THE ELECTRONIC INTENSIVE CARE UNIT: EYES IN THE SKY

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE

DEGREE OF DOCTOR OF PHILOSOPHY

IN THE GRADUATE SCHOOL OF THE

TEXAS WOMAN'S UNIVERSITY

COLLEGE OF NURSING

BY

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DENTON, TEXAS

AUGUST 2008

DEDICATION

To my family, John, Hilary and Nick, in appreciation of their encouragement, patience, and support.

ACKNOWLEDGMENTS

I gratefully acknowledge many friends and colleagues who have contributed to this dissertation through their support, guidance, and expertise. Special thanks go to Dr. Anne Young, my committee chair. She has been instrumental in my success in my completing this doctoral program.

I would like to recognize Dr. Janet Foster and Dr. Jeffrey Huber, who served as members of my dissertation committee. Their thorough review, helpful suggestions, and content expertise greatly added to this body of knowledge.

Although they must remain anonymous, I want to express my sincere gratitude and appreciation to the many eNurses and ePhysicians who participated as subjects in this research. They are pioneers in healthcare who are blazing new trails in the telemedicine frontier.

ABSTRACT

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This ethnographic study of the VISICU eICU® (Baltimore, MD) work environment in a large Midwestern healthcare system describes everyday life working in a telemedicine intensive care. The eICU® telemedicine model of care uses technology to provide intensivist-driven care in settings without bedside intensivist coverage. Previous studies of the eICU® model of care mainly focus on quantitative elements evaluating specific clinical outcomes. This study examined the way such units function.

Data were gathered through 60 hours of observation and formal interviews of eClinician team members. Thirteen eNurses, three ePhysicians, and one IT Systems Analyst participated in semi-structured interviews and twenty-seven additional eClinicians participated in the field study. Years of clinical experience and experience in critical care ranged from 5 years to over 30 years.

Findings concluded that the eICU® work environment is like working in an air traffic control center. eClinicians work at computer screens monitoring multiple ICU patients. The eClinician has access to information that is not always readily available to the bedside team. The eClinician provides this information and recommendations for interactions to the bedside team who has hands-on control to change the course of events.

Effective communication and interactions between the eClinicians and the bedside team are critical to the success of this practice model.

The eICU© model of care is a viable way to provide experienced ICU nurses and intensivists to supplement the bedside team. The work environment provides a way for eNurses to continue to use their critical thinking skills and ICU experience in a setting with less physical demands than bedside ICU nursing. The ePhysicians find value in the eICU© model of care from a patient safety and cost avoidance perspective but admit that the ideal care model includes an intensivist at the bedside.

Further study is needed to describe the eICU© care model from the perspective of the bedside ICU team. This perspective is needed in order to determine how to develop appropriate protocols, policies, communication plans, and practices that will ensure ongoing effective collaboration between the two entities.

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CHAPTER I

INTRODUCTION

Intensive Care Units (ICUs) were first developed in the 1950s in response to advances in surgery and anesthesiology that called for close, frequent post-operative observations by nursing staff (Robnett, 2006). Early ICUs looked like regular patient care units with the exception that the nurse to patient care ratio was lower and patient assessments were performed more frequently. Few of the early ICUs had advanced technology and equipment. In the 1960s, open heart surgery became more common in the United States requiring more sophisticated monitoring technology in the immediate post-operative period in the physician's absence. ICUs became highly technical patient care units that offered the ability to rapidly assess and treat the critically ill patient.

Today, ICU beds account for approximately 10% of all inpatient acute care hospital beds in the United States, 20-30% of hospital costs, and 1% of the U.S. gross domestic product (Rosenberg, Zimmerman, Alzola, Draper, & Knaus, 2000). Approximately 400,000 to 500,000 patients die in U.S. ICUs annually (Rosenfeld, Dorman, Breslow, et al., 2000). Avoidable adverse events account for some of those patient deaths.

Current best practice in ICUs includes continuous coverage by an intensivist to provide immediate physician support for the critically ill patient. Supported by the National Quality Forum (2002), the Agency for Healthcare Research and Quality

(2001), the Society of Critical Medicine (Bekes, 2004), and the Leapfrog Group (Milstein, Galvin, Delbanco, Salber, & Buck, 2000), this model is believed to improve patient safety and quality of care while decreasing complications, mortality, costs, and length of stay (Pronovost, Angus, Dorman, et al., 2002; Vincent, 2000). It is estimated that implementation of an intensivist-based model of care across the U.S. would save between 50,000 and 100,000 lives annually (Birkmeyer, Birkmeyer, Weinberg, & Young, 2000). The intensivist-led model of care is also associated with an improved work environment that is less stressful for the staff due to ready access to a qualified physician and improved communications amongst ICU team members (Haut, Sicoutris, Meredith, et al., 2006).

While the intensivist-led model of care in the ICU is preferred, there is a nationwide shortage of qualified intensivists and ICU nurses. There are approximately 6,000 ICUs in the country caring for approximately 55,000 patients daily (Schmitz, Lantin, & White, 1999). One-third of these patients are currently treated by an intensivist acting either as the primary physician or as a consultant (Schmitz, Lantin, & White, 1999). Demographic and manpower data suggest that this shortage of ICU specialists will worsen over time (Angus, et al., 2000).

Telemedicine is defined as the delivery of healthcare services across a distance with healthcare professionals "using information and communications technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of healthcare providers, all in the interest of advancing the health of individuals and their communities"

(International Society for Telemedicine and eHealth, 2008, Glossary of Telemedical Terms Q-Z section, para. 23). The eICU® product (VISICU, Inc., Baltimore, MD) is a new telemedicine model of care in the ICU that grew out of the initial premise for ICUs, to more rapidly assess and treat critically ill patients while maximizing the scarce resources of qualified ICU physicians and nurses. It is important to note that eICU® is a trade symbol and is not an abbreviation for a set of words. The eICU® model of care is a commercially available approach to supplementing patient care in the ICU by utilizing intensivists and experienced ICU nurses in a remote setting to communicate with multiple ICU bedside teams while monitoring their patients through an extensive computerized network. The members of the bedside ICU teams have instantaneous access to the eICU® team via telemedicine technology, telephone, and digital formats. Approximately 40 eICU® programs exist across the nation (Kowalczyk, 2007).

Purpose of Study

The eICU® model of care is an emerging model of intensive healthcare. This shift in health care mechanisms offers the promise of early intervention through the use of off-site monitoring. Roles of the registered nurses and intensivists in eICU® model of care are also expanding. However, this model and the roles of eICU® personnel have not been described in the health care literature. The purpose of this study was to describe the everyday world of working in eICU® work environment.

Rationale for Study

Telemedicine is a viable option to expand the limited resources of qualified intensivists and ICU nurses. To move from a bedside, hands-on ICU practice to a remote

location that is connected to patients and staff via cameras, computers, and telephone connections is a huge leap for physicians and nurses. This study provides insight into the dynamics of the eICU® work environment and the adaptations made by nurses and physicians to work in this environment. This study represents the first eICU® qualitative ethnographic research to take an in-depth look at the remote eICU® work environment. This study has implications for improved understanding of the telemedicine work environment and the adoption of a telemedicine model of care.

Theoretical Framework

Ethnography is qualitative research where the purpose is to provide a detailed, in-depth description of everyday life and practice (Hoey, n.d). Historically, there is not one philosophical approach to ethnography; rather, research has been guided by diverse philosophies derived from sociology and anthropology (Atkinson & Hammersley, 1994). Symbolic interactionism is one such philosophical orientation and will be used to guide this research study. Symbolic interactionism, developed by Blumer (1969), focuses on social interactions to explain human behavior and thought. Blumer's inspiration came from Dewey (1925/1981) who espoused that people are best understood in an interactive relation to their environment and Mead (1934) who described non-symbolic interaction and symbolic interaction. Non-symbolic interaction is reflexive while symbolic interaction is a response based on meaning. An example of symbolic interaction is when someone shakes their fist at another person who assigns meaning to this action that a punch to the face may be forthcoming. The shaken fist is interpreted as a sign of aggression which prompts a response of shielding one's face. Blumer further refined the

concept of symbolic interaction. One must ascertain the meaning of another's actions in order to determine what action he should take according to his interpretation.

Along with social interactions, one will encounter objects that play a significant role in social interactions. Blumer identifies three classes of objects including physical objects, social objects and abstract objects. One acquires meanings for the objects in the context of their environment.

Blumer's theory consists of three core principles: meaning, language, and thought, which lead to the conclusions one makes of themselves and their socialization into a larger community. The premise for the core principle of meaning is that human beings will act toward other human beings or things according to the meanings they have given to those persons or things. Language is a means for humans to "negotiate" meanings through symbols. The principle of thought involves an internal conversation to interpret the symbols of language in an effort to define self in the context of the larger community. The core principles constitute the framework whereby participants develop the concept of self. Blumer's theory asserts that through interactions with others, one can define oneself.

Scientists who utilize symbolic interactionism study social interactions through observation. Close contact and immersion into the culture are necessary to gain understanding of situations, the meaning of actions, and how participants create situations through their interactions. The ethnographic research design of this study utilizes direct observation of participants as they interact in the eICU® environment and semi-structured interviews. Through interviews and ethnographic fieldwork, this researcher gained

understanding and constructed descriptions of the eICU® work environment from the perspective of those who work there. The descriptions reflect the meanings these healthcare professionals ascribe to their daily experiences.

Symbolic interactionism was used to analyze and evaluate data collected during the field study and semi-structured interviews. Charon (1995, p. 150) writes that "social interaction defines society." He also asserts that almost all social interactions are symbolic. Symbolic interactionism involves a process of "communication, role taking, self direction, and ongoing adjustment that is an essential part of what people are" (Charon, 2007, p. 141). In order to understand the society of the eICU® work environment, one must understand the symbolic interactions that take place among the members of the eICU® team in their work environment. Data collection took place as the researcher interacted with the eICU® team by observing and participating in activities in their work environment. Interactions observed in the eICU® unit were analyzed according the following categories: role taking, communicating, interpreting one another, adjusting one's acts to one another, directing and controlling self, and sharing perspectives (Charon, 1995). Personal interviews with team members clarified meanings and causes of interactions observed in the field study. Evaluation of the symbolic interactions observed in the eICU® department enabled the researcher to define the reality of the eICU® work environment.

Assumptions

The following assumptions for this study were derived from Blumer's symbolic interactionism theory:

1. What people say they do is, in fact, what they do.
2. The meanings attributed by the eICU® nurses and physicians will accurately reflect the complexity of the work environment.

Research Questions

The research questions for this study were

1. What are the experiences of the health care workers in the eICU® setting?
2. How do health care workers function in the eICU® setting?

Orientational Definitions

For the purpose of this study, the following terms were defined:

1. *Health care workers* in the eICU® department are registered nurses and intensivists who routinely work in eICU® department.
2. *eICU®* model of care is the VISICU model of care in which a team of health care workers is physically located in a remote location to monitor critically ill patients and communicate with the bedside teams via telemedicine connections including cameras, computers and telephones.

Limitations

Study limitations include that only one eICU® department is included in this research. Therefore, generalizability of this study to other eICU® settings across the country is limited.

Summary

Intensive care units are highly technical areas that care for patients with complex medical conditions. Research indicates that the ability to rapidly assess and treat critically ill patients is improved when intensivists continuously manage the care of ICU patients. With the current shortage of intensivists in the U.S., it is currently impossible to provide that coverage for all ICU patients. It is predicted that the shortage will worsen over time resulting in even more patients not receiving the best possible care.

The eICU® model of care offers a telemedicine platform to allow intensivists and experienced ICU nurses to continuously monitor many ICU patients from a remote location. The eICU® model of care is a new approach to maximizing the advantage of intensivist medical management of ICU patients with fewer intensivists. The work environment of the eICU® team is physically removed from the ICU setting. Health care workers in the eICU® department have no face-to-face, "hands on" experiences with the patients they monitor. This remote work environment is unique to medical disciplines that are historically "hands on." This research is a description of the eICU® work environment through the words and experiences of those who work in this environment.

CHAPTER II

REVIEW OF THE LITERATURE

The electronic intensive care is an emerging form of care delivery that provides additional oversight of critically ill patients. The premise for the development of the eICU® model of care is its impact on patient safety. Public and private demands for hospitals to reduce errors and improve the quality of healthcare led to changes in the ICU work environment. This review of the literature begins with research related to patient safety, specifically in ICUs. A synthesis of the literature describing the evolution of the work environment in the ICUs that led to the development of the eICU® model of care will follow.

A literature search was conducted in PubMed and Cumulative Index to Nursing and Allied Health Literature (CINAHL) databases using the keyword eICU® The results produced eight articles for the keyword "eICU® ." Upon further review, only two of the eight articles were determined to be appropriate for this review. Citations were considered appropriate if they were research-based articles primarily focused on eICU® model of care and from peer-reviewed journals. Additional searches were conducted with the search words, "patient safety & ICU," "ICU work environment," "telemedicine work environment," "ICU collaboration," and "ICU communication" to provide the background for the development of the eICU® work environment. With these expanded searches, ten additional articles were deemed appropriate for this review.

Development of Intensive Care

While there is no concrete date associated with the beginning of critical care nursing, the literature acknowledges that it originates from the private duty nursing found in the respiratory wards that were set up during the polio epidemic in the late 1940s and early 1950s (Fairman, 1992). With continued advancements in anesthesia and surgery, it became necessary to increase the skills of nurses and decrease the nurse/patient ratio in order to prevent postoperative deaths in the first 24 hours after surgery (Robnett, 2006).

While the physical layout of early ICUs was not unlike the regular patient care units, the more critically ill patients were placed in private or semi-private rooms in close proximity to the nurses' desk. Patients with higher acuity received more frequent patient observations and monitoring of basic vital signs without the use of complex technology. With the advent of open heart surgery in the 1960s, technology in the ICUs advanced to allow additional monitoring devices such as continuous electrocardiography (ECG). Nurses were educated in ECG interpretation, advanced anatomy and physiology, and advanced assessment skills to more effectively monitor patients in the absence of the physician. In the 1970s, physicians began delegating more skills to ICU nurses that were once only in the purview of physicians such as drawing blood and arterial blood gases (Robnett, 2006).

Today, ICUs are often geographically separated from non-critical patient care units. In these units, care is provided to critically ill patients with lower nurse/patient ratios, usually 1:2, and a plethora of sophisticated equipment and complex technology (Hall, Schmidt, & Wood, 1992). Traditionally, ICU patient care is delivered using a team

model of dedicated medical experts at the bedside actively solving problems and administering care (Durbin, 2006). Problems are addressed through a shared understanding of the situation and a team approach is used to solve the problems (Hutchins & Klausen, 1998). The team consists of nurses, patient care assistants, physicians, and numerous allied health professionals. Until recently, often no single physician acted as the coordinator of the ICU care plan. Physician management of ICU patients consisted of different subspecialists who managed their "organ" of expertise. Subspecialist physicians were not continuously monitoring patient status or evaluating how the therapies they ordered interacted with those therapies ordered by other subspecialist physicians (Celi, Hassan, Marquardt, et al., 2001). Nurses addressed acute problems by emergently paging the subspecialist for a telephone or bedside consultation. Patient outcomes depended to a large extent on timeliness of problem identification by the bedside team, communication with the appropriate subspecialist physician, the accuracy of relayed information to the physician, and the diligence of the often off-site subspecialist (Moss, Trow, & Clardy, 1999).

Intensivists are physicians who are certified in critical care medicine and primarily care for patients in the ICU. This role is a relatively new specialty as the American Board of Medical Specialties certification for internal medicine critical care dates back to 1987 (U.S. Department of Health and Human Services, 2006). A number of studies within the last few years have demonstrated improvement in reducing costs and mortality when intensivists are involved in the care of critically ill patients (Dimick, Pronovost, Heitmiller, et al., 2001; Pronovost, Jenckes, Dorman, et al., 1999). Despite

mounting support for the intensivist model of care by the Leapfrog Group and the Society of Critical Medicine (Bekes, 2004), there has been slow acceptance of this model across the country (Angus, Kelley, Schmitz, et al., 2000). Subspecialist physicians resisted this model as it would negatively affect their referral patterns. Hospital administrators were reluctant to adopt the intensivist model due to the direct costs associated with hiring intensivists. However, the biggest deterrent to the intensivist model is the national shortage of intensivists in the United States (Bekes, 2004).

Grundy, et al. (1982) introduced the concept of ICU telemedicine. They introduced telemedicine as a means to supplement the scarcity and maldistribution of critical care expertise. These researchers utilized interactive television and telephone calls to provide consultations with university-based critical care physicians for ICU patients in a 100-bed community hospital. Telemedicine consultations ($N = 1,548$) were conducted with 395 patients over a period of 18 months. The authors reported that television consultations had greater clinical and educational impact than telephone consultations, but no definitive results could be reached on improved clinical and economic outcomes. The two-way television equipment was reliable and easy to use but cost prohibitive for widespread use of this technology. Interactive television was effective in providing real-time specialist expertise but the authors warned that extensive background research was necessary before telemedicine could be considered a viable option for widespread utilization as an extension of intensivist coverage.

The eICU® model of care was developed in an effort to use state of the art technology to provide intensivist-driven care even when it is not possible to have an

intensivist at the bedside (Becker, 2002; Rosenfeld, Dorman, Breslow, et al., 2000). The eICU® model of care was modeled after telemedicine which had been utilized for years to enable off-site physicians to provide quality health care in remote locations in the ambulatory health care arena (Eljamel & Nixon, 1992; Fintor, 1993; Perednia, 1991; Perednia & Allen, 1995).

The first research describing the eICU® model of care was conducted by Rosenfeld, et al. (2000). Researchers set out to evaluate the feasibility of using telemedicine to provide 24-hour intensivist oversight as a means to improve clinical outcomes for ICU patients. The study design was an observational time series triple cohort study and took place in a ten-bed surgical ICU in an academic affiliated community hospital. All patients whose entire ICU stay occurred during the 16-week study period were included in the study. Prior to the intervention, the ICU had the availability to consult an intensivist but there were no on-site intensivists. During the intervention period, intensivists in the remote eICU® location used telemedicine connections to obtain patient clinical information and to communicate with the on-site personnel. Clinical and economic performances during the intervention period were compared with two 16-week periods within the year before the intervention so data from three periods were compared.

Clinical outcomes were measured by ICU mortality and hospital mortality and ICU complications. Data analysis revealed that severity-adjusted ICU mortality decreased during the intervention period by 68% ($p < 0.05$) and 46% ($p < 0.05$) compared to the two baseline periods. There was no significant difference in hospital mortality. Severity-

adjusted hospital complications decreased by 33% ($p < 0.05$) and 30% ($p < 0.05$) respectively. The incidence of ICU complications decreased by 44% ($p < 0.01$) and 50% ($p < 0.01$). Economic outcomes were measured by ICU and hospital length of stay and costs. While the ICU length of stay decreased by 34% ($p < 0.01$) and 30% ($p < 0.01$), there was no significant difference in hospital length of stay. Costs associated with the reduced ICU length of stay decreased by 33% ($p < 0.01$) and 36% ($p < 0.05$). There was no significance in total hospital costs between the intervention period and the two baseline periods. Authors concluded that the eICU® model of care was a viable program to provide remote monitoring of ICU patients offering improved quality of care and decreasing ICU costs for units that did not have on-site 24-hour intensivist coverage.

The cost of the eICU® program is quite steep. Estimated costs to set up the program and staff the eICU® department is $2-3 million. Estimated timeframe to set-up and train eICU® staff and bedside staff ranges from six months to one year depending on the number of beds monitored. Maintenance costs are estimated at $2 million per year. Many hospital administrators have demanded additional proof that the clinical and economic benefits of the eICU® system justify the costs (Langreth, 2002).

Breslow, et al. (2004) sought to confirm Rosenfeld's results by determining if the eICU® model of care could improve clinical and economic outcomes across multiple ICUs. A before-and-after trial was conducted in two adult ICUs in a 650-bed tertiary care teaching hospital to assess the effect of the eICU® model of care on patient outcomes and economic return on investment. The study included a total of 2,140 patients who received ICU care between 1999 and 2001 ($n = 1,396$) prior to implementation and ($n = 744$) after

implementation. The eICU® team provided supplemental remote monitoring and management of patients for 19 hours/day (12:00 PM to 7:00 AM).

Clinical and economic performance during six months of the implementation phase was compared to the performance prior to the intervention. Clinical indicators included in the study were mortality both in the ICU and for the duration of the hospitalization and length of stay. Economic indicators included the variable cost per case and the average per patient hospital revenue. Findings indicated that hospital mortality for ICU patients was lower during the implementation period (9.4% vs. 12.9%; relative risk, 0.73; 95% confidence interval [CI], 0.55-0.95). ICU length of stay was shorter during the time period when the eICU® model of care was in place (3.63 days [95% CI, 3.21-4.04] vs. 4.35 days [95% CI, 3.93-4.78]). Economic findings indicated there were lower variable costs per case and higher hospital revenues, primarily from increased case volumes. Variable costs per case decreased by $2,556 or 24.6%. Cost savings were primarily due to a decrease in length of stay in the ICU. The decreased length of stay also created the capacity to increase the number of ICU cases per month by 7%. The monthly contribution margin increased by $524,000 (68%) during the 6-month intervention period which resulted in financial excess over program costs.

The ICU has evolved over time from an extension of a regular patient care unit to a physically separated unit that contains highly skilled medical personnel and advanced technology to care for critically ill patients. The eICU® model of care is a further evolution of the ICU to address the increasing complexity of patient care with better utilization of the limited number of intensivists and critical care nurses. Early studies of

the eICU® model of care have shown a decrease in ICU mortality, complications and costs.

Safety

Florence Nightingale (1863, 2004) charged medical professionals to first, do no harm. Even with that dictum, studies that span many years indicate that a significant number of patients suffer harm while in the hospital (Schimmel, 1964; Steel, Gertman, Cresenzi, et al., 1981, Bedell, Deitz, Leeman, & Delbanco, 1991; Donchin, Gopher, Olin, et al., 1995; Bracco, Favre, Bissonnette, et al., 2001; Kopp, Erstad, Allen, et al., 2006). In 1999, the National Academy of Science's Institute of Medicine (IOM) published *To Err is Human: Building a Safer Health System* (Kohn, Corigan, & Donaldson, 1999). A key message to the general public was that 44,000 to 98,000 Americans die each year due to medical errors. Of this number, ICU patients were more likely to experience an adverse event than patients in other parts of the hospital. At the time of that publication, the message to the public was that more Americans die in hospitals than from deaths due to injuries sustained in automobile accidents each year.

The message was heard by both private and public entities such as the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) and the Centers for Medicare and Medicaid Services (CMS). As a result, state departments of health began requiring healthcare entities to report on specific clinical outcomes that positively affect patient care (Hader, 2005). A consortium of publicly and privately held corporations, employing millions of healthcare consumers, formed to initiate breakthroughs in patient safety and improve the overall value of healthcare (Pronovost, Needham, Waters, et al.,

2004). The Leapfrog Group, a group of Chief Executive Officers from 100 of the nation's largest corporations who review health care delivery systems, focused on three evidence-based practices: (a) computerized physician order entry, (b) minimum volume standards for neonatal intensive care units and specific surgical procedures, and (c) full-time intensivist staffing in ICUs (Chalfin, 2004).

A second IOM publication, *Crossing the Quality Chasm: A New Health System for the 21st Century* (2001), outlined fundamental changes that were needed to improve care in the American health care system. The IOM publication identified the critical role information technology would play in making healthcare safer, more effective, efficient, patient-centered, timely, and equitable (Bakken, 2006). The IOM publication Patient Safety: Achieving a New Standard for Care (2004) re-emphasized that improved information systems were crucial components in building a new health care delivery system that prevents errors and allows the health care team to learn from errors where they do occur. Later that same year, Thompson and Brailer (2004) released a report that outlined the strategic framework for consumer-centered, information-based health care with four patient safety goals: (a) provide information in clinical practice, (b) interconnect clinicians, (c) personalize care, and (d) improve overall public health.

The Institute of Healthcare Improvement (IHI), a not-for-profit organization, developed strategies to address the recommendations made by the IOM. The IHI named their initiative the 100,000 Lives Campaign and rolled out six strategic interventions aimed to save 100,000 lives annually. Interventions included (a) development of Rapid Response Teams, (b) improved care for acute myocardial infarction, (c) prevention of

adverse drug events, (d) prevention of central line infections, (e) prevention of surgical site infections, and (f) prevention of ventilator-associated pneumonia.

The 100,000 Lives Campaign promoted teamwork and evidence-based order set bundles to improve patient safety and outcomes. Rapid Response Teams, modeled on the Medical Emergency Team (MET) concept developed in Australia, were established in hospitals across the nation (Hillman, Parr, Flabouris, & Bishop, 2001). The Rapid Response Team is comprised of ICU nurses and physicians who have been trained in advanced lifesaving techniques. With a central aim of intervening prior to cardiac or respiratory arrest and other near-misses, the team is available 24 hours a day to respond when a patient's condition is deteriorating. Belloma, Goldsmith, Uchino, et al. (2001) conducted a prospective before-and-after trial in a tertiary referral hospital. Consecutive patients admitted to the hospital were studied prior to the intervention (May – August 1999, $n = 21,090$) and during the intervention phase (November 2000 – February 2001, $n = 20,090$). Overall hospital mortality during the pre-intervention period was 302 deaths as compared to 222 deaths during the intervention period (relative risk reduction, RRR: 26%; $p = 0.004$). There were 63 cardiac arrests in the period prior to the intervention and 22 cardiac arrests during the intervention phase (relative risk reduction, RRR: 65%; $p < 0.002$). In the pre-intervention phase, there were 37 deaths and 16 deaths in the intervention period (RRR: 56%; $p < 0.005$). Those surviving cardiac arrest in the pre-intervention phase required an average of 163 ICU bed-days while those in the intervention phase averaged 33 ICU bed-days (RRR: 80%; $p < 0.001$). The overall hospital stay for patients during the pre-intervention period averaged 1,353 hospital bed-

days versus an average of 159 hospital bed-days in the intervention period (RRR: 88%; $p < 0.001$). Authors found that overall mortality decreased, the incidence of cardiac arrest and death following cardiac arrest decreased, and length of stay decreased after the ICU-based MET was activated.

The order set bundles advocated in the 100,000 Lives Campaign are evidenced-based protocols that support clinical decision making with standardized methods of care and interventions. Too few physicians have ready access to all data that would be useful to them as they care for patients (Chasin & Galvin, 1998). Computer-based decision making is a process in which computers use data-driven algorithms to seek optimal solutions based on rigid criteria (Liu, Wyatt, & Altman, 2006). Computer-based decision support can assist physicians and nurses by providing links to additional data, reducing variation in treatment regimens and alerting the provider to potential danger (i.e., patient allergies, potentially dangerous drug interactions, orders that deviate from best practice, etc.). Multiple studies have shown that computer-based decision support improves physician performance and patient outcomes (Chertow, Lee, Kuperman, et al., 2001; Hunt, Haynes, Hanna, & Smith, 1998; Johnston, Langton, Haynes, & Mathieu, 1994; Morris, 2000; Raschke, Gollihare, Wunderlich, et al., 1998).

Keeping Patients Safe: Transforming the Work Environment of Nurses (2004) was the third IOM publication addressing safety of hospitalized patients. This report illustrated the need for well managed, coordinated nursing care delivered by well educated nurses in patient care areas that are sufficiently staffed. Five areas of concern were identified in the work environment: (a) unclear unit values, (b) fear of punishment

for errors, (c) the lack of systematic analysis of errors, (d) the complexity of the work, and (e) inadequate teamwork.

Donchin, et al. (1995) investigated the causes of human errors in the ICU. They conducted an incident study in the medical-surgical ICU in a university-based hospital. Two types of data were collected, errors reported by the healthcare team immediately after an error was discovered and 24-hour continuous bedside observation of caregiver activities by a trained outside observer. Error was defined as any deviation from standard conduct or any addition or omission of activities related to standard orders or unit routines. Activities were defined in 3 categories: (a) planned activities, carrying out routine standing orders; (b) initiated activities, additional treatments and procedures that were not routine; and (c) reactive activities, those in response to changes in the patients' clinical status. Findings indicated that physicians and nurses recorded 476 errors and the observers detected 78 additional errors. A severity index indicated that 147 (29%) were errors that could potentially cause significant deterioration in the patient's status or death. From these data, it was extrapolated that there were approximately two severe errors made in the ICU every 24 hours. Verbal communication between the physicians and nurses accounted for 37% of those errors.

In 2001, the membership of the American Association of Critical-Care Nurses (AACN) committed to promoting healthy work environments in an effort to improve the quality and effectiveness of patient care while reducing errors, conflict and stress among health care professionals. Their efforts resulted in the publication, *The AACN Standards for Establishing and Sustaining Healthy Work Environments: a Journey to Excellence*

(2005). Six standards were identified as critical components in establishing and sustaining healthy work environments for health care professionals: (a) skilled communication, (b) true collaboration, (c) effective decision making, (d) appropriate staffing, (e) meaningful recognition, and (f) authentic leadership. The eICU® model of care impacts each of these six standards.

Along with clinicians, public and private entities are focused on patient safety in hospitals and specifically in ICUs. One national safety initiative is to provide continuous intensivist coverage for ICU patients. The eICU® model of care supports this safety initiative as it incorporates intensivist coverage for ICU patients from a remote location along with evidence-based protocols and clinical decision support tools.

Communication

Safe, quality patient care requires multiple persons serving in different roles to integrate their specialized knowledge via frequent, professional interactions and skilled communication (American Association of Critical-Care Nurses, 2005). Skilled communication includes written, verbal, and non-verbal interactions (Joint Commission on Accreditation of Healthcare Organizations, 2002; Institute of Safe Medication Practices, 2004). JCAHO reports that a breakdown in communication in healthcare teams is one of the leading causes of sentinel events (Joint Commission on Accreditation of Healthcare Organizations, 2007).

The AACN (2005) identified key elements to ensure skilled communication in a healthy work environment. Hospitals must (a) support and provide staff access to education on communication skills, (b) enforce a zero-tolerance policy to address and

eliminate abusive and disrespectful behavior, (c) establish structures and processes that ensure effective communication, (d) formally evaluate the impact of communication on clinical, financial and work environment outcomes, and, (e) include communication informal performance appraisals. One is deemed a skilled communicator when the focus is on finding solutions in order to achieve optional outcomes through collaborative relationships with all members of the health care team. Mutual respect among disciplines allows each team member to express their relevant perspectives via appropriate communication technologies that are readily accessible. Skilled communicators are accountable for their words and actions with the expectation that all members of the team will do the same.

A classic study of the importance of communication and interaction in the ICU was published by Knaus, et al., (1986). A sample of 5,030 patients was studied from Intensive Care Units in 13 tertiary care hospitals. The ICUs were classified by level of administration according to the National Institutes of Health (NIH) Consensus Conference on Critical Care (1983). Level I units had physician medical directors or their designees on the units at all times, high nurse-to-patient ratios and education and research activities in the units. Level II classification went to units with full-time or part-time physician directors available to the units and high to moderate nurse-to patient ratios. Level III units were described as having part-time physician directors who did not provide in-house coverage and lower, variable nurse-to patient ratios. The variable nurse-to patient ratios were based on administrative structure rather than skill-based.

Researchers tested for overall significance of differences in mortality rates across the 13 hospitals (chi square, 12 degrees of freedom) via a multiple logistic regression analysis (Chambers & Cox, 1967) which included the patient disease, Acute Physiology and Chronic Health Evaluation (APACHE) II score (Knaus, Zimmerman, Wagner, et al., 1981) and information on if the patient was admitted to the ICU following elective or emergency surgery. First, the Students *t*-test was used to determine the difference between the means of observed and predicted death rates for each hospital. Second, the significance of the individual hospital was tested using a partial chi-square test (1 degree of freedom) after controlling for prognostic factors. Those hospitals that were determined to be significantly different were compared with a reference group of hospitals who were not significantly different ($p \leq .01$). Following the comparison of patient outcomes, the researchers examined how the structure and process of each ICU related to its overall performance (Williamson, 1971).

All of the 13 hospitals studied treated a substantial number of patients with a moderate degree of severity (APACHE II score of greater than 15). Differences in patient outcomes were not limited to one diagnostic or surgical group or level of severity of illness. Administration of the units as designated by Levels I, II, and III showed no significant difference in mortality rates.

Two of the 13 hospitals showed a significant difference in treating acutely ill patients. Hospital 1 did significantly better with a death rate 41% lower than predicted, x^2 (1) = 24.6, $p < .0001$, and Hospital 13 did significantly worse with 58% more deaths than predicted, x^2 (1) = 15.4, $p < .0001$. The overall influence of individual hospitals on

outcomes proved to be highly significant, x^2 (12, N = 5,030) = 62.9, $p < .0001$. Hospital 1, a Level 1 unit, showed a significant difference in the amount and type of treatments per patient ($t = 4.74$, $p < .01$) with an average of 40% more treatment points per patient. Treatment points included laboratory tests, dressing changes, chest physiotherapies, and extensive reliance on clinical protocols. This hospital also had the most comprehensive nursing education system and excellent communication between physicians and nurses. Hospital 13, a level III unit, lacked comprehensive nursing organization, a formal educational program, and consistency in patient assignments. The ICU in Hospital 13 exhibited poor communication between nurses and physicians, distrust among team members, and staff shortages. The authors concluded that communication and coordination of staff greatly impact therapeutic efficacy in the ICU setting (Knaus, Draper, Wagner, & Zimmerman, 1986).

Good communication between nurses and physicians is critical in the exchange of information necessary to "maximize the appropriateness, effectiveness and efficiency of care" for ICU patients and their families (Dodek & Raboud, 2003, p. 1587). Daily ICU bedside rounds range from informal visits by the attending physician to a formal interdisciplinary, structured exchange of patient information. Dodek and Raboud (2003) conducted an interventional study in a 15-bed medical-surgical ICU in a tertiary teaching hospital. Prior to the intervention, the interdisciplinary ICU staff were surveyed following rounds on all ICU during a one-month period of time (n = 155 separate bedside rounds) to gain their perspective on what worked well on rounds, what did not work well, and what suggestions they had for improvement. Analysis of survey data allowed them to

develop a flow-chart of their current process and design a flow-chart process for ideal patient rounds. The ideal process included an explicit structure of role-specific responsibilities and prescribed means for the timely, succinct, and accurate exchange of patient information. The new patient rounds process was implemented and followed up with a post-intervention survey ($n = 225$ separate bedside rounds). Survey results were analyzed by survey period and profession. The average duration of patient rounds were compared pre- and post-intervention with a two sample t test. The mean duration of patient rounds was not significantly different (10.3 vs. 10.6 minutes, $p = 0.54$). The binary responses to survey questions were analyzed with a two sample test of proportions with a correction for continuity or Fisher's exact test when the proportions were close to one or zero. Overall, survey respondents agreed that with the new process there was a significant improvement in developing a long-term plan of care for patients (53% vs. 74%, $p = .0001$) and the long-term plan developed was more useful than prior to the intervention (54% vs. 76%, $p = .0001$). There was a significant improvement in structured teaching around each patient (65% vs. 79%, $p = .0001$). In addition, the interdisciplinary team expressed an overall improved satisfaction with the new rounding process and outcome from the rounds (86% vs. 95%, $p = .0001$). The authors concluded that an explicit structure for patient rounds improved ICU team communications and overall staff satisfaction (Dodek & Raboud, 2003).

Timely, succinct, and accurate communication of patient information is crucial for collaborative problem-solving and decision-making in order to formulate and carry out plans for patient care. The eICU® model of care provides a new means of communication

and collaboration through telemedicine connections joining the remote eICU® team with the bedside ICU team.

Collaboration

The AACN (2005) describes collaboration as a process rather than an event. Successful collaboration requires skilled communication, trust, knowledge, accountability, mutual respect, optimism and coordination among team members (American Hospital Association Commission on Workforce for Hospitals and Health Systems, 2002). To foster collaboration, hospitals must (a) provide staff education aimed at developing collaboration skills, (b) develop, implement and evaluate accountabilities for collaboration among team members, (c) create and maintain operational structures that ensure decision-making authority of nurses, and (d) provide ready access to structured forums, such as ethics committees, to resolve disputes as they arise among patients, families and members of the health care team (American Association of Critical-Care Nurses 2005). In order to have true collaboration, each team member must support the ongoing process of collaboration by valuing the contribution and appropriate competence each member brings to the team (American Association of Critical-Care Nurses, 2005).

The conceptual model that forms the foundation for defining collaboration was developed by social psychologists, Blake and Mouton (1970). In the context of the ICU, collaboration is defined as "ICU nurses and physicians working together, sharing responsibility for problem-solving and decision-making, to formulate and carry out plans for patient care" (Baggs & Ryan, 1990, p. 387). A single site, descriptive study was

conducted in a large northeastern university medical center to test two hypotheses: (a) ICU nurses who practice in a more collaborative setting are more satisfied with their jobs, and (b) when nurses are more satisfied when they perceive the decision-making process regarding patient transfers as collaborative (Baggs & Ryan, 1990). The sample consisted of RNs (N=68) who had patient assignments in a medical ICU during the data collection time frame. Three instruments were used in this study, the Collaborative Practice Scales (Weiss & Davis, 1985), the Index of Work Satisfaction (Stamps & Piedmonte, 1986), and the Decision about Transfer scale (Baggs & Ryan, 1990). The hypothesis that ICU nurses who practice in a collaborative setting are more satisfied with their jobs was not supported by the Collaborative Practice Scales and the Index of Work Satisfaction (r = .08). The hypothesis that ICU nurses are more satisfied when they believe the decision-making associated with patient transfers is collaborative was supported by the Decision about Transfer scale ($t = 0.67, p < 0.05$). This study confirmed that collaboration in decision-making is important to job satisfaction of the ICU nurse.

In the past, clinical decisions were made exclusively by the physician with little or no input from the patient, family, or nurse (Dracup, & Bryan-Brown, 2003). Katz (1984) found that practice paternalistic and, at times, unethical. Although nurses fill the role of patient advocate, recent research shows that only 8% of physicians recognize nurses as partners in decision making (Greene, 2002). Jain, Miller, Belt, et al. (2006) conducted a descriptive study in a 28-bed medical-surgical ICU to report on a quality improvement initiative that included the introduction of a new decision making culture. While they did not objectively measure the change in culture, they reported a noticeable

change in how decisions were made following the introduction of team decision making. They describe a change from a vertical environment to a horizontal environment. They instituted a penalty-free culture that allowed each individual in their multidisciplinary team to share ideas during daily patient rounds. In their past vertical environment, these ideas would not have been welcomed by the physicians. Critical to the success of this program was physician buy in to this change in culture in the ICU work environment.

The IOM (2000) reiterated that lack of collaboration is one of the cultural barriers to safety in hospitals. The AACN (2005) asserts that skilled communication and collaboration are as important as clinical skills. The eICU® model of care is a new culture that challenges traditional concepts of collaboration as team members from the remote eICU® team and the bedside ICU team are expected to collaborate from a distance.

Work Environment

The bedside ICU team works in an environment that includes multiple sophisticated electronic devices such as monitors, infusion pumps, and ventilators. Through the eyes of a human factors engineer, the ICU bedside work environment is an "ergonomic disaster" (Donchin & Seagull, 2002). The area is not conducive to allow the bedside team to obtain data and respond appropriately in high stress situations. This arrangement creates an environment that is unsafe for both the patient and the bedside healthcare team (Koay & Fock, 1998). The physical environment is hostile due to the blinking lights, various alarms sounds, and the hum of the ventilator, suctions, and other devices (Topf & Dillon, 1988). These various devices and monitors generate a great deal

of data for the bedside team to analyze and act upon as necessary. Humans have an innate limit on how much information they can process and act upon at any given time. When one's innate capacity for processing and responding to information is overloaded, there are immediate physiological responses such as, fatigue, stress, and inability to function. Prolonged exposure to information overload results in burnout, staff transferring to less demanding jobs, or permanent physiological changes such as hypertension and acute coronary syndrome (Donchin & Seagull, 2002).

The physical demands of working at the bedside in an ICU are challenging to the healthcare team. Multiple intravenous lines, tubes, leads, cords and cables may be difficult to identify and manage easily. Monitors may be located out of arm's reach. Multiple alarms may activate simultaneously with different tones and at different volumes. This can prove to be challenging for the staff to identify and correct the reason for the alarm (Sexton, Thomas, & Helmreich, 2000). False alarms are not uncommon. There is danger that staff may become accustomed to ignoring false alarm and possibly mistake a real alarm for a false alarm. That could result in devastating consequences for a patient (Breznitz, 1984). Noise and inadequate lighting disrupt the sleep cycles of patients and add to the physical stresses for those working at the bedside (Donchin & Seagull, 2002). Additional areas of concern for the physical well being of the health care worker at the bedside include the handling of sharp objects and physically manipulating patients by lifting, rolling or repositioning arms and legs. Injuries or the risk of injury may influence one to move out of this work environment. Losing a qualified critical care nurse

due to injury or risk of injury, can further challenge hospital leadership's ability to adequately staff the ICU.

Work environment is more than just the physical space where the work is performed. Personal interactions greatly impact work environment. Workplaces that are negative and demoralizing compromise patient safety, defeat staff recruitment and retention efforts, and can prove costly to the organization (American Association of Critical-Care Nurses, 2005). Strong and effective leadership is a key ingredient for a healthy work environment (American Association of Critical-Care Nurses, 2003). Effective leaders are skilled communicators, positive change agents, committed to quality service, results oriented, and role models for collaborative practice (American Hospital Association Commission on Workforce for Hospitals and Health Systems, 2002). Successful leaders promote professional development of staff and provide recognition and rewards for positive behaviors and skills demonstrated by team members (American Association of Critical-Care Nurses, 2003).

The physical work environment in the ICU is hostile with noise, information overload, and ergonomic challenges. Prolonged exposure in this work environment often causes injury and burnout for experienced ICU nurses. The eICU® work environment is physically different from the bedside ICU setting. Along with the physical make up of the unit, the eICU® work environment is greatly influenced by personal interactions via telemedicine connections, diffuse leadership across two physical units, and recognition and rewards associated with newly learned behaviors and skills. It is yet to be determined

the impact this new eICU® telemedicine work environment will impact the work environment.

Staffing

Staffing is a complex process that matches the needs of the patient with the skills and competencies of the nurse (American Association of Critical-Care Nurses, 2005). The condition of an ICU patient can change dramatically and frequently in a short period of time requiring flexibility in nurse staffing rather than fixed nurse-to-patient ratios (Snyder, Medina, Bell, & Wavra, 2004). The AACN (2005) indicates health care organizations have an obligation to have staffing policies in place to provide the highest quality patient care. The JCAHO (2006) requires organizations to have processes in place to evaluate staffing effectiveness and a means to change staffing models to improve effectiveness based on outcomes data.

Nurses are critical members of the bedside ICU team. Staffing levels and experience of the nurse have been shown to influence patient outcomes (Binnekade, Vroom, & de Moi, 2003; Thorens, Kaelin, Jolliet, & Chevrolet, 1995). Thorens, et al. (1995) conducted a prospective study in a university hospital medical ICU in Geneva, Switzerland, to evaluate the influence of nurse staffing on the duration of weaning from mechanical ventilation in patients with chronic obstructive pulmonary disease (COPD). Data collection took place over a period of six years. Each year, a nursing index was calculated as a ratio of the nursing workforce (R or reality) compared to the estimated severity of the patients (I or ideal) as determined by a severity score index. The value of R equaled the number of nurses employed times the number of 24-hour shifts achieved

by each nurse. Corrections were made to the R value to account for the experience of the nurse as defined by certifications, time devoted to educational activities, and personal time off from work. The I value was determined by a staffing grid that categorized staffing by patient acuity. Category one patients required one to one nurse staffing per 8-hour shift. Category two patients allowed for one nurse per two patients per shift and Category three patients allowed 1:3 nurse staffing ratios. The ideal nursing index score (R/I) equaled one. A score of one depicted a perfect match between the nurse staffing that was needed and the effective nurse staffing that was actually working in the ICU.

In this study, all ICU patients suffering from COPD who were supported by mechanical ventilation for respiratory failure during the six-year period of data collection were included in the study ($N = 87$). One–way analysis of variance was performed to compare parameters over the course of the six years of observation. Chi square analysis was utilized to compare percentages of change between years five and six. Spearman's rank coefficient test was utilized in comparing the duration of mechanical ventilation to the nursing index. A p value less than .05 was considered significant. During the first five years, the nursing index equaled < 1.0 each year indicating unfavorable staffing variances. During that same time period, the duration of mechanical ventilation progressively increased from 7.3 ± 8.0 to 38.2 ± 25.8 days ($p = .006$). A significant inverse correlation between the duration of mechanical ventilation and nursing index were seen over the same time period ($p =$. 025). In year six, the nursing index improved to 1.05 and the duration of mechanical ventilation decreased significantly from year five (38.2 ± 25.8 days to 9.9 ± 13 days, $p < .001$). The authors concluded a positive

relationship existed between appropriate ICU nurse staffing and the duration of mechanical ventilation. It was extrapolated that the positive results were influenced by nursing interventions such as better evaluation of the patient's clinical and emotional status, closer monitoring of biochemical analyses, and more frequent use of chest therapy (Thorens, Kaelin, Jolliet, & Chevrolet, 1995).

Appropriate nurse staffing according to patient acuity has been shown to positively impact patient outcomes. It is well known that there is a national shortage of nurses and a limited pool of experienced critical care nurses to ideally staff ICUs (Buerhaus, Staiger, & Auerbach, 2000). The eICU® model of care acts offers a means to extend limited resources, namely experienced ICU nurses and intensivists. The eICU® model of care supports the bedside ICU nurse by providing instantaneous access and consultation with an experienced ICU nurse who has all of the patient's data and the ability to visualize the patient. How the addition of eICU® program support for nursing will impact bedside ICU staffing ratios is unknown at this time.

Teamwork

The ICU team is a complex structure that is fluid by nature to allow the group of medical professionals to expand from the core group as the patient's condition dictates (Lingard, Espin, Evans, & Hawryluck, 2004). The AACN (2005) puts the onus on healthcare organizations to foster teamwork through collaborative decision making. As key members of the ICU team, nurses must be involved in making decisions regarding patient care (American Nurses Association, 2001). Greene (2002) asserts that there is a significant gap between what nurses are accountable for and the amount of participation

they have in making decisions regarding those accountabilities. Clinicians who believe they have no control over their practice become disenchanted and there is erosion of teamwork.

Wheelan, Burchill, and Tilin (2003) examined the relationship of teamwork in the ICU and patient outcomes. A total of 394 staff members from 17 ICUs participated in the study by completing the Group Development Questionnaire (GDO) and a demographic survey. The questions on the GDQ are based on the four stages of group development: (Stage I) dependency/ inclusion, (Stage II) counter dependency/fight, (Stage III) trust/structure and, (Stage IV) work and productivity (Wheelan, 1995; Tuckman, 1965). Demographic data collection included information about the participants. Additional data collection included the teaching status of the hospital, the setting, and each unit's results on the Acute Physiology and Chronic Health Evaluation (APACHE) III Mortality Prediction (APACHE Medical Systems, Inc., 1991) for one month's ICU admissions. Patient medical records for that same time period were reviewed to determine each unit's standardized mortality ratio (SMR).

Active fieldwork was arranged with one facilitator per hospital for data collection. Each hospital was visited several times each day over a 5-day period. ICU staff members participated in the study during their normal work shifts. The nine participating hospitals were located along the east coast of the U.S. Two were academic medical centers, one was in a rural setting, five were community-based, and one was in an urban setting. Seventy-five percent of the participants were registered nurses (75%) and the remaining 25% were almost equally divided between physicians, unit clerks, and unlicensed

assistive personnel. Eighty percent were women and 70% were between the ages of 20 and 40 years-old. Seventy-four percent of the participants were Caucasian and the remaining 26% were split between Hispanic Americans, Native Americans, African Americans/non-Hispanic, and other. Education level of the participants was high school or trade school diploma (10%), associate's degree (31%), bachelor's degree (42%), master's degree (5%), and medical doctor (9%). The mean time participants had been employed at their hospital was 16.6 years with a mean time in the ICU of 12 years. Most participants work the day shift ($n = 250$) but those on nights ($n = 108$) and evenings ($n = 36$) also participated to a lesser extent.

Study results showed demographic data had little effect on participants' perception of their group development and productivity. Data analysis showed a significant correlation ($r = -.662, p = .004$) between the ICU's stage of group development and that unit's SMR. Groups who scored closer to stage IV (work and productivity) in group development had fewer deaths in their unit than predicted. These findings support a link between ICU teamwork and patient outcomes.

Jain, et al., (2006) examined the link between teamwork and adverse events, nosocomial infections and costs in the ICU. The study took place over a 12-month period in a 28-bed ICU in a hospital in Mississippi. Unit occupancy averages 95% and the nurse-to-patient ratio is 1:2. The qualitative goals of this study were to promote a culture of healing and teamwork while achieving optimal outcomes for patients. The quantitative indicators measured in this study were adverse events per ICU day, ventilator-associated pneumonia (VAP) rate, blood stream infection (BSI) rate, nosocomial urinary tract

infection (UTI) rate, mortality, and cost per ICU episode. Cost per ICU episode was calculated by multiplying the cost per patient day by the average length of stay (LOS). The x^2 statistic was used to compare the number of infections during the baseline period and the post-intervention number of infections.

Interventions included physician-led multidisciplinary rounds, daily bed flow meetings, bundle order sets, and a culture change in how decisions are made among team members. Intensivists were contracted to conduct multidisciplinary rounds which included the patient's nurse, the ICU Charge Nurse, pharmacist, dietician, respiratory therapist, case manager, social worker, and palliative care nurse. While on rounds, the team set daily goals and used "trigger tools" (Rozich, Haraden, & Resar, 2003) to identify adverse drug events. Bed flow meetings were held daily by multidisciplinary key hospital personnel in order to facilitate the transfer of patients within the hospital based on clinical condition and bed availability. This meeting facilitated appropriate placement of patients in the ICU. Bundle order sets for the prevention of VAP, BSI, and UTI were incorporated into the daily rounds. The bundles are evidence-based best practices that have been designed to optimize care and prevent complications (Institute for Healthcare Improvement, n.d.). The culture change made in decision making allowed for each person on the multidisciplinary team to express their opinion when weighing in on decisions.

Data analysis showed improvement in VAP (from 7.5 to 3.2 per 1000 ventilator days, $p = .04$), BSI (from 5.9 to 3.1 per 1000 line days, $p = .03$), and UTI (from 3.8 to 2.4 per 1000 catheter days, $p = .17$). A downward trend was noted in adverse drug events (>20 per month to < 5 per month), average LOS per episode (5.92 to 4.71), and cost per

ICU episode (from $3406 to $2973). Measurements of improvement towards the qualitative goals were anecdotal. Team members reported improved communication, feelings of empowerment, and increased individual accountability. While Jain, et al. (2006) recognized numerous limitations to this study, they conclude that more rigorous quantitative and qualitative research is needed to test the influence of each individual variable (rounds, bed flow, bundles, and culture change) on patient outcomes, adverse events, and costs in the ICU.

Hawryluck, et al. (2002) found that there are six catalysts to teamwork within the ICU and between the ICU workforce and other specialties: authority, education, patient needs, knowledge, resources, and time. As with any team, there are inherit rules that must be followed in order for individual health care professionals to think and work as a team. Lingard and colleagues (2004) conducted a qualitative study that consisted of seven 1-hour focus groups with ICU team members from two different hospitals. There were four nursing focus groups ($n = 27$), two resident focus groups ($n = 6$ of the 10 residents), and one focus group of intensivists ($n = 4$ of the 8 intensivists on staff). The focus group interviews were recorded, anonymised and transcribed. Open and axial coding methodologies were conducted to reveal emergent themes.

In-depth analysis resulted in identification of two dominant mechanisms that influence the collaboration and conflict associated with teamwork, the perception of ownership and the process of trade. The perception of ownership was seen collectively by the ICU team and individually by team members or field of medicine. For example, the ICU team claimed ownership of the patient over those medical professionals who

provided patient care intermittently during the patient's ICU stay, such as surgeons, radiologists, etc. Within the ICU team, individual nurses claimed ownership of their patients as they had more continuous patient interactions than other members of the team. Respiratory therapy, as a profession, claimed ownership of certain aspects of care, such as ventilator management. Recognition and respect of this individual ownership by the team is based on the knowledge and skill the person in that role brings to the smooth, collaborative functioning of the team. In contrast, ownership perceptions can cause conflict in the team. One of the intensivists in the Lingard study asserted his authority by pointing out that the physician has ultimate responsibility for the patient; therefore, the intensivist has complete ownership. One of the nurses pointed out that the intensivists and residents often usurp nurse ownership of the nursing knowledge and skill associated with the care of the patient. Nurses feel theft of their ownership of knowledge and skill undermines the teamwork approach to patient care.

The process of trade mechanism manifested itself in the trade of concrete and abstract commodities by the team members. Equipment was the most common concrete resource that was traded. Trade of scarce equipment is based on patient need or lines of authority. For example, a patient with unstable vital signs might warrant a piece of equipment over a patient with stable vital signs. Trade according to lines of authority were demonstrated when the needs of the intensivist come before the needs of the resident. Abstract commodities identified in the study included trading knowledge for respect. When they felt they were not treated with the respect they deserve, nurses

reported that they allowed other team members to search through the patient's chart for information rather than freely sharing the information which causes conflict in the team. Lingard and colleagues (2004) concluded that perceptions of ownership and the process of trade play a central part in the ability of the ICU health care professionals to work as a team. The ICU team consists of distinct professionals, each with their own models of care, skill sets, economic circumstances, and competitive political agendas. The theory of social structuralism served as the theoretical model for the Lingard study (Bourdieu, 1991). According to the theory, professions are viewed as social systems where each professional's role is determined by its relation to the other professions and by its access to certain commodities. Individuals within a profession and between professions constantly try to distinguish themselves and their profession in order to gain more resources to promote their ability to perform their duties. Teamwork is achieved when there is a delicate balance sustained between achieving shared goals and competing for scarce resources.

Given that those who work in the eICU® team are physically separated from the patient and the bedside ICU medical personnel, it is yet to be determined how this work environment will affect teamwork and how the team will be defined. What aspects of patient care will the eICU® personnel claim as their own? Will the bedside ICU team recognize and respect shared ownership with the eICU® team? Can the bedside team and the remote team join to form one patient care team?

The process of trade mechanism among the bedside ICU team and the eICU® team involves the trade of data and decision support information by team members.

While both the bedside and remote personnel have access to the same patient data, the eICU® team has the advantage of instantaneous access to historical and current data as well as computerized decision support information. But that data and decision support access is of limited benefit to patient care unless it is communicated to and acted upon by the bedside team. It is yet to be determined how the eICU® and ICU personnel will find the delicate balance between accomplishing shared goals and competing for scarce resources in order to achieve teamwork.

Technology

Telemedicine plays a role in the ICU workplace not unlike how various disciplines assist and challenge practice patterns. It is no secret that technological tools are commonplace in ICUs. Wikström and Larsson (2003) conducted a qualitative study focusing on the human-machine interactions in a Swedish ICU. Fieldwork occurred in the everyday practice of the ICU and field notes served as the data. Data analysis revealed three major themes: (a) how the use of technology intervenes in the division of labor, (b) how technology challenges practical knowing/seeing, and (c) the ways in which technology changes practice. The use of technology intervenes in the division of labor when not all staff members know how to operate a device. In this particular study, the nurse leadership made adjustments in patient assignments to match the nurse with the knowledge of a bedside dialysis device to the patient in need of bedside dialysis. Knowing how to use the device was considered more valuable than knowing the patient when making this assignment of labor. Technology was shown to challenge practical knowing when a device displays a set of information and the nurse observes something

that contradicts the information displayed on the device. For example, a nurse observed blood in the urine but the dialysis machine indicated there was no blood in the urine. When technology challenges what the nurse sees, it requires further in-depth analysis of the discrepancy. Technology changes practice as demonstrated by electronic medical records. In this study, physician orders were entered electronically. When a physician entered an order that was not part of the care plan associated with the patient's diagnosis, the physician had to justify the order and manually override the computerized system. This was a distinct change in practice for the physician and it involved several members of the ICU team to successfully override the technology. The authors concluded that ICU staff members rarely solve problems through individual cognitive work. The best ICU work environments facilitate good communication and use technology as a tool that allows staff to see problems more clearly (Wikström & Larsson, 2003).

The eICU® model of care utilizes technology and various modes of communication to support the bedside team in problem solving. Division of labor is accomplished when the eICU® team monitors the patient at the request of the bedside team or when the bedside team is not physically present with the patient. The bedside ICU personnel know they can instantly access eICU® personnel at any time for decision support. In the event that there is a discrepancy in patient monitoring data and the patient's presentation, the bedside practitioner and/or the eICU® practitioner can override the technology. Having another set of eyes to oversee critical care patients and having ready access to an intensivist at all times, has no doubt changed the practice of the

bedside ICU team. Medical practice and nursing in the eICU® work environment has not been described to date.

Postmodernist Ethnography

Postmodern ethnography has been used in health care research (Buller & Butterworth, 2001; Kotarba & Hurt, 1995). This research methodology includes the ethnographer interacting directly with the people who are being studied to allow them to tell their own story (Kotarba & Hurt, 1995).

Butler and Butterworth (2001) utilized postmodern ethnography approach to studying skilled nursing practice in various clinical settings. Participants in the study included 22 expert nurses (Benner, 1984) and 14 nurses of various levels of experience and skill who were added after two years into the data collection process. The researchers conducted a sequence of formal interviews and semi-structured conversations with nurse participants followed by a "Video Review Descriptive Interview" (Buller & Butterworth, 2001, p. 408). The participants videotaped their actions in their clinical setting and reviewed the videotape with the researchers to comment on and explain their actions. Four domains revealed themselves over the course of the study, "being professional," "doing the job," "managing and facilitating," and "relating and communicating" (Buller & Butterworth, 2001, p. 413). There were 24 descriptive terms associated with the four domains that the participants used to explain and describe their clinical practice. The researchers concluded that they had successfully employed postmodern ethnography methodology to identify the four domains within a clinical nursing culture.

Kotarba and Hurt (1995) used postmodernism and ethnography as the study design for research that describes everyday life at a residential hospice facility for people with Acquired Immune Deficiency Syndrome (AIDS). Data were collected as residents, administrators, staff, and volunteers were interviewed and as one of the researchers worked at the facility as a volunteer. The facility is described as a home-like environment that carefully hides the medical aspects of care. Residents are people with AIDS who leave a life expectancy of less than six months. There are few restrictions placed on the residents. In fact, the daily routine is decided upon by the residents without the regimented schedule one would find in a hospital setting.

Data analysis from the ethnographic research revealed three major themes: organizational issues, staff practices, and staff-resident relationships. Descriptive terms for each theme were identified through the interviews and the actual experiences of one of the researchers. Organizational issues identified in data collection were categorized by the descriptive terms: managing volunteers, managing contagion, managing family, managing residents, and managing death. Volunteers played a major role in the daily operations of the hospice. Most volunteers had a strong commitment to their work but some become disillusioned by the physical demands of the job. Managing contagion involved executing infection control measures such as wearing gloves to avoid exposure to bodily fluids of the residents. Some volunteers resisted wearing gloves. Managing family was exceptionally difficult for staff and volunteers as many of them try, generally unsuccessfully, to facilitate family reconciliations. Managing death was a constant and was one of the most easily managed routine events at the hospice center.

Everyday practices at the hospice were categorized around the descriptive terms: touching, managing stress, common sense, interpreting non-verbal needs, and seeing the ordinary as extraordinary. Touch was one of the most important interactions at the hospice as it facilitated dying through the sharing of nice feelings among those who work at the facility and the residents. Staff and volunteers had an unwritten rule that they should not exhibit feelings of stress in front of residents. All developed stress management strategies to deal with their feelings of stress. Common sense was necessary to deal with everyday issues when formal guidelines are not available. Patients with AIDS lose the ability to speak within days or weeks of death. Staff and volunteers learned to look for non-verbal actions as a way to communicate and meet the needs of the dying resident. Seeing the ordinary as extraordinary was a coping mechanism used by those working in the facility to maintain enthusiasm for the work and to boost morale.

Staff-resident relationships were described as caring, pastoral, or intimate. Caring relationships were the most basic relationships at the hospice. The staff delivered care to physical needs of the resident but no emotional bond was made with the resident. Either staff did not desire an emotional bond or the resident did not allow an emotional bond to form. A pastoral relationship involved spiritual work of assisting the resident to transcend life on earth and move spiritually and physically into the afterlife. The intimate relationship was recognized as the ultimate reward for working at the hospice. It was a friendship or closeness that either happened spontaneously or developed over time.

Through the research methodology of postmodern ethnography, Kotarba and Hurt (1995) successfully described the everyday experiences of working in a residential

hospice for those dying with AIDS. The methodology allowed them to describe the culture through the words of those who work in that environment.

Forsythe (1998) supports the use of ethnography as an appropriate methodology in which to study medical informatics. She asserts that understanding the information needs of "life scientists," such as healthcare workers, is most obvious when investigated in "real-life context." A noted study by Covell, Uman, and Manning (1985) revealed findings that 70% of questions that are raised during physician visits with patients remain. In addition, 25% of the time the physicians were unaware of resources available to answer those questions. Williamson, et al. (1989) further elaborated that physicians found the plethora of scientific literature available to them is unmanageable. Hence, Forsythe (1998) supported the development of readily accessible and user-friendly information systems that will serve as an information resource for clinicians. She recognized that it would be impossible to include all known information on a given condition in one single information resource so selectivity of what would be included in the resource would be paramount to truly meet the needs of the user. Additional research (Forsythe, Buchanan, Osheroff, & Miller, 1992; Padget, 1988; Padget, 1993) identified four the types of information physicians need throughout their daily practice: (a) formal, general information, (b) formal, specific information, (c) informal, general information, and (d) informal, specific information. Formal, general information is the type of information that is available in textbooks and published articles. Formal, specific information is patient specific information, such as lab values, that can be found in the hospital's information system. Informal, general information is basic cultural information

that is not available in a textbook but is more easily ascertained via consultation with a peer. Informal, specific information is knowledge particular to the culture and norms of medical practice of the facility that is not readily available in a textbook nor a formal list of rules. This information includes guidelines for patient care that may vary by clinical settings and most readily available in conversations and reminders from those who work in the same environment. One of the primary functions of the eICU® model of care is its ability to serve as an information resource for the bedside team. The eICU® model of care provides access to experienced ICU professionals, the patient's medical record, and published literature to address all four types of information requests most commonly asked by physicians in their daily practice.

Summary

The eICU® model of care is an evolution of the modern day ICU. This study will describe the work in the eICU® department in the context of its impact on patient safety, collaboration and communication within the work environment, staffing, teamwork and technology. The eICU® model of care incorporates intensivist coverage for ICU patients from a remote location along with evidence-based protocols and clinical decision support tools to support national patient safety initiatives. The eICU® model of care provides a new means of communication and collaboration through telemedicine connections joining the remote eICU® team with the bedside ICU team. While the physical work environment in the ICU is hostile with noise, information overload, and ergonomic challenges, it is yet to be determined how the new eICU® telemedicine work environment will impact the nursing labor pool. There is a national shortage of experienced critical

care nurses which makes staffing ICUs a challenge. The eICU® model of care serves as a means to extend limited critical care nursing resources. The desire is that access and consultation merges the bedside and eICU® personnel into one patient care team with technology as the infrastructure for the new model of care.

Everyday life in an eICU® department has not been described in the published literature. This study describes the everyday experiences of working in the eICU® department through the words of those who work in that environment. Postmodern ethnography is a methodology that has been used successfully in health care research to describe cultures and work practices.

CHAPTER III

PROCEDURE FOR COLLECTION AND TREATMENT OF DATA

The purpose of this study was to describe the everyday life of the eICU® department – an off site care unit where health care professionals monitor the status of patients in actual intensive care environments. The research design for this study was postmodern ethnography. Post modern ethnography is a research methodology whereby the ethnographer interacts directly with the people who are being studied to allow them to tell their own story (Kotarba & Hurt, 1995). Postmodernists recognize that the researcher's participation in the field study influences the product of the ethnography and assert that a single interpretation of the data is not guaranteed. Instead, the product of the research is a constructed reality that is derived from varying viewpoints by the observer and those observed (Borbasi, Jackson, & Wilkes, 2003). In the postmodern context, the researcher is the interpreter of "multiple voices and experiences" (Buller & Butterworth, 2000).

In 1992, Kleinman described the use of ethnography in specific health care settings as the modern equivalents of a tribe or village. This study will describe the everyday workings of the eICU® department to the outside world through the voices of nurses and physicians who work there. In this ethnography, participant voices are recorded through interviews and observation of activity in the eICU® department. This

chapter includes a description of the (a) setting for data collection, (b) population and sample description, (c) instrumentation, (d) data collection, and (e) treatment of the data.

Setting

The setting for the study was an eICU® department located in a large healthcare system in Midwestern United States. This unit was established in the spring of 2005 to include the monitoring of ICU beds located in four hospitals around a large metropolitan area. The eICU® nurses and physicians conduct their work in a centralized location (CORE). The CORE is housed within one of the hospitals. The CORE contains computer stations with six to eight flat panel screens on each desk. Registered Nurses (eNurses) and Intensivists (ePhysicians) work from these computer stations.

Sample

This study included a purposive sample of all eNurses and ePhysicians working in the eICU® department. All eICU® staff members have worked at the bedside in ICUs prior to working in the eICU® unit and all were invited to participate in this study.

Protection of Human Subjects

Human subject approval was obtained from the participating institution's Institutional Review Board (Appendix A) and the Texas Woman's University Institutional Review Board (Appendix B). There were no restrictions for sample participants with regard to age, gender, or race/ethnicity. The principal investigator obtained written informed consent with potential participants prior to the ethnographic fieldwork and private interviews. Each participant was given a letter outlining the details

of the study, risks associated with participation, contact information for questions, and instructions on how to withdraw from participation.

Instruments

Demographic information was collected from each interview participant including the number of years in their profession, number of years worked in the ICU, length of time working in the eICU® unit, and highest level of formal educational preparation. Individual semi-structured interviews occurred at a time and place that is convenient for the participant. Open-ended questions varied over the course of the study based on information shared by participants and based on observations during the field study. The interview protocol consists of questions related to the research questions (Appendix C).

Participants were asked to describe a typical day in the eICU® unit, including a description of activities, communications, and feelings that are experienced by the staff members. The interviewer queried participants in what factors led up to them choosing to work in the eICU® department and how they learned to work in this new telemedicine work environment. Each discipline was asked to describe characteristics that enable them in their eICU® role. For example, an eNurse was asked, "What do you think makes a good eICU® nurse?"

Interview questions uncovered commonalities and differences among eICU® staff members. The staff members were asked to describe how the eICU® work environment compares to the ICU work environment. Participants were asked what they like and dislike about working in the eICU® department. They were asked to describe how the eICU® work environment is similar to and different from the ICU.

Fieldwork involved 60 hours of observation of activities associated with work in the eICU® department. Observations were used to confirm those activities that were described during the personal interviews as well as identifying activities that needed further investigation. Fieldwork was the key to assuring congruence that what the researcher was hearing from the participants is what the researcher experienced and observed in the field. Given the postmodernism approach to this ethnography, the researcher made note of her feelings during specific observed activities.

Observations in the eICU® department occurred in multiple blocks of time to encompass different times of day and night to capture a variety of staffing matrixes. The eICU® department is staffed with eNurses around the clock, seven days a week. Intensivists are not included in the staffing matrix for the entire 24 hours of every day. The researcher conducted fieldwork during time periods with staffing matrixes that included and did not include intensivists. Team dynamics were observed according to these varying staffing matrixes.

Data Collection

Ethnographic fieldwork and semi-structured interviews were held in the CORE and private offices in the eICU® department. Following informed consent, the principal investigator interacted with the eICU® team during field study in the CORE on weekdays, evenings, and weekends. Interactions between the principal investigator and the eICU® team during the field study and interviews caused no disruption to patient care. Semi-structured interviews were conducted with individual members of the eICU® team in concurrence with the field studies. Selection of the study participants was determined by

the health care worker's availability and willingness to participate regardless of their depth of experience in the eICU® work environment. The principal investigator observed the daily eICU® work environment by sitting in the CORE alongside the health care workers.

Field notes were transcribed within one week after completion of the field work. Interviews were recorded and transcribed to written text within one week of the interview. Any names or identifiers used during interviews were eliminated during the transcription. Identified themes were tracked via an audit trail and confirmed with the eICU® personnel throughout the data collection period.

Trustworthiness was established by ensuring credibility, transferability, dependability and confirmability. Credibility was established through a thick description that accurately described the information gathered in personal interviews with as many of the eICU® staff as possible and extensive time spent observing the staff working in the CORE. Transferability was ensured through triangulation of the sources of the data (Lincoln, & Guba, 1985). Multiple eICU® staff from various disciplines were interviewed and observed. In this study, concurrent analysis of findings occurred at the same time interviews and fieldwork are ongoing to ensure dependability. Some participants were interviewed and observed more than once. Emerging categories and supporting data were verified with eICU® staff for member checks. This, along with audit trails, ensured confirmability (Lincoln, & Guba, 1985).

Treatment of Data

Methods described by Lofland and Lofland (1995) were used to gather and analyze data. This method allows for the analysis and refinement of social concepts that form the basis for a conceptual model of the phenomenon under investigation. Data collection and analysis were performed concurrently. Transcribed interviews and participant observations were analyzed for descriptive comments about the eICU® work environment and the relationships of those working in the eICU® department. Each transcript was read within a week after the interview. Initial data was coded by reviewing each transcript line by line and recording in the margin of the transcript words and phrases that capture the actions of the eICU® personnel. Statements found in the interview transcripts were clustered into categories. Emerging categories were clarified by observation in the field study and verbal confirmation from the participants. A process of coding, memos, and typologizing ensured the capture of pertinent categories.

Typologizing refers to the diagramming process that analyzes the possibilities that result from the combination of two or more variables (Lofland & Lofland, 1995). Diagramming is a disciplined process that is based on the rule of mutual exclusiveness of categories and the rule of exhaustiveness to ensure that each data example can only be placed in a single category and the categories devised should classify all of the relevant data.

CHAPTER IV

ANALYSIS OF DATA

The purpose of this study is to describe the everyday world of working in the eICU® department. Guided by a post modern existential philosophical framework, interviews and observations of the eICU® staff were conducted. Interview transcripts and participant observation notes were analyzed for descriptive comments about the eICU® work environment and the relationships of those working in the eICU® department. Data were coded by reviewing transcripts to identify words and phrases capturing the actions of the eICU® personnel. These statements were clustered into categories that were further clarified by observation in the field study and verbal confirmation from participants. The process of coding, memos, and typologizing themes captured relevant categories. This chapter discusses the sample characteristics and study findings.

Sample

Currently, 44 eNurses, 26 ePhysicians, and two Information Technology (IT) staff members compose the eICU® team This study included a purposive sample of 43 eClinicians who completed semi-structured interviews including 13 nurses and three physicians and one IT staff member who work in the eICU® department. Twenty-seven additional eClinicians participated in the observational field study. All eClinicians worked at the bedside in ICUs prior to working in the eICU® unit. Years of clinical experience and experience in critical care ranged from a minimum of five years to over

thirty years. Some of the eNurses continue to work at least one shift per week at the bedside in an ICU. At the time of this study, years of eICU® experience ranged from five months to three years, when this unit opened. Educational preparation for the eNurses ranged from Associate's Degree to Masters Degree with several eNurses currently pursuing advanced degrees.

Findings

The VISICU eICU® care system is a commercially available telemedicine platform that supports a complex model of care that provides instantaneous support for the bedside ICU team with experienced ICU nurses and intensivists from a remote location that is affectionately referred to as " in the box." Findings will present the evolution of an eICU® department and then examine elements of the work in the department.

Evolution of the eICU® Department

The concept for an eICU® model of care evolved over an extended time period at Metropolitan Hospital, the flagship institution in the Good Shepherd Healthcare System (GSHS) (all names used are pseudonyms). Important factors associated with a decision to implement an eICU® model of care related to financial drivers, technology development, and buy in from key stakeholders.

Approximately nine years prior to opening the eICU® department, Dr. Young, Medical Director of Critical Care, began considering electronic and telemedicine technology in Intensive Care Units. Initial concerns about diminishing referral patterns from community hospitals in a 100-mile radius around Metropolitan Hospital, the

flagship hospital in the Good Shepard Healthcare System (GSHS) provided the impetus for considering a new model of care. The evolution of the eICU® product and the buy in from the key stakeholders resulted in a contractual agreement with VISICU to institute the eCollaborative department at GSHS. The contract was signed five years ago and the eICU® department at the GSHS began monitoring a limited number of patients three years ago.

Beginnings to Reality

Securing buy-in for the program was relatively easy. Dr. Young's group of physicians was the dominant medical group for Metropolitan Hospital and nursing leadership was included in the planning and implementation of the eICU® model of care. While initially, there was not a concerted effort made to gain support from bedside nurses, it was recognized by all involved in project development that adoption of this new model of care would be a culture change for GSHS. The buy-in from these groups made all who were involved believe this program could be implemented with a minimum amount of anxiety. Dr. Young won favor with the Board of Directors to get the funding for the eICU® initiative. The healthcare system held a highly publicized media event to kick-off the initiative and educate both the system personnel and public about the eICU® model of care.

Anne, the Director of Nursing for the eICU® department, was involved in the project planning group for the eICU® initiative at GSHS from the beginning. As the new Nursing Director for the Critical Care Unit at University Hospital, she remembered being impressed with the eICU® model of care. She thought the program would add an

additional layer of safety and quality to ICU patient care with the GSHS. Eventually, she was approached by her supervisor to act as the clinical lead in the development and implementation of the eICU® initiative at GSHS.

Planning for the Unknown

Planning for implementation of the eICU® required envisioning the end product with very little information about the eventual outcome. Once institutional buy-in was achieved, it was now time to deal with the nuts and bolts of how the unit would function. Implementation did not always match the early imagined picture. Unexpected expenses cropped up when finalizing decisions about how the unit would function. While working closely with the VISICU and IT persons, GSHS planners approached the process with mixed emotions ranging from excitement to wonder about what they were getting into. The GSHS clinical experts guided the VISICU and IT leaders on what "made sense" within the existing clinical settings within GSHS. Unexpected expenses for equipment upgrades and replacement added to the $5 million budget allotted for the eICU® program

Initially, the thought was to have the eICU® department open only certain hours during the day. However, after speaking with others currently utilizing the eICU® model of care, it was decided that it was best if the unit functioned 24 hours per day, seven days per week. Other eICU® Teams (eTeams) who had tried less than 24-hour per day coverage found that the bedside clinicians had difficulty remembering when the unit was open or closed. Good Shepherd Healthcare System opted initially to have eICU® nurses (eNurses) on duty 24 hours per day and eICU® physicians (ePhysicians) on duty ten hours per day in the evenings when there are typically less physicians in-house in the

ICUs. After determining the staffing needs, eICU® leaders set out to find personnel to function in the capacity of eNurses and ePhysicians and train them on the specific VISICU eICU® product.

Docs in the Box

Staffing the new unit required an evolution of ideas. Initial plans for coverage were unrealistic, adding greater burden to an already busy workload for physicians. The process of finalizing a more realistic alternative plan would take over a year. Initially, staffing decisions for physician coverage were easily made according to what was practical at the time. For instance, from the beginning the thought was to have physicians "in the box" monitoring patients in the evenings starting at 9 PM with two physician groups supplying the coverage. Physicians were not pleased with working eICU® shifts in addition to the hours of patient care already included in their workload. When providing overnight, onsite intensivist coverage, opportunities were available to nap for a couple of hours during downtime. That was not the case in the eICU® work environment. Working a shift in the box, required that the physician work all day until 9 PM when they reported to their eICU® work station. They would then work in the eICU® department until 7 AM the following morning and then care for patients until approximately 3-4 PM. The eICU® model of care allowed the physician little to no mental downtime. As Dr. Young stated, "It was killing them." As a result, an alternative staffing model evolved.

Plans were made to have physicians move away from active practice and work only in the eICU® department. Dr. Young conversed with Dr. Zachary, one of his contemporaries, about moving away from their practice and exclusively working shifts in

the eICU® department as a "nice way for us to slow down or retire." Other physicians were also looking for a change and agreed to cover shifts exclusively in the eICU®. With two-thirds of the shifts covered by intensivists who were no longer seeing in-house ICU patients, the remaining shifts were covered by most intensivists routinely working in the ICU.

Shifting Nursing from Specialists to Generalists

Experienced ICU nurses were necessary in order to provide coverage in the eCollaborative 24 hours a day. The leadership team put time and energy into deciding what personality characteristics and skills would be necessary to successfully transition bedside nurses to eNurses. Early on the decision was made to only hire experienced ICU nurses currently employed by GSHS. There was value in knowing that these nurses already understood and worked well with the healthcare system's processes. Hiring from within the healthcare system also allowed leadership to know the personalities and work ethic of the eNurses. It was important that eNurses were "sure of their skills," and that they got along well with others on their team and were good communicators. As Anne explained, "Communication would be the number one skill." Proficiency in computers was not a pre-requisite because computer skills could be learned easier than ICU and collaborative communication skills.

Some eNurses were sought out because of their exceptional skills, respect by the bedside team, and communication skills. Other nurses sought out employment in the eCollaborative as they were seeking new alternative settings for nursing practice. A range of reasons existed for why nurses wanted to leave bedside practice. The nature of the ICU

environment including the toll of the work, chemical hazards, and no time for patients contributed to motivation for nurses to leave the bedside and move into an alternative practice setting. Donna, an eNurse with more than 20 years of nursing experience, explained her reasons for leaving the ICU, "I would leave at the end of every shift feeling physical, mental, and emotional exhaustion." Most nurses attributed it to getting older and wanting to avoid or minimize physical stressors associated with bedside care. Donna further explained that bedside nursing "is a young girl's game." Another eNurse recounted an on-the-job injury to her knee while repositioning an obese patient as a reason to move away from the bedside. While most of the eNurses did not have a career-limiting on-the-job injury, most expressed the desire to leave the bedside to avoid the "toll it takes on the body over time."

Other eNurses touted reasons for leaving or limiting their bedside nursing practice due to conditions such as exposure to hazardous chemicals and dealing with human excrement. As eNurse Beverly said, "I felt like I needed to shower and change clothes immediately when I got home so not to expose my family to the hazardous chemicals I had been exposed to during my shift." She went on to further explain her reason for leaving the bedside, "I was sick and tired of smelling and cleaning up shit."

A few of the eNurses left the bedside due to increasing demands that took more of their time away from the patient. For example, a change in the GSHS visitation policy allowing visitors in the ICUs 24 hours per day was seen as detrimental by some of the eNurses because it interfered with their ability to provide quality patient care. One nurse described it as "the family constantly looking over the shoulder of the nurse." Another

eNurse noted, "As a nurse, I was spending more time dealing with families and less time with the patient."

Another source of dissatisfaction for bedside nurses was limited patient contact due to increasing amounts of paperwork. Many eNurses indicated that they rarely left the ICU on time at the end of the shift because of the need to catch up on necessary paperwork not completed during the shift. The eNurses were intrigued at the possibility of working in an environment that was a computerized real-time documentation world that could support the bedside nurse and lighten his/her paperwork load.

Constant change at the bedside was another source of dissatisfaction for a majority of the eNurses. Specifically, eNurses cited constant changes in equipment, procedures, medications, computer programs, paperwork, and personnel as mental and emotional stressors encountered by the bedside team. Nurses viewed the expectation by leadership that nurses adapt to numerous ongoing changes as unreasonable. Overall, nurses believed that each of these changes resulted in more work for the nurse and less help from ancillary personnel. More work and less help from others made the ICU work environment more restrictive for nurses.

Many ICU nurses felt as if they never had freedom to leave the unit for lunch or bathroom breaks. As eNurse Margaret explained, "If you get hungry on the unit, you just stay hungry." In recruiting eNurses, it was explained to the nurses that the eICU® model of care would not restrict freedom of movement. In fact, eating and drinking were encouraged so staff would feel the need to frequently go to the bathroom as a means to increase physical activity in an otherwise sedentary work setting.

Working as an eClinician brought about a reverse of the process of specialization. Suddenly, in-depth knowledge in a selected area was less useful than broader knowledge about critical care patients. Each bedside nurse joining the eTeam brought a level of expertise in a particular subspecialty of critical care. Given that the eTeam monitors patients in many different specialty critical care units, members of the eTeam had to learn how to support bedside teams in specialties outside of his/her area of expertise. This situation was anxiety provoking for the new eNurses and ePhysicians. The fear was that the eTeam would lose credibility if they were unable to answer questions posed by the bedside team. It was impossible to train each eNurse and ePhysician to have expertise in all specialties, so the focus shifted to make the role of the eNurse as a generalist rather than a specialist. Their nursing specialty was critical care but they would act as generalists across the various ICUs.

Donna, an eNurse, expressed the concern she felt the first time she monitored patients in the neurology ICU. She thought, "I don't know neuro. I can't monitor a neuro patient. What if a neuro nurse calls and asks me a neuro question?" Donna soon realized, "Most likely a neuro nurse is not going to call you with a neuro question. They are the experts at neuro. More likely, the neuro nurse might call me with a cardiovascular question, about the patient's EKG rhythm, or that kind of thing." Donna recognized that the bedside team would more likely call with questions outside their area of expertise. Again, realizing that she may not know the answer to the bedside nurse's question, Donna went on to say, "Typically there is someone sitting in this room [the Bunker] with the expertise to help you answer the question."

Training the eTeam

After the eNurses were hired and ePhysicians identified, education on the VISICU system occurred. The vendor brought in educators to work with the eTeam. Overall, the eNurses did not find it difficult to learn how to work in the eICU® work environment although some needed additional time. Melissa recalled, "There were people who needed extra time with someone to sit down and work with them.... Frankly, the software is very user friendly. So, people really did not have too much of an issue with learning the computer system."

About half of the eNurses were not particularly computer savvy prior to working in the eICU® work environment. They explained that they knew enough about the bedside programs to function effectively in the ICU work setting, but rarely checked emails prior to working as an eNurse. Melissa, the eICU® Clinical Manager, did not see that as a problem. She expressed, "I was more interested in getting nurses that were well respected on the units and that had really sound nursing skills and nursing knowledge than I was about anybody who had any computer skills. I really felt that the computer skills we could deal with but I couldn't bring people in and teach them how to be a good ICU nurse. They had to come with that."

The eCollaborative leadership recognized that communication between the bedside team and the eClinicians would make or break the eICU® model of care initiative at GSHS. They also recognized that the eClinicians would have to take ownership of ensuring that collaborative communications with the bedside team were practiced at all

times without exception in the eCollaborative work environment. Anything short of that would undoubtedly greatly hinder the success of the unit.

The Clinical Manager identified collaborative communication as paramount in training bedside clinicians to work in the eICU® work environment. She recognized that teaching effective communication skills would be ongoing. She stated, "The communication skills are something you just have to work with continuously." She further explained, "We didn't know what we didn't know at the time! You learn over time what things offend people. We spent lots of time in training on communication skills and in discussions about how to phrase things." She gave a specific example, "Saying, 'Did you know the potassium is high?' comes across much differently than, 'I was checking in, I got a result back, may I share it with you?' The same message comes across two very different ways." The eTeam spent a great deal of time talking about collaborative communication skills needed when all communication with the bedside team would not be face-to-face. Melissa went on to say, "I think the other thing that assisted the eNurses with effective communication is that two-thirds of them still work at the bedside. I think that's important for both bedside team and the eTeam. It's important for the bedside team to know that the eTeam members really know what it's like out there in the trenches." Melissa and Anne both emphasized that polishing communication skills never stops for the eTeam because "there is always a way that you can communicate better and always somebody who's going to be offended by the way you said something."

Becoming the Eyes in the Sky

Following completion of training, a systematic plan was devised – beginning with 50 ICU beds to supervise and adding an additional 50 when they were seven months into the program. Anne, Melissa, and hospital educators worked with bedside staff through journal clubs and face-to-face educational sessions to educate them on the eICU® model of care and its intent. During installation of equipment, staff nurses, nursing leadership, and eNurses had input into where cameras would be placed in to the proximity to beds, and where the central monitoring center (CORE or Bunker) would be located. A system-wide clinical implementation group, which was one of the suggestions in the VISICU roll-out plan, met for two all day meetings where they defined work flows for both the bedside clinicians and the eICU® team (eTeam). Together, they defined eTeam involvement with events such as cardiac arrests, when the bedside nurse needed help, or when the eNurse saw something via the monitors or camera that needed to be addressed by the bedside team. The clinical implementation group talked at length about how communication was going to happen between the bedside team and the eTeam. Anne remembers those all day meetings as being "really very insightful and very successful in getting the nursing staff on board." She summarized the sentiment of the bedside nurses as, "Overall, there was a positive excitement; although, maybe with a little bit of that 'big brother' fear that you just can't avoid." Another expression, "eyes in the sky," was adopted by the bedside team to describe the eTeam and their function.

Standards were developed by both the eTeam and the bedside team to limit the amount of time that the eICU® cameras are on in the patient's room to decrease the

perception by the bedside team that they are being watched. Camera time is monitored by eCollaborative leadership. Those eNurses and ePhysicians who do not follow the camera time standards are counseled and are subject to disciplinary actions for repetitive noncompliance with the standards.

VISICU required the GSHS to officially name their eICU® department with a unique identifier. The eTeam decided on "eCollaborative" as the name of their unit to further emphasize their role as partners with the bedside team. The eTeam also wrote and committed to the following mission statement: "To act as a fully-integrated part of the ICU care team for the purpose of optimizing patient outcomes." With these key elements in place, the eICU® model of care went live at GSHS 10 months after the system's media event to announce the initiative.

After implementation, operational feasibility moved to the forefront. Initially, the unit began monitoring 50 ICU beds with one eNurse during the day and one eNurse and one ePhysician on duty in the evenings. That proved to be an unreasonable load for the eTeam. Due to high acuity of the patients monitored and the number of quality checks performed by the eNurse, a more appropriate nurse-to-patient ratio was 1:25 – 30. There did not appear to be a need to limit the ratio of ePhysicians to monitored patients. By the end of the calendar year 100 patients were monitored by the e-collaborative using two eNurses per shift around the clock and one ePhysician in the evenings. Initially, both the eNurses and ePhysicians had specific patient assignments. That later changed to eNurses having specific patient assignments and the ePhysician having oversight of all monitored patients.

The Good Shepherd Healthcare System is located in a large metropolitan city in the Midwestern U.S. The eCollaborative unit is housed in a 700 square footage space that was once reserved for storage on the first floor, in a non-clinical area of the system's Metropolitan Hospital. A maximum of 180 beds in ten distinct ICUs across four different system hospitals can be monitored from this location by the eTeam at any given time. The specialty ICUs monitored in the eCollaborative included neurology, cardiac medicine, cardiovascular post-operative care, neurosurgical, surgical, progressive care, and medical critical care units. Two of the hospitals with monitored beds are metropolitan, academic, not-for-profit acute care facilities and the other two are community, for-profit acute care hospitals.

The eCollaborative is like a world unto itself. When in the eCollaborative it is difficult to discern that you are actually in a hospital. One enters the eCollaborative unit off of a main hospital corridor through a combination lock opaque glass door that remains open during the day and closed and locked in the evenings. The door empties in to an anteroom containing a wall of personal lockers for the eTeam, a couple of conversational clusters of comfortable chairs and low tables, and tabletops with computers used regularly by the shift supervisors and IT personnel assigned to the unit. Immediately off the anteroom, there is a small kitchen area, the Clinical Manager's office, and a conference room. The kitchen area is home to the new coffee pot that serves premium flavored coffees, teas, and hot chocolates by the cup. The coffeepot has proven to be a lifesaver to the night shift eNurses. Sprinkled on the walls of the anteroom and kitchen

area are bulletin boards and white boards that are home to papers and notifications that are both work related materials or light hearted messages. The white board has a hand-written message, "Learn from the past, live in the present, plan for the future, and dream big." One must walk through the anteroom to enter the CORE of the department.

The CORE, also referred to as the Bunker or "the box," is a rectangular room lined around the perimeter with eight computer stations and a large table in the center of the room with mismatched chairs scattered around the table. There is rarely a time when food is not out on the table and all who enter the Bunker are welcome to partake in whatever happens to be available.

Each computer station has a desk that easily moves up and down to allow one to work both sitting and standing. There is a large trash can and a multiple-line telephone at each work station. Each computer station has two computers, two keyboards, two mice, one headset with an earpiece, and microphone, and a total of six to eight screens. One of the eNurses explained, "I think sometimes some people are really intimidated because it looks like, oh, my gosh, you've got six computer screens and you narrow it down to say well it's really only two computers."

The six computer stations for the eNurses are arranged in pairs, or pods, along the long wall in the room with occupants working with their backs to each other, although pod partners frequently turn around to face each other as they speak to one another. Located between each computer desk in each pod are plastic drawer units containing things like correction ink, canisters of moist antiseptic wipes, condiments, bottles of pain reliever, various pens and pencils, and miscellaneous papers. Cork board strips on the

walls beside each computer station have papers tacked on them pertaining to frequently called telephone numbers, call schedules, and other relevant notices.

Located along the shortest wall are two computer stations reserved for ePhysicians. Although the pod is set up for two ePhysicians to work at one time, the unit currently operates with only one ePhysician on duty in the evenings. Between the two ePhysician computer stations is an additional smaller station with two screens that allow the ePhysician to view digital radiological films.

At end of the rectangular room are double windows looking out onto an outdoor green space. On the window ledge is the lone plant in the room and a portable radio that plays constantly on one of only three radio stations that have clear reception in the CORE. Under the window, one can find a bathroom scale, a portable stair stepper machine, and a large rubber exercise ball. Occasionally, eNurses may choose to sit on the rubber ball rather than in their traditional office chair. The other end of the room has a desk with two computers once used by a clerical person until the position was eliminated. There is a normal array of hospital office equipment including a fax/copier, box for shredding confidential documents, bookshelves that hold hospital and department polices and procedures and references books, and cabinets that contain office supplies. Three pieces of abstract artwork hang on the wall by the eNurses' work stations. A red analog telephone hangs on one wall for use in a power failure and hidden from open view is a panic alarm button that immediately alerts hospital security if activated.

Uneven temperature regulation in the eICU® CORE leaves the two pods on either end of the room cold and the pod in the middle of the room too warm. The eClinicians

adapt to the colder pods by wearing additional layers of clothing while those in the middle pod use portable fans to combat the heat.

The Bunker has different day and night characteristics. By day, the Bunker is well lit and the front door to the unit is propped open. It is not unusual for unannounced tours, hospital leaders, students, equipment and drug representatives, and nurses orienting to the ICU to drop into the unit. In contrast, by night, lights in the department are turned down. At change of shift, one of the eNurses announced as she turned down the lights, "Now, it is officially the night shift." Rarely does anyone other than members of the eTeam visit the unit on the night shift. Monica, an eNurse who works both day and night shifts, stated, "On the day shift, it is open house. On the night shift, it is by invitation only." As a result, conversations and activities are more reserved during the day shift than on the night shift.

Working in the eCollaborative - Life in the Box

Healthcare professionals working in the eCollaborative are either physicians or nurses. There are basically two shifts for each discipline. For the eNurses, the shifts are day shift (7 AM until 7 PM) and night shift (7 PM until 7 AM). For the ePhysicians, there is an evening shift (4 PM until 9 PM) and night shift (9 PM until 7 AM). On the weekends, ePhysicians work two 12-hour shifts not unlike the eNurses (7 AM to 7 PM and 7 PM to 7 AM).

Role of the eClinician

Both the eNurse and ePhysician function to support the bedside team. Administratively, one eNurse on each shift acts as the eCollaborative Charge Nurse. The role of Charge Nurse is not unlike that role at the bedside. The eICU® Charge Nurse makes the eNurse assignments and posts them both digitally in the Patient Assignment Log (PAL) and in hard copy format. Assignments to cover beds in a specific ICU are made according to the eNurse's skill and expertise as well as his/her ability to communicate well with that bedside team. Units who have not embraced the eICU® model of care require an eNurse who has a high skill level for communicating effectively in a collaborative, non-threatening style. The eCollaborative Charge Nurse acts as a resource to the eNurses. Along with his/her own PAL, he/she also sees alerts for all of the eICU® monitored patients.

The eClinicians pull on their existing ICU skills, viewing themselves as 'virtual' charge nurses and actively utilizing their critical care knowledge within the context of a global patient care team. According to Donna, "The eNurse functions like a virtual Charge Nurse who knows pertinent information about many patients instead of every minute detail about the care of two ICU patients." Most interactions with the bedside team involve discussions about specific patient issues. She explained that most questions from the bedside team are those that would normally go to the Charge Nurse on the unit. As Donna put it, "The computers and the cameras are great tools, but the most important thing we do is provide the bedside team with instant access to an experienced ICU nurse [eNurse] or an intensivist [ePhysician] when they need it." Donna expressed that one of

her greatest satisfactions as an eNurse is when she can support a new ICU nurse who would normally have to rely on access to the ICU Charge Nurse for guidance.

The skill set used by the eNurses is not unlike the skills utilized at the bedside. One of the eNurses, Madison, said, "You're still using all the same information you used at the bedside, you're just using it in a different way. You're using that same basic assessment of a patient and your critical care nurse thinking skills to know appropriate and best care for the patients. You look at the patient's orders, results of their [diagnostic] tests, and how they are doing."

eClinician Work Flow

Work flow for the eNurse is somewhat structured although each eNurse develops his/her own unique way of accomplishing the work. Some tasks are similar to work flow of the bedside Charge Nurse. Each shift begins with an eNurse-to-eNurse handoff of patients. The eNurse from the previous shift gives a brief report on pertinent patient information to the oncoming eNurse. This report includes any changes in the patient status that were documented on report sheets throughout the shift as the report sheet guides the report to the oncoming eNurse. The oncoming eNurse is alerted to any new patients that were received in their assigned unit on the prior shift as well as any discharges and unstable patients. Pertinent information included in the report sheet and communicated in the eNurse handoff include: (a) the patient's name and age, (b) code status, (c) diagnosis, (d) intubation status and type of oxygen delivery system, (e) cardiac rhythm, (f) vital sign parameters, (g) infusion and monitoring lines, (h) test results, and (i) those test results that are pending. Both the oncoming and off going eNurse co-sign with

a digital signature that they have both checked the computerized medical record to ensure that all documentation is in order and all eICU®-related tasks have been completed.

Sometimes, e-Nurses have their personal routine at shift changes. For example, as the eNurses physically vacate and occupy the computer station, one of them wipes down the keyboards and work area with moist antiseptic cloths prior to signing onto the multiple computer programs that are displayed on their computer screens. These programs include the VISICU computer program, the hospital's electronic medical record (EMR), the vital sign monitoring system, the bed board and the comprehensive nurses' notes program.

Rounds

The eNurse rounds on patients remotely according to the patient's acuity. The ePhysician generally only rounds on those patients known by the physician or those who have been identified as high acuity who are exhibiting trend of deteriorating condition. One can tell when the eNurse is rounding as he/she will don their headset with the earpiece and microphone in order to communicate with the patient and others at the bedside. The acuity system is color coded as red for the highest acuity, yellow for moderate acuity, and green or an eyeball icon as the lowest acuity. The frequency of rounding is dictated by the acuity scale. Patients with an acuity rating of red are rounded on every hour. Patients of lesser acuity with a yellow rating are rounded on every 2 hours and patients who are rated green or eyeball are rounded on every 4 hours.

While each eNurse has their own unique way of conducting rounds, the same basic activities are covered by each eNurse. Work flow varies from one nurse to another.

Some flip back and forth from one screen shot to another while others look at one screen on all of their patients and then move to another screen to check on all of their patients. Regardless of the exact process for viewing screen shots, each eNurse rounds in order to do a systemic assessment of each patient on his/her PAL. The assessment includes a review of patient data and a current visual assessment of the patient via the remote camera. The eNurse reviews all of the Smart Alarms that have occurred on each patient within the last 12 hours or since the last rounding time. Cardiac rhythms are reviewed for the last 24 hours.

The Camera

The visual assessment on the patient via the camera is an essential part of rounding on the patient. The process of how one enters and exits the room via the camera has been standardized in order to ensure that each member of the eTeam does it the same way. The eNurse uses the mouse to click on the patient's name on his/her PAL to activate the camera. As the camera is activated, the eNurse or ePhysician rings a chime known as the "doorbell" to indicate in the room that the camera is now on. Some units and family members have exercised the option of having the eNurse not ring the doorbell as some find it annoying or confusing for the patient. Whether the eNurse rings the doorbell or not, he/she announces his/her presence via speakers located in the ICU room as the camera comes to life in the ICU room. The standard way to announce the eNurse's presence is by saying, "Hello, my name is Agnes. I am with the eCollaborative. I have a camera in the room and I am just doing my rounds." The eTeam has developed etiquette standards around activating the camera and communicating via the camera. Camera time

should be brief except if the patient is unstable or coding. The patient's privacy must always be protected. If the eNurse activates the camera while the patient is bathing, the camera is immediately deactivated. The patient's condition is never discussed over the camera. Confidential issues are discussed with the bedside nurse over the telephone and not the camera. The eNurse is expected to offer assistance in a professional manner to the bedside nurse, the patient, or the family via camera communications. The eNurse is expected to announce his/her exit from the room as the camera is deactivated. The eCollaborative Shift Supervisors and Clinical Manager monitor camera time to ensure that the eTeam is keeping camera monitoring times to a minimum. Also, any complaints from the bedside team regarding inappropriate use of the camera are fully investigated by leadership.

The camera is navigated by the eNurse via mouse clicks. Initially, the camera is positioned to give the eNurse a broad view of the patient. The eNurse may observe something in the broad view of the patient that prompts an intervention for the safety and quality of care for the patient. Common examples of statements from the eNurse to the patient such as, "Mr. Walker, please put your oxygen tubes back in your nose," or, with a patient who is at high risk for falls, "Ms. Adams, please stay in the bed. Can I get your nurse for you?" Then, the eNurse systematically zooms in via the camera to monitor intravenous medication infusions, ventilator settings, checking guardrails on infusion pumps, and listening for alarms that might be heard from equipment in the room.

Alerts

Throughout the entire 12-hour work shift, the eNurse and the ePhysician are cognizant of alerts indicating changes in the patient's condition and new orders that have been entered into the EMR by the bedside team. Changes in the patient's condition pop up via the VISICU decision support system in the form of Smart Alerts® (VISICU, Inc., Baltimore, MD). Alerts are identified by patient and a color coded severity system with red as the most severe and requiring immediate attention, yellow as moderately severe, and green as minor severity. When a Smart Alert® pops up on the eClinician's screen, the eNurse or ePhysician use the mouse to pull up the patient's historical and current hemodynamic status to determine if the alarm is real or artifact. The role of the eNurse is to trouble shoot for possible reasons for the alarm. Once the reason for the alarm is identified, the alarm is dismissed and reset by the eNurse. If the eNurse is unable to clarify reason for alarm, the eNurse will camera into the patient's ICU room to visualize the patient and identify if the bedside nurse is working with the patient and is aware of alarm. The eNurse consults with the bedside nurse as needed to either dismiss the alarm or to determine if a bedside intervention is necessary. If no member of the bedside team is in the room when the eNurse activates the camera and the alarm is real, the eNurse will notify bedside nurse of the situation by telephone. If the eNurse cannot reach the bedside nurse in a timely manner, the eNurse will contact the bedside Charge Nurse. The role of the ePhysician in regards to Smart Alerts® is to offer advice and consultation including issuing orders to the bedside team in the absence of the attending physician.

Every four hours, the eNurse updates the VISICU with the census of the ICUs he/she is monitoring. The eNurse ensures that the census in the hospital's EMR and VISICU systems match. This vitally important process allows the eNurse access to view the patient through the remote camera and access to the patient's current and historical data.

Shortly after the beginning of each shift, the eNurse gets a fax from the bedside Charge Nurse that includes the unit census and a list of which bedside nurses are assigned which patients. By 10 AM/PM, the eNurse checks in with the bedside Charge Nurse. The bedside Charge Nurses communicates any known admissions, discharges, or planned procedures that will occur during the current shift. The Charge Nurse alerts the eNurse of any significant changes in a specific patient's condition and he/she also identifies the most critical patients and those who need to be watched by the eNurse more closely.

Work flow for the ePhysician is less structured than that of the eNurse. For the ePhysician who comes on duty at 4 PM, there is no physician-to-physician handoff and no formal report. Individual eNurses informally communicate specific patient concerns with the oncoming ePhysician. The handoff from one ePhysician to the next at change of shift is also informal. There is a brief conversation between ePhysicians regarding patients who require close monitoring. Camera and communication etiquette expectations are the same for the eNurses and ePhysicians.

Telephone calls into the eCollaborative from the bedside team increase when the ePhysician is on duty. Bedside nurses have expressed their appreciation for instant access to an intensivist via the eICU® model of care. Calls to the ePhysician from the bedside

nurse are often for consultation, second opinion, to get orders, and to get radiological films read to confirm line placements. All ePhysician interventions are recorded in their intervention log.

Codes

Codes for respiratory and/or cardiac arrest may be called by either the bedside team or the eTeam. The bedside team may push the eICU® button in the room to ask for help during a cardiac arrest or the eTeam may call a code if they witness the event while the camera is on in the room. The expectation during a code is that the eTeam will activate the camera, ask if they may be of assistance, continue to monitor the room via the camera for the duration of the code, and complete a code evaluation form to be sent to the hospital's code team for performance improvement opportunities.

During codes, the ePhysician communicates with the bedside team and may be called upon to run the code until physicians arrive at the bedside. Then, the ePhysician communicates a brief history of the event with the bedside physician, offers assistance, and then quietly monitors the situation for the duration of the code.

Information Resources

Nurse-to-eTeam consults may be initiated to exchange information regarding patients, diagnoses, procedures, use of equipment, or various other topics related to a patient's condition and care. The eTeam sees themselves as resources for information. They have instant access to a decision support and information systems built into the VISICU system and the GSHS electronic library. These same resources are not as easily accessible to the bedside team. There is also an issue of time. The bedside nurse may

have access to information resources but does not have the time to search for the information needed. Madison, an eNurse, explains, "We Google a lot. We do have a resource in our system called The Source but I personally find it very difficult to find what it is you're actually looking for in it. I find it a lot easier to Google. We have access to the [the healthcare system] library, where we can look stuff up there, find articles about things if we need to. We have lots of different things." Madison continues, "We have time to search for patient data and information on the patient's record whereas the bedside nurse does not have the time."

Discussions and involvement of the eTeam with the bedside team for both urgent and non-urgent consultations may be initiated by either a member of the eTeam or the bedside team. The bedside nurse may call to have a nurse-to-eNurse consultation. It is not unusual for the bedside to ask the eNurse to conduct the quality control audit on central line insertions as the nurse is often assisting the physician in the insertion. Central line insertion audits are a JCAHO expectation and documentation of completed audits may be reviewed by JCAHO surveyors.

Another regulatory requirement regarding central lines is the expectation that line necessity, location, and assessment of the site is documented daily. This documentation falls to the eNurse on the night shift in the form of a line log that is updated daily. If the night eNurse is unable to confirm the line and visualize the line via the camera, this task is passed on to the day shift eNurse.

eICU® Documentation

In the eICU® work environment, one eNurse explained that the eNurse does very little free text documentation as part of their work flow. Most of the work done by the eTeam is done through mouse clicks. This eNurse also explained that while the eICU® documentation is done to assist the bedside team, "Nothing we do is a legal document." The eTeam documentation resides only in the VISICU program and does not become part of the patient's permanent medical record.

Attention to detail in both urgent and non-urgent patient issues is one of the most important things the eTeam brings to the patient care arena to ensure patient safety and quality of care. The eNurse makes notations of pertinent patient information on the Quick Report Sheet as this is the sheet utilized in the hand off of the patient to the eNurse on the next shift. Non-urgent issues identified during rounding that need to be discussed with the bedside nurse are made on a separate piece of paper. One eNurse explains that she has the time to check on details that might be overlooked by the busy bedside nurse. She shared an example of a non-urgent issue that she routinely monitors, "I check dietary issues as those are often missed by the bedside team." She recognized that dietary issues may not be urgent but they can negatively impact a patient's health and well being.

Each monitored patient has a profile in the VISICU system. The eNurse updates the profile on each of his/her assigned patients. The eNurse ensures that vital signs are trending which is another confirmation that patient is both in the hospital's EMR and the Visicu system. Patient information such as height and weight and medical record number are confirmed by the eNurse. Progress notes, laboratory and radiology results on each

patient are read by the eNurse. If critical values have not been reported to the bedside team, the eNurse will relay those critical values to the appropriate bedside clinician. Reporting of critical values is a JCAHO expectation and documentation may be reviewed by JCAHO surveyors.

On the day shift, the eNurse checks microbiology results on each patient. He/she ensures blood cultures have been drawn and notes if the results of the blood cultures are positive or negative. If the cultures are positive, the eNurse ensures the appropriate antibiotics have been ordered and administered. This information is passed on to the night shift eNurse in the patient handoff.

Non-urgent issues that need to be addressed are posted by the eNurse in the computerized task list. Not all eNurses utilize the task list as they do not believe bedside nurses and physicians look at these tasks lists routinely. Most eNurses address non-urgent issues in a telephone conversation rather utilizing the task list to ensure that no items are missed or overlooked.

The eNurse updates the care plan on each patient on his/her PAL. Some eNurses complain that updating the care plan in the VISICU is redundant since the bedside team develops and maintains their own care plan on each patient. The VISICU care plan is primarily for use by the eTeam. After the care plan is reviewed and updated, the eNurse "validates" the care plan by clicking the validate button at the bottom left hand corner of the care plan page. When the eNurse reviews the care plan on the patient, he/she will make a check mark by that patient's room number on the Intervention Log.

Intervention Log

The Intervention Log is updated throughout the entire shift. An intervention consists of activity done or offered to make a difference for the patient. Occasionally, an eNurse or ePhysician will identify and intervene on an error. The goal of intervening on errors is to reduce complications and not to punish or blame others. Frequently during each shift, a member of eTeam will intervene in some way to avoid a potential error or to enhance the quality of patient care. For example, an eNurse noticed that patients with similar names were in the same ICU and brought that information to the attention of the bedside so proper patient identification alerts were put in place to avoid errors. That action taken to alert the bedside team of this potential risk to patient safety would be logged as an intervention. The Shift Supervisors in the eICU® unit oversee the Intervention Logs and report a tally of the interventions for the month to eCollaborative staff and leadership, hospital leadership, and individual ICU leadership.

The Reality of Working in the eCollaborative

Impact on eClinicians

Working in the eCollaborative has impacted the lives of those working in the unit. The impact differs for the ePhysicians and the eNurses.

ePhysicians. Working in the eCollaborative has impacted the lives of those working in the unit. For the private physicians who take mandatory shifts "in the box," some do not like that these shifts are additions to their busy practices and on call responsibilities that take more time away from their families and personal time off. Others are not bothered by taking eICU® shifts as they believe having the ePhysician

available to the ICUs cuts down on the number of calls they get from the ICUs after hours. Those physicians believe it is a trade off and do not mind participating as they will reap the benefits during the time that they are not on duty. All agreed that the time commitment was not significant as the eICU® shifts were split amongst a large enough number of physicians not to make it much of a burden.

The two dedicated ePhysicians do not have significant private practices so their obligations to the eCollaborative are their primary source of income. They enjoy the defined work hours and the "limited interactions with dysfunctional families" of patients. One of the ePhysicians expressed pleasure in the fact that when he leaves the eCollaborative, he has no need to carry a pager. And, although he commutes a great distance to work as an ePhysician at GSHS, when he is at home, he is truly committed and available to his family in a way that was not possible when he was in private practice. The ePhysicians see value in the services provided by the eICU® model of care from a quality of care perspective. They are quick to recognize that they are limited in what they can do to intervene in patient care and admit that there is no substitution to having in-house physician support for hands-on interventions such as intubating patients and inserting central line catheters.

eNurses. The eNurses echo the feelings of the ePhysicians in their belief that their purpose is to support the bedside team to improve the quality of care and safety of the patient. Working in the eCollaborative has admittedly improved the quality of life for all of the eNurses who participated in this study. Most expressed their belief that this work environment would lengthen the life of their nursing career by decreasing the physical

stresses associated with bedside nursing. Many of the more seasoned eNurses plan to work in this telemedicine environment until they retire. Some of the younger nurses see the eICU® work environment as a transitional role in their careers.

Even in the event of a code, both the eNurses and ePhysicians admit that the stress level of working in the eCollaborative is much less than working at the bedside. The work environment is "laid back" for the most part and the eTeam does not feel micromanaged in their work. Some see their work in the eICU® department as a way to have a less stressful work environment with set hours, little overtime, and less time being called off due to low census which works well with their lives and family obligations outside of work. Some plan to continue to work in this environment until they finish school or until their children are older, and others have expressed an interest in staying in this work environment until the next innovation in nursing comes around.

Maintaining Credibility

Preserving the credibility of the eNurses and the ePhysicians is paramount in their eCollaborative roles. Such credibility enhances communication receptiveness when eTeam members intervene in a bedside situation. The eNurses are encouraged to work shifts at the bedside in ICUs monitored by the eCollaborative. There is a belief that the bedside team will respect eNurses when they work side-by-side at the bedside. Sometimes resentment still remains. For example: Donna, an eNurse who also continues to work shifts at the bedside, recalls a conversation she had with a bedside nurse, "I saw Monica the other day in the parking garage after I worked a shift in the ICU, and she

screamed at me, 'Oh, you worked as a real nurse tonight.' I told her that I am a 'real nurse' every night."

Some resentment may remain from the time when the unit was first initiated. When nurses were recruited to work on the eTeam, it left some units short staffed. One of the ePhysicians recalled that there was talk that the ICUs were being "raided" of the most experienced and best ICU nurses in order to staff the eICU® department. Some of the bedside nurses looked upon the eNurses as defectors from bedside practice and questioned their commitment to the field of nursing.

Hands Tied Behind Your Back

There are frustrations by the nature of the eICU® work environment. All of the eTeam members were once accomplished bedside clinicians. One ePhysician described his frustration in watching a code from the view of the camera, "You can do everything you could do in the room with your hands tied behind your back." Hence, there is a need for very clear communication and collaboration with the bedside team as they are "your hands" on the patient.

One evening during rounds, the eNurse noticed a patient was acting restless and trying to get out of bed. No alarms were triggered even though her nasal oxygen cannula was not in place. To the eNurse, it appeared that the patient might be exhibiting behaviors not uncommon with respiratory distress and oxygen starvation. The eNurse asked the ePhysician on duty to visualize the patient from his computer station. After assessing the patient via the camera, the ePhysician agreed that the behavior was consistent with lack of adequate oxygenation. Both the ePhysician and the eNurse communicated with the

patient via the camera to ask if she was okay and to ask her to put her nasal oxygen cannula back in place. She did not respond verbally and did not reposition her oxygen tubing. The ePhysician called the bedside nurse and asked that she go to the patient's room to do an assessment. The ePhysician and eNurse monitored the situation through the camera until the bedside nurse indicated that the patient was not in respiratory distress. The nurse communicated that the patient had a history of exhibiting similar behavior in an effort to get attention from the nursing staff when she was lonely. As the ePhysician restated the obvious, "There is only so much we can do through a camera. There is no substitution for the bedside caregiver."

Time Moves Slowly

Sometimes waiting for beside nurses to take action on a selected task seemingly takes a long time. Dealing with this phenomenon takes patience on the part of the eNurse. Steven, an eNurse, explained some of his frustrations while patiently waiting on the bedside nurse to take action on a patient's changing condition, "Time moves more slowly when you are watching through the camera. You have to remember that time is moving much faster for the bedside nurse. She has more than one patient, families and others to deal with, and many more things that are pulling her away from the patient." He explains, "I have to be understanding of that on my end. If the patient is in danger and the nurse has not intervened, then I will escalate up to the Charge Nurse. But, if the patient is in no immediate danger, I wait for the nurse to address the situation." Donna, a seasoned ICU nurse turned eNurse, says, "Sometimes I just want to jump through that camera and take action myself. It can be hard to wait on the nurse to take action." Madison states, "Some

days I feel more stressed than others .... There may be a Charge Nurse who does not really understand what you're saying but you feel like there is something that really needs to be done [for the patient]. That can be stressful because you don't have robot arms to reach through the camera and take care of the issue yourself."

eTeamwork

The close proximity of those working in the CORE has a big impact on the climate and collegiality of the work environment. The eTeam often uses humor and statements made for shock value as they interact with one another. As the day shift winds down and there is a decreased risk of having someone from administration or the outside pop in the unit for unannounced visit, the banter amongst the eTeam is more spirited and most eTeam members join in the conversations. It is important to note that there are no walls between the pods. The eTeam works in close quarters with little privacy. Most conversations within the unit and on the telephone are overheard by all in the CORE. During both the day shift and the night shift, one can hear the eTeam conversing with each other socially and professionally. There are frequent eNurse-to-eTeam consultations regarding patient issues.

The eTeam members admit that they all have "strong personalities." Donna elaborates, "The problem is that you can't get away from issues that you find irritating. You can't go run and hide in your patient's room because you don't have a patient room to run into." As a result, the eTeam members resolve personality conflicts and issues among themselves in real time to avoid tension in the workplace. Steven, an eNurse,

commented, "If we have a problem with a co-worker, we say it and resolve it right away."

The eNurses and ePhysicians are complimentary of each other and the value that their roles bring to the entire eTeam. Both disciplines believe they have unique and positive relationships that are very different than those relationships at the bedside. Madison, an eNurse, shared, "I do think that we have a unique relationship with our physicians who work here. They're really a big part of our team. We are not afraid to bring anything to their attention and ask them anything or to explain something to us or whatever. It's kind of like they're just one of us when they're sitting there. They are just very much just one of the gang." One of the ePhysicians reciprocated, "The eNurses are great with lots of experience."

Walking on Egg Shells - Communicating with the Bedside Team

The experiences of interacting with the bedside team while working in the eICU® work environment were more strained. The goal of communication between the eTeam and the bedside team is to share information in an effort to provide the highest quality of patient care. Effective interaction between the eTeam and bedside team is critical to the success of the eICU® model of care as the eTeam can only make recommendations of actions to be taken by the bedside team given the fact that they are operating from a remote location away from the patients. The e-Team described the interaction process with the bedside team as "walking on eggshells." As Anne, the eICU® Nursing Director, explained, "Communication [is] the number one skill" that is necessary in encounters with between the bedside ICU team and the eTeam. The eTeam takes ownership of

ensuring that all communications are professional, non-judgmental, and non-offensive towards their bedside counterparts.

As far as communicating, Madison shared, "You just have to get a feel for how to communicate with the bedside team. The camera is what scares people most of all including talking over the camera." Steven, an eNurse on the night shift, shared how he communicates with the bedside team, "Well, with the bedside nurses, I just try to be very gentle with my suggestions. I make suggestions versus orders because I'm not their boss. I tell them something I'm seeing and what I would or would not do that might keep the patients safer or help them get better quicker."

Some bedside team members respond well to communications by the eTeam and others do not reciprocate the same collaborative communication style back to the eTeam. Madison, an eNurse, explains, "It's not always the long term nurses, but usually the ones with a chip on their shoulder who are rude in their in how they speak to us. Those nurses feel like they know what they're doing and they don't need somebody watching them. What they don't realize is that we're not really watching them, we're watching the patient." She further elaborates, "We're tracking and trending what's going on to make sure patients are safe. If people could just come to grips with that, then everybody would just be okay." Madison goes on to say, "It [communications with the bedside team] has gotten much, much better over time. But in the beginning it was really, really rough." Melissa, another eNurse, admitted, "Probably the biggest error we continue to make is ticking people off."

Measuring the Return on Investment

Anne developed the Intervention Log as a means to report on the benefits of the eICU® model of care to facility and hospital system executives. As the eICU® program began, Anne collected data in the hopes of showing decreased length of stay and decreased mortality rates for ICU patients monitored by the eTeam. Anne remembered thinking to herself, "I realized that I was not going to be able to show that we were decreasing length of stay. I started asking my colleagues across the country if they had decreased length of stay. And, they confirmed that many had not decreased length of stay." She recalls, "I didn't know how much pressure I was going to be under to keep my program running, so I quickly evaluated that the true value in this service was all of the interventions that are happening by these fabulous nurses in the eICU® unit. So, we started logging them. In looking at the log, we were able to show that we prevented patient harm. We had identified errors that had occurred and we had prevented potential errors from happening. We realized that we had to utilize these interventions to communicate what GSHS was getting for their investment." As one of the ePhysicians confirmed, "The eCollaborative is not a money maker. Its value is in cost avoidance."

Anne specifically used the Interventions Log in speaking with the Chief Nursing Officer (CNO) from one of the community hospitals. Six ICU beds had been monitored by the eTeam for about a year. Anne explained, "I knew I would never have enough data in ten years to show that we decreased their length of stay or we'd even decreased their mortality. And, I went to her and I said, 'I can't show you that we've decreased mortality

and I can't show you we've decreased length of stay, but I can share with you the interventions attributed to the eNurses and ePhysicians. I believe that if we turn this [eICU® model of care] off tomorrow we would be affecting the quality and safety of your patients.' " Anne read examples of actual interventions that were initiated by the eTeam on patients in this hospital's ICU. By the time Anne read the third example of an intervention, the CNO "was sold." From then on, Anne, Dr. Young, and Melissa have continued to use the Interventions Log to justify the value of the eICU® model of care.

Unexpected Outcomes

The eICU® model of care is relatively new around the U.S and definitely was new to GSHS. Certain aspects of the eICU® work environment were a given, such as less physical activity, no hands on patient care, small open work space, and extensive work with computers. While these aspects were recognized, the impact of the issues was not anticipated prior to opening and working in the eCollaborative.

Physical and mental stressors. As eNurses transitioned into the telemedicine work environment, they found that there were physical stressors related to this work environment that were not foreseen. One of the eNurses rubs her neck as she complained that she gets a recurring pain in her upper back from repeatedly using the computer mouse. Another eNurse commented that her neck hurts from the angle of the monitors. She has learned over time to keep her work table low and her chair high to avoid discomfort. Two eNurses have had carpal tunnel syndrome surgery, but further investigation shows that the repetitive injury associated with this syndrome occurred prior to these nurses working in the eICU® department.

Several eNurses admit to having had blood shot eyes daily when they first started working as an eNurse. At least one had glasses prescribed with antireflection and magnification. After a while, she forgot to wear them and now she never wears them. One eNurse wears gloves while she works as she has developed a contact dermatitis since working in the eICU® department.

Freshman 15. Whereas physical stress was a main reason for some to leave the bedside work environment, the eICU® work environment is the extreme opposite. The lack of physical activity in this new work environment has its own challenges. Weight gain, fatigue, boredom, and lack of ability to concentrate are common side effects of the lack of movement by the eTeam. One eNurse describes the weight gain when someone joins the eTeam as the "Freshman 15." In an effort to combat the weight gain due to the change in activity levels in this new work environment, the eNurses initiated a weight loss program affectionately known as "The Biggest Loser" that has shown a great deal of success in weight control for the eTeam.

Bag of tricks. Boredom comes from the repetitive work related activities that are inherent to the role of continuously monitoring patients by rounding on each of them according to their level of acuity. Working on the computer for long periods of time without breaks decreases the ability to concentrate. As one eNurse described it, "Your brain gets fuzzy if you look at the computer screen for too long." Distractions and frequent breaks are encouraged to fight the boredom and lack of ability to concentrate. Given that each eTeam member has a pod partner, it is relatively easy to take breaks without compromising patient care. All of the eNurses and ePhysicians bring in items to

facilitate distraction. One eNurse referred to the various personal backpacks and bags around the CORE as their "bag of tricks." These bags contain things like magazines, bills that need to be paid, books, food items, and other personal items. Diversion plays an important role in maintaining mental sharpness while at the computer.

For some, food fulfills a diversionary role in the eCollaborative work experience. Food is frequently out on the table and all who enter The Box are welcome to partake in whatever happens to be available. eNurses freely admit, "Most of the food that is brought to the hospital by drug reps ends up here." Another eNurse chimes in, "You can get lots to eat if you stay around here for any length of time."

Some eTeam members keep one of their computer screens on a non-work related website in order to have a distraction at eye's view at all times. Others periodically walk away from the computer station to "clear their head." They visit with one another in the unit or they walk outside of the unit for a fresh perspective. When an eNurse leaves the CORE, his/her eNurse pod partner pulls up a screen to monitor the alarms on his/her patients in order to watch them while he/she is off of the unit. Occasionally, visitors to the unit provide a much needed distraction. One evening, a Chaplain brought in one of her service dogs for a visit. She stated, "This is a stress reliever for the staff."

Summary of the Findings

Following a 10 year effort, the eICU® department, eCollaborative, at the Good Shepherd Healthcare System opened to provide remote monitoring of intensive care patients. Physician coverage is currently 15 hours during the weekdays and 24 hours per day on the weekends. Experienced critical care nurses transitioned to the role of eNurse

and provide 24 hours per day, seven days per week coverage. The eNurses chose to work in the eCollaborative as a result of feeling physical, emotional and mental stress while working at the bedside. Working in the eICU® work environment is not without its own set of stresses including weight gain, boredom, lack of ability to concentrate for long periods at a time, transient eye strain when first moving to the telemedicine work environment, and frustrations associated with working with the bedside team.

The transition from the bedside to the telemedicine work environment involved education and training. Learning to work the VISICU computer system was relatively easy compared to learning to communicate effectively with the bedside team. Verbal communications between the bedside team and the eTeam is through telephone or camera connections and neither of these modes of communication offer face-to-face interactions.

Justifying the value of the eICU® work environment to the hospital is done by documenting the interventions that members of the eTeam make during their shifts to positively impact patient safety and quality of care. The return on investment of the eCollaborative centers around cost avoidance rather than from decreasing length of stay or decreasing mortality of ICU patients. The computer technology associated with the eICU® model of care is an effective tool, but the strength of the program is instant access by the bedside team to an experienced eNurse or ePhysician.

CHAPTER V

SUMMARY OF THE STUDY

The eICU® model of care is an emerging model of intensive healthcare. This shift in health care delivery mechanisms offers the promise of early intervention through the use of off-site monitoring by experienced nurses and intensivists. Roles of the key players, registered nurses, and intensivists, in eICU® model of care are also expanding. This model and the roles of eICU® personnel have not been described in the health care literature. The purpose of this study was to describe the everyday world of working in an eICU® department through an ethnographic study of the telemedicine work environment.

Summary

An existential ethnographic design guided by the philosophical underpinnings of symbolic interaction was utilized to explore the everyday life of eICU® personnel. Data were gathered through the use of 60 hours of field observation and by individual interviews of eClinicians. The purposive sample consisted of 43 eClinicians who participated in the observational portion of the field study. Seventeen eClinicians completed semi-structured interviews including 13 RNs and three physicians and one IT staff member who work in the eICU® department. Evaluation of the symbolic interactions observed in the eICU® department enabled the researcher to define the reality of the eICU® work environment. Study findings examine departmental evolution, the nature of the eCollaborative, the reality of working in the eCollaborative, and outcomes.

Evolution of the eICU® Department

During the three years that the eCollaborative has been in existence, it has continued to evolve. The inception began with the Medical Director of Critical Care's desire to establish the eICU® model of care in an effort to increase the number of referrals of ICU patients from outlying community hospitals. He continues to drive the evolution of the program. His latest proposal is to reach out to ICUs outside of the Good Shepherd Healthcare System to provide eICU® coverage on a fee for service basis. Should that proposal become a reality, it will no doubt necessitate the need for further evolution of the eCollaborative.

Currently, the eClinicians had professional roots in GSHS with five or more years of ICU experience prior to working in the eCollaborative. The majority of the ePhysicians rotate duties in the eCollaborative while maintaining their own private practices. Some of the eNurses continue to work in shared positions with the bedside teams in an effort to improve staff relations and communication as well as maintaining their bedside skills. Most eNurses chose to work in the eCollaborative as a result of feeling physical, emotional and mental stress while working at the bedside. Most believe their quality of life has improved and their nursing careers will be lengthened by their working in the eICU® work environment.

Most of the eTeam found the transition from the bedside to the telemedicine work environment to be relatively easy. Learning to work the VISICU computer system was not difficult and just took hands-on practice, but learning to communicate effectively with the bedside team has proven to be an ongoing challenge. Verbal communications via

telephone and camera connections without face-to-face contact between the bedside team and the eTeam requires a special skill set, education, and continuous practice.

As the eCollaborative has evolved, the importance of interpersonal skills and communication have only grown in importance and many of the eTeam have shown great improvement in conducting difficult conversations with the bedside team in a collaborative effort for the benefit of the highest quality of patient care. The eNurses and ePhysicians must communicate in ways that are not offensive to the bedside team. The eNurses and ePhysicians must communicate necessary interventions clearly and effectively to elicit the appropriate actions from the bedside team. Given that the eTeam has no hands-on contact with the patient, all actionable interventions suggested by the eTeam must be executed by the bedside team. In order to diminish any perceptions by the bedside team that the eTeam is spying on them or critiquing their every move, camera time by the eTeam is limited.

The eCollaborative

The eCollaborative is a separate and distinct work environment housed in a non-clinical area of a metropolitan hospital. When one enters the unit, it is like entering a world of its own. Computer stations line the walls and eClinicians typically work in pairs even though their backs are to each other.

The roles of the eNurse and ePhysician are clearly defined as acting as information resources to the bedside team. Historically, eNurses were specialized ICU nurses prior to joining the eTeam. In the eICU® work environment, they have had to move to a generalist role rather than a specialist role as they monitor many different ICUs

that cover many different medical specialties. They round on patients, utilizing a camera to visualize ICU room activities, responding to computerized alerts that indicate a decline in a patient's condition, and providing support during cardiac or respiratory arrest codes. The ePhysicians may even run the code until a physician arrives at the bedside.

Bedside clinicians may call via telephone or push a button at the bedside to request a consultation with an eClinician. The eClinician has multiple sources of information at their fingertips via computerized information systems. The VISICU eICU® product contains an information database, the healthcare system has their version of a computerized information resource database, and the eClinicians often use internet-based search engines to address the questions and concerns of the bedside team.

Documentation by the eClinicians is minimal as most of their computer activity is done with the mouse rather than free text. Interventions initiated by the eClinicians are documented each shift as a means to quantify the value of the eICU® model of care for the safety and quality of patient care.

The Reality of Working in the eCollaborative

Relationships and encounters that occur within the eTeam and between the eTeam and the bedside team are often worlds apart. The working relationship amongst the eTeam can be described as *esprit de corps*. The individual eNurses and ePhysicians function as a true team. Open communication was observed during the field study.

The eClinicians do experience frustrations associated with the eICU® work environment. ePhysicians do experience a sense of limitation when off site. An ePhysician communicated that there are two patient events that clearly need intensivist

interventions, intubating a patient and inserting a central intravenous line. Neither of these hands-on interventions can be performed from a remote location. It is imperative that the ICU has someone available in the unit to perform these actions emergently as needed.

The eNurses also experience the frustration that can build when unable to intervene in a hands-on capacity. Even when intervening at the request of the bedside team, eNurses must wait for the bedside nurse to complete the requested assessment or carry out the suggestion. Sense of time passage is a significant factor.

There are frustrations by the nature of the eICU® work environment. All of the eTeam members were once accomplished bedside clinicians. Preserving the credibility of the eNurses and the ePhysicians is paramount in their roles. eNurses are encouraged to work shifts at the bedside in ICUs that are monitored by the eCollaborative. There is a belief that the bedside team will have more respect and improved communication with the eNurses when they work side-by-side with them at the bedside.

While the eICU® work environment is supportive and collegial, the interactions with the bedside team may not be the same. The experiences of interacting with the bedside team while working in the eICU® work environment are strained at times. The goal of communication between the eTeam and the bedside team is to share information in an effort to provide the highest quality of patient care. Effective interaction between the eTeam and bedside team is critical to the success of the eICU® model of care as the eTeam can only make recommendations of actions to be taken by the bedside team given the fact that they are operating from a remote location away from the patients. Practicing

collaborative communication is an ongoing opportunity for improvement with the eClinicians. Without collaborative communication, the eClinicians are ineffective as support to the bedside team.

Outcomes

Traditional metrics of success in the ICU such as reduction in length of stay and decreases in mortality have not been realized in the eCollaborative. The number of interventions logged by the eTeam over time is the metric used to justify the value of the eICU® work environment. The interventions are actions taken by the eTeam to positively impact patient safety and quality of care. The return on investment of the eCollaborative centers on cost avoidance. If it were not for these interventions, errors may have been made that could increase patient morbidity and mortality. Instant access to the eNurse and ePhysician in an effort to decrease complications, decrease errors, expedite patient care, and improve the quality of patient care are the pillar on which the eCollaborative stands.

Unexpected Outcomes

There are unexpected outcomes associated with the eClinicians as a result of working in the eICU® work environment. Some of the eNurses experienced discomfort and blood shot eyes associated to moving to a work environment that involves long periods of time working from computer screens. Most have adapted to these physical stressors by repositioning the level of their computer screens and by taking frequent breaks.

Even though many of the eNurses moved to the eICU® work environment to avoid the physical stressors found at the bedside, there are stressors associated with a

telemedicine work environment. Lack of physical activity and an environment that lends itself to snacking has led to weight gain, fatigue, boredom, and inability to concentrate. It is necessary to build distracters into this work environment to combat these physical stressors. All of the eClinicians take frequent breaks and have their "bag of tricks" to distract themselves during their breaks.

Discussion of the Findings

According to Madison, one of the eNurses, working in the eICU® department is like working in air traffic control. One works in front of a computer screen monitoring multiple sites at any given time to act as a support to the onsite team who has hands on control to change the course of events. Like an air traffic controller, the eNurse or ePhysician monitors the situation with a broad view and has access to various additional forms of information that are not always readily available to onsite team members. The eTeam, like the air traffic controller, is instantaneously accessible in order to gather and relay information that is requested from the onsite team. They can also actively offer recommendations for actions to be taken by the onsite team, whether they are pilots or medical professionals, to ensure a safer and higher quality outcome. It is important to note that both in air traffic control and the eICU® model of care effective communication and interactions between those at the remote control center and onsite is critical to the success of the practice model.

The essence of working in the eICU® work environment is the supportive team environment that has been created for the sole purpose of supporting the bedside clinicians with experienced ICU nurses and intensivists in order to provide the best

possible care to ICU patients. Interactions with the bedside team are either passive or active. In the passive mode, the eTeam is readily available when contacted by the bedside team. In the active mode, the eTeam has identified a need for a patient intervention and they contact the bedside team to take action. The irony is that the bedside team is often skeptical, not appreciative and offended by the active mode of support. In order to infuse into the ICU patient care team as contributing members of the team, the eClinicians must constantly practice collaborative communication in order not to offend the bedside health care workers.

Across the board, the eNurses very much enjoy the eICU® work environment. They see it as a way to continue to use their critical thinking skills and years of ICU experience in a setting with less physical demands than bedside ICU nursing. While all of the ePhysicians interviewed saw value in the eICU® model of care from a patient safety and cost avoidance perspective, most were quick to point out that the ideal situation is to have an intensivist physically present in the ICU. Both eNurses and ePhysicians recognize that experienced ICU nurses and intensivists are in limited supply. They believe the eICU® model of care is a viable way to stretch those limited resources over a broad number of ICU patients by utilizing a telemedicine platform. Areas of focus for this study were safety, communication, work environment, collaboration, staffing, teamwork, and technology.

Safety

Early studies of the eICU® model of care (Breslow et al., 2004; Langreth, 2002; Rosenfeld et al., 2000) demonstrated a decrease in ICU mortality, complications and

costs. Although those metrics were not the focus of this study, the findings show that the perceived value of the eCollaborative is in improved quality of care and patient safety. Participants in this study believe the return on investment for this eICU® is cost avoidance associated with the prevention of errors and patient complications in the ICU. This added safety stems from the second set of eyes they provide to remotely monitor ICU patients. The eTeam may see opportunities for interventions in patient care that might be missed by the bedside team had they not been there watching from afar. When an opportunity for bedside intervention is identified by the eTeam, they communicate information and recommendations to the bedside team for them to activate the intervention.

Communication

Findings from this study confirm that eClinicians must be skilled communicators to ensure the success of the unit and the effectiveness of patient interventions. It is an expectation that all eTeam members are accountable for their words and actions and that all members of the collective team, both at the bedside and within the eCollaborative, will do the same. Good communication between nurses and physicians, even when there is no face-to-face contact, is critical in the exchange of information necessary to "maximize the appropriateness, effectiveness and efficiency of care" for ICU patients and their families (Dodek & Raboud, 2003, p. 1583). Communication skills are taught during orientation to the unit and the eClinicians are constantly monitored and mentored on collaborative ways to communicate via camera modality.

Collaboration

Collaboration amongst the bedside team and eClinicians is evolving over time. In order to have true collaboration, each team member must support the ongoing process of collaboration by valuing the contribution and appropriate competence each member brings to the team (American Association of Critical-Care Nurses, 2005). Education and experiential knowledge of what the eTeam can contribute to bedside care is ongoing to ensure true collaboration between the eClinicians and the bedside clinicians.

Work Environment

The work environment of the eCollaborative was shown to be supportive for eNurses and ePhysicians. Leadership is strong and effective. The physical demands placed on the personnel are noticeably less than they experienced in their bedside practice. Personal interactions within the eICU® work environment are positive and supportive. This research supports the literature presented earlier by Donchin and Seagull (2002) earlier stating humans have an innate limit on how much information they can process and act upon at any given time. When one's innate capacity for processing and responding to information is overloaded, there are immediate physiological responses such as, fatigue, stress, and inability to function. This phenomenon was witnessed in the eICU® work environment. Distractions are a necessary component of the work flow in order to not overload the eClinician's ability to function effectively and avoid fatigue, boredom, and the inability to concentrate.

Staffing

Staffing of the eCollaborative is static for the ePhysicians and flexible according to census for the eNurses. Both disciplines primarily function in the eICU® model of care as resources for the bedside ICU nurses. Studies (Binnekade, Vroom, de Moi, & de Haan, 2003; Thorens, Kaelin, Jolliet, & Chevrolet, 1995) have shown that staffing levels and experience of the nurse positively influence patient outcomes. The eICU® model of care supports the bedside ICU nurse by providing instantaneous access and consultation with an experienced ICU nurse who has all of the patient's data and the ability to visualize the patient. It is important to note that the addition of eICU® program support for nursing had no impact bedside ICU staffing ratios in this study setting.

Teamwork

Hawryluck, et al. (2002) identified six catalysts to teamwork within the ICU workforce: authority, education, patient needs, knowledge, resources, and time. Further analysis resulted in identification of two dominant mechanisms that influence the collaboration, the perception of ownership and the process of trade. In this study, it is very clear that ownership of the patient clearly lies with the bedside team. Occasionally, temporary patient ownership may occur, as in a code situation when the ePhysician runs the code until the bedside physician arrives to resume primary responsibility for patient care. The process of trade in the eICU® work environment is centered on the sharing of information. Effective teamwork only worked in this eICU® setting when both the bedside team and eTeam when the eCollaborative personnel served in a support role

provide information to the bedside team. When that supportive role was recognized and appreciated, true teamwork was accomplished.

Technology

The eICU® model of care utilizes technology and various modes of communication to support the bedside team in problem solving. The technology supports the division of labor when the eClinician monitors the patient when a member of the bedside team is not physically present with the patient. Via technology, bedside ICU personnel can instantly access eICU® personnel at any time for decision support. In the event that there is a discrepancy in patient monitoring data and the patient's presentation, the bedside practitioner and/or the eICU® practitioner can override the technology. Having another set of eyes to oversee critical care patients and having ready access to an experienced ICU nurse or physician, has changed the practice of the bedside ICU team. It is important to note that even though the eClinicians have some of the most sophisticated patient monitoring systems to date, they are no substitute for having a clinician at the bedside.

Conclusions and Implications

Based on study findings, the following conclusions can be made.

1. The eICU® model of care is relatively new and continues to evolve as more clinical settings adopt the model.
2. Collaborative communication is the key to successful interaction. The eTeam is readily available to act as an information resource to the bedside team but they are only effective when communication is collaborative.

3. Physical and emotional stressors for the eClinicians include weight gain, fatigue, boredom, inability to concentrate, and lack of respect from the bedside nurses.

Implications of this study are:

1. The eICU® model of care is evolving over time and must have ongoing support by the key stakeholders in order to survive. As demonstrated in this study, the return on investment may not be what was expected. Return on investment needs to be examined from a safety perspective where eICU® activities prevent potential errors.
2. The leaders in the eICU® department must support and take care of the eClinicians as there are unique physical and emotional stressors associated with this new telemedicine work environment.
3. Communication training and continued efforts toward effective communication is essential to effective intervention. Ongoing communication training is essential for eClinicians.
4. The bedside team expects the eClinicians to act as instantaneously available information resources for a broad range of questions and concerns. Formal and informal training on search engine strategies is needed for the eClinicians to improve their ability to effectively and efficiently search the internet and online medical databases in order to most appropriately answer questions by the bedside team.

Recommendations for Further Study

More studies are needed to evaluate and describe the eICU® work environment:

1. Qualitative studies of other eICU® units are needed to compare and contrast the characteristics that make up a telemedicine work environment.
2. Quantitative studies are needed to determine what measurable effects, if any, are associated with the physical and emotional stressors associated with working in the eICU® unit.
3. This program is moving to a staffing model that requires all newly hired eNurses to work both in the eICU® CORE and at the bedside. Further study is needed in this unit and others across the country to determine if this staffing model results in improved collaborative communications and interpersonal relationships between the eTeam and the bedside team.
4. Further study is needed to specifically determine both quantitatively and qualitatively the information needs of the bedside team and the eTeam in order to identify currently available databases or the need to develop new information databases that will meet all or a majority of their needs.
5. Further study is needed to identify the most effective methods of providing training for eClinicians regarding use of biomedical databases and electronic information resources.
6. The eICU® staffing model in this study did not include a clinical informaticist. Further study is needed to determine if that staffing model exists and what value a clinical informaticist might add to this model of care.

7. A presumption of the eICU® work environment is that critical care nurses who move to this model of care will be able to extend their years of working as a nurse. Further study is needed to confirm this presumption.
8. Further quantitative study is needed to determine the importance of the interventions initiated by the eTeam. It is yet to be determined the extent of benefit seen in cost avoidance attributed to the interventions.

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APPENDIX A

Healthcare System Institutional Review Board Approval

INTERDEPARTMENTAL COMMUNICATION
Research Compliance Administration

DATE: November 8, 2007

TO:

FROM: Research Compliance Coordinator
Research Compliance Administration (RCA)

SUBJECT: Final Approval

STUDY NUMBER & TITLE: # 07-087 - Adult The Electronic Intensive Care Unit: Eyes in the Sky – N/A
Expedited Categories 6 & 7,

The study listed above has received final approval from the Institutional Review Board (IRB-03). IMPORTANT NOTICE: If your study includes an informed consent statement, the Institutional Review Board (IRB) requires that the consent statement(s), assent(s), or authorization(s) given to subjects be the newly-stamped version (as applies).

Please note that although this study has been granted final approval by the IRB, special requirements apply if the principal investigator becomes aware that an individual enrolled on the study either is a prisoner or has become a prisoner during the course of his/her study participation (and the study has not been previously granted approval for the enrollment of prisoners as a subject population). In such cases, all research interactions and interventions with the prisoner-participant must cease and if it is wished to have the prisoner-participant continue to participate in the research, Research Compliance Administration (RCA) must be notified immediately. In most cases, the IRB will be required to re-review the protocol at a convened meeting before any further research interaction or intervention may continue with the prisoner-participant. Refer to the Standard Operating Procedure on *Involving Prisoners in Research* for further information.

As the principal investigator (PI) of this study, you assume the following reporting responsibilities:

1. CONTINUING REVIEW - A status report must be filed with the Board. The Research Compliance Administration (RCA) staff will generate these reports for your completion. Additionally, you must contact RCA to request that this report be generated for your completion within 90 days after termination or completion of the investigation or the investigator's part of the investigation. This study is approved from November 8, 2007 to November 8, 2008. Approval from this Board does not indicate institutional commitment of resources or fund. Approval from this Board does not indicate authorization to perform new procedures without appropriate approvals.

2. STUDY AMENDMENTS - Investigators are required to report on these forms ANY changes to the research study including protocol design, dosages, timing or type of test performed, population of the study, and informed consent statement. An amendment form can be obtained on our website.

3. UNANTICIPATED PROBLEMS INVOLVING RISKS TO SUBJECTS OR OTHERS, AND NONCOMPLIANCE – You must report to the IRB any event that appears on the **List of Events that Require Prompt Reporting to the IRB**. Refer to the SOP on "Unanticipated problems Involving Risks to Subjects or Other and Noncompliance" for more information and other reporting requirements.
Link to SOP: _____
Note: If the study involves gene therapy and an adverse event occurs which require prompt reporting the IRB, it must also be reported to the Institutional Biosafety Committee (IBC).

4. UPDATED INVESTIGATIONAL BROCHURES, PROGRESS REPORTS and FINAL REPORTS - If this is an investigational drug or device study, updated clinical investigational brochures must be submitted as they occur. See link
Two copies of progress or final reports must be provided to the Board along with the investigator's written assessment of the report, briefly summarizing any changes and their significance to the study.

5. ADVERTISEMENTS - If you will be advertising to recruit study participants for a drug or device study regulated under FDA requirements, i.e., investigational drugs or devices will be used, and the advertisement was not submitted to the Board at the time your study was reviewed, a copy of the information contained in the advertisement and the mode of its communication must be submitted to the reviewing board as an amendment to the study. These advertisements must be reviewed and approved by the Board PRIOR to their use.

6. LEAVING THE INSTITUTION - If the PI leaves the Institution, the IRB must be notified as to the disposition of EACH study.

PLEASE REFER TO THE ASSIGNED STUDY NUMBER AND THE EXACT TITLE IN ANY FUTURE CORRESPONDENCE WITH OUR OFFICE. In addition, SOPs exist which cover a variety of topics that may be relevant to the conduct of your research. See link
All documentation related to this study must be neatly filed and must be maintained in your files for audit purposes for at least three years after termination of the research (seven years if you are subject to HIPAA). If you have any questions, please call RCA at 962-8249.

Enclosures: ☒ Documentation of Review and Approval
☒ Informed Consent Statement
Authorization form
X ☐ Advertisement
Other:

INSTITUTIONAL REVIEW BOARDS & SUBCOMMITTEES REVIEWS

DOCUMENTATION OF REVIEW AND APPROVAL

IRB STUDY NUMBER: 07-057
IRB Office will assign

SECTION I: INVESTIGATOR INFORMATION

Principal Investigator: _____ Department: _____
(Last, First, Middle Initial — must have faculty/staff status or faculty sponsor must sign)

Building/Room No.: _____ Phone: _____ E-Mail: _____

Contact Information:
Name: _____ (Sponsor) Address: _____

Phone: _____ Fax: _____ E-Mail: _____

If this is a Student Protocol, List Name of the Student: Trudi B. Stafford Phone: _____

Protocol Title: **The Electronic Intensive Care Unit: Eyes in the Sky**

Sponsor/Funding Agency: _____ PI on Grant: _____

Sponsor Protocol #/Grant #: _____ Period: From: _____ to _____

Sponsor Type: ☐ Federal; ☐ State; ☐ Industry*; ☐ Not-for-Profit; ☒ Unfunded; ☐ Internally Funded

Grant Title (if different from project title):

*NOTE: Information on the fee for IRB review of non-, for-profit-sponsored projects is available at the following link:

SECTION II: TYPE OF REVIEW

☒ Expedited Review

☐ Full Board Review (*Choose One*) → ☐ Behavioral or Social Sciences (IRB-01)
☐ Biomedical (*Choose One*) → ☐ IRB-02 ☐ IRB-03 ☐ IRB-04 ☐ IRB-05

SECTION III: SPECIAL SUBJECT POPULATIONS

Research to Include: ☐ Minors ☐ Pregnant Women ☐ Cognitively Impaired ☐ Prisoners
☐ Economically or Educationally Disadvantaged ☐ Fetuses (or Fetal Tissue)

SECTION IV: RESEARCH SUBMISSION

Included with Research Submission: ☒ Informed Consent, dated*: 10/07 ☐ *Authorization*, dated**:
☒ Summary Safeguard Statement, dated**: 10/07 ☒ Protocol, dated**: 10/07
☐ Drug Brochure, dated**: ☒ Advertisement, dated**: 10/07
☐ Other: Description: , dated**:

* *version dates are required on the informed consent statements.*

** *dates are optional and only necessary if required by the investigator or sponsor.*

SECTION V: INVESTIGATOR STATEMENT OF COMPLIANCE

I assure the Board that all procedures performed under the project will be conducted in strict accordance with those federal regulations, policies that govern research involving human subjects. I agree to submit any deviation from the project (e.g. change in principal investigator, research methodology, subject recruitment procedures, etc.) to the Board in the form of an amendment for IRB approval prior to implementation. By signing this form, I am certifying that all co-investigators listed on the study are aware of the research and are agreeing to participate.

Note: This form and any additional material requested by the Board will not be processed unless they are neatly typed and legible, properly prepared, and signed personally by the principal investigator.

Signature of Investigator: _____ Date: 10-15-07

SECTION VI: IRB APPROVAL

This protocol, informed consent statement, authorization, and/or waiver of authorization for use of human subjects in research has been reviewed and approved by the Indianapolis Institutional Review Board or the Institutional Review Board for a maximum of a one year period beyond the final approval date unless otherwise indicated as follows:

Authorized IRB Signature: _____ IRB Approval Date: NOV 0 8 2007

Recorded in the Minutes of: _____

Rev. 10/04

APPENDIX B

Texas Woman's University Institutional Review Board Approval

TEXAS WOMAN'S UNIVERSITY
DENTON DALLAS HOUSTON

Office of Research
6700 Fannin Street
Houston, TX 77030-2343
713-794-2480 Fax 713-794-2489

December 13, 2007

Ms. Trudi Stafford
College of Nursing-Anne Young Faculty Advisor
6700 Fannin St.
Houston, TX 77030

Dear Ms. Stafford:

Re: The Electronic Intensive Care Unit: Eyes in the Sky

The above referenced study has been reviewed by the TWU Institutional Review Board (IRB) and was determined to be exempt from further review.

Any changes in the study must receive review and approval prior to implementation unless the change is necessary for the safety of subjects. In addition, you must inform the IRB of adverse events encountered during the study or of any new and significant information that may impact a research participant's safety or willingness to continue in your study.

Sincerely,

William P. Hanten

Dr. William P. Hanten, Chair
Institutional Review Board - Houston

APPENDIX C

Interview Protocol for eICU® Nurses and Physicians

Interview Protocol for eICU® Nurses and Physicians

The Electronic Intensive Care Unit: Eyes in the Sky

Demographics:
Number of years in Nursing/Medicine: ____
Number of years as ICU Nurse/Critical Care Physician: ____
How long as an eICU® Nurse/Physician: months: ____ years: ____

Educational Preparation:
Diploma: ____ Associate: ____ Bachelor: ____ Masters: ____ Doctorate: ____

1. Tell me about a typical day in the eICU® department.
2. How did you decide to work in the eICU® department?
3. Tell me about something that might trigger a nurse or physician to work in the eICU® department.
4. What did you need to learn to work in the eICU® department.
5. Tell me what you do in the eICU® department
6. What do you think makes a good eICU® nurse/physician?
7. What do you and the other eICU® nurses/physicians have in common?
8. How is the eICU® model of care like the ICU?
9. What do you like most about working in the eICU® department?
10. What do you like least about working in the eICU® department?

Probe Questions:
Tell me more about that.
Give me an example of what you are telling me.
Tell me how often you do that.