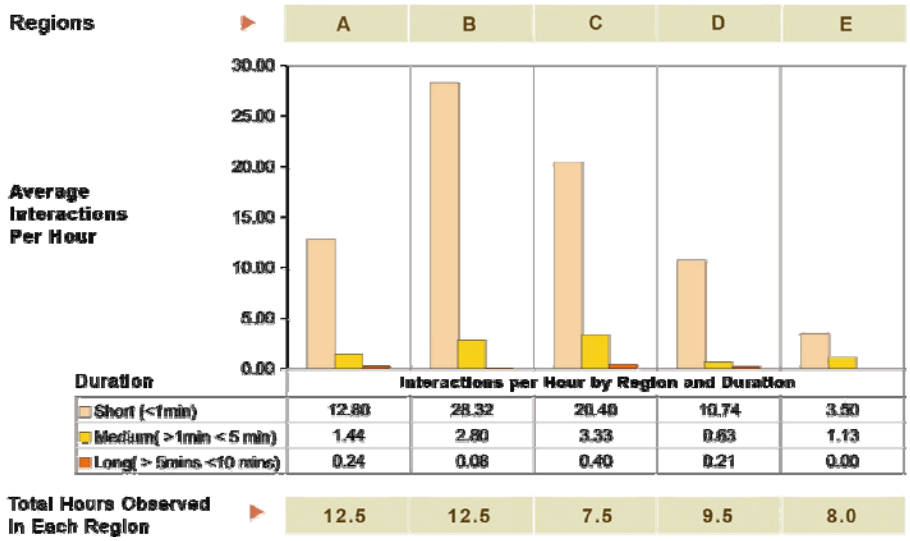


Figure 13 : Hourly Variations in Interactions among Regions within the New ICCU

3.3 Analysis by Sub-Region (selected locations) within new ICCU

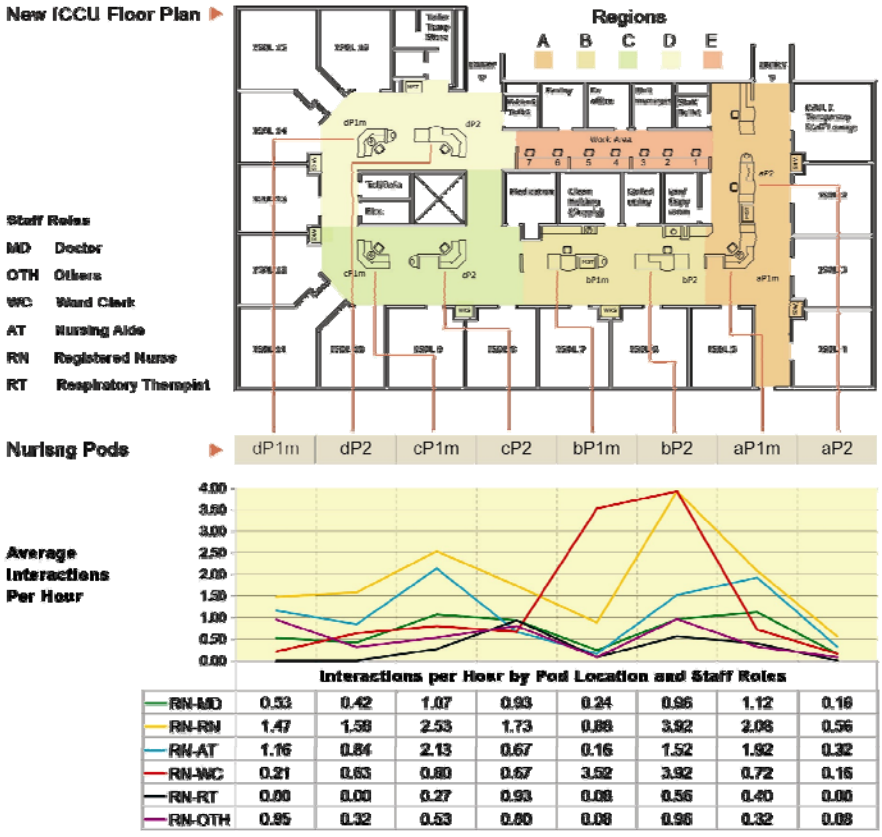
The following section analyzes variations in interaction patterns among the nursing pods and corridor areas in the new ICCU.

Figure 14 clearly shows that in terms of hourly short interactions nursing pod bP2 was significantly higher than the rest ($X^2 = 18.19,\ p < 0.02$). Nursing pod bP2 is located in region B (Figure 6), which in the previous analysis reported the highest

number of hourly interactions among all regions. Figure 14 also shows that there was no significant variation in interaction frequencies except for the sharp peak at bP2. The rest of the pods had similar interaction volumes without significant differences. In case of the short and medium conversations hourly variations displayed no specific trend at all.

Figure 14 : Variation in Frequency of Interactions among Nursing Pods in New ICCU

Further comparative analysis between the pods with respect to role pairs (Figure 15) revealed an almost similar trend as in (Figure 14) with peak hourly interactions occurring mostly at or adjacent to pod bP2. More specifically, RN-RN and RN-WC interactions peaked significantly at bP2 and then on an average leveled out to a similar low volume at other pods. The assigned workstation for the Ward Clerk (WC) was bP1m while the charge nurse was assigned to bP2. The analysis of inter-pod variations revealed that bP2 was clearly the communication hub in the new ICCU with the other pods reporting a much lower volume of interaction.



	dP1m	dP2	cP1m	cP2	bP1m	bP2	aP1m	aP2
RN-MD	0.53	0.42	1.07	0.93	0.24	0.96	1.12	0.16
RN-RN	1.47	1.58	2.53	1.73	0.88	3.92	2.08	0.56
RN-AT	1.16	0.84	2.13	0.67	0.16	1.52	1.92	0.32
RN-WC	0.21	0.63	0.80	0.67	3.52	3.92	0.72	0.16
RN-RT	0.00	0.00	0.27	0.93	0.08	0.56	0.40	0.00
RN-OTH	0.95	0.32	0.53	0.80	0.08	0.96	0.32	0.08

Figure 15 : Variations in 2 person Interactions among Nursing Pods in New ICCU

A comparative analysis of the corridor areas within each of the five regions (Figure 16) showed that on a per hour basis there were no significant differences in the number of short interactions. More than 90% of the interactions in each of the corridor regions were less than 1 minute in duration. Unlike the inter-pod variations the analysis of inter-corridor variations did not reveal any distinct pattern or peak. Rather, the hourly figures appeared to suggest that a somewhat similar level of interaction was happening across the corridors in regions A, B and C (Figure 17)

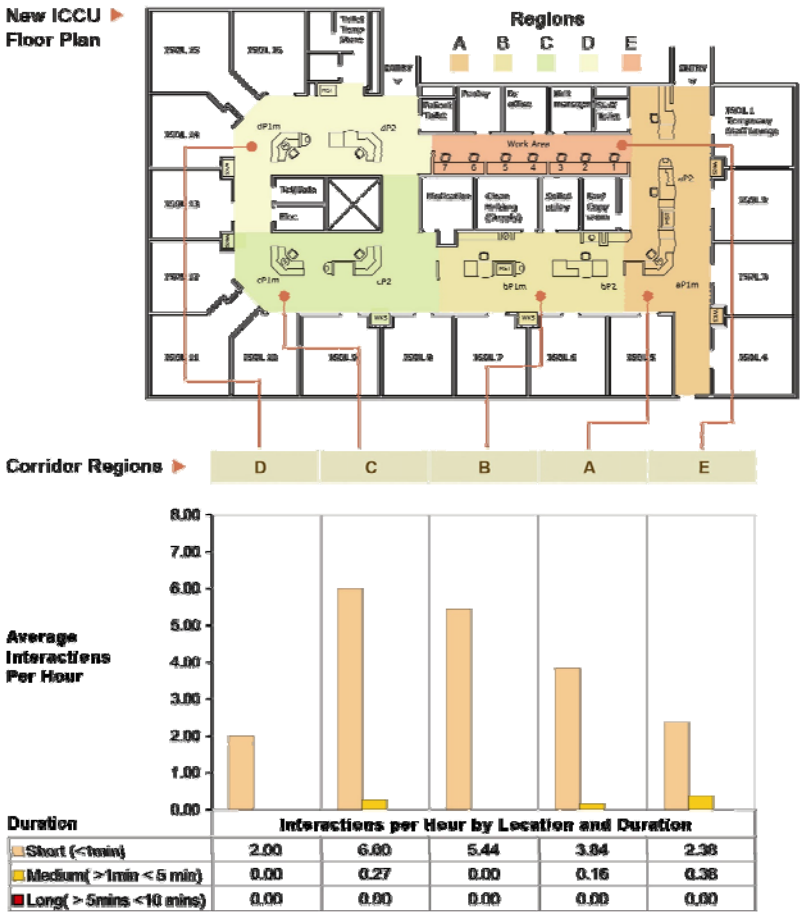


Figure 16 : Variation in Frequency of Interactions across Corridor Regions in New ICCU

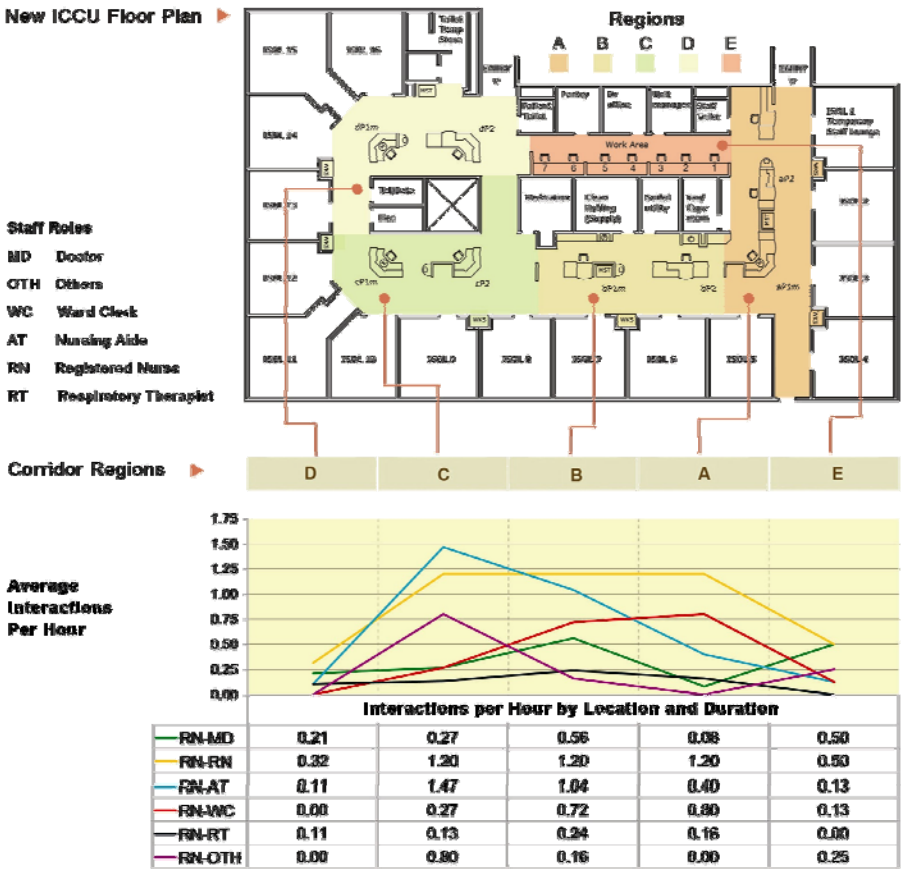


Figure 17 : Variations in 2 person Interactions across Corridor Regions in New ICCU

3.4 Analysis of Old ICCU

Analysis of the pre-move data for specific location of interactions (Table 2) showed that about 84% of all the interactions occurred at the two nursing stations (Figure 1), with the rest happening in the corridor. Among the two nursing stations 58 %(n=574) occurred at Nursing Station A, which was more than twice that of Nursing Station B that had 26% (n=259). Since both locations in the old ICCU were observed for equal periods, the actual total interactions are shown in Figure 18 , which clearly demonstrates that nursing station A was a communication hub in the old ICCU.

Table 2 : Categorization by Location and Duration of all Interactions (pre-move data)

Sub-Region Aggregates	Length of conversation				Row Totals	Percent of Total
	S	M	L	XL		
Nursing Station A (NS-A)	461	104	7	2	574	57.89%
Nursing Station B (NS-B)	217	36	5	1	259	26.09%
Corridor (C)	120	35	5	0	160	16.11%
Column Totals	798	175	17	3	993	100.00%

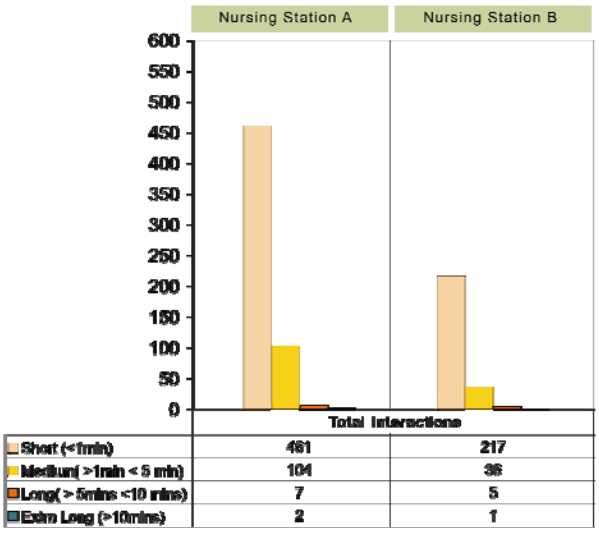


Figure 18: Total interactions at Nursing Stations A and B

Hypothesis 3: The frequency of staff interactions at each nursing pod will decrease with an increase in distance of that pod from a central communication hub.

Results did not support hypothesis 3. While Figure 14 showed the existence of a dominant communication hub centered at pod bP2, Figure 19 clearly shows that there is no relationship between frequency of interaction at a pod and its distance from the communication hub.

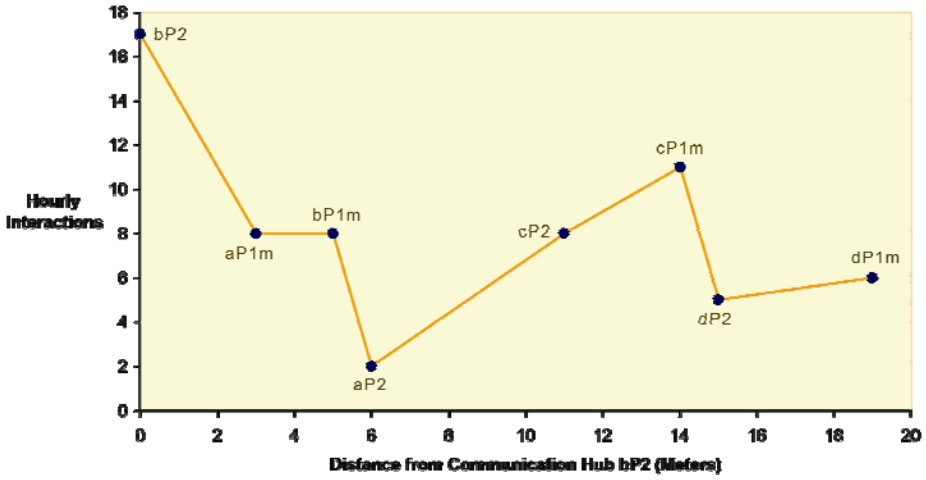


Figure 19 : Variation in Hourly Interactions with Distance from Communication Hub

3.5 Summary of Key Findings

Pre-Post Move Comparison

- There was a 35% decrease in interactions in corridor areas in the new ICCU and a 62% decrease at the nursing pods.
- There were 50% fewer conversations across all the duration categories in the new ICCU.
- The number of two person interactions fell by around 57% in the new ICCU while those involving 3 and 4 fell by 60% and 81%, respectively.
- On average, there were 50% fewer interactions per hour involving RNs in the new ICCU. RN-MD hourly interactions also decreased by slightly less than half (48%).
- In both the old and new ICCU there was a significant peak in interactions at one nursing station.

Analysis of new ICCU

- Region B reported the highest number of short conversations per hour.
- There was a sharp peak in frequency of interaction at one workstation (bP2), which in effect became the unit "hub."
- No significant differences in interaction patterns were found in different corridor areas in the new ICCU.
- No relationship between frequency of hourly interaction and distance from the communication hub was found.

CHAPTER 4 : DISCUSSION AND CONCLUSIONS

Hypothesis 1, that *the frequency of communication between medical staff will decrease in a decentralized layout with smaller and higher number of nursing pods as compared to a centralized layout with larger and fewer nursing stations,* was supported. The results showed that average interactions per hour at the nursing pods had reduced by more than half (62%) in the new ICCU. These reductions occurred with no changes in the number of ICCU beds from the old to the new, or in staffing (ratio of staff to beds). Hypothesis 2, *that staff will show a tendency for congregation and hence higher frequency of communication at a certain location (communication hub) within the nursing unit,* was also supported. Hypotheses 3, that t*he frequency of staff interactions at each nursing pod will decrease with an increase in distance of that pod from a central communication hub* was not supported by results. The frequencies of interactions observed at the pods showed no clear relationship to distance from the communication hub. The remainder of this chapter discusses these findings in relation to the underlying research questions that were explored.

Those questions were stimulated by the fact that billions of dollars are being spent annually on new hospital construction for the purpose, fundamentally, of improving quality of care. As the literature reviewed in Chapter 1 indicates, there are a variety of factors impacting quality of care. One of these is the frequency and nature of communication and interaction among medical staff. The other is the design of nursing units.

This thesis sought to understand the relationship between these two factors. Specifically, it explored how a more decentralized nursing unit design, currently considered best practice among many design and health professionals, affects communication patterns.

The results of this study clearly indicated that the more decentralized nursing unit design reduced interaction; and it did so not only for interaction among nurses, but also for interaction between nurses and doctors. It also found that even when there are multiple nursing stations or pods, interaction patterns tend to "peak" around one specific area. In effect, the nursing staff created an interaction "hub" even when one had not been designated by design or policy. There are a variety of factors that appear to have contributed to how nurses used space on the nursing unit, and to the rather dramatic decrease in interaction in a more decentralized unit. The following sections explore some of the factors influencing interaction patterns, and the implications of these for quality of care and the design of nursing units.

4.1 Affordances and Activity Magnets

One framework for understanding the observed variation in interactions by region is provided by the concept of "affordances" (Gibson, 1977) that refers to whatever it is about the environment that contributes to and supports the behavior that occurs in it. It can include elements in a physical layout that influence the establishment of informal communication and interaction processes. It can also include, as the concept of organizational ecology (Becker & Steele, 1995; Becker, 2004, 2007) suggests, the interplay of physical design, work processes, staff and

patient demographics, and technology. Locating several different elements in close proximity creates what Becker & Steele (1995) called “activity magnets.” In combination, in the context of the corporate office, separate activity magnets like a copier, beverage area, rest room, and secretary attract activity because employees need to use these services or see the people in this area as a regular part of their daily routine. In the context of a nursing unit, activity magnets become things such as the presence of the ward clerk, patient monitoring systems, and supplies. Together, these “affordances” or activity magnets are likely to create an activity “hub.” The following sections look how physical proximity and visual accessibility, staffing, technology, pod design, and storage and waste disposal take on the role of affordances that attract interaction.

4.1.1 Physical Proximity and Visual Accessibility

The most fundamental difference in the physical layout of the new ICCU from the old unit is the adoption of decentralized nursing pods. That, combined with a larger floor area, has reduced overall physical proximity of staff members. In the context of both a larger space and pods designed for individual work and distributed across the ward, Region B, in particular, was ideally located for maximum visual and physical proximity to the other areas on the ward. From region B staff could easily see and be seen by people working at other pods in adjacent regions. This advantage of being able to quickly seek out people might explain, in part, the higher frequency of interactions in this area.

According to research in the corporate workplace (Allen, 1976; Kraut et al., 1990) on the role of proximity and its impact on communication frequency, the above mentioned changes in the physical layout could have had a significant impact on the observed interaction frequencies. Allen's research in corporate R&D units, however, consistently found that face-to-face communication declined dramatically after about 50 meters, much longer than even the furthest distances in this study. It may be that in the context of a nursing unit, the differences at which communication is affected are much smaller. Or it may be that the key is less distance per se than visual connectivity. Kraut et al. (1990) found that communication declined significantly even on the same floor when employees were located around a corner of the floor, a situation which more closely approximates the ICU studied here.

The larger floor area and decentralized layout of the new ICCU also reduced visual access among nurses located in the areas, that the data suggested constitute a "hub" and those furthest from the "hub". Based on his research on different types of workplace settings, Becker (2007) suggested that a degree of physical and visual proximity is necessary to support a culture of communication and collaboration. Kalisch & Begeny (2005) also suggest that less visual proximity reduces the likelihood of chance encounters and the associated opportunities for staff members to provide assistance or engage in verbal exchanges. This is critical in an organizational context where continual learning and sharing of information, skills, and insight, as well as opportunities to discuss and negotiate diagnoses and treatment plans is a fundamental characteristic of the work process. In a hospital context, a case study at the Sutter Roseville Medical Center in California, found, for example, that decentralized stations in the med-surg and oncology units left the nurses feeling

isolated and unable to effectively support each other (Flynn & Barista, 2005). In informal conversations and observations with staff on the new ICCU, staff commented about the visual isolation of the pods furthest from the “hub”, and noted that these pods were the least desirable in which to work.

4.1.2 Design of Nursing pods

Although there was a marked decrease in all larger group interactions in the new ICCU, the reduction was highest for four or more person group interactions. That might be a consequence of the fact that in the new ICCU each of the nursing pods was designed with seating for only one person. Moreover, their smaller size made it less conducive for a group of people to gather around without spilling onto the corridor. In the old layout, the larger centralized stations provided the space and chairs for several nurses, creating more opportunities for larger group interactions, a fact confirmed by the higher observed volume of 4 and 5 person interactions as compared to the new layout. In the absence of a large nursing station in the new ICCU it is unlikely that four or more people would stand in the middle of the corridor and converse within earshot of the patients while also creating potential obstruction for other staff. While the temporary nurse’s lounge in the new ICCU had the space to allow group interactions, it was located at one extreme corner of the ward and hence attracted few groups of staff members for unplanned interaction at a location that essentially eliminated contact with patients.

4.1.3 Layout

In contrast to the concept of affordances that highlights the positive influence of design, certain design features can also reduce opportunities for interactions. For example the nursing pod that showed absolutely no interactions was located right in front of the staff toilet. That, combined with its being located right next to an entry to the ICCU that was closed during the period of the study for construction reasons, and the absence of any specialized medical equipment could easily account for the lack of interaction observed there.

The alcove work stations that were designed to allow the nurse to perform charting activities without disturbing the patient while keeping an eye on him or her through a window outside the patient rooms were also among the areas that had few interactions. The primary reason appears to be that with the new ICCU having adopted a decentralized layout the pods are now close enough to the patient rooms for the nurse to just walk up to them for writing tasks and have the benefit of a larger workstation nearby with available seating that allows a fair amount of visual access to the patient rooms, The design of the workstations was also such that any person using them has to stand or sit with their back facing the hallway, which could create a psychologically disconcerting feeling with other people constantly walking by. Charting at the workstation in the presence of patient families in the hallway also created issues regarding confidentially of information. The presence of mobile computers called COWs (computer on wheels) seems to have further added to the redundancy of the alcove work stations. All of these factors appear to have contributed to the low usage and subsequent lack of observed interactions occurring at these work stations.

4.1.4 Staffing

Both the ward clerk as well as the charge nurse was assigned to nursing pods in region B. Since both of these people play a critical role in the patient care process and in managing nurses while on duty, their location acts as a magnet that draws others to their desks, creating further opportunities for interactions in that region.

4.1.5 Storage and Waste Disposal

The distribution and storage of supplies in the new ICCU might also have some bearing upon the observed interaction patterns. Unlike in the old unit, patient rooms in the new ICCU have internal storage space for supplies as well as individual toilets. Additionally there is soiled linen storage incorporated within the alcove workstations outside the rooms. This has presumably reduced the need for staff to travel for disposal of waste material or to retrieve supplies. One consequence of that could be fewer chance encounters and informal conversations.

4.1.6 Patient Acuity and Room Assignments

The practice of admitting higher acuity patients requiring frequent bedside assistance to rooms in or close to Region B is also likely to have contributed to higher interaction in Region B, since patients who were assigned to nearby rooms acted as an activity magnet for staff who wanted to maintain visual contact and the ability to quickly enter a patient room if necessary..

4.1.7 Technology

The presence of more advanced technology in the new ICCU in the form of electronic patient monitoring systems that allowed staff to access real time data on all admitted patients while sitting at one location reduced the need to travel for information, which in turn generated fewer opportunities for chance meetings. The collocation of equipment like the patient monitoring system, pneumatic tube system, as well as the close proximity of the fax/copy , medication and utility rooms has also made region B more *affordable* then others in terms of encouraging chance encounters and interactions. For example within region B, pod bP2, with the highest interaction, is right in front of the staff chart and adjacent to a patient monitoring system.

4.2 Integrated Workplace Strategies

It is of particular interest to note that in the above mentioned example of the alcove workstation, as well as pods, the presence of some of the very same factors that helped create a communication hub, like access to patients and technology, failed to generate interaction. All the nursing pods were essentially similar in design, and each had more or less access to either technology or patients or both. None, however, enjoyed the benefits of all the factors at once as seen in region B, and particularly at the pod bP2. This suggests that the presence of any one or two factors is not sufficient to create conducive conditions for interactions to take place. Rather, it is the confluence of all the previously mentioned affordances that together interact to create an integrated workplace strategy (Becker and Steele, 1995) that encourages and sustains informal and opportunistic interactions. All of these elements can be

considered as focal points of magnet activity zones. The circulation paths being created by the presence of these magnet activity zones draws people and increases the opportunities for unplanned interactions (Becker, 2007). This leads to the concept of organizational ecology which is the underlying basis behind the creation of the observed communication hub.

Figure 20 depicts each contributing factor as a component of the complete network that represents the organizational ecology of Region B. At the center lies the communication hub supported and sustained by the firmly established network of affordances.

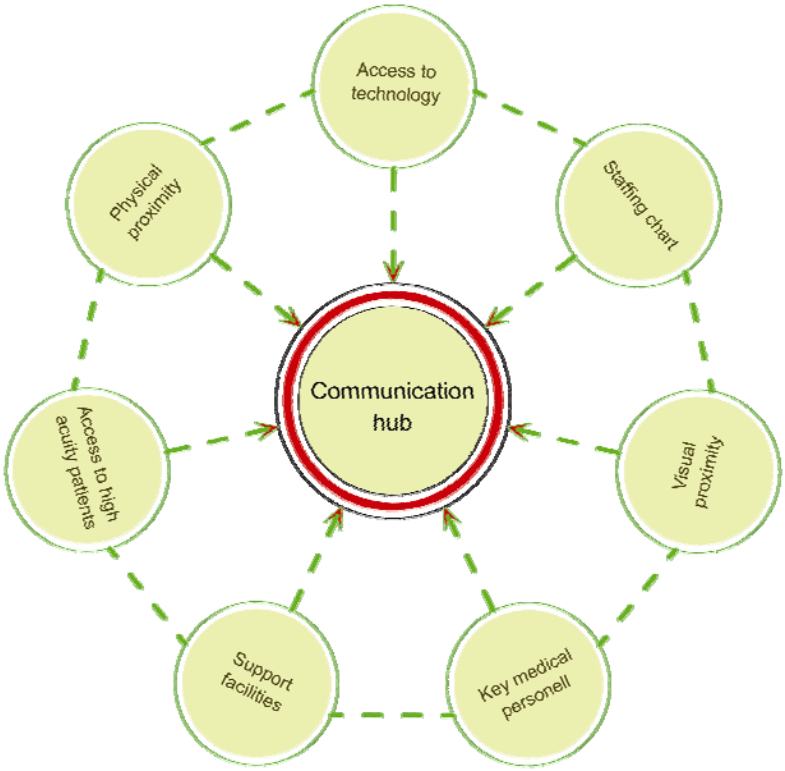


Figure 20: Organizational Ecology Network in the new ICCU

4.3 Implications for Quality of Care and Nursing Unit Design

The evidence showing a significant reduction in interactions in the more decentralized new ICCU raises a critical concern given the extensive research discussed in Chapter One linking hospital errors and incidents to inadequate communication processes among members of health care teams.

While modern healthcare practice undergoes a transition towards multidisciplinary teams, effective communication is a critical and influential factor in determining the effectiveness of such teams (Wood et. al., 2001; Shortell et. al., 1991). This further reinforces the need for designing environments that facilitate and not impede interactions and communication.

The reductions observed in this study were all in face-to-face interactions, which is a cause for further concern given that the examination of the actual patterns of communication among clinical staff have shown that over 50% of information seeking interactions occur face to face (Coiera & Tombs, 1998; Coiera et al., 2002; Parker & Coiera, 2000; Coiera, 2000) .This preference for informal face to face communication was found even in a hospital with a mature computer based record system (Safran et al.,1999).

These and other studies suggest that irrespective of the presence of electronic communication systems it is through the multitude of conversations throughout the day that clinicians present, examine and interpret clinical data and ultimately decide on clinical actions. So, merely the introduction of high tech medical equipment like

the patient monitor systems, as seen in the new ICCU, may not offset the decrease in face to face interactions.

The central role of interpersonal communication in informal and opportunistic on-the-job learning can be understood through the communities of practice framework which focuses on knowledge sharing across informal networks of people who share a common interest or task (Lave & Wenger, 1991). From this network of personal relationships comes the co-operation ,commitment and trust that forms the social capital that provides community (team) members with the "resources" (e.g. information , support and training) they need to learn and do their job effectively (Becker, 2007). These studies help reinforce the importance of informal face-to-face communications for knowledge sharing and learning.

That fact that in a decentralized layout staff have created a kind of informal social and communication hub suggests that staff have a need for social connectivity that is powerful and valued. This tendency was observed even in the old ICCU. In the stressful atmosphere of an ICCU frequent communication provides emotional respite from stress as well as opportunities for such things as discussing and negotiating patient diagnosis and treatment, and asking for and/or providing help to co-workers with specific tasks and skills. In the face of an increasing preference for decentralization in nursing unit layout (Wade 2006; Joseph 2006) these findings warrant a more thorough analysis of their costs and benefits for a range of valued patient and staff outcomes; and then to use this knowledge to rethink the design of nursing stations in fundamental ways.

As originally proposed by Frissen, the decentralized layout focuses more on functional efficiency through bringing staff and supplies physically and visually closer to the patients. A general consequence of this is a reduction in time spent walking by nurses and a corresponding increase in the time spent in direct patient care activities (Joseph, 2006). In fact from the time that the need for individual patient rooms arose, the increase in nurses' travel raised an important design issue, still addressed in all nursing unit designs today. The critical question faced by the architect was how to strike a balance between the need for individual privacy or for added support space, and the size of the total unit and the goal of close nurse patient access (Kliment, 2000). More often the design solution appears to be in favour of functional and operational efficiency since it is easier to measure and track while the impact of staff interaction and its effects on stress reduction and knowledge sharing are more difficult to quantify and have only recently become areas of interest. Ulrich et al., (2004), while highlighting the importance of designing ward layouts and nurse stations to reduce staff walking and increase patient care time, also noted the need to facilitate staff activities such as communication and respite from stress. The solution however does not lie simply in providing a centralized nursing station. Centralized nursing stations, in addition to limiting visual access to patient rooms, can also become chaotic and crowded areas that create high noise levels that are stressful for both patients and staff (Wade 2006)

Having clearly established the importance of both functional efficiency as well as interaction opportunities the practical design approach should be one that tries to create a balance between the two instead of a purely decentralized or centralized solution that offers one at the cost of the other.

4.4 Overall Conclusion and implication on Practice

This study tried to connect two separately established areas of research: 1) the importance of communication in delivering quality of care; and 2) the relationship between physical design and communication in healthcare delivery. As noted above, the challenge going forward, in terms of design, is to create solutions that work simultaneously on many levels: improving operational efficiency, reducing nurse fatigue, increasing patient safety (visual access to patients); promoting varied forms of communication. Decentralized pods maximizes visual access, but slight other goals and benefits. One solution might be, in larger wards, to design multi-hub units; that is, to engage in deliberate duplication, or what Becker & Steele (1995) and Becker (2007) have called functional inefficiency. These are solutions that are not, for example, necessarily the fastest route between two points, or the least expensive design, but ones in which the longer "journey" is beneficial because it creates opportunities for unplanned opportunistic interactions that can lead to new insights and informal information sharing and learning

Malcolm Gladwell in his book *Tipping Point* (Gladwell, 1990) and Becker (2004) note that Gore Associates, maker of Gore-Tex fabrics, employed functional inefficiency when they duplicated manufacturing lines after reaching about 250 persons per line. Conventional economies of scale thinking would recommend just making a 500 person line. William Gore, the founder of Gore Associates, realized that while that might be more efficient operationally, it would likely undermine the kind of interaction and communication processes that was the foundation for the continual innovation at the heart of his company's success.

The “multi-hub” concept in effect follows Gore's path, sacrificing some short term cost savings for longer term effectiveness. A “multi hub” approach in which each central station serves a cluster of not more than 6-8 rooms, with that model being replicated for larger units, duplicates some equipment and space; however, it also works on many levels since it reduces walking distances, provides high visual access to patient rooms, and serves as a communication node. The scale and acuity of the unit would play a deciding factor in cluster size served by each hub.

As with the manufacturing line example the cluster size around each nursing hub would be critical in maintaining a sustainable organizational ecology that supports communication and allows a community of practice to develop. Too large and it runs the risk of losing out on functional efficiency; while too small it may simply end up becoming a decentralized layout and lose out on interaction opportunities. Such a design approach might be worth considering as we continue to explore new ways of designing hospitals that improve patient safety and quality of care while recognizing that both of those outcomes are dependent on simultaneously creating a working environment that is effective on multiple levels for health care staff.

4.5 Study Limitations

The data collected during this study is not an indicator of the actual usage of a spatial feature or space since the only data collected was how frequently interactions took place at that location. So areas that might have reported low communication may have a reasonably high usage in terms of non-interaction activities like charting; and they may be efficient from a utility point of view. Future research would do well to

record all activities within an area rather than focus only on interactions so that a wider range of possible benefits can be considered when making decisions about the layout of the nursing unit.

In the absence of observational data on activities inside enclosed spaces such as patient rooms, the med room, and the staff lounge the collected data cannot be used to state with certainty that the low interactions observed at the nursing pods are not in fact being offset by those taking place inside the rooms or elsewhere.

The fact that the observations in the new ICCU were conducted within a short time of the staff being transferred to the new space raises the possibility that their interaction patterns were affected by their unfamiliarity in the decentralized unit and might in fact have resembled the patterns in the old unit given sufficient time to adapt. The only way to test this would be to conduct similar observations in the new ICCU after a considerable time has elapsed and then compare those finds with that of this study.

4.6 Future Research Directions

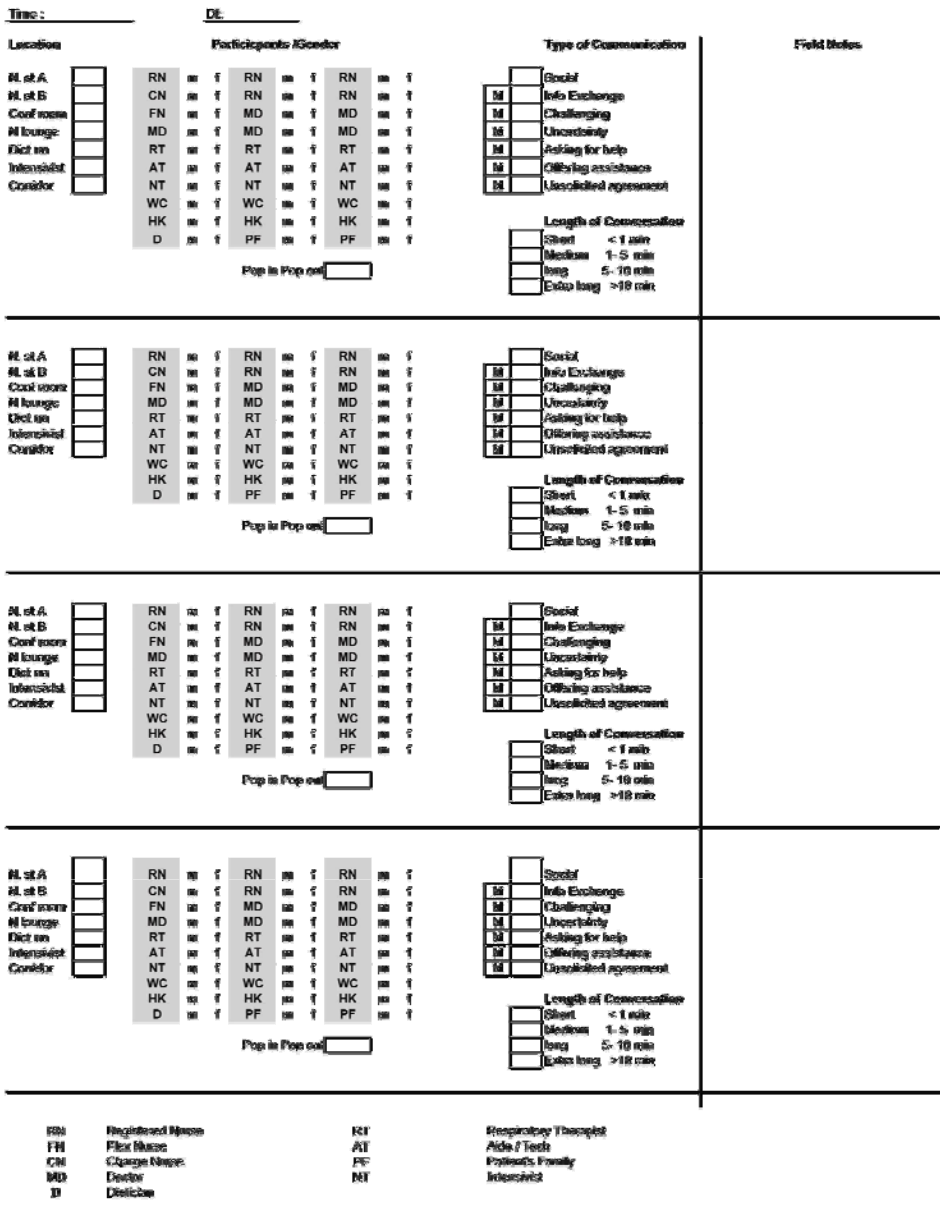
Some of the limitations discussed above pose interesting research questions, answers to which might help further clarify the effects of different nursing unit designs on not only interaction and communication patterns, but the effects of these on informal and opportunistic learning and knowledge sharing that may contribute both to increased job skills and improved quality of care. While this study focused solely on unplanned and informal interactions, additional research on planned interactions in the

form of medical rounds and during staff shift changes could also provide important information regarding how inter-disciplinary medical teams interact and share information. Recording the actual nature and content of staff conversations would further help to discover whether informal interactions are predominantly of a social nature or if formal interactions consist of mostly medical discussions. Another area of interest lies in the study of non interaction activates like charting, using electronic systems etc at specific locations like nursing pods. Combined with the data on interactions happening at specific locations it would provide information on the actual usage hours of each area.

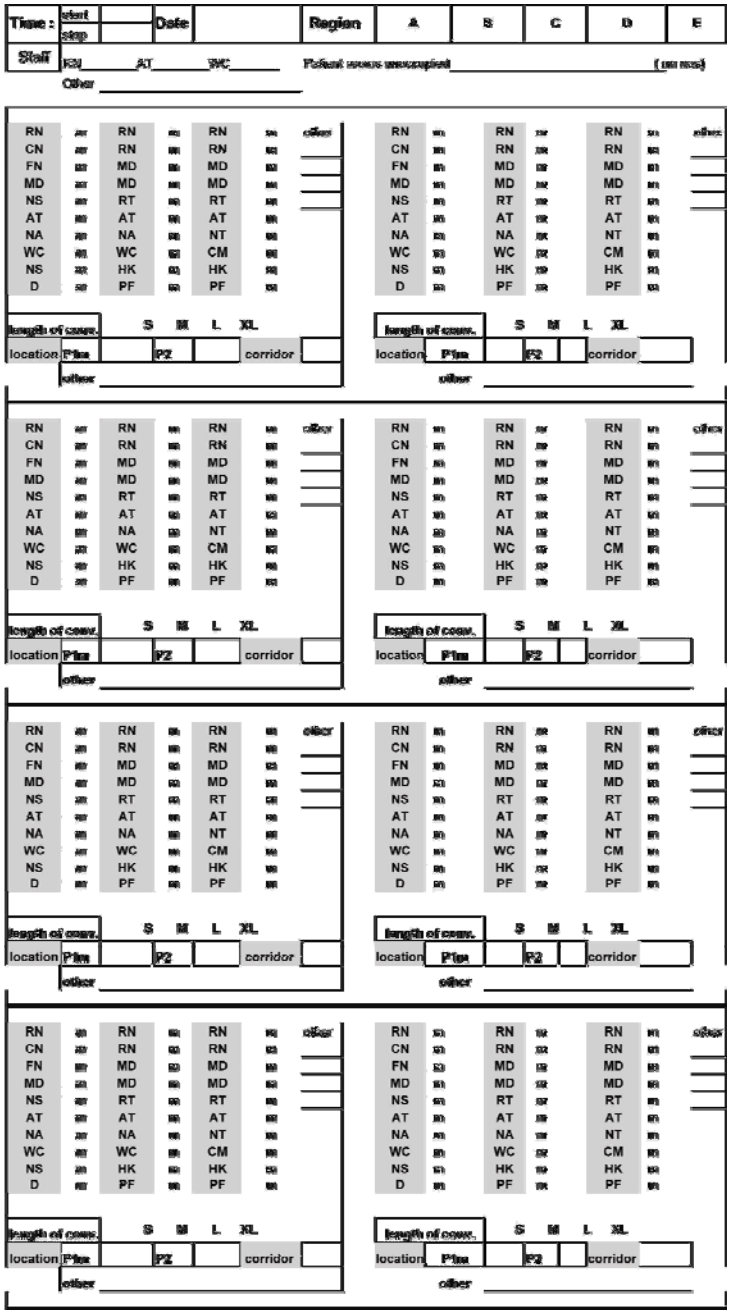
Further research potential lies in observing the frequency of movement of medical staff to and from specific areas on the ward with high volumes of interaction. This would help to understand if the high volume of interactions at a particular location is due to a few active staff members or if that location is being used by most staff members from time to time. A similar study could also observe the tendency of medical staff to seek assistance after a certain distance. Studying the activities of staff inside patient rooms might provide insights into whether they might actually be engaging in a high volume of interactions that could make up for the low interactions observed at individual decentralized nursing pods.

APPENDIX A: Observation Data Recording Sheets

Pre-move Data Entry Sheet



Post-move Data Entry Sheet



APPENDIX B: Detailed Descriptions and Region Plans for the New ICCU

Plan Detail: Region A

Plan Detail: Region B

Plan Detail: Region C

Plan Detail: Region D

Plan Detail: Region E

APPENDIX C: Categorization by Location and Duration of all interactions

(post-move data)

Categorization by Sub Region and Duration of Interactions						
Sub-Region Aggregates	Length of conversation				Row Totals	Percent of Total
	S	M	L	XL		
Pods (P1m/P2/P3)	588	78	9	0	675	75.08%
Corridor (C)	199	7	0	0	206	22.91%
Across pods (AP)	40	0	0	0	40	4.45%
Across regions (AR)	25	0	0	0	25	2.78%
Computors in region E (PC)	9	6	0	0	15	1.67%
Chart (CH)	8	2	0	0	10	1.11%
Pneumatic tube(P*)	5	0	0	0	5	0.56%
Medical storage (MST)	3	0	0	0	3	0.33%
Column Totals	797	93	9	0	899	100.00%

APPENDIX D: Analysis of Original Pre-move Data Set

Categorization by Location of all Observed Pre-Move Interactions

Hours of Obs	Location	Length of Conversation								Row Totals	Percentage of Region total	Region Total
		S		M		L		XL				
		Total	Hourly	Total	Hourly	Total	Hourly	Total	Hourly			
23	Nursing Station A	461	20.04	105	4.57	7	0.30	2	0.09	575	54.35%	
	Nursing Station B	217	9.43	36	1.57	5	0.22	1	0.04	259	24.48%	
	Corridor	122	5.30	36	1.57	5	0.22	0		163	15.41%	
	Dictation Room	15	0.65	3	0.13	1	0.04	0		19	1.80%	
	Nurse's Lounge	12	0.52	5	0.22	3	0.13	0		20	1.89%	
	Conference Room	11	0.48	6	0.26	2	0.09	4	0.17	23	2.17%	
	Multiple locations	2	0.09	2	0.09	0		0		4	0.38%	
	Intensivist's Room	1	0.04	0		0		0		1	0.09%	
	Patient Room	1	0.04	1	0.04	0		0		2	0.19%	
	Totals	838	36.43	190	8.26	23	1.00	7	0.30	1058		1058

Categorization by Number of Particpiants and Duration of Interactions

Number of particpants	S	M	L	XL	Row Totals	Percent of Total
2	747	146	20	4	917	86.67%
3	76	36	3	3	118	11.15%
4	12	6	0	0	18	1.70%
5	3	2	0	0	5	0.47%
Column Totals	839	190	23	7	1058	100.00%

Categorization by Roles , Location and Duration of Interactions

Staff Roles	RN-MD				RN-RN				RN-AT				RN-WC				RN-RT				RN-OTH				Totals
Duration	S	M	L	XL	S	M	L	XL	S	M	L	XL	S	M	L	XL	S	M	L	XL	S	M	L	XL	
Nursing Station A	24	4	0	0	109	26	4	1	74	14	2	0	79	10	0	0	33	7	0	0	7	1	0	0	397
Nursing Station B	16	4	1	0	68	9	3	1	25	3	0	0	32	3	0	0	1	0	0	0	7	2	0	0	175
Corridor	14	2	0	0	48	14	1	0	18	3	0	0	10	1	0	0	5	0	0	0	5	2	0	0	124
Dictation Room	0	0	0	1	4	2	1	1	2	1	1	0	4	1	0	0	0	0	0	0	0	0	0	0	18
Nurse's Lounge	7	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	13
Conference Room	2	0	1	0	2	0	1	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	9
Multiple locations	1	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Intensivist's Room	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Patient Room	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Column Totals	63	11	2	1	230	53	10	3	120	22	3	0	125	15	0	0	40	7	0	0	24	5	0	0	734

APPENDIX E: Staff Role Abbreviations

Codes	Roles
RN	Registered Nurse
FN	Flex Nurse
CN	Charge Nurse
MD	Doctor
D	Dietician
RT	Respiratory Therapist
AT	Nurse Aide
PF	Patient's Family
NT	Intensivist
NA	Nutirtion assistant
HK	Housekeeping staff
NS	Nursing students
CM	Case Manager
OTH	All others

APPENDIX F: Detailed Analysis of Interactions within Regions and Sub Regions of the new ICCU by Length of Conversation

Categorization by Region and Sub-Region of all Observed Interactions

Hours of Obs	Location		Length of Conversation						Row Totals	Percentage of Region total	Region Total
	Region	Sub-Region	S		M		L		XL			
			Total	Hourly	Total	Hourly	Total	Hourly	Total			
12.5	A	Pfm	89	7.12	14	1.12	2	0.16	0	105	58.01%	
		C	48	3.84	2	0.16	0		0	50	27.62%	
		P2	16	1.28	2	0.16	1	0.08	0	19	10.50%	
		AR	8	0.64	0		0		0	8	4.42%	
		AP	2	0.16	0		0		0	2	1.10%	
		MST	1	0.08	0		0		0	1	0.55%	
		P3	0		0		0		0	0	0.00%	28.13%
	Column Totals		160	12.8	18	1.44	3	0.24	0	185		181
12.5	B	P2	190	15.04	22	1.76	0		0	210	53.85%	
		Pfm	91	7.28	11	0.88	1	0.08	0	103	26.41%	
		C	68	5.44	0		0		0	68	17.44%	
		AP	22	1.76	0		0		0	22	5.64%	
		AR	14	1.12	0		0		0	14	3.59%	
		CH	8	0.64	2	0.16	0		0	10	2.56%	
		P	5	0.4	0		0		0	5	1.28%	
		MST	2	0.16	0		0		0	2	0.51%	43.38%
	Column Totals		354	28.32	35	2.8	1	0.08	0	434		390
7.5	C	Pfm	63	8.40	18	2.40	2	0.27	0	83	45.86%	
		P2	50	6.67	5	0.67	1	0.13	0	56	30.94%	
		C	45	6.00	2	0.27	0		0	47	25.97%	
		AP	8	1.07	0		0		0	8	4.42%	
		AR	3	0.40	0		0		0	3	1.66%	
		MST	0		0		0		0	0	0.00%	28.13%
	Column Totals		153	20.4	25	3.33	3	0.40	0	197		181
9.5	D	Pfm	50	5.26	3	0.32	1	0.11	0	54	48.09%	
		P2	41	4.32	3	0.32	1	0.11	0	45	40.91%	
		C	19	2.00	0		0		0	19	17.27%	
		AP	8	0.84	0		0		0	8	7.27%	
		AR	0		0		0		0	0	0.00%	
		MST	0		0		0		0	0	0.00%	12.24%
	Column Totals		102	10.74	6	0.63	2	0.21	0	126		110
8	E	C	19	2.38	3	0.38	0		0	22	59.46%	
		PC	9	1.13	6	0.75	0		0	15	40.54%	
		AP	0		0		0		0	0	0.00%	
		AR	0		0		0		0	0	0.00%	4.12%
	Column Totals		28	3.50	9	1.13	0		0	37		37
			S		M		L		XL			100.00%
50	Grand Totals		797	15.94	93	1.86	9	0.18	0			899

APPENDIX G: Detailed Analysis of Interactions within Regions and Sub Regions of the new ICCU by Staff Role Pairs

Categorization by Region and Staff Roles of all Two Person Interactions Involving a RN

Hours of Obs	Location		Length of Conversation						Row Totals	Percentage of Region total	Region Total
	Region	Sub-Region	S		M		L	XL			
			Total	Hourly	Total	Hourly	Total	Hourly	Total		
12.5	A	RN-RN	42	3.36	6	0.48	1	0.08	0	49	36.03%
		RN-AT	31	2.48	2	0.16	0		0	33	24.26%
		RN-WC	24	1.92	0		0		0	24	17.65%
		RN-MD	13	1.04	3	0.24	1	0.08	0	17	12.50%
		RN-RT	8	0.64	0		0		0	8	5.88%
		RN-OTH	5	0.40	0		0		0	5	3.68%
	Conversations involving a RN		123	9.84	11	0.88	2	0.16	0		136
	All 2 person Conversations		148		14		3		0		165
12.5	B	RN-WC	89	7.12	8	0.64	1	0.08	0	98	36.70%
		RN-RN	74	5.92	5	0.40	0		0	79	29.59%
		RN-AT	34	2.72	1	0.08	0		0	35	13.11%
		RN-MD	22	1.84	1	0.08	0		0	24	8.99%
		RN-OTH	18	1.28	4	0.32	0		0	20	7.49%
		RN-RT	8	0.72	2	0.16	0		0	11	4.12%
	Conversations involving a RN		245	19.60	21	1.68	1	0.08	0		267
	All 2 person Conversations		316		28		1		0		345
7.5	C	RN-RN	31	4.13	5	0.67	1	0.13	0	37	30.89%
		RN-AT	29	3.87	3	0.40	0		0	32	26.82%
		RN-MD	14	1.87	1	0.13	0		0	15	12.29%
		RN-WC	13	1.73	1	0.13	0		0	14	11.38%
		RN-OTH	11	1.47	4	0.53	1	0.13	0	16	13.81%
		RN-RT	7	0.93	2	0.27	0		0	9	7.39%
	Conversations involving a RN		105	14.00	16	2.13	2	0.27	0		123
	All 2 person Conversations		139		18		2		0		159
9.5	D	RN-RN	27	2.84	1	0.11	1	0.11	0	29	37.18%
		RN-AT	17	1.79	1	0.11	1	0.11	0	19	24.36%
		RN-MD	8	0.84	2	0.21	0		0	10	12.82%
		RN-OTH	12	1.26	0		0		0	12	15.38%
		RN-WC	6	0.63	1	0.11	0		0	7	8.97%
		RN-RT	1	0.11	0		0		0	1	1.28%
	Conversations involving a RN		71	7.47	5	0.53	2	0.21	0		78
	All 2 person Conversations		93		5		2		0		100
8	E	RN-MD	6	0.75	1	0.13	0		0	7	33.33%
		RN-RN	5	0.63	1	0.13	0		0	6	28.57%
		RN-OTH	1	0.13	2	0.25	0		0	3	14.29%
		RN-AT	2	0.25	0		0		0	2	9.52%
		RN-WC	1	0.13	1	0.13	0		0	2	9.52%
		RN-RT	1	0.13	0		0		0	1	4.76%
	Conversations involving a RN		16	2	5	0.625	0		0		21
	All 2 person Conversations		25		6		0		0		31
			S		M		L	XL			
50	Grand Totals		560	11.2	58	1.16	7	0.14	0		625
	All 2 person Conversations		721		71		8		0		800

APPENDIX H: Detailed Analysis of Interactions at all Locations by Duration and Role Pairs (post-move data)

Categorization by Roles , Location and Duration of Interactions

Role pairs	RN-MD				RN-RN				RN-AT				RN-WC				RN-RT				RN-OTH				
Duration	S	M	L	XL	S	M	L	XL	S	M	L	XL	S	M	L	XL	S	M	L	XL	S	M	L	XL	
Location																									
aP1m	10	3	1	0	21	4	1	0	22	2	0	0	9	0	0	0	5	0	0	0	4	0	0	0	82
aC	1	0	0	0	18	0	0	0	5	0	0	0	10	0	0	0	2	0	0	0	0	0	0	0	33
aP2	2	0	0	0	5	2	0	0	4	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	16
aAR	0	0	0	0	2	0	0	0	1	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	6
aAP	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
aMST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
aP3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
total Region A	13	3	1	0	42	6	1	0	31	2	0	0	24	0	0	0	8	0	0	0	5	0	0	0	136
bP2	11	1	0	0	46	1	0	0	18	1	0	0	45	4	0	0	5	2	0	0	8	4	0	0	148
bP1m	3	0	0	0	8	3	0	0	2	0	0	0	39	4	1	0	1	0	0	0	1	0	0	0	62
bC	7	0	0	0	15	0	0	0	13	0	0	0	9	0	0	0	3	0	0	0	2	0	0	0	49
bAP	0	0	0	0	2	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	12
bAR	1	0	0	0	2	0	0	0	1	0	0	0	3	0	0	0	0	0	0	0	1	0	0	0	10
bCH	1	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	7
bMST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2
bP	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
total Region B	23	1	0	0	74	5	0	0	34	1	0	0	89	8	1	0	9	2	0	0	16	4	0	0	267
cP1m	8	0	0	0	13	5	1	0	13	3	0	0	5	1	0	0	2	0	0	0	2	2	0	0	55
cP2	6	1	0	0	13	0	0	0	5	0	0	0	5	0	0	0	5	2	0	0	4	1	1	0	43
cC	2	0	0	0	9	0	0	0	11	0	0	0	2	0	0	0	1	0	0	0	5	1	0	0	31
cAP	2	0	0	0	4	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	8
cAR	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2
cMST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
total Region C	14	1	0	0	31	5	1	0	29	3	0	0	13	1	0	0	7	2	0	0	11	4	1	0	123
dP1m	4	1	0	0	12	1	1	0	11	0	0	0	2	0	0	0	0	0	0	0	9	0	0	0	41
dP2	3	1	0	0	16	0	0	0	6	1	1	0	5	1	0	0	0	0	0	0	3	0	0	0	36
dC	2	0	0	0	3	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	7
dAP	1	0	0	0	3	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	6
dAR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
dMST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
total Region D	8	2	0	0	27	1	1	0	17	1	1	0	6	1	0	0	1	0	0	0	12	0	0	0	78
eC	4	0	0	0	3	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	12
ePC	2	1	0	0	2	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	9
eAP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
eAR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
total Region E	6	1	0	0	5	1	0	0	2	0	0	0	1	1	0	0	1	0	0	0	1	2	0	0	21
grand totals	64	8	1	0	179	18	3	0	113	7	1	0	133	11	1	0	26	4	0	0	45	10	1	0	625

APPENDIX I: Location Abbreviations for New ICCU

Location	Descriptions
Region A	
aP1m	Nursing pod number 1 with patient status monitors
aC	Corridor area
aP2	Nursing pod number 2
aAR	Across two regions involving region A
aAP	Between any two pods in region A
aMST	Medical storage system
aP3	Nursing pod number 3
Region B	
bP2	Nursing pod number 2
bP1m	Nursing pod assigned to ward clerk
bC	Corridor area
bAP	Between any two pods in region B
bAR	Across two regions involving region B
bCH	Staffing Chart
bMST	Medical storage system
bP	Pneumatic tube system
Region C	
cP1m	Nursing pod number 1 with patient status monitors
cP2	Nursing pod number 2
cC	Corridor area
cAP	Between any two pods in region C
cAR	Across two regions involving region C
cMST	Medical storage system
Region D	
dP1m	Nursing pod number 1 with patient status monitors
dP2	Nursing pod number 2
dC	Corridor area
dAP	Between any two pods in region D
dAR	Across two regions involving region D
dMST	Medical storage system
Region E	
eC	Corridor area
ePC	Personal computer locations
eAP	Between any two computor locations in region E
eAR	Across two regions involving region E

APPENDIX J: Total Observed interactions Categorized by Duration (Pre and post-move data)

Pre-move data

Length of Conversation	N	Percent of Total
Short (<1min)	798	80.36%
Medium (>1min < 5 min)	175	17.62%
Long (> 5mins <10 mins)	17	1.71%
Extra long (> 10 mins)	3	0.30%
Total	993	100.00%

Post-move data

Length of Conversation	N	Percent of Total
Short (<1min)	797	88.65%
Medium (>1min < 5 min)	93	10.34%
Long (> 5mins <10 mins)	9	1.00%
Extra long (> 10 mins)	0	0.00%
Total	899	100.00%

APPENDIX K: Total Observed interactions Categorized by Duration and Number of Persons Interacting (Pre and post-move data)

Pre-move data

Categorization by Number of Particpiants and Duration of Interactions						
Number of Persons	Length of conversation				Row Totals	
	S	M	L	XL		Percent of Total
2	712	136	15	2	865	87.02%
3	72	32	2	1	107	10.76%
4	12	5	0	0	17	1.71%
5	3	2	0	0	5	0.50%
Column Totals	799	175	17	3	994	100.00%

Post-move data

Categorization by Number of Particpiants and Duration of Interactions						
Number of Persons	Length of conversation				Row Totals	
	S	M	L	XL		Percent of Total
2	721	71	8	0	800	88.99%
3	71	20	1	0	92	10.23%
4	5	2	0	0	7	0.78%
Column Totals	797	93	9	0	899	100.00%

APPENDIX K: All 2 Person Interactions Categorized by Duration and Role Pairs (Pre and post-move data)

Pre-move data

Staff Roles	Length of Conversation				Row Totals	Percent of All total
	S	M	L	XL		
RN-RN	224	49	8	2	283	32.72%
RN-AT	117	20	2	0	139	16.07%
RN-WC	121	14	0	0	135	15.61%
RN-MD	53	11	1	0	65	7.51%
RN-OTH	39	7	0	0	46	5.32%
RN-RT	19	5	0	0	24	2.77%
RN Interaction TOTAL	573	106	11	2	692	80.00%
All Other 2 Person Interactions	139	30	4	0	173	20.00%
All Total 2 Person Interactions	712	136	15	2	865	100.00%

Post-move data

Staff Roles	*Length of Conversation*				Row Totals	Percent of All Total
	S	M	L	XL		
RN-RN	179	18	3	0	200	25.00%
RN-WC	133	11	1	0	145	18.13%
RN-AT	113	7	1	0	121	15.13%
RN-MD	64	8	1	0	73	9.13%
RN-OTH	45	10	1	0	56	7.00%
RN-RT	25	4	0	0	30	3.75%
RN Interaction TOTAL	560	58	7	0	625	78.13%
All Other 2 Person Interactions	161	13	1	0	175	21.88%
All Total 2 Person Interactions	721	71	8	0	800	100.00%

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