Critical Communication:

Observing How ICU Environments Impact Nurse Communication

by

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ABSTRACT

The goal of this research was to contribute to the understanding of how the physical design of Intensive Care Unit (ICU) environments may be improved to enhance nursing communication, and in turn, the quality and safety of patient outcomes. This study was guided by two research questions: (1) What are the major characteristics of nurse communication in a hybrid ICU nurse station design? (2) What are the factors in the built environment that enhance or hinder nurse communication in a hybrid ICU nurse station design?

The research design was exploratory and qualitative. Observations were conducted in two ICUs with hybrid nurse station layouts. Participant observation was used to systematically observe and document nurse communication and the physical attributes of the ICU nurse work environment that affect communication. Literature, observations, and information regarding staffing and design about the selected ICUs were analyzed for the generation of concepts and the exploration of significant themes.

Results show that nurse interactions with other staff members varied within the different zones of the ICU pod. A biaxial map illustrates four key types of core nurse communication interactions: *At ease*, *On guard*, *In motion*, and *On the edge*. The quadrants representing barriers to nurse communication are *On guard* and *On the edge,* and included interactions with other staff members in the pod. The quadrants representing facilitators to nurse communication are A*t ease* and *In motion*. The hybrid nurse station layout supported nurse-nurse communication, but not communication interactions with other staff members

present on the pod. The results provide a broad understanding of how nurse communication is affected by the environment in which nurses work, and allows for the emergence of design opportunities to enhance nurse communication.

This thesis is dedicated to Stacey, Paul, and Smokey

for helping me celebrate the small victories.

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Mom, thank you for teaching me the importance of education, dedication, and having fun. You are the reason I am where I am today.

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INTRODUCTION

1.1 Statement of the Problem

The ability to provide safe, quality care to patients is the primary goal and focus for many caregivers. Yet, each year approximately 44,000 Americans die in hospitals due to preventable medical errors (Kohn, Corrigan, & Donaldson, 1999). Nurses and the quality of their work environment, including its professional, technological, and physical characteristics, can play an important role in reducing errors and increasing patient safety in the hospital. Aiken and colleagues have conducted a compelling series of studies linking characteristics of the professional work environment and patient outcomes (Aiken, Clarke, Sloane, Sochalski, & Silber, 2002; Aiken, Clarke, & Sloane, Lake, & Cheney, 2008; Friese, Lake, Aiken, Silber, and Sochalski, 2007; Rogers, Hwang, Scott, Aiken, & Dinges, 2004). Recent studies using human factors frameworks have expanded models linking a broader set of work environment characteristics, including technology, to safety and quality outcomes (Carayon, Alvarado, & Hundt, 2003; Donchin & Seagull, 2002; Donchin et al., 1995; Gurses & Carayon, 2009; Hendrich & Chow, 2008).

To date, however, there has been minimal study of the role of physical design in nursing practice environments that support quality and safety. The purpose of the current study is to explore the role of physical design in nurse communication in the intensive care unit (ICU). The goal of this research is to contribute to the understanding of how ICU environments, specifically their

physical design, may be improved to enhance nursing care, and in turn, the quality and safety of patient outcomes.

Nursing care in ICUs is often characterized as complex, fast-paced, and emotionally charged. ICU patients are critically ill and require constant monitoring and instantaneous decision-making from nursing staff. The potential for errors in these complex work environments is high (Beckmann, Bohringer, Carless, Gillies, Runciman, Wu, & Pronovost, 2003; Donchin, et al., 1995). A study by Bates et al. (1995) has found error rates in surgical and medical ICUs to be substantially higher than any other area of the hospital. Furthermore, communication failures are the leading cause of inadvertent patient harm, and breakdowns in team communication are a main contributor to sentinel events (Leonard, Graham, & Bonacum, 2004; JCAHO, 2004).

To date, a great deal of the research on nursing practice and quality of care in the ICU has focused on professional practice environment characteristics, particularly inter- and intraprofessional team communication (Baggs et al., 1999; Boyle & Kochinda, 2004; Kalisch, Curley, & Stefanov, 2007; Leonard, Graham, & Bonacum, 2004; Manojlovich & DeCicco, 2007; Nelson & Venhaus, 2005; Reader, Flin, Mearns, & Cuthbertson, 2007; Sutcliffe, Lewton, & Rosenthal, 2004). This research shows that teamwork and communication affect the quality of patient outcomes. Yet, there is minimal research on how the built environment influences nurse communication in the ICU. Improvements in physical design

characteristics that support nurse communication have the potential to enhance the quality and effectiveness of clinical care in ICU environments.

1.2 Purpose of the Study

This study explores the relationship between the built environment and nurse communication in a critical area of the hospital, the ICU environment. The focus of the research is how the increasingly popular hybrid nurse station layout affects nurse communication. A hybrid nurse station layout provides two distinct nurse work areas; (1) a de-centralized nurse station next to the patient room and (2) a scaled down central station closer to the core of the unit. The nurse station next to the patient room allows for closer proximity to the patient, increases the amount of time nursing staff spend in direct care of the patient, and improves nurse workflow, patient satisfaction, and caregiver efficiency (Gurascio-Howard & Malloch, 2007). The centrally located nurse station allows staff additional work and collaboration space in the core of the unit. To date, there has been no study of the relationship between the design of hybrid nurse work stations and nurse communication.

1.3 Research Questions

What are the major characteristics of nurse communication in a hybrid ICU nurse station design?

What are the factors in the built environment that enhance or hinder nurse communication in a hybrid ICU nurse station design?

1.4 Definition of Terms

Terms defined in this section are those included in the research questions and significance of the study.

Built Environment: The physical spaces, surroundings, furniture, and objects that make up a healthcare setting in which individuals work and heal. This includes design characteristics such as physical layout, ventilation systems, acoustics, access to nature and daylight, lighting, and ergonomics. These spaces and characteristics are designed to balance organizational, customer, and employee needs (Mallak, Lyth, Olson, Ulshafer, & Sardone, 2003; Ulrich et al., 2008).

Collaboration: "An interpersonal relationship between and among colleagues defined by the commonality of a goal recognized by each party shared authority, power, and [decision-making] based on knowledge and expertise." Communication, coordination, problem-solving, shared processes, and professionalism each encourage and sustain this collaboration (Dougherty & Larson, 2010, p. 18-19).

Communication: A process by which information is exchanged between individuals through a common system. (Shortell, Rousseau, Gillies, Devers, & Simons, 1991)

Evidence-Based Design (EBD): A methodology for creating healthcare environments, informed by credible research to achieve the best possible outcomes and examine designs for subsequent decision-making (Ulrich, Quan, Zimring, Joseph, & Choudhary, 2004). This process includes reviewing existing

research, balancing significant findings with primary data gathered from research, applying research to design, a post-occupancy evaluation, and disseminating findings with the design community (Cama, 2009).

Healing Environments: A thoughtfully designed healthcare space comprised of characteristics that promote well-being and enhance patient and staff experiences.

Hybrid Nurse Station Layout: A unit layout comprised of a combination of decentralized nurse stations next to patient rooms with direct view of the patient, and a scaled down, centrally located nurse station. The aim of positioning the caregiving team closer to the patient is to improve nurse workflow, patient satisfaction, and caregiver efficiency. (Gurascio-Howard & Malloch, 2007, p. 46) The combination of central and decentralized nurse stations in a hybrid layout allows staff to work in multiple areas and select what works best based on the task at hand.

Intensive Care Unit (ICU), Critical Care Unit (CCU): The area of a hospital where the direct delivery of medical care occurs for a critically ill or injured patient. Criteria for admission to the intensive care unit are determined by patient acuity and amount of nurse monitoring required.

Latent Condition: A flaw in a system that establishes a situation in which a triggering event leads to an accident or error. The flaw results from decisions made indirectly by individuals involved in a given project (e.g. healthcare managers/administrators, architects, and designers) (Chaudhury, Mahmood, & Valente, 2009; Ebright, Patterson, Chalko, & Render, 2003).

Teamwork: Communication, planning, and decision making with the collective goal of satisfying the needs of the patient, while respecting and valuing the unique qualities, practice spheres, and abilities of each healthcare provider (Thomas, Sexton, & Helmreich, 2003).

1.5 Research Methodology

This study explored major characteristics of nurse communication and factors of the built environment that are related to nurse communication in a hybrid Intensive Care Unit (ICU) design. This was done by observing how nursing staff work within the context of their built environment. Observations were conducted in two ICUs with hybrid nurse station layouts. Observations focused on nurse-nurse communication in relation to the built environment. Participant observation was used systematically to observe and document nurse communication and the physical attributes of the ICU nurse work environment that affect communication. The a(x4) coding scheme and environmental mapping tool were used while observing nursing experiences relating to communication, sorting observations into four main categories: actors, artifacts, activities, and the overarching atmosphere (Rothstein, 2001). Literature review and observation methods were employed to identify the characteristics of the built environment and factors in the practice environment that influence nurse communication in the ICU.

Qualitative analysis was used to transform the raw unstructured observational data into patterns and themes. A grounded theory approach was

employed to allow the researcher to work inductively to generate key concepts, and then begin to identify relationships between these concepts and the research questions. Inductive reasoning allows concepts to emerge from data without preconceived notions. The goal of the grounded theory process is to generate concepts from data that is systematically gathered and analyzed though constant comparative analysis (Strauss & Corbin, 1998, p. 12). Constant comparative analysis was used to explore the categories used to organize the observational data, and identify similarities and differences within the same category (Lincoln & Guba, 1985). For this study, literature, observations, and information regarding staffing and design about the selected ICUs were analyzed in the exploration for significant themes.

1.6 Significance of Study

Extensive research shows that provider communication is critical to quality and safety in intensive care units. Improved nurse communication leads to better team collaboration and consequently has the potential to positively affect patient outcomes. The findings illustrated the relationship between ICU caregivers and their communication needs in their work environment. However, there is minimal research on how the built environment impacts nurse communication.

The interplay between characteristics of the ICU built environment and nurse communication should be considered in order to provide facility design teams with relevant data necessary to improve health care delivery. The results provide a broad understanding of how nurse communication is affected by the

environment in which nurses work, and allow for the emergence of key insights (and associated design opportunities) that can enhance nurse communication. This research will add to the existing Evidence-Based Design body of knowledge, and improve the way that critical care work environments are designed.

Chapter 2

REVIEW OF LITERATURE

2.1 Introduction

This study explores the relationship between the built environment and nurse communication in a hybrid Intensive Care Unit (ICU). This chapter reviews the theoretical model supporting this research, literature on nurse work and the built environment related to quality and safety factors in healthcare and the ICU, and evidence reinforcing the importance of communication and the built environment in supporting nurse work.

2.2 Theoretical Model

This exploratory study is grounded in two theoretical perspectives: 1) a multi-level interactive ecological framework and 2) a work system model. These models were selected to emphasize the different factors present within healthcare work environments that influence the quality of nurse work. The frameworks also guide which aspects of the healthcare environment need to be researched in order for changes to be effective.

2.2.1 The Ecological Perspective

The ecological perspective is a multilevel, interactive framework concerned with changing organizational behavior in conjunction with the physical and social cultural environment (National Institute of Health, 2005). This theoretical model emphasizes the interaction and interdependence of factors within and across all levels of a health system, including individuals, teams,

healthcare units, and the organization. There is extensive research on team communication in healthcare environments, but the research is segmented and does not look at all factors influencing staff communication. This current research looks at nurse communication and the built environment, taking into consideration the individual nurses, team dynamic, unit leadership, and the healthcare organization.

Two main concepts emerge from the ecological perspective. The first concept identifies five (5) different levels of health-related behaviors: intrapersonal or individual factors, interpersonal factors, institutional or organizational factors, community factors, and public policy factors (National Institutes of Health, 2005). Institutional policy and social norms must be taken into consideration when attempting to change organizational behavior at the community level (Figure 1). For example, to effectively enhance ICU staff communication, changes must occur at all levels of a system, including the individual nurse, healthcare team, ICU unit, hospital, and policy levels. The primary focus of this research was nurse communication at the unit level. Each of the other levels will be taken into consideration in terms of their relationship with nurse communication at the unit level.

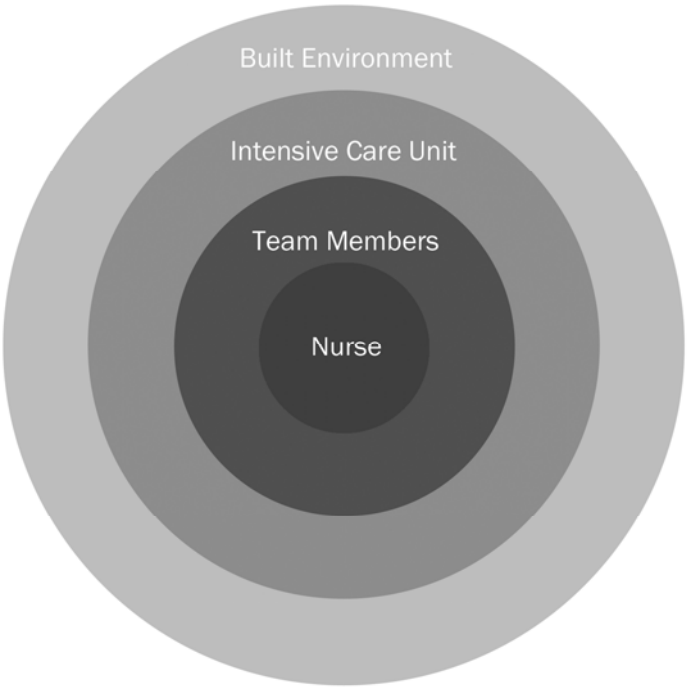


Figure 1. A Multilevel Approach (Adapted from National Institute of Health, 2005, p. 10)

The second main concept of an ecological perspective states that people influence and are influenced by the social relationships with people within their environments and communities (Figure 2). Caregivers working within intensive care units work long shifts in close proximity to their teammates. According to an ecological perspective, the social relationships that are fostered among these individual caregivers within ICU environments can influence the hospital community, unit culture, and the individual caregiver.

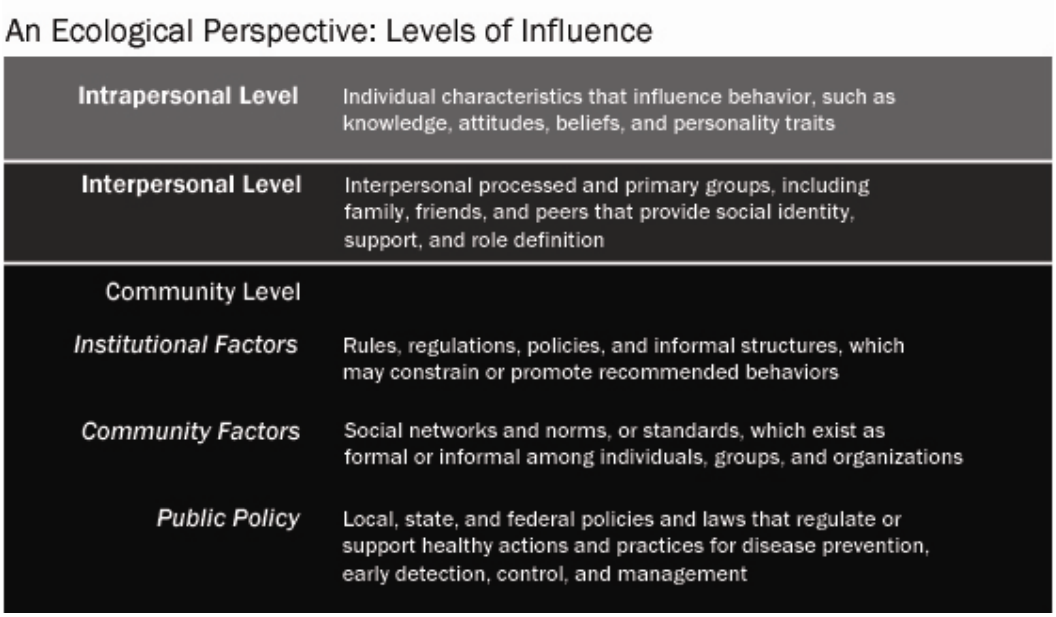


Figure 2. An Ecological Perspective: Levels of Influence (Adapted from National Institute of Health, 2005, p. 11)

In this research, the ecological perspective allows for an in-depth understanding of the factors affecting nurse communication at multiple levels present in healthcare environments including: intrapersonal, interpersonal, and community levels. The primary focus of this research was interpersonal nurse communication by observing individual nurses, nurse teamwork, and the surrounding community (including social norms present on the unit and in the healthcare institution) in the context of the ICU built environment.

2.2.2 Work System Model

The second theoretical perspective for this study derives from a work system model which "is comprised of five elements: (1) the individual performing different (2) tasks with various (3) tools and technologies in a (4) physical environment under certain (5) organizational conditions" (Carayon, Alvarado, &

Hundt, 2003, p. 8). The work systems model focuses on the elements that comprise a work system, interactions among these elements, and how the design of work systems influence work processes and outcomes. It provides a framework for studying performance obstacles inherent in nurse work. Human factors and systems engineering are used to design more efficient work systems for improved quality of care and patient outcomes.

The work system model complements the ecological perspective by looking directly at the work systems that caregivers encounter in the context of a healthcare environment. For this specific study, the ecological perspective is applied to the intensive care unit on an individual, team, unit, and built environment level. This theoretical model, shown in Figure 3, is concerned with improving nurse communication by making changes to work processes. When designing optimal healthcare environments, the work system needs to be taken into account along with the built and organizational conditions.

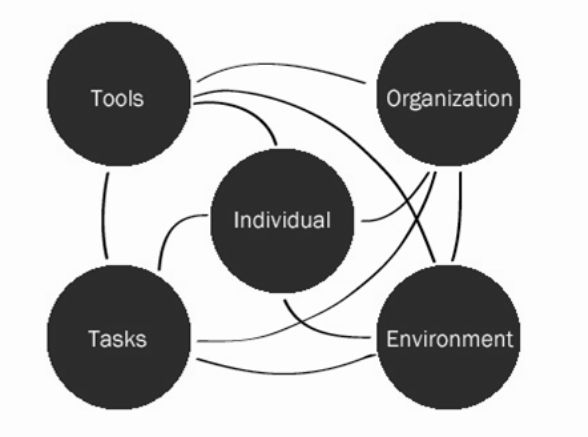


Figure 3. Work System Model (Adapted from Carayon, Alvarado, & Hundt, 2003, p. 65)

2.3 The Demand for Quality and Safety

Nurse work and the physical design of hospital settings are integrally tied to a national emphasis on quality and safety in healthcare environments. The focus of this current research of nurse communication and the built environment contributes to a growing knowledge base of the factors that link professional practice environments, nursing care delivery processes, and patient outcomes. This section provides a broad overview of literature related to healthcare and the importance of nursing practice, setting the stage for a review of the research on the built environment and nurse communication in the ICU.

2.3.1 Errors and Patient Outcomes

Today, hospital leaders in the United States are dealing with a multitude of significant demands: growing costs, workforce shortages, increased employee expectations, unpredictable reimbursement, and elevated patient demands (Sadler, DuBose, & Zimring, 2008). Safe, quality care for patients and staff is an issue that affects these significant demands. In a report by the Institute of Medicine the new healthcare system of the 21st century will be characterized by a quality and safety revolution (IOM, 2001). This report identified aims of improvement built around the core need for healthcare to be safe, effective, patient-centered, timely, efficient, and equitable. A healthcare system that achieves improvements in these different areas will be more apt to deliver quality patient care. Furthermore, a healthcare system that effectively integrates quality and safety goals into its work environments is expected to significantly reduce patient mortality rates, patient

length of stay, staff injuries, and unnecessary costs associated with these incidents.

Approximately 44,000 Americans die in hospitals annually due to preventable medical errors (Kohn, Corrigan, & Donaldson, 1999). Adverse events in the United States cost more than 37.6 billion dollars per year; however, preventable adverse events represent more than 50 percent of these expenditures. An ideal healthcare delivery system could save more than $17 billion per year (Kohn, Corrigan, & Donaldson, 1999). Hospitals need to eliminate avoidable system-based errors that affect the safety of thousands of patients every year (Sadler, DuBose, & Zimring, 2008). Patient lives could be saved by considerably reducing preventable errors such as patient falls, hospital-acquired infections, and medical errors. Nurses and the quality of their work environment play an important role in the pursuit to eliminate errors and increase patient safety. Therefore, hospitals will have to change their work environments along with their systems and processes in order to reduce errors and improve patient outcomes.

2.3.2 Work Complexity and Errors

Medical care has become increasingly complex in order to meet the evolving needs of patients. Errors are inevitable when work complexity is coupled with inherent human performance limitations (Leonard, Graham, & Bonacum, 2004). While the profession of nursing has changed to adapt to this complex work environment, the built environment has not**.** Many existing hospital work environments are characterized by inefficient work processes, poorly designed

built environments, gaps in technology, and unsupportive organizational cultures (Hendrich & Chow, 2008). These inefficiencies contribute to stress for hospital nurses, and limit the time that they spend caring for the patient. Additionally, stress contributes to nurse burnout, which hinders the recruitment and retention of nurses (Hendrich & Chow, 2008).

A study by Ebright, Patterson, Chalko, and Render (2003) explored human and environmental factors that affect decision making of registered nurses (RNs). Observations and interviews were used to understand factors that contribute to work complexity of expert RNs in acute care settings and ultimately impact nurse work performance. The study found eight (8) patterns of work complexity: "disjointed supply sources, missing or nonfunctioning supplies and equipment, repetitive travel, interruptions, waiting for systems/processes, difficulty in accessing resources to continue care, breakdown in communication, and breakdowns in communication processes or mediums" (Ebright, Patterson, Chalko, & Render, 2003, p. 637). Findings from this study suggest that through support for registered nurse work, improvements can be made in patient safety and RN recruitment and retention. These changes depend not only on improvements in the practice environment, but the redesign of environments to support caregivers in work situations.

2.3.3 The Role of the Built Environment on Patient Outcomes

Increasing attention is being directed toward the impact of the physical design of hospital spaces on patient safety and the quality of care being delivered.

Attention to the built environment needs to encompass both patient and staff needs, because caregiver wellbeing directly affects the patient healing process (Ulrich, Zimring, Joseph, Quan, & Choudhary, 2004). Findings from a study on RN work complexity suggest that by redesigning healthcare environments, improvements can be made to patient safety, as well as to staff recruitment and retention (Ebright, Patterson, Chalko, & Render, 2003). There is strong evidence indicating that the physical design of hospitals has a quantifiable affect on the quality and effectiveness of clinical care. Poorly designed healthcare environments undermine a caregiver's effectiveness in the deliverance of quality patient care (Joseph, 2006; Ulrich et al., 2008).

A series of reports by The Center for Health Design with funding from the Robert Wood Johnson Foundation reviews literature related to the physical environment and patient outcomes. Ulrich, Zimring, Joseph, Quan, and Choudhary (2004) conducted a systematic literature review and found six-hundred (600) studies demonstrating that the design of hospital environments impacts the quality of patient outcomes, staff performance, and patient and staff satisfaction. There are varying levels of evidence linking effectively designed physical environments with reduced staff stress, improved patient safety, improved patient outcomes, and quality of care. Through the literature review the researchers concluded several actions that hospitals can take immediately. The recommendations include single-bed rooms, noise reduction, views of nature,

efficient wayfinding systems, ventilation, improvements in lighting, and provide unit layouts and nurses stations to improve staff efficiency.

2.3.4 The Role of the Built and Nurse Work Environments on Patient Outcomes

The complexity of nurse work paired with the nature of human errors reinforces the importance of well-designed nurse work environments. Nurses are more likely to make errors when the environment they work in or the equipment they use is poorly designed. The design of the healthcare environment and equipment shapes human performance needs, affecting staff interactions, work processes, and the movement of patients and materials (Reiling, Knutzen, Thomas, McCullough, Miller, & Chemos, 2004). Furthermore, even knowledgeable and experienced nurses may inadvertently make mistakes when the environment they work in or equipment they use is poorly designed.

A report by the Center for Health Design reviewed literature supporting the importance of the physical and social environments of the healthcare workplace in providing safe, effective care. Through an extensive review of peer-reviewed journal articles and research reports, Joseph (2006) concluded that the built environment is crucial in improving the health and safety of staff, increasing the quality of care that patients receive, minimizing errors, and increasing job satisfaction. “There is an urgent need to address the inherent problems in the healthcare workplace that lead to staff injuries and hospital-acquired infections, medical errors, operational failures, and wastage” (Joseph, 2006, p. 12). A

healthcare work environment using evidence-based design can reduce infections, decrease injuries, improve staff adjustment to night shift work, and reduce noise-related stress. Additionally, effective workplace design can increase patient and staff satisfaction by facilitating family participating in the care process through support spaces, the design of pleasant environments, and smaller units with visual transparency (Becker, 2007).

An article prepared for The Center for Healthcare Design's white paper series looks specifically at the hospital work environment and nurses' impact on the quality of patient care. Hendrich and Chow (2008) reviewed evidence related to nurse work related to the built environment, organizational culture, and patient safety. Suggestions to improve patient outcomes included changes in nurse work process related to documentation, medication, communication, and supply/equipment management—each of which is affected by the physical environment.

An article by Chaudhury, Mahmood, and Valente (2009) included a literature review, analysis, and focus group with hospital staff members on the effects of the physical environment in reducing errors in acute care settings. Findings showed that the physical environment affects nurse work and the quality of care delivered to patients. The review found that poorly designed work environments contribute to staff fatigue, stress, and burnout, which in turn result in errors. Factors such as noise levels, ergonomics, lighting, and unit layout can contribute to errors in acute care settings. Their analysis reveals that there is a

recognizable gap in EBD research as applied to the built environment and its impact on nursing staff health, effectiveness, errors, and job satisfaction.

Carayon, Alvarado, and Hundt (2003) produced a report for the Institute of Medicine that focuses on the redesign of nurse work and work environments to improve patient safety. The report focuses on studies related to human factors, job stress, and organizational design research to support work and workspace design in healthcare environments. In their report, Carayon et al. proposed the work system framework (which guides the current study) comprised of individual, tasks, tools, technologies, built environment, and organizational conditions. Work redesign can lead to more efficient and effective use of nurses, reduce the occurrence of errors, and improve worker safety.

2.4 Nursing and the Work Environment

Nurses are critical to effective healthcare delivery and optimization of their efficiency and effectiveness is central to maximize patient safety (Hendrich & Chow, 2008). Nurses are best able to assess patient health and needs because they spend more time with patients than any other healthcare team member. Close proximity to patients offers nurses an advantage in assessing their wellbeing and the ability to communicate those changes to the team for improved patient outcomes (Daugherty & Larson, 2010).

With increased complexity and rapid changes in healthcare delivery, nursing practice has become increasingly sophisticated. Nurses working in healthcare settings today need to be able to adapt to a complex work environment

that is characterized by new technologies, increasing patient acuity levels, and high staff turnover. However, the current nursing shortage exacerbates the challenges present in the work environment and affects the quality of care delivered to patients (AACN, 2002). With Baby Boomers putting increasing demands on the healthcare system at the same time many nursing staff are leaving the profession, the shortage of competent registered nurses in the U.S. is predicted to exceed 300,000 by 2020 (Auerbach, Buerhaus, & Staiger, 2007). The constant turnover of registered nurses negatively affects a team's structure and ultimately hinders nurse work. Furthermore, the nursing shortage complicates the mandate for increasing patient safety, and is a growing issue for hospitals and healthcare organizations.

2.4.1 Practice Environment

Nurses are the foundation of a hospital's care delivery, and their efficiency and effectiveness as a team is central to maintaining patient safety. Elements of the work environment that contribute to inefficiencies and stress for nurses are inefficient work processes, gaps in technology infrastructure, and unsupportive organizational cultures (Hendrich & Chow, 2008). Inefficiencies inherent in the work environment, coupled with a lack of adequate nursing staff, limit the amount of time nurses are able to spend taking care of their patients and thus contribute to job-related stress.

A series of studies by Aiken and colleagues directly linked characteristics of the professional practice environment and patient outcomes. For example,

adequate nurse staffing and organizational support for nurses was associated with improved staff satisfaction and enhanced quality of patient care (Aiken, Clarke, Sloane, Sochalski, & Silber, 2002). A study by Aiken, Clarke, Sloane, Lake, and Cheney (2008) measured the effects of the nursing practice environment on patient mortality rates and nurse outcomes. The Nursing Work Index measured care environments through factors such as nurse job satisfaction, burnout, intent to leave, and reports of quality of care. Results revealed that better care environments support positive job experiences, decreased concerns with the quality of patient care, and lower mortality rates. Friese, Lake, Aiken, Silber, and Sochalski (2007) found that nurse staffing levels and education preparation of registered nurses were significant predictors of outcomes of cancer patients undergoing surgery. Nurses were more likely to make an error when they worked a shift longer than twelve (12) hours or worked more than forty (40) hours per week (Rogers, Hwang, Scott, Aiken, & Dinges, 2004). These studies emphasized the importance of the nursing professional practice environment and its impact on the quality of nurse work and patient outcomes.

2.4.2 Human Factors Engineering: Work Environment and Care Processes

Reason (2000) suggests that it is important to direct attention to "latent failures" of the work environment, which include management decision and organizational processes. Latent failures influence conditions of work such as workload, supervision, communication, equipment, and knowledge, which in turn increase the likelihood of active failures that can lead to accidents or adverse

outcomes (Carayon, Alvarado, & Hundt, 2003). For example, leadership and processes such as staff hierarchy, quality and pattern of staff communications, workload, and unit culture can affect nursing and medication errors, either directly—through miscommunication—or indirectly by creating work conditions such as staff fatigue that lead to errors.

Additionally, Johnson (2002) looks at the systematic causes of errors and suggests that there are four levels of causal factors that contribute to human error in healthcare work environments. The first level consists of factors that affect individuals, including poor equipment design, poor ergonomics, technical complexity, and multiple competing tasks. Level two address factors that affect team-based performance, such as coordination and communication, acceptance of inappropriate norms, and operation of different procedures for the same tasks. Level three factors relate to the management of healthcare applications such as poor safety culture, inadequate resource allocation, and insufficient staffing. Finally, level four involves issues surrounding regulatory organizations such as a lack of national structures to support clinical information exchange and risk management (Johnson, 2002).

The four levels of casual factors correlate to the ecological theory in terms of the presence of multiple levels of a system contributing to a single issue, in this case human errors. The multiple levels of factors related to errors go above and beyond the relationship between nurse and patient. For human errors or "active failures" to be reduced, "latent factors" such as organizational, managerial, and

procedural factors need to be addressed at all levels of the system or environment in which they are occurring.

Recent studies using human factors frameworks have expanded models linking a broader set of work environment characteristics to quality and safety outcomes. A study exploring the causes of human errors in the intensive care unit found that a significant number of dangerous human errors occur in ICU environments (Donchin, Gopher, Olin, et al., 1995). They propose human factors engineering as a way to study the interface between hospital staff and their work environments. A report commissioned by the Institute of Medicine (2003) focuses on nurse work design and patient safety (Carayon, Alvarado, & Hundt, 2003). Human factors have a significant effect on nurse work and the occurrence of errors. The redesign of nurse work, systems, processes, and technology is important in the reduction of these errors.

Improvements in healthcare work environments and processes have the potential to increase staff retention, enhance patient safety, and improve the quality and effectiveness of clinical care (Hendrich & Chow, 2008). Further research is needed to explore the impact that the design of work environments has on nurse communication. This will allow for enhancements in ICU design that support the physical and emotional health of the critical care workforce.

2.5 Nursing Care and the ICU Environment

2.5.1 ICU Characteristics

Critical care environments are emotionally charged; end-of-life decisions occur frequently, and must be made quickly (Alameddine, Dainty, Deber, & Sibbald, 2009). Mortality rates in an intensive care unit are greater than any other unit within an acute care hospital. The ICU patient population is vulnerable and requires a significant amount of staff attention and care. ICU nurses are continuously inundated with patient demands, family needs, and end-of-life care decisions. Nurse work in ICU environments is often characterized as complex and fast-paced, as a result of caring for high acuity patients. The demands of this emotionally charged work environment can be stressful to nurses—which in turn affects job performance, job satisfaction, and patient outcomes.

2.5.2 ICU Nurse Work and Patient Outcomes

Patient safety is a major problem in the ICU. The prevalence of errors is most frequent in intensive care units (Beckmann, Bohringer, Carless, Gillies, Runciman, Wu, & Pronovost, 2003; Donchin, Gopher, Olin, et al., 1995). Bates et al. (1995) found the frequency of adverse events to be highest in medical and surgical intensive care units. A study looking at the nature and causes of human errors found that error rates in ICUs are as high as one point seven (1.7) per patient per day (Donchin, Gopher, Olin, et al., 1995). Effective and efficient nurse work is vital to quality, safe patient care.

A qualitative study by Gurses and Carayon (2009) revealed that ICU nurses are more prone to accidents that result in errors because of the demands of critically ill patients and families, the high nursing workload, and a challenging built environment. Interviews with fifteen (15) ICU registered nurses revealed an in-depth understanding of the main performance obstacles of ICU nurses. Seven types of performance obstacles emerged, including physical work environment, family relations, equipment, supplies, information transfer and communication, help from others, and intra-hospital transport. Findings show that the physical environment, family relations, and malfunctioning equipment are the most frequent obstacles in ICU environments that impact the performance of nurses. Performance obstacles related to the physical environment were reported by eleven percent (11%) of the ICU nurses, and the most frequent obstacles reported were high noise level, crowdedness, and lack of space. Family relations issues included distractions caused by family members and spending an inordinate amount of time meeting family needs. Thirdly, issues with equipment included unavailability and misplacement. Communication was a central theme present in many of these obstacles and was especially vital during information transfer such as shift changes and interaction with physicians.

Donchin, Gopher, Olin, et al. (1995) studied human errors in intensive care units. Over a four month period, they found that twenty-nine percent (29%) of errors had the potential to significantly harm the patient. Verbal communication between nurses and physicians was present in over thirty-five

percent (35%) of the errors reported, yet verbal communication between nurses and physicians represented only two percent (2%) of the total activities recorded in a 24-hour period. Donchin and colleagues argue that communication problems between physicians and nurses could be a source of the occurrence of many of these errors.

The research team observed factors contributing to communication issues which included: physicians were frequently called from the floor for emergencies; physicians were responsible for more patients than nurses (6:2) resulting in intermittent physician contact with patients and more chances for errors; and physicians were less experienced than nurses (Donchin, Gopher, Olin et al., 1995). These factors reveal the importance of efficient and effective communication among ICU team members. Furthermore, this study revealed that nurses were more involved with patients than physicians were, and should therefore be used to relay patient information to physicians.

A narrative review by Alameddine, Dainty, Deber, and Sibbald (2009) categorizes ICU experiences into physical, emotional, and professional environments. The emotional wellbeing of ICU staff is critical in this complex work environment, and approaches to alleviate stress and emotional exhaustion include attention to communication and teamwork. Elements that enhance the professional practice environment are teamwork, effective communication, supportive management, and autonomy. All three aspects of the ICU work

environment are critical to nurse work and enhancing the quality of patient care provided.

2.6 Communication

2.6.1 Communication and Patient Outcomes

Failure in communication and breakdowns in staff communication are the leading cause of inadvertent patient harm and a main contributor to sentinel events (Leonard, Graham, & Bonacum, 2004; JCAHO, 2004). Critical care staff must work together as a team and collaborate to effectively respond to the constant demands of the vulnerable ICU patient. Teamwork in intensive care units can help to improve rapid medical intervention, active dialogue, and open communication, all of which are necessary for successful patient outcomes (Dougherty & Larson, 2005). Effective communication is essential in promoting a culture of safety in complex work environments such as the ICU. Collaboration and teamwork are key strategies to enhanced caregiver communication and prevent errors. Timely and accurate communication prevents errors that can negatively affect patients and reduce providers' confidence.

In an analysis by the Joint Commission for Hospital Accreditation, more than seventy percent (70%) of two thousand four hundred fifty-five (2455) sentinel events showed communication failure as the main cause for patient harm (Leonard, Graham, & Bonacum, 2004). Research indicates that effective teamwork, collaboration, and communication are critical to the achievement of high-quality and safe patient care (Disch, Beilman, & Ingbar, 2001; Hendrich &

Chow, 2008; Gurascio-Howard & Malloch, 2007; Kalisch, Curley, & Stefanov, 2007; Leonard, Graham, & Bonacum, 2004; Reader, Flin, Mearns, & Cuthbertson, 2007).

Additionally, "the complexity of medical care, coupled with the inherent limitations of human performance, make it critically important that clinicians have standardized communication tools, create an environment in which individuals can speak up and express concerns, and share common 'critical language' to alert team members to unsafe situations" (Leonard, Graham, & Bonacum, 2004, p. 85). A work environment that promotes effective communication plays an important role in work complexity and nurses' cognitive thinking (Ebright, Patterson, Chalko, & Render, 2003). Enhancing communication in a complex work environment can reduce distractions, decrease errors, and increase patient safety. Teamwork and effective communication is essential in promoting a culture of safety in complex work environments and allowing ICU staff to perform their jobs (Dougherty & Larson, 2010; Reader, Flin, Mearns, & Cuthbertson, 2007). Team communication promotes information transfer and facilitates shared decision making related to patient care.

2.6.2 Inter-professional Teamwork, Collaboration, and Communication

To date, a great deal of the research on team communication has focused on professional practice environment characteristics. The following section reviews literature with the goal of enhancing staff communication through inter-

professional teamwork, leadership and organizational management, cross-disciplinary communication, and collaboration tools.

Teamwork is imperative in developing efficient communication skills among staff members working within the same unit (Amos, Hu, & Herrick, 2005; Kalish, Curley, & Stefanov, 2007). Cross-disciplinary teamwork is enhanced through team-based training that encourages assertiveness, interdisciplinary communication, and a shared perception of teamwork (Reader, Flin, Mearns, & Cuthbertson, 2007). Multidisciplinary teamwork is linked to higher job satisfaction, increased safety outcomes, improved quality of care, and greater patient satisfaction. Still, there has been very little research conducted on teamwork and collaboration among nursing staff in relation to patient care (Kalisch, Curley, & Stefanov, 2007). One study implemented a teamwork training intervention to enhance nurse communication and engagement, which resulted in a considerably lower number of ambulatory falls. It also demonstrated improved ratings of unit teamwork, and increased staff retention (Kalish, Curley, & Stefanov, 2007). These results reinforce the importance of cohesive nurse teamwork and positive patient outcomes.

Effective leadership and organizational management enhance communication, coordination, and problem solving. According to Shortell, Rousseau, Gillies, Devers, and Simons (1991), successful unit leadership improves teamwork and affects work processes, which results in a higher quality of patient care. The development of a collaborative partnership between leaders is

critical to creating healthy ICU work environments. Creating an environment that fosters open communication, mutual respect, and trust requires collaboration among the leaders. "Purposefully establishing a collaborative partnership and then modeling these behaviors to the rest of the team, and holding them accountable, are key steps in creating an environment that is healing to patients, families, and caregivers" (Disch, Beilman, & Ingbar, 2001, p. 366). Healthcare leaders are responsible for making sure the environment is supportive to caregivers, and ensuring that quality care is delivered to patients.

The implementation of standardized collaboration tools has been shown to enhance communication in hospital work environments. A study by Pronovost et al. (2001-2003) implemented the use of a daily goals form to improve communication among ICU providers. The daily goals form asked caregivers to state the tasks, care plan, and communication plan. Staff use of the form was associated with improved staff communication and a 50 percent reduction in patient length of stay. Additionally, a study performed at Kaiser Permanente facilities in 2000–2004 focused on improving teamwork and communication by employing standardized tools and behaviors. Enhanced staff communication was achieved through the implementation of a situational briefing model (SBAR), appropriate assertion, and critical language (Leonard, Graham, & Bonacum, 2004). Nelson and Venhaus (2005) implemented a critical thinking tool for telephone communication used by nursing staff when calling physicians. Nurses were more prepared when contacting physicians about patient care issues, which

resulted in enhanced patient care. These standardized tools can improve patient safety and staff relationships.

Strong evidence supports a correlation between nurse-physician collaboration and communication and patient outcomes. Baggs et al. (1999) found associations between improved nurse-physician collaboration and a lower risk of the negative patient outcomes of readmission to the ICU and risk-adjusted mortality. Additionally, relationships between nurses and physicians have been recognized as a source of workplace stress (Boyle & Kochinda, 2004; Nelson & Venhaus, 2005). Nurses, physicians, and other clinicians, are trained to communicate differently, which makes teamwork in high-stress environments even more challenging. Teamwork training can help to bridge the current gap between educational differences and create a shift in the unit culture towards a collaborative community. Also, results from a study by Embriaco, Papazian, Kentish-Barnes, Pochard, and Azoulay (2007) show that perceived conflicts and poor relationships between critical care staff were factors that contributed to burnout. Preventing conflicts through improvements in communication among ICU nurses and physicians may decrease burnout syndrome. Developing partnerships between nurse leaders and doctors can lead to work environments characterize by enhanced teamwork, collaboration, productivity, and morale, which in turn results in improved communication, decision making, and patient care (Disch, Beilman, & Ingbar, 2001).

A growing body of research supports a correlation between teamwork, collaboration, and communication and patient outcomes. Nurse work, including tasks and processes, are closely linked to patient outcomes, but nurse-nurse relationships are not frequently studied. Dougherty and Larson (2010) developed the first scale to measure nurse-nurse collaboration and communication in relation to patient outcomes. However, it does not employ the built environment as a potential way to improve nurse-nurse collaboration and communication. Research concerning the relationship between nurse communication and the built environment could provide valuable insights that lead to targeted, user-centered design improvements, thereby enhancing teamwork and ultimately, saving patient lives.

2.7 Nursing Practice and the Built Environment

The design of the built environment can facilitate or impede a hospital's safety and quality goals (Henriksen, Isaacson, Sadler, & Zimring, 2007). The physical design of work environments affects the quality of patient care and provider working conditions. A thoughtfully designed work environment becomes especially critical in ICUs, where nursing staff provide care for high acuity patients. Donchin and Segull (2002) argue that ICU environments are "ergonomic disasters," and are dangerous for the patients and caregivers working within these environments. This complex work environment is taxing on the physical and mental health of our ICU caregivers, and may contribute to nurses leaving the ICU and the profession.

According to Alameddine, Dainty, Deber, and Sibbald (2009) changes to ICU care delivery systems along with ergonomic improvements in patient care areas, have the potential to improve both the work environment and patient outcomes. Well-designed built environments have a quantifiable impact on patients and caregivers (Ulrich, Zimring, Joseph, Quan, & Choudhary, 2004; Joseph, 2006; Ulrich et al., 2008). Crowded, acoustically ineffective, and poorly designed nursing workspaces add to staff stress and may increase the risk of medical errors (Chaudhury, Mahmood, & Valente, 2009). Hospitals that incorporate Evidence-Based Design (EBD) environmental characteristics into the design of their work environments show increased staff efficiency and improvements in patient healing.

Research shows that effectively designed healthcare environments can reduce staff stress and fatigue and increase effectiveness in delivering care, improve patient safety, reduce stress and improve outcomes, and improve overall healthcare quality (Ulrich, Zimring, Joseph, Quan, & Choudhary, 2004). Environmental characteristics such as acoustics, air quality, thermal conditions, ergonomics, and lighting can influence staff efficiency and contribute toward patient safety. Improvements to the physical design of work environments can reduce staff stress and errors and are critical in making hospitals safer and more healing for patients and staff.

Additionally, literature reviews by Chadhury, Mahmood, and Valente (2009) and Ulrich et al. (2008) found that noise, lighting, ergonomics, single-

patient and acuity-adaptable rooms are physical environmental factors that have the greatest influence on workplace errors. The following examples link specific environmental characteristics to staff efficiency and patient outcomes. High noise levels in work areas negatively affect nurse efficiency and impede effective communication (Joseph & Ulrich, 2007). They suggest design factors such as single-patient rooms, acoustical tiles, reducing loud noise sources, and full-height walls for patient treatment areas. Insufficient lighting levels can affect the performance of healthcare workers and lead to medical errors (Ulrich et al., 2008). Ergonomic equipment and furniture is associated with staff efficiency. Ergonomics is important to create the optimal staff working conditions and is associated with the efficiency and safety of staff work (Carayon, Alvarado, & Hundt, 2003). A study by Page (2004) establishes that single-patient rooms have been associated with improved staff communication, fewer patient transfers, reduced medication errors, and decreased infection rates. Hendrich, Fay, and Sorrells (2004) found that acuity-adaptable rooms paired with decentralized nurse stations resulted in fewer errors, reductions in patient falls, shorter patient length of stay, improved clinical outcomes, and patient and staff satisfaction. These studies confirm that the physical design of nurse work environments is critical for supporting nurse work and reducing errors.

2.8 Nursing Practice, the Built Environment, and Communication

Nurses are central to the efficiency and effectiveness of healthcare delivery because they spend more time directly with the patient than any other healthcare

provider (Hendrich & Chow, 2008). For this reason, nurses are critical in the exchange of information related to patient care in complex work environments such as the ICU. Additionally, nurse work environments, along with nurse staffing levels are determinants of the effectiveness of nursing care and the quality of patient outcomes (Aiken, Clarke, & Sloane, Sochalski, & Silber, 2002). Effective nurse communication and collaboration are imperative for ICU nursing staff to perform their jobs (Reader, Flin, Mearns, & Cuthbertson, 2007) and to reduce errors in this demand for quality and safety. Patient outcomes are likely to be improved through enhanced nurse communication.

Critical care work settings require instantaneous medical intervention, active dialogue, and open communication in order to respond to the constant demands of the vulnerable ICU patient population. ICU nurse work is highly collaborative and requires a supportive built environment that allows for both focused individual work and interactive group work. Factors that facilitate collaboration and team communication in ICUs are low staffing ratios, smaller units, the presence of experienced and specialized nurses, and close proximity among staff members (Dougherty & Larson, 2005). In addition to these professional practice characteristics the built environment can also enhance nurse communication.

Research in other fields links the design of the work environment to teamwork, collaboration, and communication. For example, Heerwagen, Kampschroer, Powell, and Loftness (2004) studied the impact of the physical

design of offices on collaboration in knowledge work environments. Collaborative work environments require the effective design of spaces, furnishings and technologies that support a balance between individual work and group interaction. Some characteristics of spaces that enhance collaboration and communication in work environments are visual transparency, shared information displays, mobility within the space, and ease of switching between individual and collaborative work.

Joseph (2006) suggests that the built environment is a critical element in establishing teamwork and effective communication in hospital environments. Hospital work environments support individual work and allow for breakdowns in communication, rather than supporting teamwork and collaboration. Joseph looks to Becker (2007) for specific design elements to enhance collaboration and support a culture that values communication. Similar to Herweegan and colleagues, Becker suggests providing staff with accessible spaces along with technology that offer the opportunity for group interaction and promote effective communication and knowledge sharing. In establishing a culture of teamwork and communication, Joseph proposes design characteristics specific to healthcare spaces, such as flexible workspaces, smaller unit size, visual connections, different types of meeting spaces, and neutral spaces. These design features could potentially enhance teamwork, foster interaction, facilitate information seeking, support knowledge sharing, and reduce staff hierarchies. Heerwagen, Kampschroer, Powell, and Loftness (2004) and Becker (2007) provide a useful

framework for promoting teamwork and communication. Further research needs to be performed to see how these environmental characteristics affect nurse collaboration, teamwork, and communication in healthcare settings.

2.9 Conclusion

Extensive research has made it clear that communication and the built environment are critical to patient safety and the quality of care that nursing staff deliver. However, there is minimal research on how the built environment affects nurse communication in the ICU. Improvements in physical design characteristics that support nurse communication have the potential to enhance the quality and effectiveness of clinical care in ICU environments. The current study explores the relationship between the built environment and nurse communication in ICU environments.

Chapter 3

METHODOLOGY

3.1 Research Design

A qualitative approach was used to explore the relationship between nurse communication and the built environment. Qualitative research collects data in the form of "words and/or images' not numerically coded for analysis" (O'Leary, 2004, p. 11). The approach included a literature review to collect current research related to nurse teamwork, collaboration, communication, and the built environment. On-site observations were conducted to capture rich, detailed information about the ICU built environment and nurse communication.

The researcher gathered data about nurses working in two Intensive Care Units (ICUs) with a hybrid nurse station layout. Data collection in two similar ICU environments facilitated a thorough exploration, description, and analysis of a specific situation. This allowed the researcher to explore in depth a "bounded system" and more fully understand the individual, group, actions, and events as an entirety. Furthermore, two units within the same healthcare system allowed for cross-referencing to see if the observation data was similar in both environments.

3.2 Site Description and Access

Mayo Clinic Hospital was selected as the primary research facility for this study. The Intensive Care Unit pods at Mayo Clinic Hospital were selected based primarily on their hybrid ICU layout and accessibility (i.e. staff receptivity to the observation protocol).

This research was approved by both Mayo Clinic Hospital and Arizona State University's Institutional Review Boards before the observational data were collected. A letter of approval from Mayo's IRB office was sent to Arizona State University's IRB office to verify access into Mayo's ICU. The researcher met with the nurse manager or team leader before every observational session and was led to the pod. The nurse manager introduced the researcher to the staff working in the pod to make them aware of the presence of an observer within the pod. The researcher fielded any questions that the staff had about her presence within the pod.

3.3 Observational Research

This study employed a qualitative research design with participant observation as the primary data collection method. A qualitative design was considered appropriate for the study objectives because there is minimal research on nurse communication and the built environment. For this study, observation was used to determine how nurses communicate in relation to their work environment and which elements of the built environment enhance or hinder nurse communication. According to O'Leary, observing involves "the recognition and recording of facts, situations, and empathetic understanding" (O'Leary, 2004, p. 10). One advantage of observation is that it allows the researcher to document actual nurse behavior, rather than responses related to behavior within the context of their work environment (O'Leary, 2004). The observations employed in this

study were non-participant, where the researcher was present in the ICU pod but remained unobtrusive.

Rothstein's a(x4) (Figure 4) coding scheme was used to organize the data collection process. Nurse experiences relating to communication were observed and recorded (Figure 5) in four main categories: actors, artifacts, activities, and the overarching atmosphere (Rothstein, 2001). Descriptions of each of these categories follow Figure 4. The facility, date, and time was noted at the top of each a(x4) data collection sheet. Observations focused on the built environment, including nursing unit layout, the nurse station and equipment, and the nursing behaviors and activities related to communication. Another observational method used was environmental mapping, in which the observer paid particular attention to nurse interaction with people and the environment. Every 10 minutes the observer documented nurse-nurse communication in terms of the built environment on a printed floor plan (Figure 6) using the key shown in Figure 7. Observations focused on nurse work and the spaces that they utilize in accomplishing these tasks. Additionally, the observer occasionally asked short and focused questions for clarification throughout the observational data collection process.

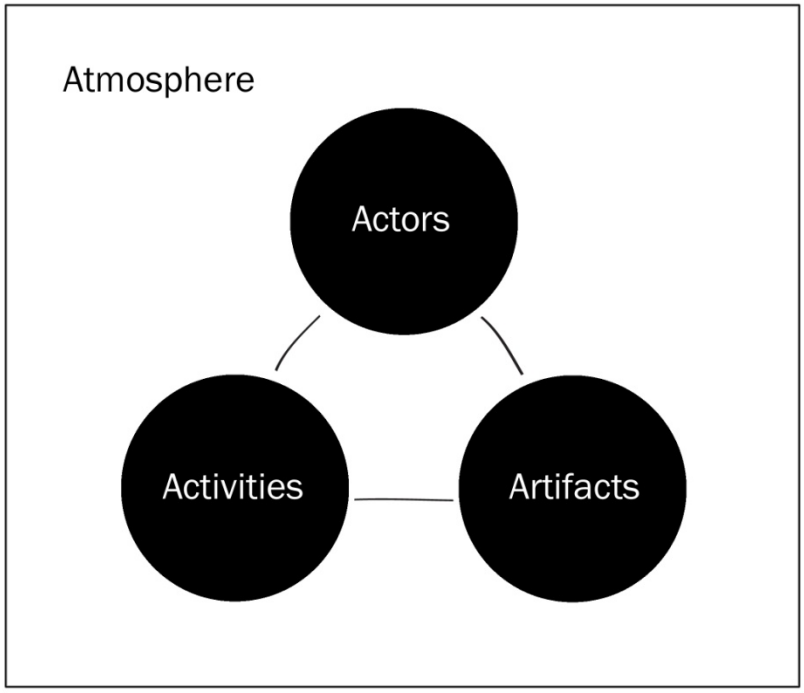


Figure 4. Framework: a(x4) (Rothstein, 2001)

Actors: All players involved in observed situation including their roles and relationships with as much detail as possible.

Artifacts: All objects being used by the actors and their apparent role. This includes primary (in use) and secondary (not in immediate use) objects.

Activities: All primary and secondary activities of actors involved in situation.

Atmosphere: The environment in which the situation takes place incorporating character, function, and features (Rothstein, 2001).

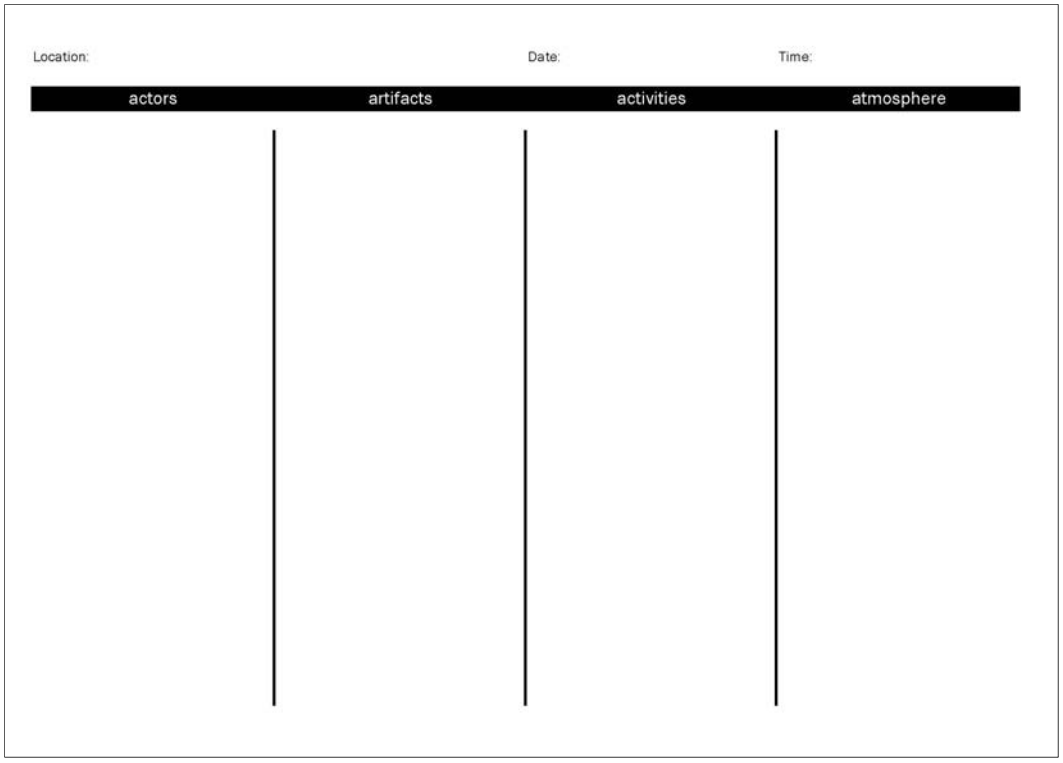


Figure 5. Observational collection tool: a(x4)

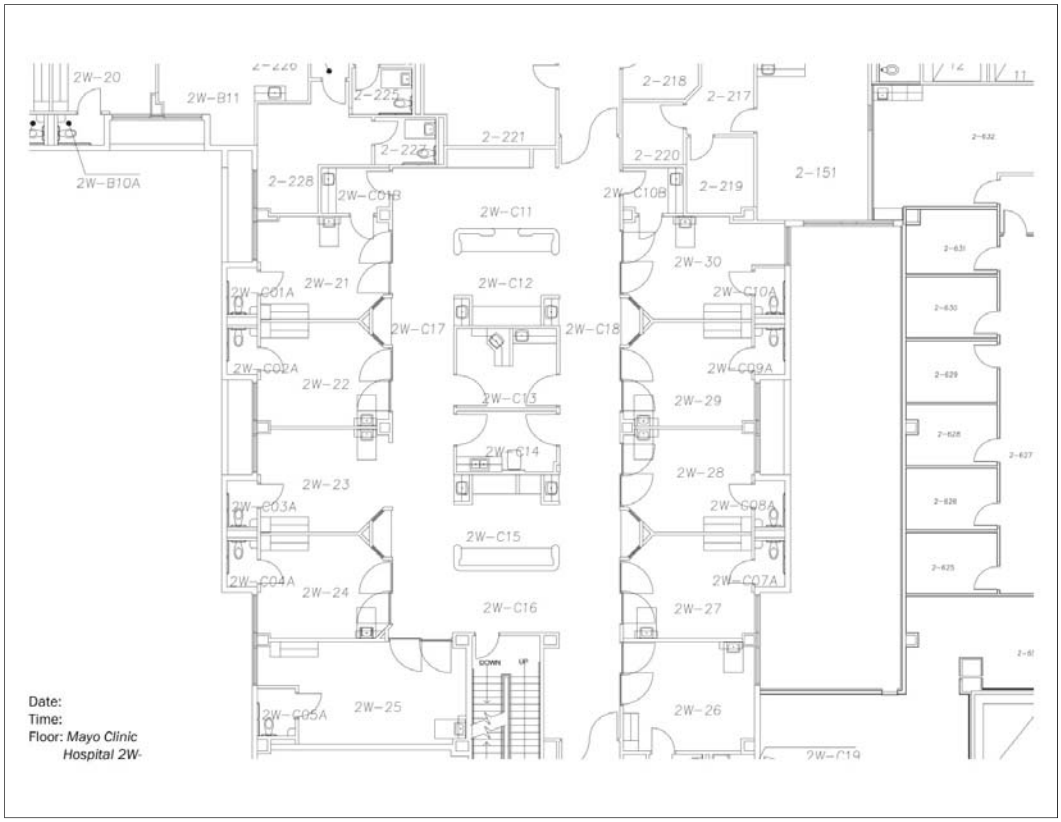


Figure 6. Observational collection tool: Environmental mapping

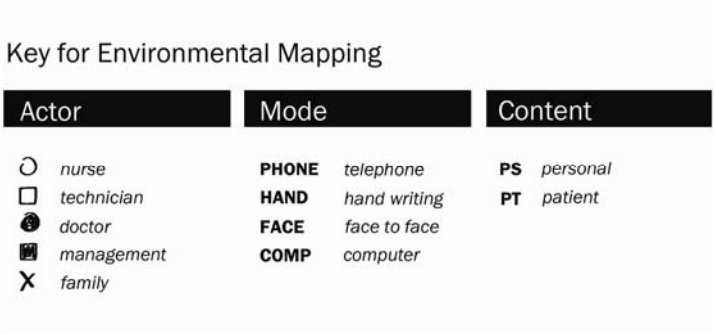


Figure 7. Key for Environmental Mapping Observational Collection Tool

The observation sessions took place over a four-week period, and were conducted during various hours, with a particular focus on shift changes and nurse rounds where communication is critical and interaction among staff is high. Observation times were selected to capture different activities in the ICU during

different shifts and maximize exposure to such situations. Hospital management was asked to identify times when different types of communication would be occurring (coinciding, it was hoped, with times when an observer would not be detrimental to patient care). The observer was present on the unit, but remained removed from the work being done. The aim of the observer was to blend into the environment, and remain as unobtrusive as possible. In order to maintain patient confidentiality, the researcher did not enter patient rooms. No patient information was recorded during observations.

3.4 Data Analysis

Qualitative analysis was used to transform the raw unstructured observational data into patterns and themes, and then interpret the implication of those themes within the context of the study's research questions. Thematic exploration is an analysis process that facilitates the shift from raw data to meaningful understanding through "the generation/exploration of relevant themes" (O'Leary, 2004, p. 196). It can include analysis of raw data, such as words, concepts, literature, and non-verbal cues, which, through constant comparison by the researcher, leads to the discovery of significant themes. Analysis promotes the development "of analytic categories that capture relevant aspects of these data, and the assignment of particular items of data to those categories," (Hammersley & Atkinson, 1995, p. 208-209). For this study literature, observations, and information regarding staffing and design about the

selected ICUs were analyzed for the generation of concepts and the exploration of significant themes.

Data analysis began after the first set of observations, when the initial data was coded according to the a(x4) framework, with the goal of identifying broad concepts. As the data collection progressed, the analysis was done concurrently. Constant comparative analysis was used to explore the categories and organize the data (Lincoln & Guba, 1985). This method examines the observational data coded in terms of a particular category, and makes note of the similarities and differences within the same category. The comparison of each item of observational data may lead to further clarification of categories and the emergence sub-categories. The data were continually explored for further refinement of categories leading to the emergence of key concepts.

A grounded theory strategy was employed to allow the researcher to work inductively to generate key concepts, and then begin to identify relationships between these concepts. Inductive reasoning allows concepts to emerge from data without preconceived notions. The goal of the grounded theory process is to generate concepts from data that is systematically gathered and analyzed though constant comparative analysis (Strauss & Corbin, 1998, p. 12). According to Lincoln and Guba (1985), constant comparative analysis encourages a thought process that leads to descriptive categories and eventually theory generation. Furthermore, this iterative process supports the soundness of the observational data being collected. To establish validity and reliability, the findings from

different components of the study must be examined to establish trustworthiness (Lincoln & Guba, 1985). Data analysis was discussed weekly with faculty throughout the data collection and analysis process. A selected section of the observational data was re-coded by a committee member and differences were examined and discussed.

Chapter 4

RESULTS OF DATA ANALYSIS

4.1 Introduction

This chapter presents the analysis of observational data collected to answer each of the research questions. Analysis of the data indicated in the maps and recorded in field notes revealed key themes associated with patterns of nurse communication in the ICU built environment. Following a description of the sample facility and participants, each of the key themes and its supporting data will be discussed supporting detail.

4.2 Facility and Participant Description

Data were collected at two intensive care units at the Mayo Clinic Hospital in Phoenix, Arizona. The Mayo Clinic Hospital was the first hospital designed and built by Mayo Clinic. Built in 1998, the facility consists of 244 licensed beds, 18 operating rooms, and a Level II trauma center. Mayo Clinic Hospital's two intensive care unit (ICU) pods have 10 patient beds each. They also have an "intermediate" pod for lower acuity patients (observations were not performed in this pod). The layout for each of the ICUs is hybrid; it includes de-centralized nurse stations close to the patient rooms and central areas. The ICU floor plan shows the hybrid layout with two central nurse stations at the north and south ends of the unit (Figure 8) and four de-centralized alcoves (Figure 9) with a direct view into the patient room.

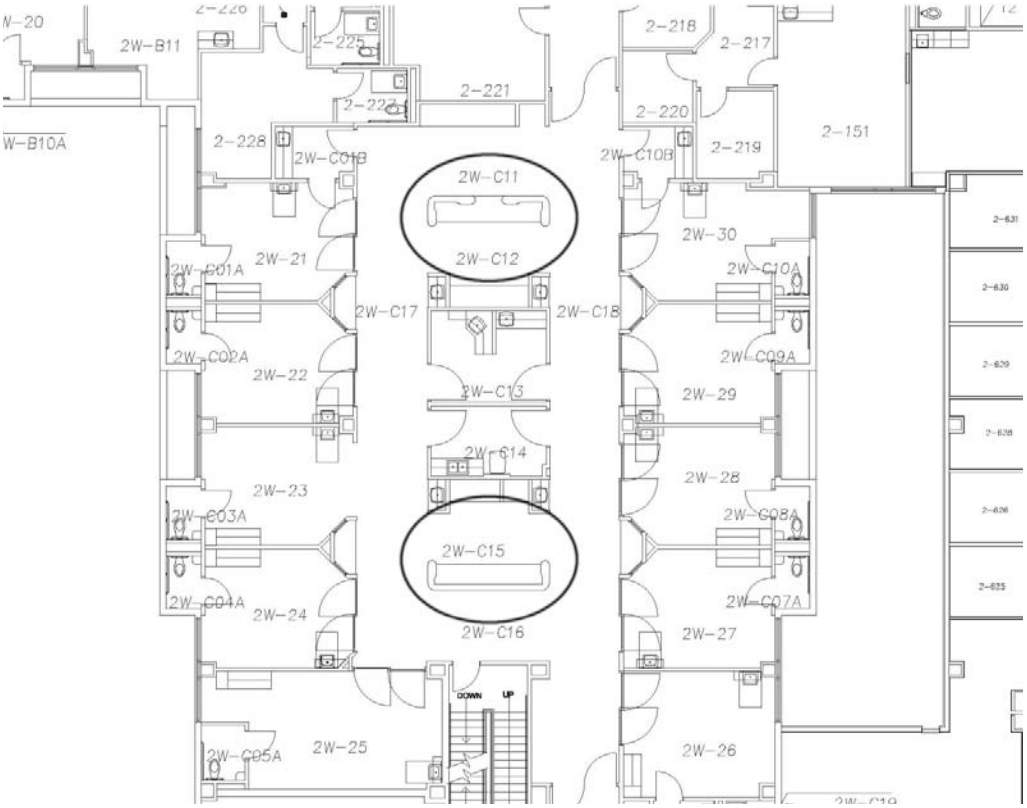


Figure 8. ICU floor plan for Mayo Clinic Hospital, central nurse stations

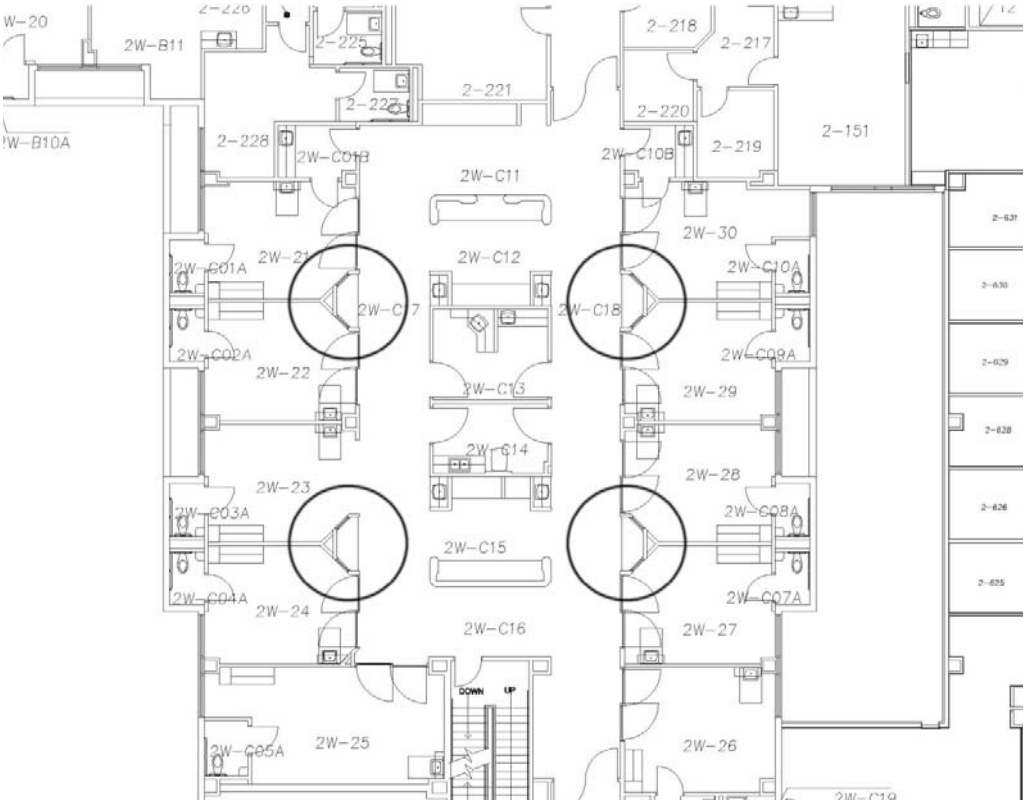


Figure 9. ICU floor plan for Mayo Clinic Hospital, de-centralized nurse stations

The acuity level of patients in the two ICU pods is relatively high compared to typical ICUs due to the specialized patients that are taken care of at Mayo Clinic Hospital. The nurse-to-patient ratio varies based on patient acuity level, but it never exceeds 1:2. The number of full-time-equivalent registered nurses in the pod during a 12-hour shift is typically five. A nurse's day shift starts at 7:00 a.m. and night shift starts at 7:00 p.m. The medical staff working on the pod consists of registered nurses, doctors, intensivists, technicians, management, and residents. Intensivists are licensed physicians who specialize in providing care to the most critically ill patients. There are six intensivists on staff and they have various backgrounds, such as anesthesiology, surgery, and pulmonary. Mayo

Clinic employs their physicians and hospitalists; therefore doctors have a presence on the unit that promotes opportunities to interact with nurses and other staff members. Shift changes in the ICU occur in the morning between 7:00 a.m. and 7:30 a.m. and at night between 7:00 p.m. and 7:30 p.m. Multidisciplinary rounds start at 7:15 a.m. and the nurses participate as the teams approach their patient. Multidisciplinary rounds allow all members of the ICU team to come together and offer expertise in caring for critically ill patients.

4.3 Analysis of Observations: a(x4) and Environmental Mapping

The data analysis used for this research includes a review of the literature and thematic exploration to transform observational data into themes. Participant observations and information collected about the unit staffing and design facilitated the development of analytic categories and, ultimately, key concepts. The key concepts that emerged from the data were related to the overarching categories of actor, mode, and zone established through analysis of observational data. The central themes and subsequent concepts were defined based on the observational data and then supported with visual examples of the environmental maps recorded during the data collection process. An overview of the approach for analysis of each research question is provided below, followed by detailed descriptions of the results for each research question.

Research Question 1: What are the major characteristics of nurse communication in a hybrid ICU nurse station design?

Review of the literature on nurse communication and broad thematic analysis of the observation data indicated that nurse communication is comprised of three overarching components: *Actor*, *Mode*, and *Zone*.

Actor: The focus of this research is on nurse communication. Results related to the category of *Actor* explored nurses and the individuals on the ICU pod with whom the nurse communicates. These included other nurses, doctors, technicians, nurse management, and family members of patients. Nurse-patient communication was not observed in this study. Therefore, patients were not included as actors.

Mode: Mode of communication included the methods and styles used for communication. Methods of communication included paper documentation, telephone, face-to-face, and computer and laptop. The different styles of communication address the frequency and network scope of nurse communication.

Zone: Zone of communication considers locations in which communication occurs. General zones of communication within the ICU pod include the central nurse station, de-centralized nurse station, the hallway, patient room doorway, and medication room.

The main categories of *Zone*, *Actor*, and *Mode* provide a framework to support the development of subcategories. These subcategories were further developed into key concepts that clarified the major characteristics of nurse communication in the hybrid ICU nurse station design. These characteristics are

listed below with definitions that include support and validation from the observations, and are further illustrated through environmental maps collected throughout observations.

Research Question 2: What are the factors in the built environment that enhance or hinder nurse communication in a hybrid ICU nurse station design?

Research question two was addressed through exploration of the relationship between the three overarching concepts; *Actor*, *Mode*, and *Zone*. A biaxial map was developed to explain factors that enhance or hinder nurse communication in the built environment.

4.3.1 Actor

Actors in the ICU pod may be grouped into (1) *native*, (2) *semi-natives*, and (3) *non-natives.* This section lists the characteristics defining each group of actors and focuses on natives or nurses. The primary non-natives that interact with nurses are doctors, technicians, and family members. These are described at further length below with support from observational data collected on site.

Natives or nurses represent the locals of the pod. They spend the most time in both the central and de-centralized nurse stations. The dynamic among nurses is comfortable and informal and it is seen through the ease with which they interact among each other. For instance, one memo (created by the researcher) stated: *(The nurses are more comfortable among each other. There is no 'barrier' and they are able to be in close proximity to each other.)* This is illustrated by, *(Two nurses talking about personal information standing in front of central nurse*

station leaning against station. Another nurse is still sitting at station participating in conversation drinking coffee.)

Three actors, nurse managers, clinical nurse specialists, and physician's assistants, interact with nurses as ***semi-natives***. Semi-natives spend less time on the unit. They come into nurse work areas, but may bring their own laptop and sit out of the way of nurse work. An example semi-natives communicating with nurses was seen at the central nurse station: *(Nurse Managers are present on the floor, and one was overheard saying "I don't want to be in my office". They interact with nurses at the central nurse station.),* and *(A physician's assistant at the back of the central nurse station working on a computer, turns around to talk to the technician that brought a cart next to the central nurse station.)*

Non-natives consist primarily of technicians, doctors, and family members. The most evident ways that foreigners are set apart from natives is that (1) they spend less time of the unit than natives and (2) they stay mostly in the neutral zones such as the hallway and patient areas. Some example of *non-natives* in *neutral territory* include: *(Technicians congregate in hallway at COW [computer on wheels] and talk about the patients.)* and *(Doctors are present on the unit and primarily are in the patient rooms.)* Non-natives do not typically enter the central nurse station or use the computers within it, and if they do, their stay is brief. Additionally, they stay out of the way of the nurses and their work, and even bring their own carts, equipment, and computers onto the unit.

Family members also are non-natives. Visiting hours for the Intensive Care Unit, different than the rest of the hospital, are 9:00 a.m. to 6:30 p.m. and 8:00 p.m. to 11:00 p.m. The gap in visiting hours is due to the evening shift change that takes place around 7:30 p.m. Family members are allowed onto the floor during the day and usually go directly to the patient room once they enter the pod *(e.g. (A family comes down the hallway from the main entrance and goes directly into the patient room.))*

4.3.2 Mode

Actors were seen communicating (1) *face-to-face*, (2) via *portable telephone*, (3) *computer*, and (4) *written documentation*. This section describes these different modes of communication, and sets the stage for the development of modes of communication based on actor type discussed in a later section.

Face-to-face communication occurs when actors talk directly together. Face-to-face interactions involving nurses were seen happening near or through the central and de-centralized nurse stations. This type of communication was typically observed away from patient areas. The content of face-to-face communication was both professional and personal; some concerned patients and patient care, while other face-to-face communication did not. Face-to-face communication among nurses was seen happening all over the unit, such as across the pod from the de-centralized nurse stations, in the medication room doorway, and sitting next to each other at the central nurse station. Face-to-face

communication between natives and non-natives occurred mostly at the central and de-central nurse stations, and at patient room doorways.

Telephone use was seen primarily during communication with natives. Each had his/her own portable phone, which they carried at all times. This phone was used primarily for patient-related discussions and for logistical or coordinating purposes among staff members. Nurses would use the phone upon exiting the patient room and were observed travelling and performing other tasks while on the phone. They also used the phone at the central nurse station in between other modes of communication.

Computer and ***written*** communication were seen primarily by natives at the central and de-centralized nurse stations. Nurses were not observed documenting in patient areas even though there are computers on wheels (COWs) in each patient room. They would leave patient rooms to document, and return frequently to obtain more information to record outside of the patient room. Nurses were seen performing other modes of communication while documenting patient information in the computer, such as talking to another nurse face to face or talking to someone else on their portable telephone simultaneously.

4.3.3 Zone

The zones were identified primarily through mapping where nursing staff communicate with other actors based on the ICU pod layout. Key areas or hot spots of communication emerged based on where nurse spent time relaying information through the different modes of communication discussed in the

previous section. Key areas discovered included: (1) *activity center*, (2) *neutral territory*, and (3) *home base*. The following themes describe patterns that emerged through observations related to nurse communication based on different zones of the ICU pod.

The central nurse station is an ***activity center*** and is a point of reference for everyone in the pod. It functions as a thoroughfare, staff locator, and initial meeting place. The central nurse station is a *thoroughfare* or pass-through for nurses working in the pod (Figure 10). Nurses repeatedly walk through the nurse station even when it would be easier to walk around it *(A nurse leaves patient room 28, goes in a circle back to 28 through the central nurse station and throws something onto a reclining chair on the other side of the central nurse station in the hallway.)*. Other staff members typically did not walk through the central nurse station and would go out of their way to walk around it even if going through was more direct or convenient. Nurses work primarily from central and de-centralized nurse stations, for instance *(Three nurses are sitting behind the nurse station at the computer terminals.)* and *(A nurse is using a computer terminal to record patient data at the central nurse station. Another is at the decentralized nurse station recording patient data also.)*

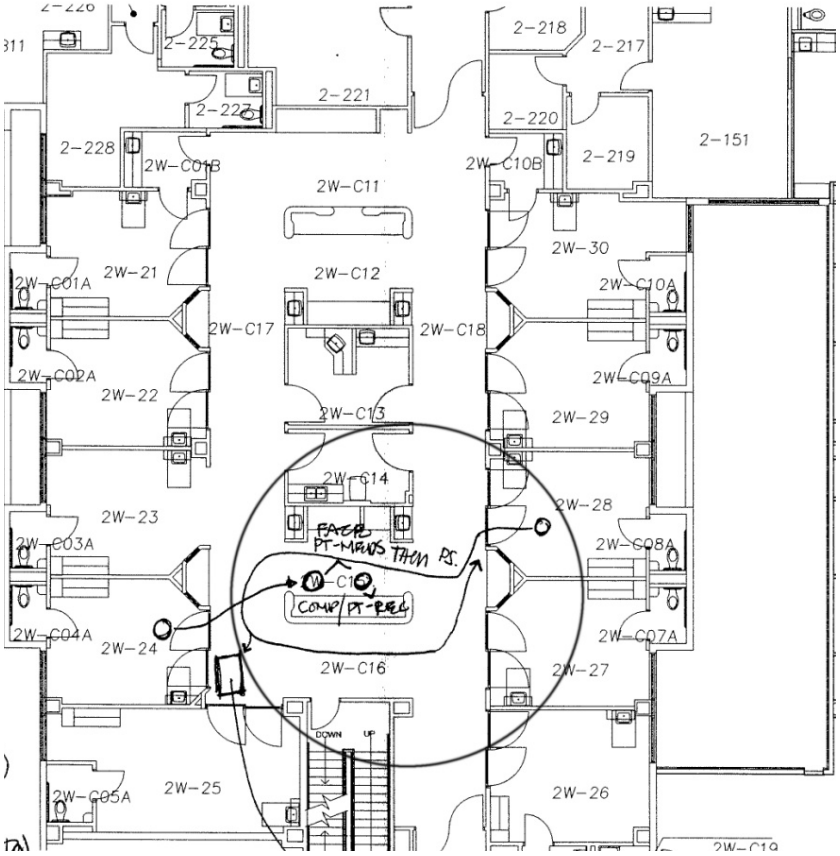


Figure 10. Environmental map of the activity center as a thoroughfare

The central nurse station also functions as a *locator*, in that nurses travel from another area of the pod or from a patient room to the central nurse station to find somebody to help with a patient-related task or to retrieve some information (Figure 11). A nurse locates another nurse for help with a patient; *(A nurse comes to the central nurse station to ask another nurse if she will help her turn a patient. They both walk toward the patient room together.).* The central nurse station operates as an *initial meeting place* (Figure 12) for non-natives who enter onto the pod, and helps orient them to determine where they are needed. Unintended or *serendipitous meetings* (Figure 13) happen in or around the central nurse station.

The following example of an unintended meeting occurs the central nurse station; (*A nurse comes from the other end of the pod to get a piece of paper from the printer. She then comes back to the central nurse station to look for something and then ends up talking to the case manager.)*. Non-natives will congregate around the front of the central nurse station, while natives maintain their position within the central station. The central nurse station encourages nurse communication by providing a place for nurses to work, educate, and share. This central activity center helps foster a positive organizational nursing culture.

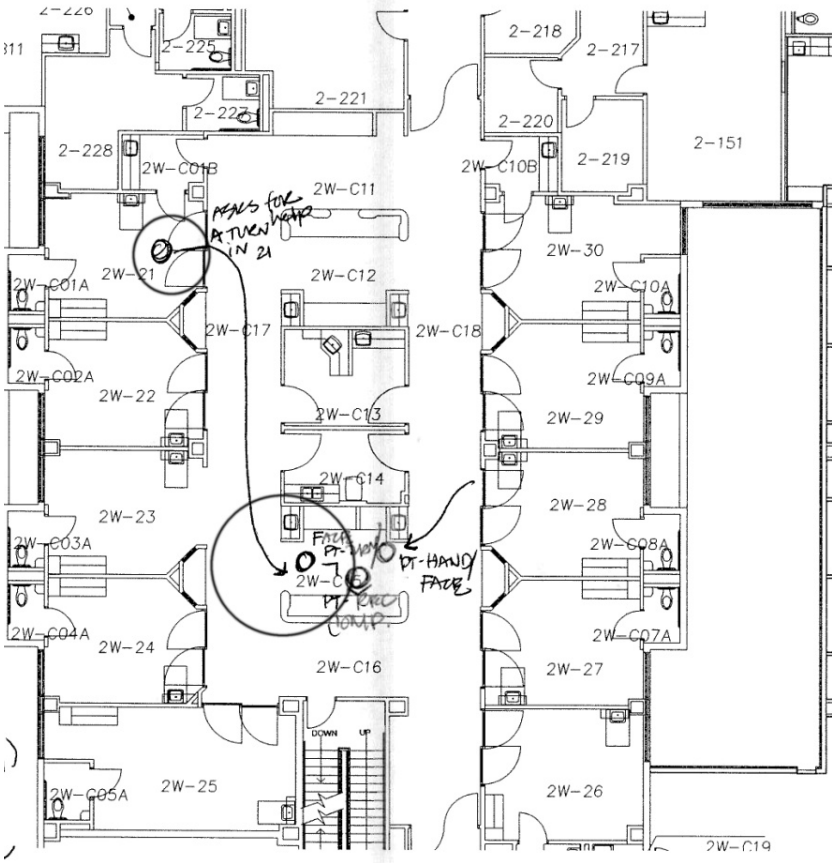


Figure 11. Environmental map of the activity center as a locator

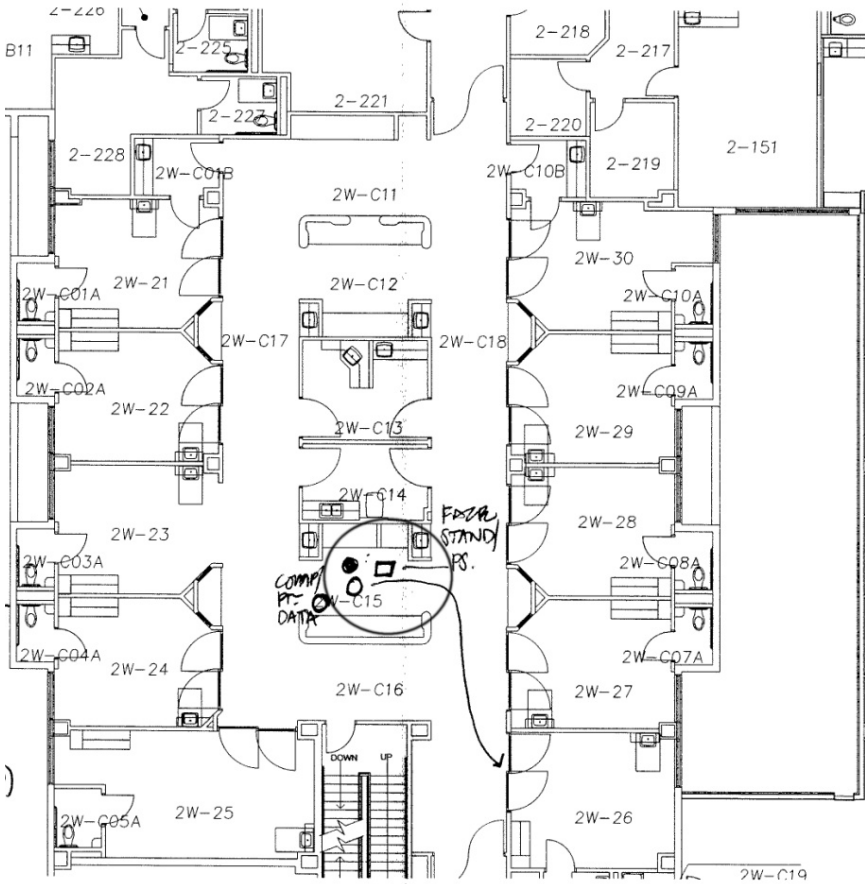


Figure 12. Environmental map of the activity center as an initial meeting place

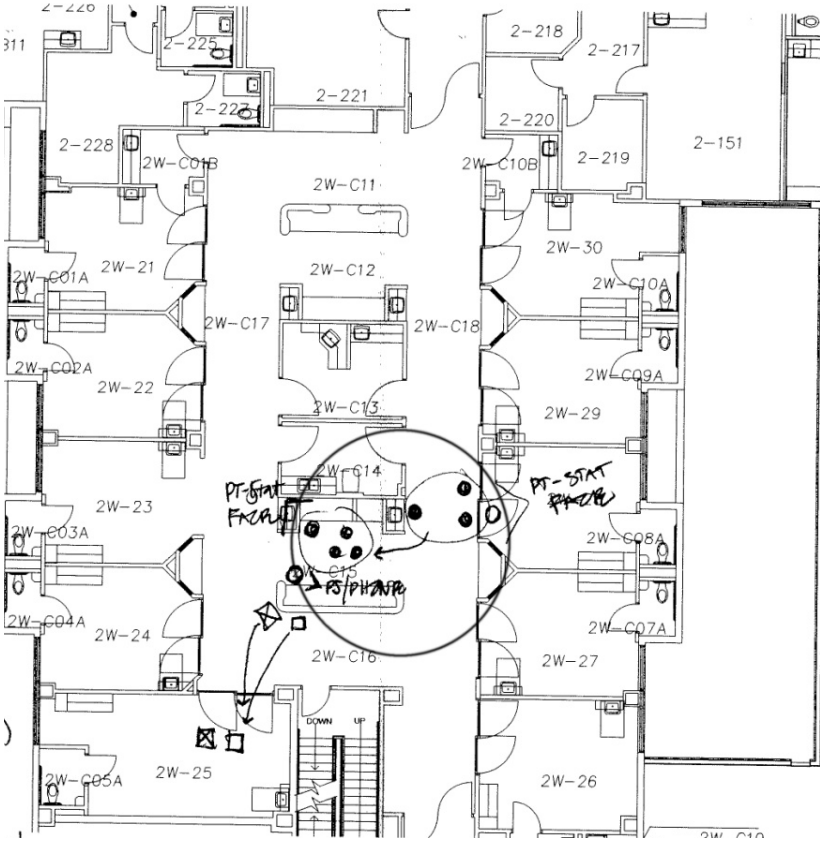


Figure 13. Environmental map of the activity center as a serendipitous meeting place

The hallway was determined to be ***neutral territory,*** (Figure 14) and provided a place where all staff working in the pod could communicate face-to-face. All actors were seen communicating with one another, across disciplines, in the hallway. An example of the hallway as a neutral territory, *(A nurse and doctor walk from inside the central nurse station to the outside of it and lean against the high outside counter facing each other to talk about a patient.)* and *(All the doctors and nurses are in hallway between centralized and de-centralized nurse station.)*. Staff is heard having patient-related and personal conversations in the

hallway among one another. This neutral territory facilitates information transfer because it is a zone where everyone is comfortable working.

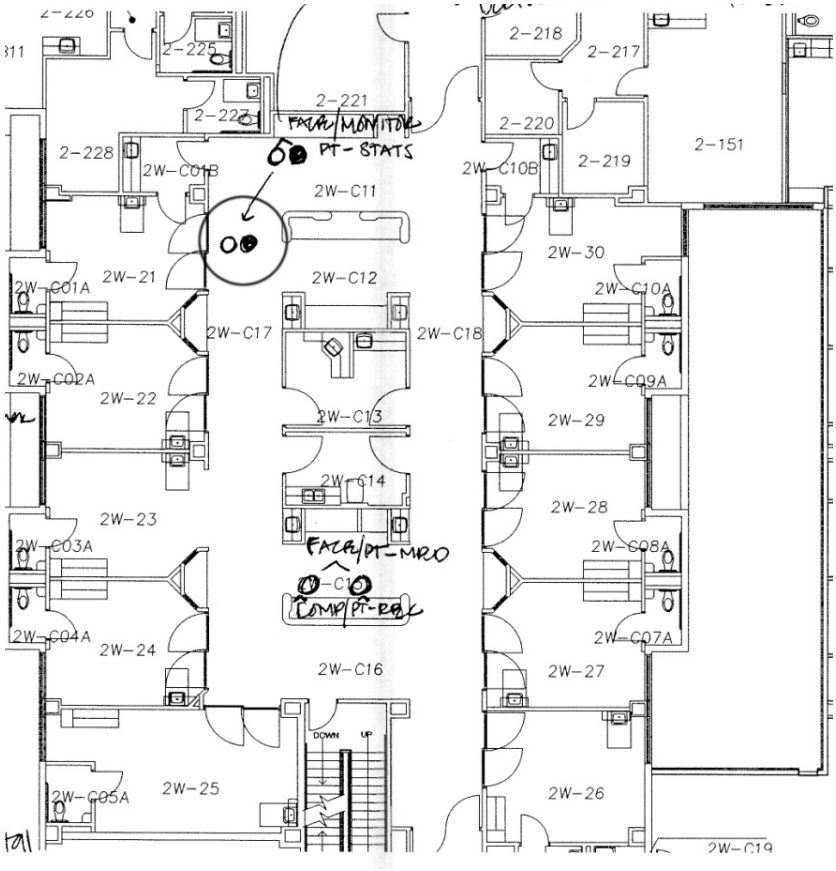


Figure 14. Environmental map of a nurse and doctor in neutral territory

Home base is the primary workspace or territory of each actor. Nurses work from the central and de-centralized nurse stations, semi-natives work remotely at the central nurse station, and each non-native group has its own usual workspace. Doctors work from the front counter of the central nurse station, technicians bring their own carts and work from the hallways, and family members stay mostly in the patient room. These will be discussed in further detail based on the Actor-Zone intersection.

A nurse is observed working at the central nurse station, *(The nurses behind the central nurse station are sitting down and having conversations with the nurses standing on the outside of the central station.).* Semi-natives are seen working at the central nurse station usually at the back counter computer or with their own laptops. For example, a physician's assistant is seen working at the back counter of the central nurse station; *(A physician's assistant and doctor are talking to each other through the central nurse station. The physician's assistant facing the computer at the back of the nurse station has the conversation with the doctor standing at the front of the central nurse station without turning around. She turns around at the very end, and when they are finished turns back to the computer.).*

The following observations are examples of home bases for non-natives. Technicians work from their carts in the hallways, *(A technician is pushing a COW through the hall and stopping in front of patient rooms. She is on the phone standing in front of COW.).* A doctor's home base is seen in the following example, *(A doctor is stationed in front of the central nurse station using the high counter to look through binder/chart.).* Finally, family members are seen going directly to the patient room in this observation, *(A family comes down the hallway from the main entrance and goes directly into the patient room.).*

Actors in the ICU pods may be categorized as natives, semi-natives, and non-natives. There are multiple modes of communication including face-to-face, telephone, computer, and hand-written. There are two major zones named *owned*

territory, consisting of the activity center and de-central nurse stations, and *neutral territory* or the hallway.

Staff nurses, the focus of this study, were observed to be primarily natives who multi-task throughout their 12-hour shift. They engage in multiple modes of communication including face-to-face, written documentation, computer documentation, and telephone communication. They work in all of the zones and their main focus is patient care. They spend the majority of their time focused on taking care of their patients, and their main work area is the central and de-centralized nurse stations. When at the stations nurses are primarily seen on the computers documenting patient information while intermittently hand writing notes, talking to other nurses, or using their phones.

In contrast to the natives or nurses, semi-natives and non-natives come to the unit for specific, focused tasks. Semi-natives and non-natives primary modes of communication are *linking*, *checking-in*, *flying solo*, or *hyper-focused*. Additionally, they use a narrower range of zones, and stay mostly in neutral territory. When family members are unable to occupy their narrowly appointed zone, they appear lost.

4.4 Interactions: Actor, Mode, and Zone

Interaction between ICU staff members and their built environment (zone) are critical to successful communication. The next section discussed the development of a biaxial map that illustrates nurse interactions with other staff members in the context of the built environment.

4.4.1 Interactions: Barriers and Facilitators

Interactions across Actor, Mode, and Zone illustrate the impact that the ICU environment has on nurse communication. These intersections act either as a facilitator or barrier to nurse communication (Table 1). The ***actor-mode*** intersection includes the key themes of *multi-tasking* (multi-modal), *linking* (multi-actor), *check-in*, *fly solo*, and *hyper-focused*. These themes are based on different actors and their mode of communication. The key themes related to the ***actor-zone*** intersection are *territorial ownership*, *bridge* (dual-zone), *floating*, *drop and ditch*, *lost*, and *counter wall*. Finally, the ***mode-zone*** intersection is exemplified by the following key themes: *content shift*, *cross room conversations*, *proximity volunteer*, *mobile phone*, *remote recording*, *gravitate*, and *concentrated movement*.

Table 1

Division of themes based on actor

Actor	Mode	Zone
Native *Nurse*	Multi-tasking (Multi-modal)	Home: nurse stations (remote recording, territorial ownership)
Semi-native *Clinical Specialist, Physician's Assistant, Case Manager*	Linking (multi-actor)	Home: Bridge (dual-territory)
Non-native *Technician* *Doctor* *Family*	 Check-in Fly Solo Hyper-Focused	Home: (neutral territory) Floating Drop and Ditch Patient room (Lost in neutral)

These key themes are presented as intersections of Actor-Mode, Actor-Zone, and Mode-Zone. There is a table at the beginning of each intersection to categorize the key themes, and listed below is more detail with support from observations.

Actor-Mode

This section lists the key themes that differentiate each actor group in terms of mode of communication (Table 2). A theme that describes nurses as natives is *multi-tasking*. A key theme that characterizes semi-native communication is *linking*. The primary non-natives that interact with nurses are technicians, doctors, and family members; and some of the attributes described in the key themes are *checking-in, flying solo, and hyper-focused.*

Table 2

Intersections between Actor-Mode

	Actor				
	Native	Semi-native	Non-native		
			Technician	Doctor	Family
Mode	*Multi-tasking*	*Linking*	*Checking in*	*Flying Solo*	*Hyper-focused*

Nurses are seen ***multi-tasking*** (Figure 15) and are constantly shifting from one mode of communication to another with ease and agility. An example of nurse multitasking is seen in this instance, *(The nurse at the central nurse station is sitting down and using the desktop computer with a laptop in front of it. She is also answering her phone and making phone calls while recording patient data*

into the desktop computer.). Communication multitasking is also seen between nurses; *(Nurses talk to each other while still on the computer recording patient information. They do not even look up at each other while talking at the central nurse station.).*

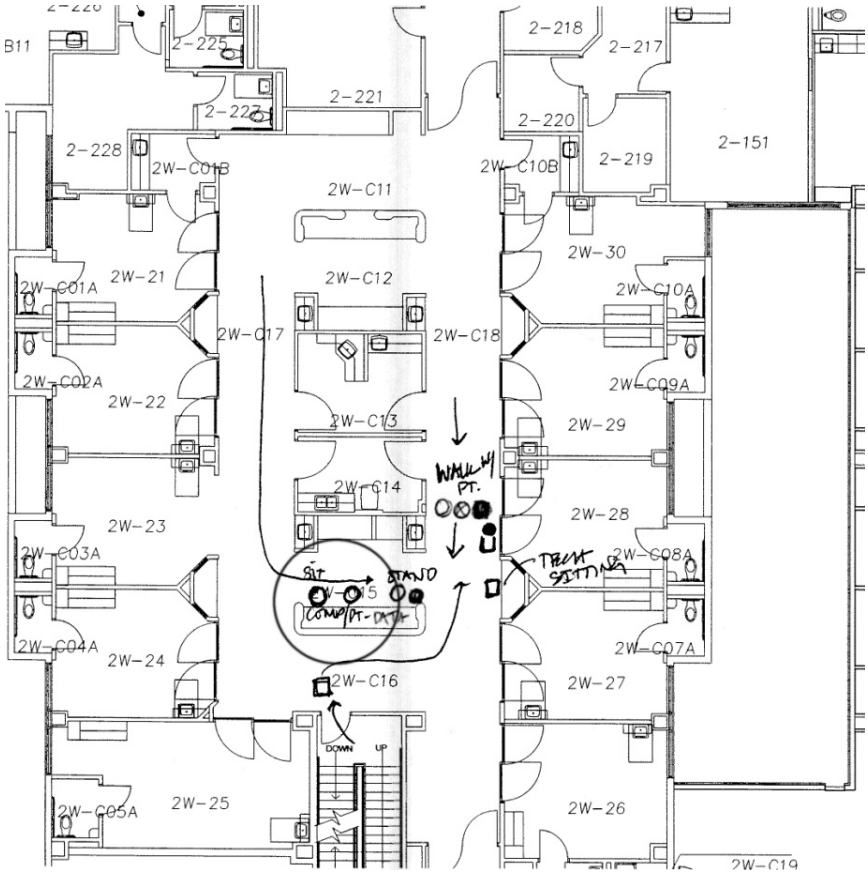


Figure 15. Environmental map of nurses multitasking

Semi-natives are seen *linking* or communicating with multiple actors (Figure 16)**.** Clinical Specialist, Physician's Assistant, and Case Managers are comfortable communicating with all actors on the floor. They work primarily from the central nurse stations and work from their laptops or a computer that is not being used by a nurse. Semi-natives were observed talking to other staff

members from inside the central nurse station while seated and also came from the inside to the outer counter to have a conversation with both natives and non-natives. They transition easily when communicating with all actors in the pod and do not change their demeanor.

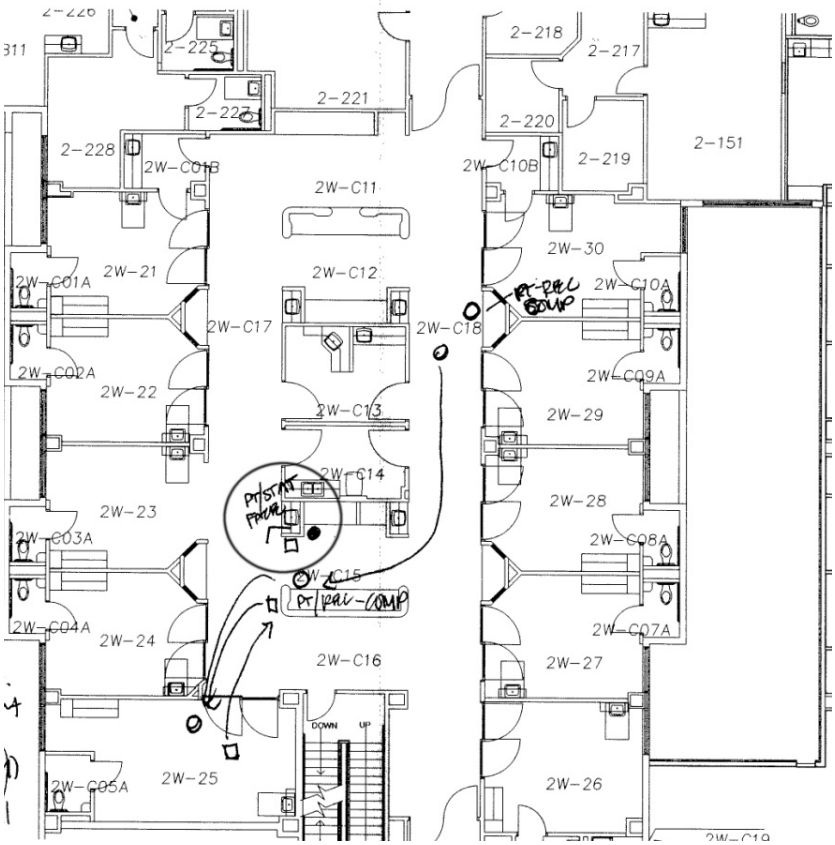


Figure 16. Environmental map of semi-native linking

Technicians, one of the non-native groups, are seen ***checking-in*** at the central or de-centralized nurse stations. Most often technicians enter the pod and go directly to the central nurse station to see where they need to be. Sometimes they go directly to the de-centralized nurse station next to the room where the patient they were called to help is located. A technician is observed checking-in at

the central nurse station for a patient related discussion, *(A technician walks to the doctors at the central nurse station and asks a question related to the patient she is doing a procedure on.)*. A technician is seen stopping by the de-centralized nurse station, *(A technician wanders over to the de-central nurse station 28/27 and asks why he has been called to the pod. They tell him he is there to change a patient bed. They go and get the new bed and he stands in the doorway with the new bed.).*

Doctors, also non-natives, usually go directly to the patient area to interact with and take care of their patients. Many times they interact only with the patient; *(Doctors move from one patient room to the next.)*. They ***fly solo*** (Figure 17) or have minimal interaction with other staff members and leave immediately after they are done with the task at hand. For example, *(The doctor is still in front of the nurse station recording patient data on her laptop. She has not talked to anyone.).*

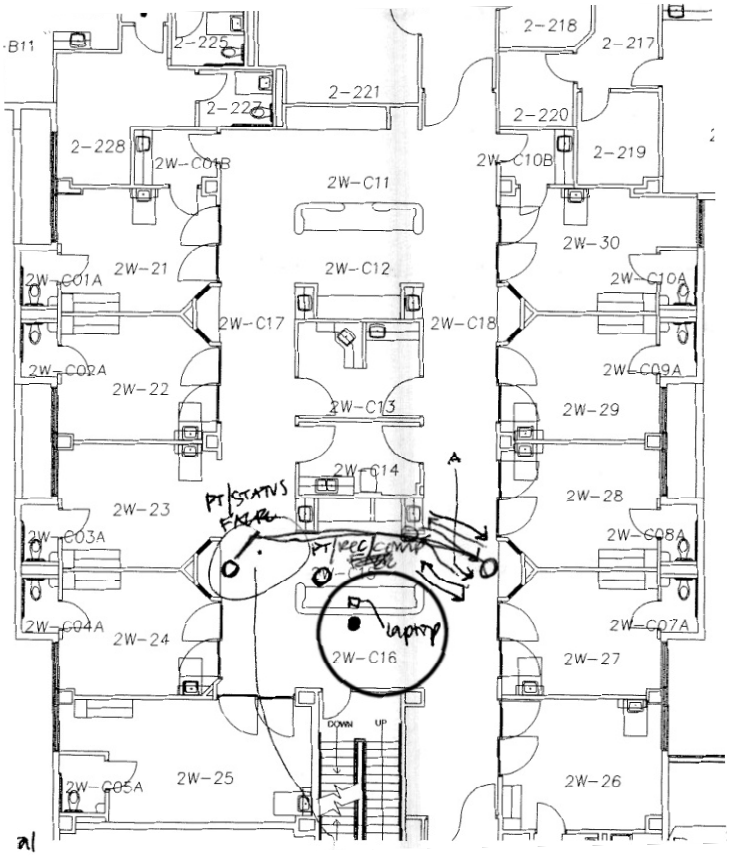


Figure 17. Environmental map of a doctor flying solo

The final non-native group, family members are ***hyper-focused*** (Figure 18) when interacting with others. All of their communication is initiated by a need to for knowledge about information related to their family member who is a patient in the pod. Family members are observed walking directly to the patient room once in the pod and staying in or near the patient room. For example, *(A family member follows the nurse out of the patient room to the decentralized nurse station computer. They nurse talks to family member while reading stats off of the computer.).*

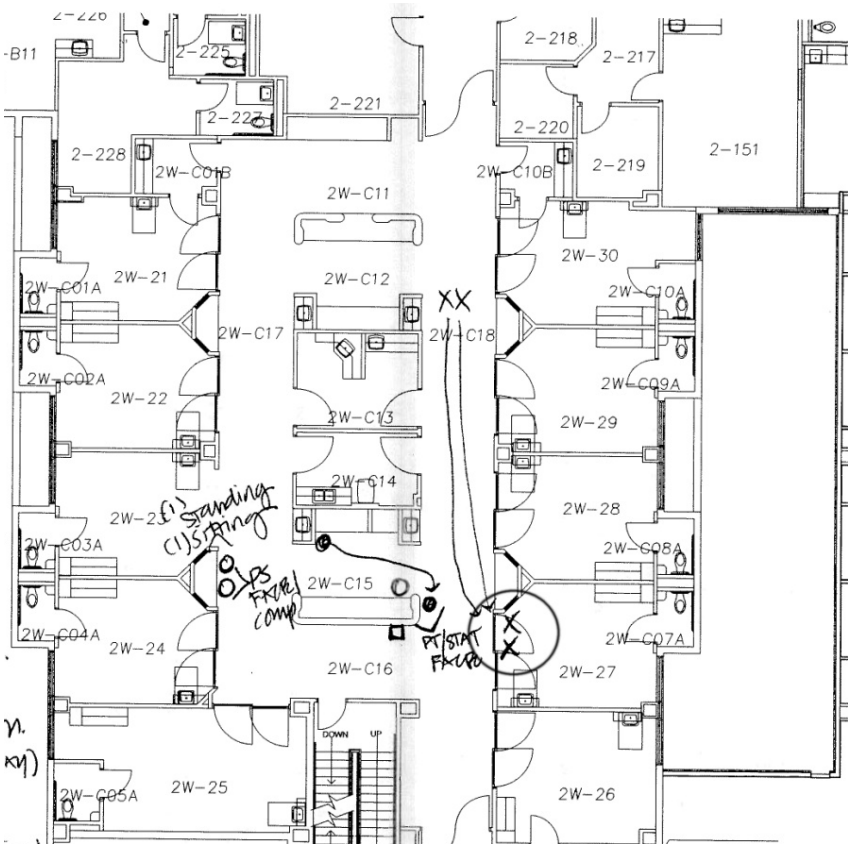


Figure 18. Environmental map of family members hyper-focused

Actor-Zone

Table 3

Intersections between Actor-Zone

	Actor				
	Native	Semi-native	Non-native		
			Technician	Doctor	Family
Zone	*Territorial ownership, Counter Wall*	*Bridging*	*Floating*	*Drop and ditch*	*Lost*

Nurses work primarily from the central and de-centralized nurse station where they work on computers, document patient information, and converse with

other nurses. There is a sense of ***territorial ownership*** associated with these nurse stations. Even though there is no personalization at the central nurse station, nurses primarily occupy these stations and leave personal belongings on counters, chairs, and under the desks. Territorial ownership is seen during observations in these instances: *(A nurse comes from the de-central nurse station and grabs her personal bag in a cupboard at the central nurse station. She then brings it to the floor of her de-central nurse station.); (Decentralized stations in view have no nurses but there are white sweaters on the chair backs.)* ; *(Nurses use desk space for coffee, papers, and personal stuff.).*

Nurses were the primary users of the computers, and appear to have priority over other staff members with regard to the computer usage at central and de-centralized nurse stations. Non-native and semi-natives brought their own COWs and laptops onto the pod. The following examples exemplify nurses having territorial ownership over the central and de-centralized nurse stations and computers *(Three nurses are using the central nurse station computers to chart. One is using the de-central nurse station to the right of the central nurse station.)* and *(A nurse is using a computer terminal to record patient data at the central nurse station. Another is at the decentralized nurse station recording patient data too.).* Nurses are even seen walking from another part of the pod to use a computer at the central nurse station; *(A nurse walks from another area of the pod to a computer at the central nurse station.).*

Semi-natives are seen ***bridging*** or being comfortable in different zones. They work remotely on the unit, and are seen using each zone in a similar way. They are observed working at the back of the central nurse station on a desktop computer, with their personal laptop at the front of the central nurse station, and on their portable phone roaming the hallways. For example, *(The case manager is sitting in the middle of the desk and she is using her own laptop.)*, and *(A physician's assistant at the back of the central nurse station working on a computer turns around to talk to the technician that brought a cart next to the central nurse station.)*. Semi-natives can work successfully in different zones and unlike non-natives are seen working at the central nurse station.

Technicians were observed ***floating*** (Figure 19) around the pod, and they usually bring their own work station onto the floor in the form of a cart or a computer on wheels. For example, *(Technicians usually are pushing some sort of cart when they come through the pod.)* Technicians spend the majority of their time in hallways and patient rooms, and usually pull their cart up directly to the hallway in front of the patient room in which they are working. For instance, *(A technician is in the hallway with the COW at an angle to the patient room.)* and *(A technician is pushing a portable x-ray unit that takes up the entire hallway. The technician stops in front of patient rooms with the x-ray machine and takes up a portion of the hallway.).*

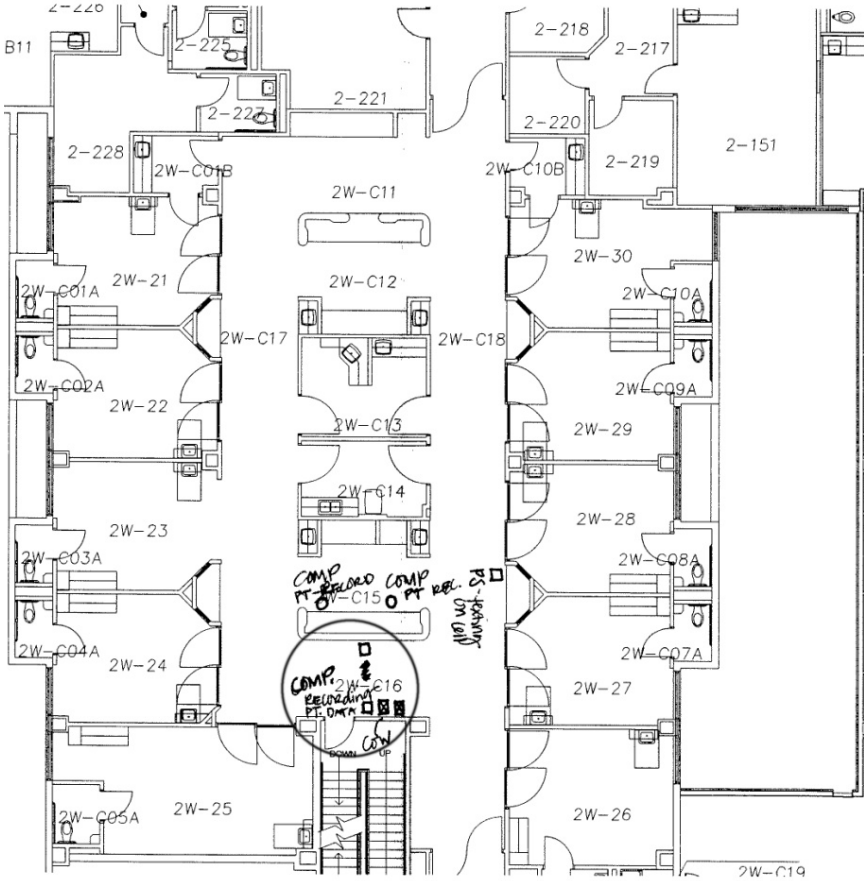


Figure 19. Environmental map of technicians floating in the hallway with a computer on wheels (COW)

Doctors bring their own laptops and binders of paperwork which they ***drop and ditch*** (Figure 20) at the outer counter of the central nurse station while they go to the patient room. For instance, *(Doctors come onto the floor with residents. They enter a patient room after asking the nurse at the de-central nurse station a question, and then they come back out and conference at the central nurse station. They stopped at the outer counter of the central nurse station when they first entered to drop off a patient binder.).*

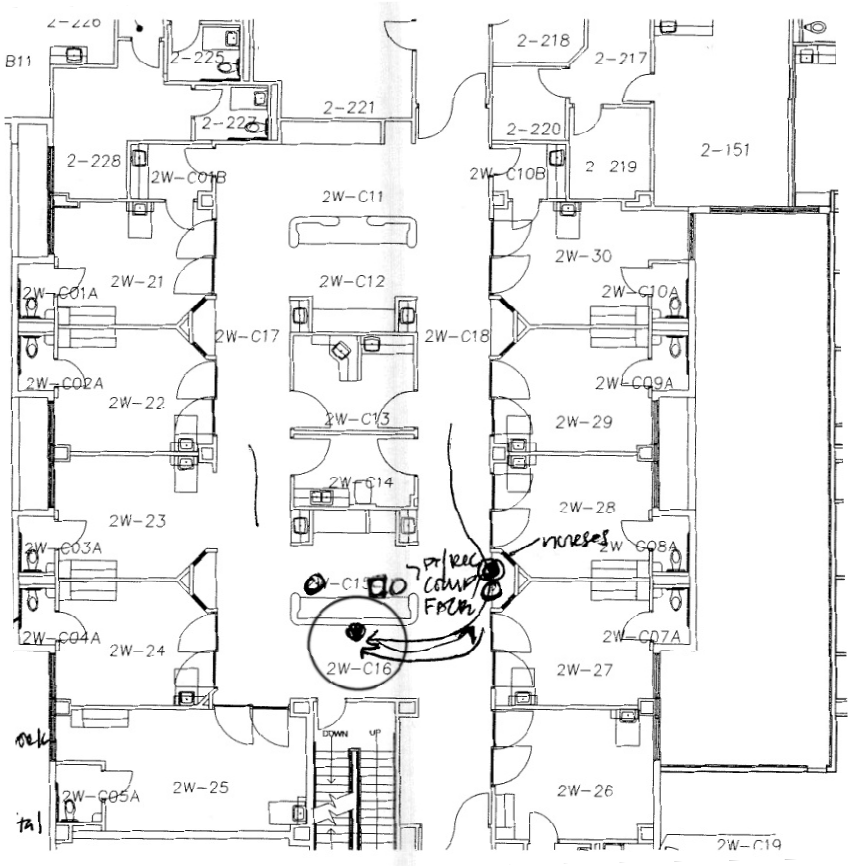


Figure 20. Environmental map of a doctor drop and ditching

Family members spend most of their time in the patient room. If there is a staff member in the patient room they loiter in the hallway and appear ***lost*** (Figure 21). Nurse communication with lost family members are illustrated in this example, *(As a nurse walks from de-central nurse station to a patient room she asks a family member in the hallway "Are you doing all right?".)*. Family members mainly stay in the patient room or the waiting area outside of the main entrance to the unit to avoid appearing lost in the pod hallway.

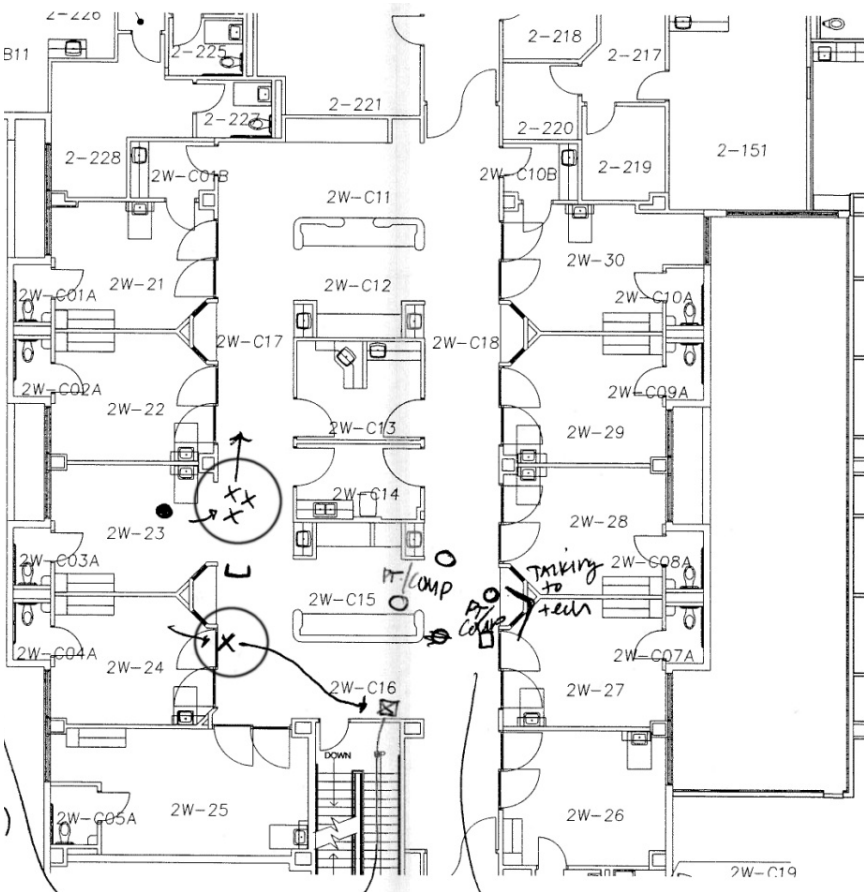


Figure 21. Environmental map of lost family members

The three groups of actors have their own patterns of interaction with zones. In addition, features of the zones, like counter walls, and the kinds of movement of actors within the zones help to describe the actor-zone interaction. The following themes help to further delineate actor communication within the context of the built environment and across different zones.

The ***counter wall*** acts as a divide between nurses and other staff members and reinforces the native-zone territoriality (Figure 22). The counter on the outside of the central nurse station is a place where doctors and technicians can congregate and talk to nurses who are stationed on the inside of the central nurse

station. Nurses sit on the inside of the central nurse station at the lower counter and work on the computers. The following example shows the divide between nurses and other staff members, *(Nurses and technicians are having a patient related conversation at the central nurse station while a nurse is sitting down working on the computer and the technician is standing on the outside edge of the counter flipping through a binder.)* This outside counter exemplifies the divide between natives and non-natives.

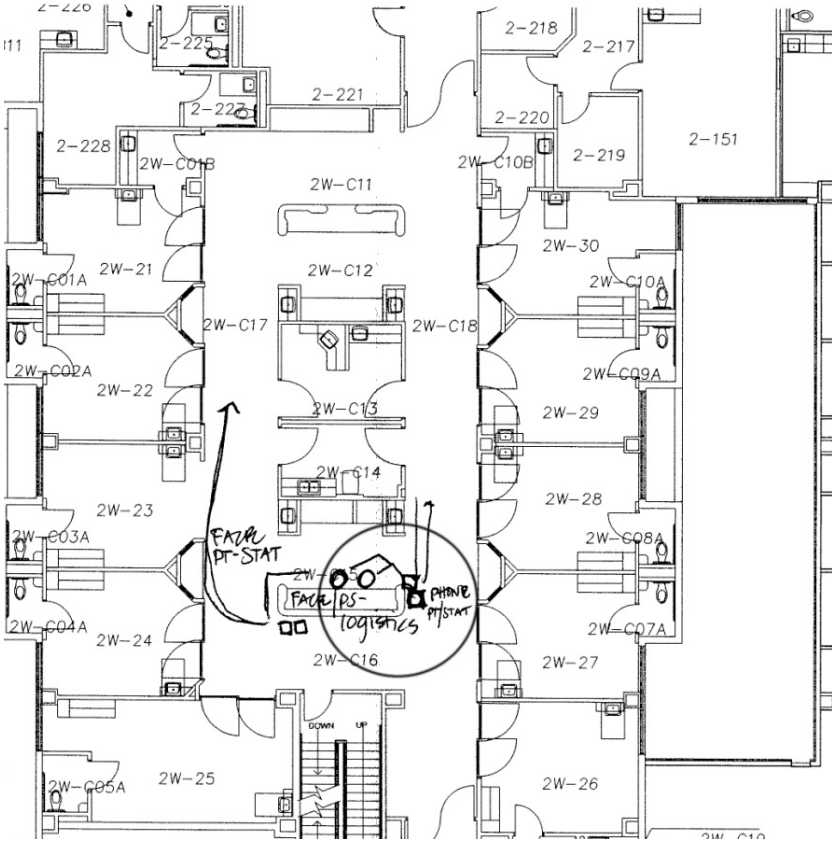


Figure 22. Environmental map of counter wall

Types of movement further describe how actors, particularly nurses, use space in each of the zones. ***Concentrated movement*** seen in Figure 23 is based on heightened activity between key zones such as the central nurse station, de-

centralized nurse station, and patient area. These instances of concentrated movement are primarily seen by nurses. Extra movement is observed frequently from patient to de-centralized, de-centralized to central, and central to patient zones. The following observations are some example of extreme/concentrated movement; *(Nurses and technicians are walking in and out of the patient room and using the decentralized nurse station to record patient data in the computer system.), (A nurse is standing at the back of the central nurse station while hand writing against the back wall. She then walks over to the computer at the central nurse station, then to the de-centralized nurse station, and finally back to the central nurse station.)*, and *(The nurse from patient room 26 keeps going from the corner room to the computer at the central nurse station.)*. Nurses are continually walking from the patient room to either the central nurse station, the de-central nurse station, or the med room.

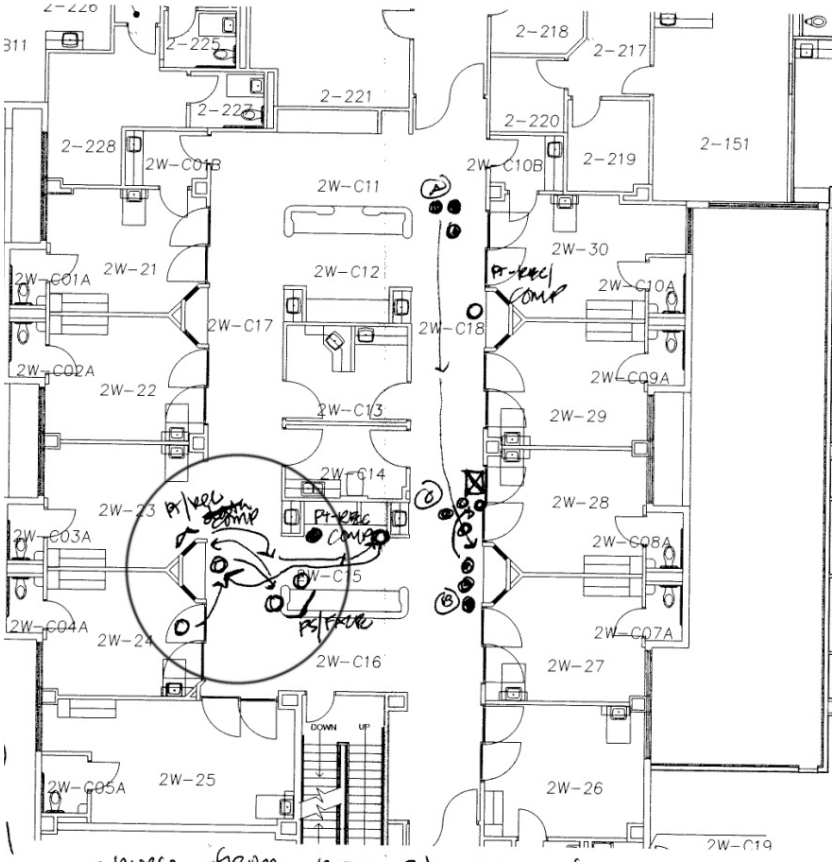


Figure 23. Environmental map of a nurse exhibiting concentrated movement between patient room, de-centralized nurse station, and central nurse station

Mode-Zone

This section describes these different modes of nurse communication in relation to the built environment. Some of the key mode-zone themes that emerged through analysis were related to face-to-face interactions and included *content shift*, *cross-room conversations*, and *unspoken communication*. Another theme, *mobile phone*, was related to portable phone usage by nursing staff. Finally, *remote recording* was an action seen by nurses who would travel out of

the patient room to record patient data at either the central or a de-centralized nurse station.

Table 4

Intersections between Mode-Zone

Zone	Mode: Face-to-face	Mode: Telephone	Mode: Computer/Hand Documentation
Owned	*Cross-room conversations, Content shift*		*Remote recording*
Neutral		*Mobile phone*	
Both	*Proximity volunteer, Gravitate*		*Concentrated movement*

A ***content shift*** seen in Figure 24 is a shift between patient related and personal related conversations among staff. Specifically, patient-related conversations primarily occur in the patient room, patient room doorway, or de-central zones; and personal conversations take place closer to the central nurse station and in the hallway surrounding the station. The following instance shows a conversation that has shifted from patient-related to personal as the staff members moved from the de-centralized nurse station to the central nurse station; *(A nurse and two doctors move from the de-centralized nurse station to the outside of the central nurse station and lean against the tall counter to talk to a nurse sitting behind it. The conversation shifts to a personal one once they leave the hallway surrounding the de-centralized nurse station and head towards the central nurse station.).*

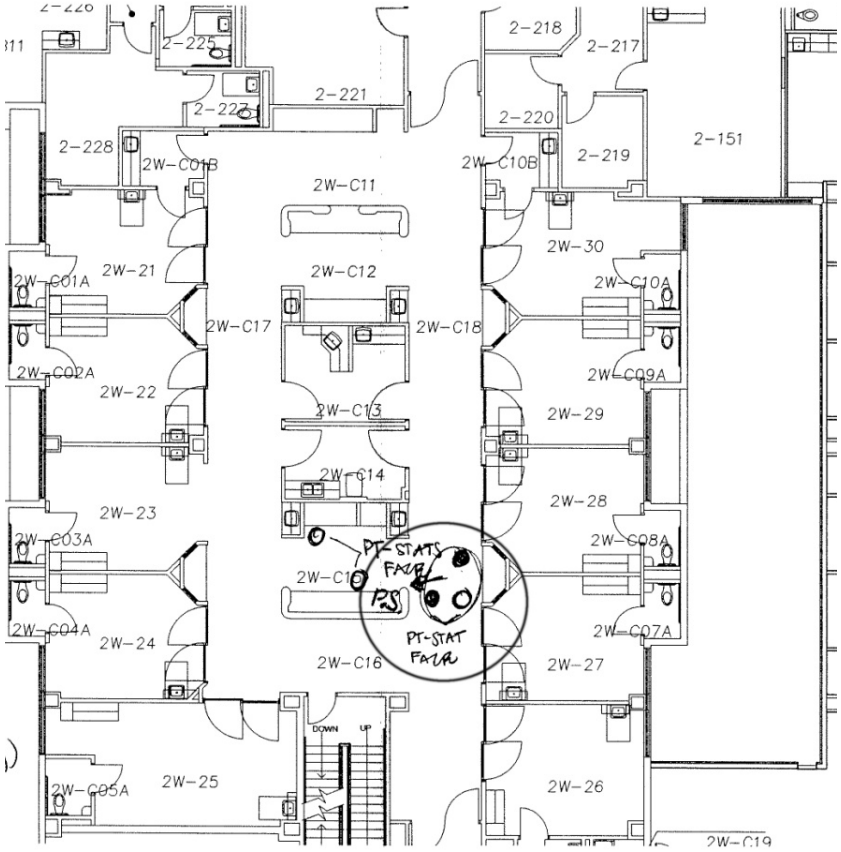


Figure 24. Environmental map of a content shift between a nurse and doctors

Communication that happens across the pod is illustrated by the ***cross-room conversations*** seen in Figure 25**.** Nurses are heard communicating across the open central nurse station from either the de-centralized nurse stations or patient room doorways. For example, *(A nurse in a patient room calls to other nurse at the central nurse station to help her with a patient.)*. The open yet compact pod allows for visual transparency and allows nurses to talk across the pod without raising their voices.

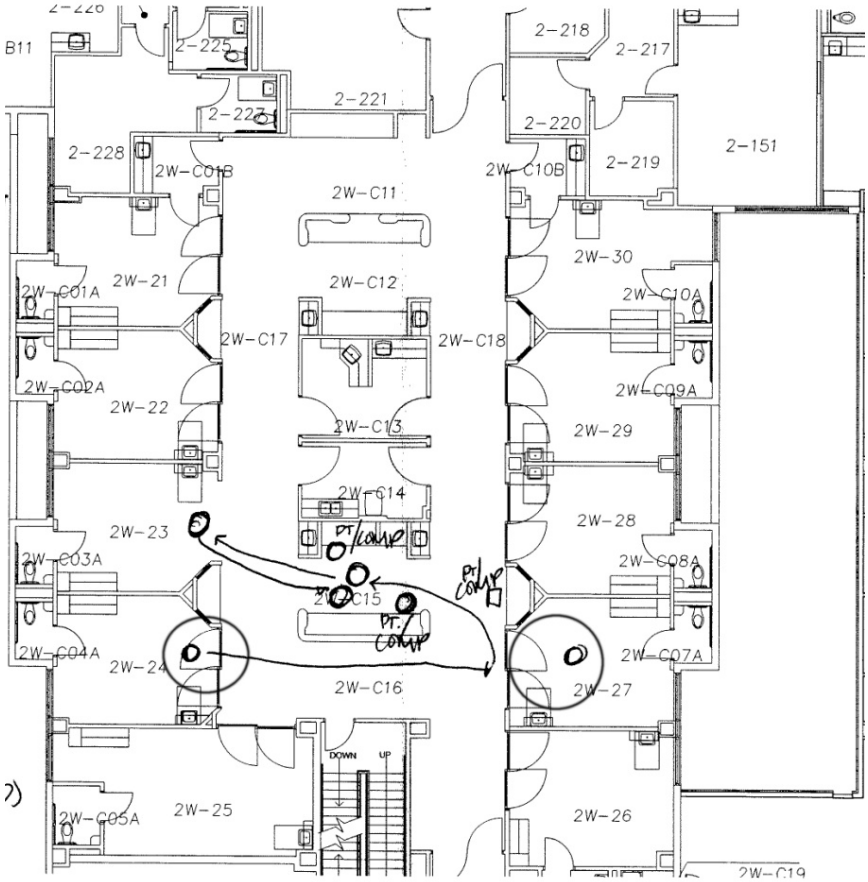


Figure 25. Environmental map of nurses having a cross room conversation

Proximity volunteer is seen in Figure 26 when a staff member offers help to another staff member unexpectedly. This happens near the central nurse station in this example; *(A nurse hears beeping at the central nurse station. She walks over to the patient room and says, "What's up guys?" to the nurses in the patient room. Then she walks back to the central nurse station and asks other nurses for help with one of her patients.).* Contributing factors to proximity volunteer the visual openness of the central nurse station. Nurses are seen helping each other most often, and help will be offered to a nurse who is in the middle of a patient-related task. The nurse offering the help is usually positioned at a nurse station.

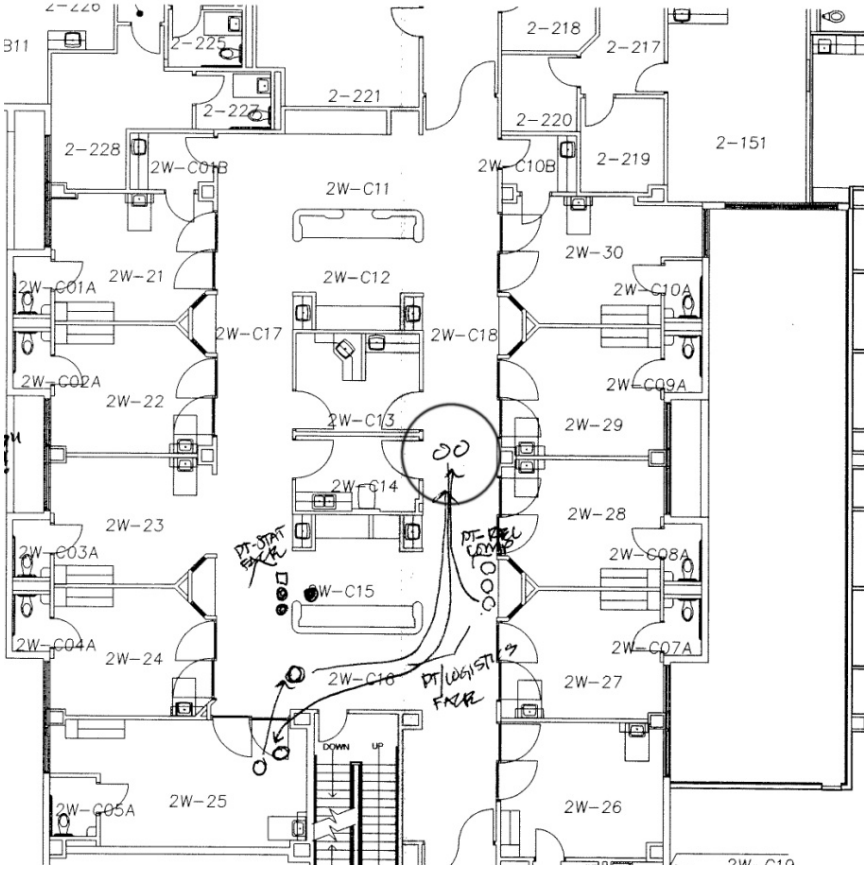


Figure 26. Environmental map of proximity volunteer between nurses

Mobile phone **(**Figure 27) is when nursing staff are seen walking and on their personal portable telephone. Conversations are started once they leave the patient room and are generally patient-related. Two examples of mobile phone include: *(A nurse walks on the phone from a patient room to the central nurse station two times before going back to the same patient room. He was off the phone before he entered the patient room.)* and *(A nurse gets on the phone when she comes to the central nurse station and is walking around the nurse station while she is on it.).* Additionally, nurses are seen multi-tasking while on the phone, but will almost always get off of the phone before entering the patient

room. The phone is used primarily to relay patient information to family or other staff members. It is also used to communicate to other areas of the hospital such as a lab, or as a paging system to locate other staff members.

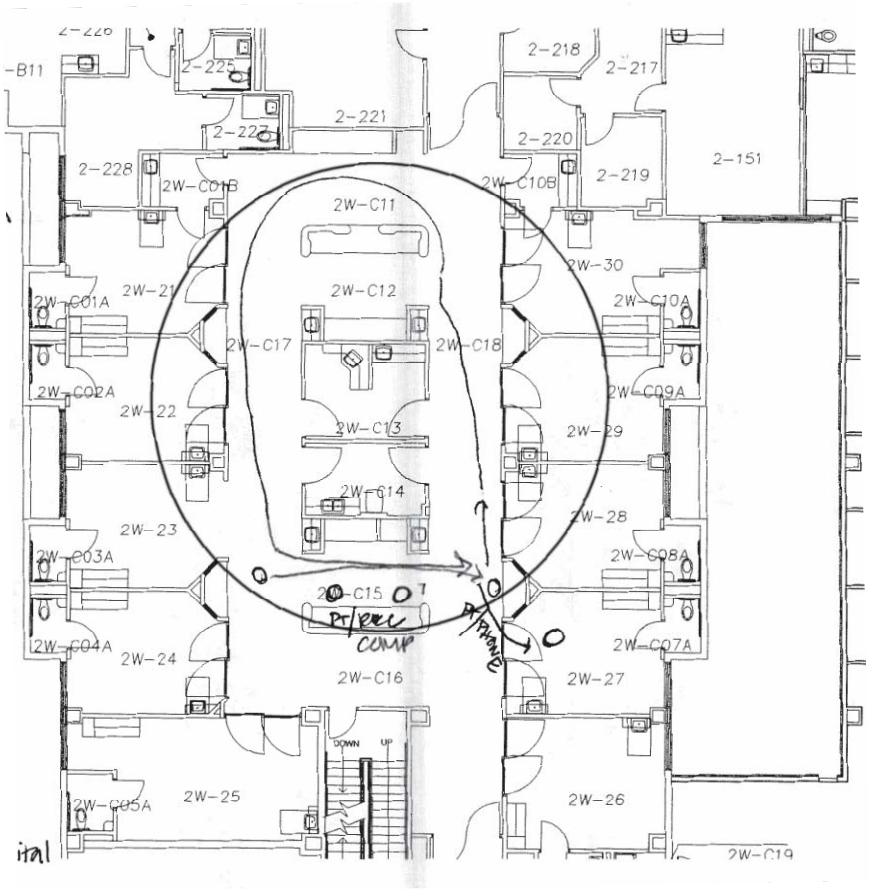


Figure 27. Environmental map of mobile phone

Remote recording (Figure 28) is when a nurse travels out of the patient room to record patient data at a nurse station. Remote recording is seen in these examples: *(A nurse currently using the central computer station has patients down at the other end of the pod.)*, *(Nurses and technicians are walking in and out of the patient room and using the decentralized nurse station to record patient data in the computer system.)*, and *(Both nurses at the central nurse station are*

coming or going to patient rooms and then recording patient data.). All three instances show that nurses are going out of their way to record patient data at a nurse station.

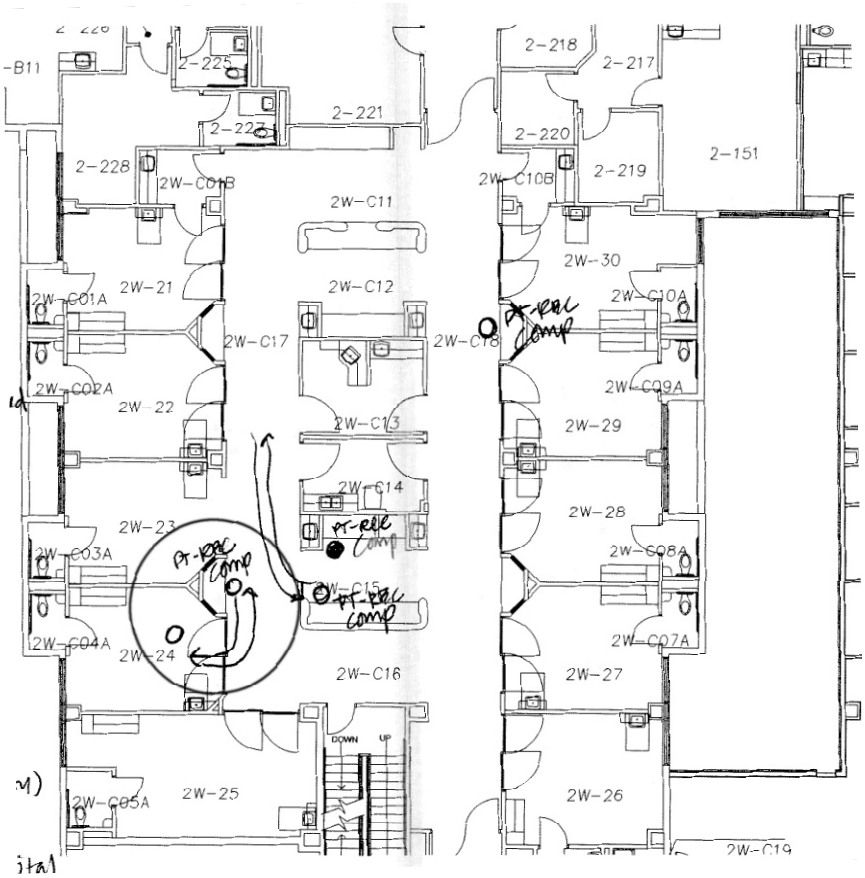


Figure 28. Environmental mapping of a nurse remote recording patient data at a de-centralized nurse station

Gravitate is seen in Figure 29 *w*hen staff members move to where another staff member is working to initiate communication. These are usually patient-related conversations where the information being relayed is considered important. Gravitate is seen in the following example, *(The doctor sitting across from the central doctor's station comes to the front of the station when the nurse*

leaves patient room 21. They are having a face-to-face conversation about patient needs. The nurse is behind the nurse station using the computer while they are talking to record patient data.). Also, the staff member that gravitates towards the other is more "free" than the other "stationary" staff member that is in the act of performing a focused task. These instances of communication usually occur at the central nurse station, patient room doorway, hallway, and de-central nurse station.

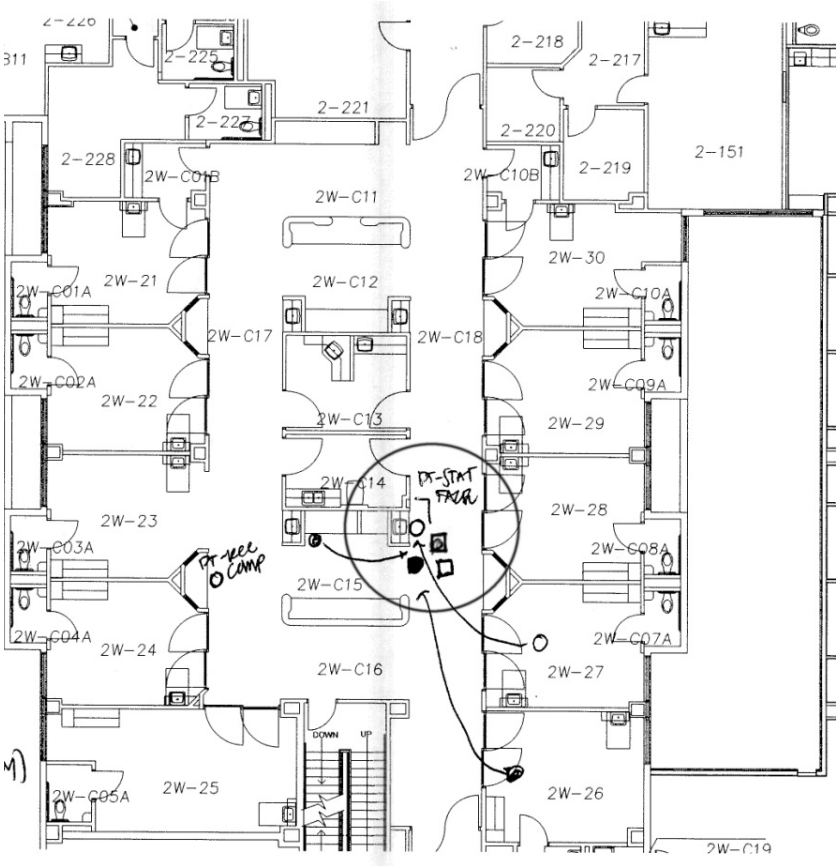


Figure 29. Environmental map of gravitate to nurse in hallway

Observations on the two ICU units were organized according to three overarching categories; *Actor*, *Mode*, and *Zone*. Nurses were identified as natives on the ICU unit with unique styles and modes of communication that change

according to the locations or zones. In contrast to other groups in the ICUs, semi-natives and non-natives, nurses engage more in multitasking, communicate with more modes, and cross all of the zones. They appear to have more mode-zone interactions. The unique characteristics of nurse-mode-zone interaction are further analyzed in a biaxial map, which begins to illuminate factors in the built environment that enhance or hinder nurse communication in a hybrid nurse station design.

4.4.2 Biaxial Map

Nurse interactions with other staff members based on the different zones of the ICU pod are displayed in Figure 30. Out of the Actor-Zone comparison emerged four categories describing core nurse communication interactions: At ease, On guard, In motion, and On the edge. Nurse communication patterns are affected by the actor and zone factors. These nurse communication intersections are explained in more detail within this section.

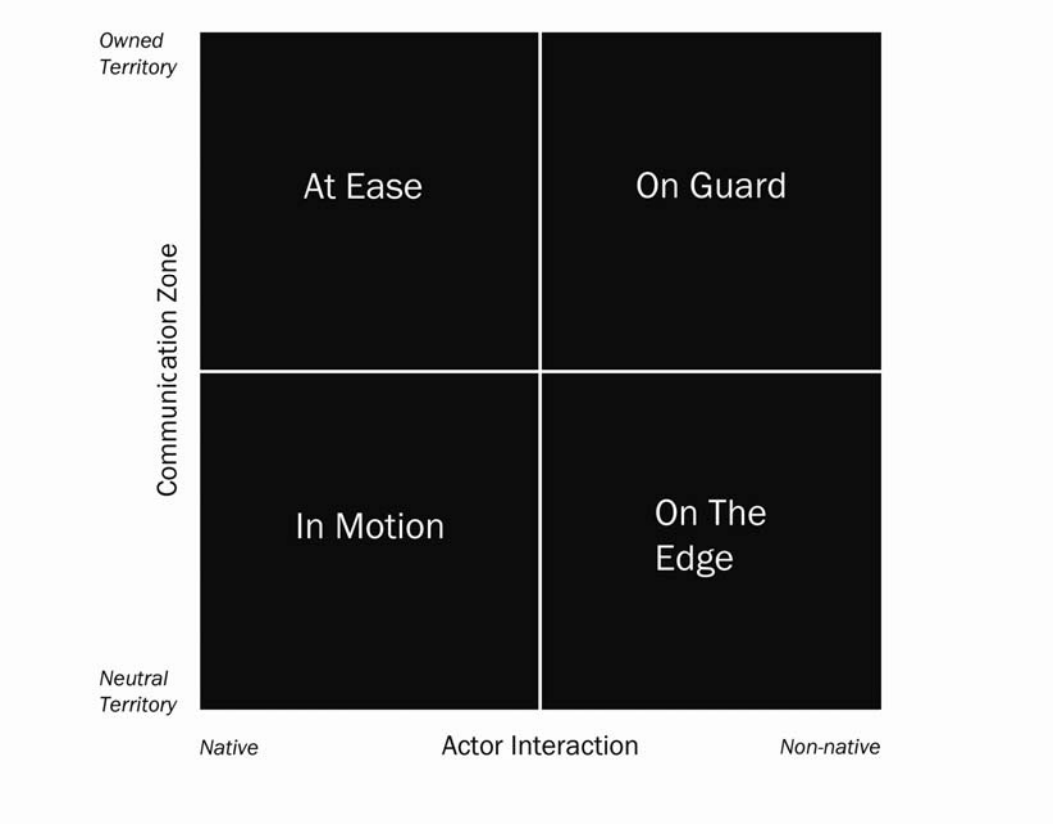


Figure 30. Biaxial Map of nurse communication based on actor, mode, and zone

At ease describes interactions among nurses occurring within nurse work areas including central and de-centralized nurse stations. When nurses interact with each other in or around nurse stations they are comfortable and informal. At the central nurse station conversation shifts from patient-related to personal effortlessly. This casual element present in nurse interactions are seen in the following examples: *(The nurses behind the central nurse station are sitting down and having conversations with the nurses standing on the outside of the central station.), (A nurse at the back wheels across the central nurse station in the chair*

and on a phone to talk to nurses at the front part of the central station.), *(Two nurses talking about personal information standing in front of centralized nurses station leaning against station. One nurse is still sitting at station participating in conversation drinking coffee.)*, and *(Nurses in the hallway to the left of the central nurse station are still having a personal conversation. One nurse is sitting in a chair at the decentralized station and the others are standing around her.*).

These nurse-nurse interactions illustrate the ease and comfort that nurses experience when they are communicating with one another. The nurse stations help to facilitate a sense of community, which in turn helps to facilitate open communication between nurses. The mode used most in this quadrant between natives is face-to-face; computer, hand-written, and telephone usage also occurred alongside face-to-face communication.

Nurse interactions with non-natives happening in owned territory are described as ***on guard***. Nurses have few interactions with other staff members such as doctors or technicians within nurse stations. Technicians and doctors do not enter nurse stations unless necessary, and when they do their stay is typically brief. The following two examples are of technician interactions with nurses within central nurse stations: *(A technician walks all the way around the front of the nurse station to talk to a doctor in the back about patient stats.)* and *(A technician is kneeling at the central nurse station at a computer. He says 'Watch my leg there' to another nurse walking by behind him through the central nurse station. There were chairs available for him to sit on.).* Additionally, the

following nurse interaction with doctors exemplifies their "on guard" stance; *(A nurse leaves the central nurse station when 5 doctors are using the back of the central nurse station to have a patient related discussion.).* Nurse communication with other *non-natives* is a problem within the central nurse station.

In motion is a nurse-nurse interaction happening in neutral territory. These interactions are focused on getting work done efficiently. Nurses are focused and work quickly when they are in neutral territory, such as the hallway and patient zones. Communication interactions between nurses in these zones are typically patient-related and done in passing. Nurses on the pod, *(have a sense of urgency. They are walking quickly to and from the patient rooms with a purpose, and even sometimes running.).* The mode of communication used in this quadrant is face-to-face and mobile phone communication.

Nurse interactions with other staff members in neutral territory are considered ***on the edge.*** These interactions are seen as fleeting and not having anywhere to land and happen. Examples of nurses interacting with technicians and doctors in neutral territory; *(Technicians talking to nurse in hallway about patient care next to the central nurse station.)*, *(A nurse and doctor walk from inside the central nurse station to the outside of it and lean against the high outside counter facing each other to talk about a patient.)*, and *(A nurse and doctor are using the central nurse station outer counter and are moving in and out of the doorway of patient room 27.).* The following observation is an example of nurse communication with a family member, *(A nurse talks to a family member*

in the hallway about logistics in regard to moving a patient to go and get a CAT scan.). Communication between natives and non-natives is in limbo and this is seen in the way and areas where nurses communicate with other staff members. The mode used most often in this quadrant by nurses is primarily face-to-face communication with non-native actors.

The quadrants within the biaxial map highlight factors that may enhance or hinder nurse communication in a hybrid nurse station design. The quadrants that represented barriers to nurse communication were *on guard* and *on the edge*. These two quadrants showed communication interactions with *non-natives* in both *owned territory* and *neutral territory*.

The quadrants that represented facilitators to nurse communication were *at ease* and *in motion*. Both of these quadrants were based on nurse-nurse interactions across both zones. Nurses, being natives, spent the most time on the floor together. This enabled them to work closely and comfortably with each other, which fostered a positive nurse culture of communication. This was observed in the way that nurses volunteered to help each other, had personal conversations at the central nurse station over coffee, and walking around the pod on their portable phone while performing other tasks.

Nurse-nurse communication is supported through a hybrid nurse station design. The design of the pod to include both central and de-centralized nurse stations allow for nurses to select where they work based on the task at hand. Nurse communication with other staff members is impeded because non-natives

do not have designated spaces within the pod to work. The addition of flexible spaces for semi-natives and non-natives to interact would facilitate cross-actor communication. These zones could encourage quick interactions between staff members and spaces for non-natives to perch would allow for work to get done and not impede on native territory.

4.5 Conclusion

The findings in this study were based on key concepts surrounding nurses and how they communicate within the context of their surrounding environment. Nurse communication with other staff members is greatly affected by their built environment. The themes and biaxial map shown in this chapter reinforce the importance of designing an ICU environment that is conducive to effective nurse communication.

Chapter 5

DISCUSSION AND CONCLUSIONS

5.1 Introduction

This chapter discusses the results of the data analysis presented in the prior chapter based on the research questions and issues presented in the current literature. The topics discussed include a discussion of the results, limitations, implications, and directions for future research.

The purpose of this study was to understand nurse communication in relation to the built environment. Interpretation of findings will clarify nurse communication needs in an ICU with a hybrid nurse station layout, and suggest a possible framework to further understand how to design ICU environments based on key stakeholder's communication needs.

The first section of this research introduces the overarching concepts of *Actor*, *Mode*, and *Zone*. These core concepts are the basis of nurse communication, and the subsequent key themes further clarify and support these concepts. The second segment of this research focuses on the relationship between the main concepts: *Actor*, *Mode*, and *Zone*. This section explores how the built environment positively or negatively affects nurse communication. A biaxial map was developed to illustrate the relationship between actors and zone. These concepts were compared to determine how nurses communicate with staff members based on where the interaction is happening within the ICU pod. Four

quadrants emerged that demonstrate how nurses communicate in ICUs with a hybrid nurse station layout.

5.2 Discussion of Results

The research suggests that characteristics of nurse communication in the hybrid ICU environment are associated with three key factors: who the interaction is happening with, how the information is being relayed, and where in the pod is the interaction occurring. This is made apparent through the core concepts of *Actor*, *Mode*, and *Zone* that emerged through observations. These concepts and their supporting themes helped define nurse communication in a hybrid ICU nurse station layout.

The first outcome to emerge from the analysis of observations was the different actor roles present within the pod. This was seen most apparently in the actor theme seen in the native-non-native continuum. Nurses were observed as the "natives" of the floor because they spent the most time on the pod taking care of patients. This research supports the theory that nurses are central to the efficiency and effectiveness of healthcare delivery because they spend more time directly with the patient than any other healthcare provider (Hendrich & Chow, 2008). Nurses are central to the exchange of information related to patient care in ICU work environments, and this collaboration requires a supportive built environment that allows for focused individual work and interactive group work. Some suggestions to facilitate nurse communication and collaboration in ICUs are low staffing ratios, smaller units, the presence of experienced and specialized nurses,

and close proximity among staff members (Dougherty & Larson, 2005). Mayo Clinic Hospital's ICU pod supported nurse work in terms of the hybrid nurse station layout. The mix between central and de-centralized nurse stations allowed nurses to select a space that worked best for their needs or tasks that nurses need to accomplish. The two types of nurse stations facilitated both individual and group work occurring simultaneously, and offered nurses the kind of work environment flexibility that is required in ICUs.

The second key finding of this study was concerned with mode and types of communication. A nurse's mode of communication changed based on what kind of information they were trying to relay and the target of their communication. The major modes of communication observed were face-to-face, telephone, computer, and written documentation. The frequency and content of these interactions varied based on the *Actor* or *Zone* factor. Nurses were observed switching from one mode of communication to another quickly and easily when performing tasks or interacting with another nurse. The nurse stations provided an area for nurses to document patient data, make phone calls, or have personal conversations with other nurses. When working in neutral territories, nurses were on the go, helping other nurses, taking care of patients, and walking while talking on the phone. The mode of communication depended heavily the built environment and where nurses chose to interact with other staff members in the ICU pod.

This research suggests that the central nurse station or *activity center* is necessary to facilitate nurse communication. The central nurse station provided a place for nurses to interact easily with one another and have both patient-related and personal conversations. Also, the *activity center* promotes a positive organizational culture focused on strong community among nurses. This nurse community facilitates communication, fosters education, encourages helping others, and facilitates the transfer of patient information. Even though the central nurse station provided enhanced nurse-nurse communication, nurse interactions with non-natives were not adequately supported at the central nurse station. Observations showed that communication interactions between native and non-natives were restricted and there was a visible need for a zone and space for these interactions to happen.

Work environments for *non-natives*, such as doctors, technicians, and family members, were absent. Because of native territoriality, there is a lack of spaces for non-natives to perform necessary work within the pod. This negatively affected the way that nurses interacted with them and ultimately affected team communication. This can be seen in the biaxial map that illustrates nurse communication based on the built environment. The biaxial map represents native and non-native communication intersected with the built environment zones of owned and neutral territories. This interaction changed based on who and where nurses were communicating. The four main quadrants that resulted from the

biaxial map (figure 31) include: At ease, On guard, In motion, and On the edge.

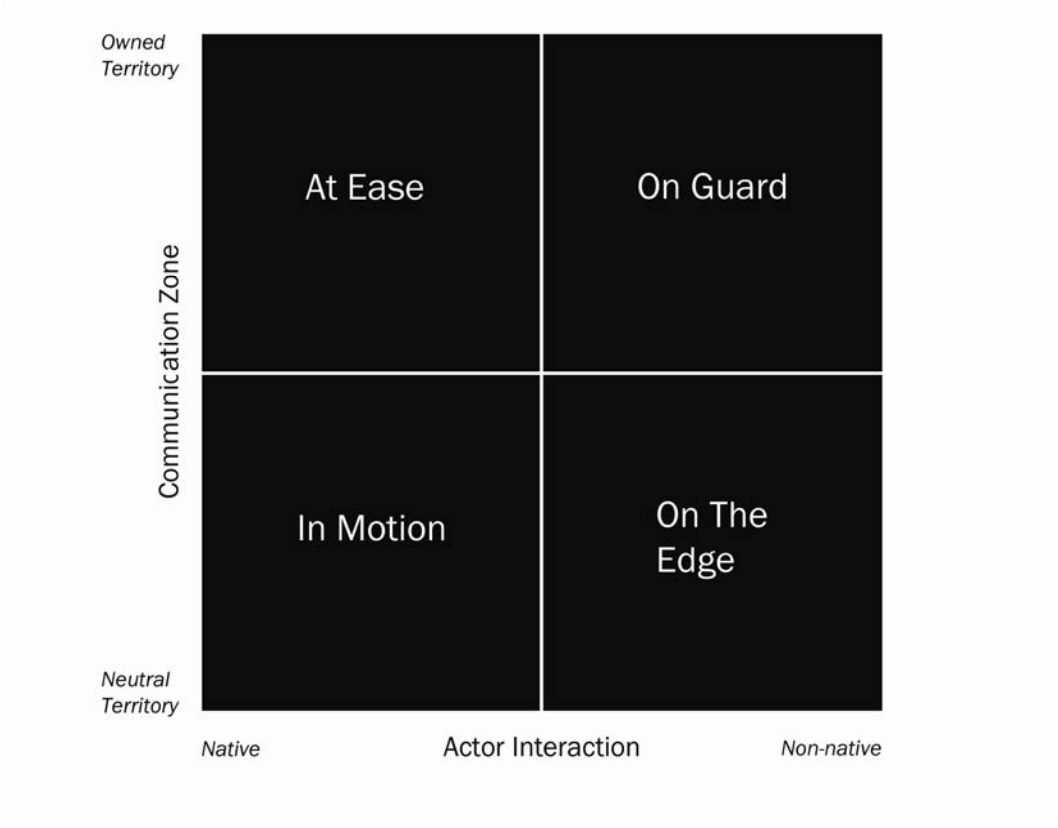


Figure 31. Biaxial Map of nurse communication based on actor, mode, and zone

On guard and *on the edge* quadrants presented in the biaxial map represented barriers to communication between natives and non-natives. Issues with communication in these quadrants were in both owned and neutral territories. Information transfer between nurses and non-natives was observed to be less effective than nurse-nurse communication taking place in the same zones.

Changes to the built environment have the potential to improve team communication between nurses and other staff members in ICU environments.

Heerwagen (2004) suggests design characteristics to enhance collaboration and communication in work environments including visual transparency, shared information displays, mobility within the space, and ease of switching between individual and collaborative work. The following design solutions to enhance team communication were initially presented as part of the review of literature. A design solution proposed by Becker (2007) suggests specific design elements to enhance collaboration and promote a culture of communication. These design elements include providing staff with accessible spaces and technology that offer the opportunity for group interaction to promoting effective communication and knowledge sharing. Specific to healthcare environments, Joseph (2006) proposes design characteristics such as flexible workspaces, smaller unit size, visual connections, different types of meeting spaces, and neutral spaces to promote a culture of teamwork and communication. These design features could enhance teamwork, foster interaction, facilitate information seeking, support knowledge sharing, and reduce staff hierarchies among staff members in healthcare environments.

5.3 Limitations of the Study

A limitation of this study was the exploratory nature of the research. The newness of the research methods used and the small amount of Evidence-Based Design research available on nurse communication limited the amount of comparable research. However, the broad exploration presented in this study

helps to initiate future research on nurse communication and hybrid unit design layouts in the emerging field of evidence-based design.

This study does not take into consideration the potential change in nursing staff's behavior due to the observer's presence on the unit. This research allows for an in-depth understanding of nurse communication in intensive care units, but cannot be generalized to other areas of the hospital. Additionally, other ICU units and organizations may have different nurse communication needs based on technology availability, unit layout, organizational differences, and patient needs.

5.4 The Research Problem and Implications

This research was focused on how nurses communicate in an ICU with a hybrid nurse station design. It offered a look into how nurses interact with and against their work environment, and specifically how the built environment impacts the way nurses communicate. This research also explored the intersections between the characteristics of nurse communication and the design of a hybrid ICU. The information collected in this research could be used in many different ways, including: changing the way ICUs environments are designed to facilitate nurse communication; re-designing work environments to enhance the work experience of different stakeholders in healthcare environments; and finally identifying the characteristics that will best improve nurse communication in the ICU.

Furthermore, the information from this research can aid in the incorporation of the nurses' perspective into the design process. This research will

add to the Evidence-Based Design body of knowledge, and be a catalyst to further the study of nurse work environments, including, but not limited to, the importance of nurse communication and hybrid nurse station layouts.

5.5 Future Research

This research has initiated research on hybrid nurse station design. Future research related to hybrid nurse station layouts could include: Studying how other stakeholders communicate in the environment, studying hybrid nurse station layouts in other areas of the hospital, comparing hybrid layouts to other nurse station layouts such as fully centralized or de-centralized layouts, studying the correlation of nurse communication to other outcomes and factors, and more focused and quantitative research.

A focus on the effects of hybrid unit design on other staff members in particular, doctors, technicians, and family members, would be valuable. By looking into the needs of other staff members, the information will be available to design units based on quantifiable metrics for different stakeholders on the unit. Research focused on communication needs of different stakeholders within hybrid nurse station unit could potentially enhance team communication and inevitably patient outcomes.

Generalization in future research would increase the significance of findings. This could include other units, additional staff members, and different organizations. A focus on other types of critical care units with hybrid nurse station layouts would allow for more comprehensive information available to base

design decisions. Furthermore, research performed in other healthcare organizations in different geographical locations would allow for a more diverse range of data.

Research surrounding hybrid ICU could be expanded by connecting the impact of the nurse station layout directly to outcomes such as patient outcomes, errors, and the professional practice environment. Additionally, more in-depth qualitative and quantitative data collection, such as focus groups, shadowing nursing staff, deep dives, staff interviews, and surveys; would allow for more focused data that would support more specific design decisions.

5.6 Conclusion

This research begins to describe nurse communication in ICUs and understand how a hybrid nurse station layout affects the way staff communicate in these environments. More knowledge is needed on how the built environment affects nurse work in general, and nurse communication in particular. This study initiates research surrounding nurse communication and suggests possible frameworks for design decision-making to enhance staff communication and ultimately patient outcomes. The intersection of the concepts *Actor*, *Mode*, and *Zone* concepts reveals gaps in Evidence-Based Design research that could be enhanced by further research on nurse communication and hybrid nurse station layouts.

REFERENCES

Aiken, L., Clarke, S. P., Sloane, D. M., Lake, E. T., & Cheney, T. (2008). Effects of Hospital Care Environment on Patient Mortality and Nurse Outcomes [Electronic Version]. *The Journal of Nursing Administration, 38*, 223-229.

Aiken, L. H., Clarke, S. P., Sloane, D. M., Sochalski, J., & Silber J. H. (2002). *Hospital Nurse Staffing and Patient Mortality, Nurse Burnout, and Job Dissatisfaction* [Electronic Version]. *JAMA, 288(16),* 1987-1993.

Alameddine, M., Dainty, K., Deber, R., & Sibbald, W. (2009). The intensive care unit work environment: Current challenges and recommendations for the future [Electronic Version]. *Journal of Critical Care, 24*, 243-248.

American Association of Colleges of Nursing (AACN) (2002). Hallmarks of the Professional Nursing Practice Environment. [Electronic Version] *Journal of Professional Nursing, 18(5)*, 295-304.

Amos, M. A., Hu, J., & Herrick, C. A. (2005). The impact of team building on communication and job satisfaction of nursing staff [Electronic Version]. *J Nurses Staff Dev, 21(1),* 10-16.

Auerbach, D. I., Buerhaus, P. I., & Staiger, D. O. (2007). Better late than never: Workforce supply implications of later entry into nursing [Electronic Version]. *Health Affairs, 26,* 178-185.

Baggs, J. G., Schmitt, M. H., Mushlin, A. I., Mitchell, P. H., Eldredge, D. H., Oakes, D., & Hutson, A. D. (1999). Association between nurse-physician collaboration and patient outcomes in three intensive care units [Electronic Version]. *Critical Care Medicine, 27*(9), 1991-1998.

Bates, D. W., Boyle, D. L., Vander Vliet, M. B., Schneider, J., & Leape, L. (1995). Relationship between medication errors and adverse drug events [Electronic Version]. *Journal of General Internal Medicine, 10*, 199-205.

Becker, F. (2007). Organizational ecology and knowledge networks. *California Management Review. 29(2),* 1-20.

Beckmann, U., Bohringer, C., Carless, R., Gillies, D. M., Runciman, W. B., Wu, A. W., & Pronovost, P. (2003). Evaluation of two methods for quality improvement in intensive care: Facilitated incident monitoring and retrospective medical chart review [Electronic Version]. *Critical Care Medicine, 31(4),* 1006-1011.

Boyle, D.K. & Kochinda, C. (2004). Enhancing Collaborative Communication of Nurse and Physician Leadership in Two Intensive Care Units [Electronic Version]. *Journal of Nursing Administration, 34(2),* 60-70.

Cama, R. (2009). *Evidence-Based Healthcare Design.* Hoboken, New Jersey: John Wiley & Sons, Inc.

Carayon, P., Alvarado, C. J., & Hundt, A. S. (2003). *Reducing workload and increasing patient safety through work and workspace design.* Madison, WI: Center for Quality and Productivity Improvement.

Chaudhury, H., Mahmood, A., & Valente, M. (2009). The Effect of Environmental Design on Reducing Nursing Errors and Increasing Efficiency in Acute Care Setting: A Review and Analysis of the Literature [Electronic Version]. *Environment and Behavior, 41(6),* 755-786.

Disch, J., Beilman, G., & Ingbar, D. (2001). Medical directors as partners in creating healthy work environments [Electronic Version]. *Adv Pract Acute Crit Care, 12,* 366-77.

Donchin, Y., Gopher, D., Olin, M., Badihi, Y., Biesky, M., Sprung, C. L., …, & Cotev, S. (1995). A look into the nature and cause of human errors in the intensive care unit [Electronic Version]. *Critical Care Medicine, 23*, 294-300.

Donchin, Y. & Seagull, F. J. (2002). The hostile environment of the intensive care unit. [Electronic Version]. *Curr Opin Critical Care, 8,* 316–320.

Dougherty, M. B. & Larson, E. (2010). The Nurse-Nurse Collaboration Scale [Electronic Version]. *Journal of Nursing Administration, 40(1),* 17-25.

Dougherty, M. B. & Larson, E. (2005). A Review of Instruments Measuring Nurse-Physician Collaboration [Electronic Version]. *Journal of Nursing Administration, 35(5),* 244-253.

Ebright, P. R., Patterson, E. S., Chalko, B. A., & Render, M. L. (2003). Understanding the Complexity of Registered Nurse Work in Acute Care Settings [Electronic Version]. *Journal of Nursing Administration, 33(12),* 630-638.

Embriaco, N., Papazian, L., Kentish-Barnes, N., Pochard, F., & Azoulay E. (2007). Burnout syndrome among critical care healthcare workers [Electronic Version]. Current *Opinion in Critical Care, 13*, 482-488.

Friese, C. H., Lake, E. T., Aiken, L. H., Silber, J. H., & Sochalski, J. (2007). Hospital Nurse Practice Environments and Outcomes for Surgical Oncology Patients [Electronic Version]. *Health Research and Educational Trust, 43(4),* 1145-1163.

Gurascio-Howard, L., & Malloch, K. (2007). Centralized and Decentralized Nurse Station Design: AN Examination of Caregiver Communication, Work Activities, and Technology. *Health Environments Research & Design Journal, 1(1),* 44-57.

Gurses, A. P. & Carayon, P. (2009). Exploring performance obstacles of intensive care nurses [Electronic Version]. *Applied Ergonomics, 40,* 509-518.

Hammersley, M. A. & Atkinson, P. (1995). *Ethnography: Principles in practice.* London: Routledge.

Hendrich, A. & Chow, M. (2008). Maximizing the Impact of Nursing Care Quality: A Closer Look at the Hospital Work Environment and the Nurse's Impact on Patient-Care Quality. *The Center for Health Design,* White Paper Series 4. Retrieved from http://www.healthdesign.org/hcleader/HCLeader_4_NursingCareWP.pdf

Hendrich, A., Fay, J., & Sorrells, A. K. (2004). Effects of acuity-adaptable rooms on flow of patients and delivery of care. *American Journal of Critical Care, 13*, 35-45.

Henriksen, K., Isaacson, S., Sadler, B. L., & Zimring, C. M. (2007). The role of the physical environment in crossing the quality chasm. *The Joint Commission Journal on Quality and Patient Safety, 33,* 68–80.

Heerwagen, J. H., Kampschroer, K., Powell, K. M., & Loftness, V. (2004). *Collaborative Knowledge Work Environments, 32,* 510-528.

Institute of Medicine (IOM). (2001). *Crossing the quality chasm: A new health system for the 21st century.* Washington, DC: National Academics Press.

Johnson, C. (2002). The Causes of Human Error in Medicine [Electronic Version]. *Cognition, Technology & Work, 4,* 65–70.

Joint Commission on Accreditation of Healthcare Organizations (JCAHO). Sentinel event statistics, June 29, 2004, Retrieved from http://www.jointcommission.org/sentinelevents/sentineleventalert/

Joseph, A. (2006). The Role of the Physical and Social Environment in Promoting Health, Safety, and Effectiveness in the Healthcare Workplace [Electronic Version]. *The Center for Healthcare Design, 3,* 1-17.

Joseph, A. & Ulrich, R. (2007). Sound Control for Improved Outcomes in Healthcare Settings [Electronic Version]. *The Center for Healthcare Design, 4*, 1-17.

Kalish, B. J., Curley, M., & Stefanov, S. (2007). An Intervention to Enhance Nursing Staff Teamwork [Electronic Version]. *Journal of Nursing Administration, 37(2),* 77-84.

Kohn, L. T., Corrigan, J. M., & Donaldson, M. S. (1999). T*o Err Is Human: Building a Safer Health System*. Washington, DC: National Academy Press.

Leonard, M., Graham, S., & Bonacum D. (2004). The human factor: the critical importance of effective teamwork and communication in providing safe care [Electronic Version]. *Quality & Safety in Health Care, 13,* 185-190.

Lincoln, Y. S. & Guba, E. G. (1985). *Naturalistic Inquiry.* Beverly Hills, CA: Sage.

Mallak, L. A., Lyth, D. M., Olson, S. D., Ulshafer, S. M., & Sardone, F. J. (2003). Culture, the built environment and healthcare organizational performance. *Managing Service Quality, 13(1),* 27-38.

Manojlovich, M. & DeCicco, B. (2007). Healthy work environments, nurse-physician communication, and patient outcomes [Electronic Version]. *American Journal of Critical Care, 16(6)*, 536-543.

Nelson, J. W. & Venhaus, R. (2005). Improving Retention Through Nurse/Physician Communication [Electronic Version]. *Nurse Leader, 3,* 54-56.

O'Leary, Z. (2004). *The essential guide to doing research.* London: Sage.

Page, A. (2004). Work and workspace design to prevent and mitigate errors. *In Keeping patients safe: Transforming the work environment of nurses* (pp. 226-285). Washington, DC: The National Academies Press.

Pronovost, P., Berenholtz, S., Dorman, T., Lipsett, P. A., Simmonds, T., & Haraden, C. (2003). Improving Communication in the ICU Using Daily Goals [Electronic Version]. *Journal of Critical Care, 18(2),* 71-75.

Reader, T. W., Flin R., Mearns, K., & Cuthbertson, B. H. (2007). Interdisciplinary communication in the intensive care unit. *British Journal of Anaesthesia, 98(3),* 347-352.

Reason, J. (2000). Human error: models and management [Electronic Version]. *British Medical Journal, 320(7237)*, 768-770.

Reiling, J. G., Knutzen, B. L., Wallen, T. K., McCullough, S., Miller, R., & Chemos, S. (2004). Enhancing the Traditional Hospital Design Process: A Focus on Patient Safety [Electronic Version]. *Journal on Quality and Safety, 30(3),* 114-124.

Rodgers, A. E., Hwang, W., Scott, L. D., Aiken, L. H., & Dinges, D. F. (2004). The working hours of Hospital Staff Nurses and Patient Safety [Electronic Version]. *Health Affairs, 23(4*), 202-212.

Rothstein, P. (2001). *a(x4): A user-centered method for designing experience.* IDSA Education Conference Proceedings, Boston Massachusetts.

Sadler, B., DuBose, J., & Zimring, C. (2008). The Business Case for Building Better Hospitals Through Evidence Based Design. *Health Environments Research & Design Journal, 1(3),* 22-39.

Shortell,S. M., Rousseau, D.M., Gillies, R. R., Devers, K. J., & Simons, T. L. (1991). Organizational Assessment in Intensive Care Units (ICUs): Construct Development, Reliability, and Validity of the ICU Nurse-Physician Questionnaire [Electronic Version]. *Medical Care, 29(8),* 709-726.

Strauss, A. L. & Corbin J. M., (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory.* Thousand Oaks, CA: Sage.

Sutcliffe, K. M., Lewton, E., & Rosenthal, M. M. (2004). Communication Failures: An Insidious Contributor to Medical Mishaps [Electronic Version]. *Academic Medicine, 79(2),* 186-194.

Thomas, E. J., Sexton, J. B., & Helmreich, R. L. (2003). Discrepant attitudes about teamwork among critical care nurses and physicians. *Critical Care Medicine, 31(3),* 956-959.

Ulrich, R. S., Zimring, C., Zhu, X., DuBose, J., Seo, H., Choi, Y., … Joseph, A. (2008). A Review of the Research Literature on Evidence-Based Healthcare Design. *Health Environments Research & Design Journal, 1(3)*, 61-125.

Ulrich, R., Zimring, C., Joseph, A., Quan, X., & Choudhary, R. (2004). The role of the physical environment in the hospital of the 21st century: A once-in-a-lifetime opportunity. *The Center for Health Design for the Designing the 21st Century Hospital Project.* Retrieved from http://www.healthdesign.org/research/reports

U.S. Department of Health and Human Services: National Institute of Health (2005). Theory at a Glance: A Guide for Health Promotion Practice (Second Edition). Retrieved from http://www.cancer.gov/theory.pdf

APPENDIX A

ARIZONA STATE UNIVERSITY'S OFFICE OF INTEGRITY AND ASSURANCE EXEMPTION APPROVAL

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Gerri Lamb
From:	Mark Roosa, Chair Soc Beh IRB
Date:	12/03/2010
Committee Action:	**Exemption Granted**
IRB Action Date:	12/03/2010
IRB Protocol #:	1010005636
Study Title:	Critical Communication: A Study Exploring ICU Environments and Nurse Communication

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(2) .

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.

APPENDIX B

MAYO CLINIC HOSPITAL'S OFFICE OF INTEGRITY AND ASSURANCE

EXEMPTION APPROVAL

From: IRBe
Sent: Sunday, November 21, 2010 10:01 AM
To: Pipe, Teresa B. (Teri), Ph.D., R.N.
Subject: A study has been deemed Exempt by the IRB

Principal Investigator Notification:

From: Mayo Clinic IRB
To: Teresa Pipe
CC: Teresa Pipe
Re: **IRB Application #:** 10-007704
Title: : Critical Communication: A Study Exploring ICU Environments and Nurse Communication

IRBe Protocol Version: 0.01
IRBe Version Date: 11/8/2010 9:46 AM

IRB Approval Date: 11/21/2010
IRB Expiration Date:

The above referenced application is determined to be exempt (45 CFR 46.101, item 2) from IRB review. Continued IRB review of this study is not required as it is currently written. However, any modifications to the study design or procedures must be submitted to the IRB to determine whether the study continues to be exempt. As protected health information is not being requested from subjects, HIPAA authorization is not required in accordance with 45 CFR 160.103.

AS THE PRINCIPAL INVESTIGATOR OF THIS PROJECT, YOU ARE RESPONSIBLE FOR THE FOLLOWING RELATING TO THIS STUDY:

(1) Submission to the IRB of any modifications and supporting documents for review and approval prior to initiation of the changes.

(2) Submission to the IRB of all unanticipated problems involving risks to subjects or others (UPIRTSO).

(3) Compliance with Mayo Clinic Institutional Policies.

Mayo Clinic Institutional Reviewer

APPENDIX C

CONSENT LETTER FOR OBSERVATIONAL PURPOSES

Information Letter

Critical Communication: A study exploring ICU environments and nurse communication

xx/xx/xxxx

Dear Hospital X ICU staff:

I am a graduate student under the direction of Professor Gerri Lamb in the College of Architectural and Landscape Architecture at Arizona State University. I am conducting a research study to explore the relationship between the built environment and nurse communication in ICUs.

I am inviting your participation. I will be observing nurse work related to communication within the context of an ICU with a decentralized nursing station layout. Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty. You must be 18 or older to participate in the study.

Possible benefits of your participation in this study are a further understanding of how the physical design of ICU impacts nurse communication, and potential design insights as to how ICU units could be designed to enhance nurse communication. There are no foreseeable risks or discomforts to your participation.

All staff being observed on the unit will remain anonymous. The results of this study may be used in reports, presentations, or publications but your name will not be known.

If you have any questions concerning the research study, please contact the research team at: Emily Newcomb (emily.newcomb@asu.edu) or Gerri Lamb (gerri.lamb@asu.edu). If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788. Please let me know if you wish to be part of the study.

Sincerely,
Emily Newcomb

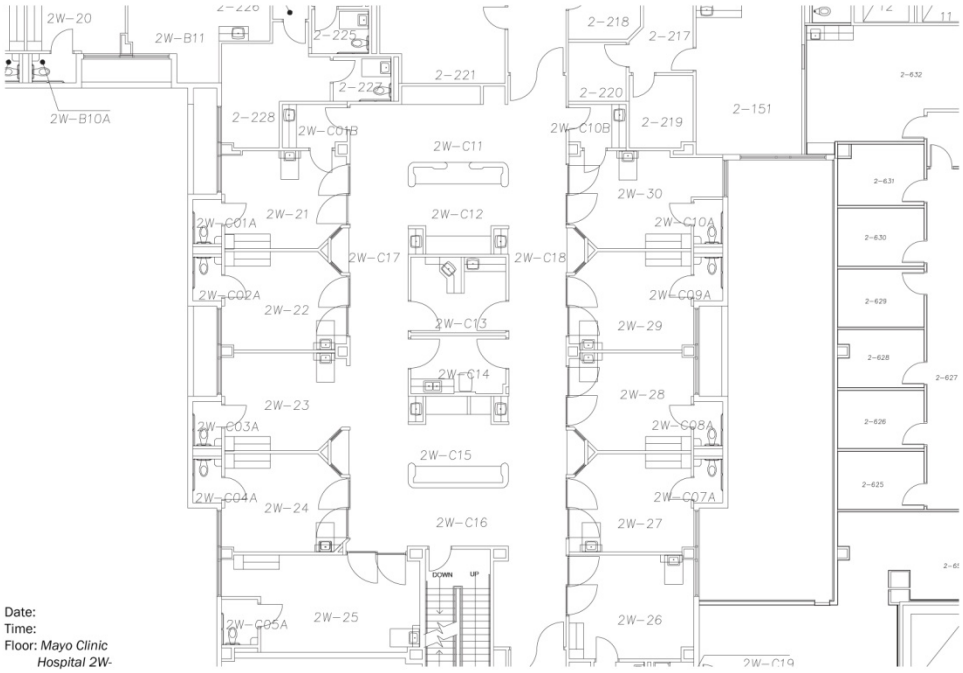
MSD Healthcare and Healing Environments
emily.newcomb@asu.edu

APPENDIX D

DATA COLLECTION TOOLS: A(X4) AND ENVIRONMENTAL MAPPING

Location: Date: Time:

actors	artifacts	activities	atmosphere



Date:
Time:
Floor: *Mayo Clinic Hospital 2W-*