Understanding ICU Nurse Decision-Making about Patient Early Mobility

By

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ABSTRACT

Intensive care unit (ICU)-acquired functional disabilities result in substantial public and personal costs, including higher healthcare-related costs, increased one-year mortality, decreased quality of life, and increased caregiver burden. Up to 69% of ICU survivors have functional disabilities one year after discharge. Duration of bedrest in the ICU is associated with the development of functional disabilities. Early patient mobility in the ICU is well-established as a safe intervention to decrease negative effects of bedrest and complications attributed to an ICU admission. However, early mobility is not a consistent standard of care in ICUs. Deciding when and how to initiate early mobility can be a complex decision and involve multiple members of the interdisciplinary team. Yet, current work has not accounted for the role of the nurse. ICU nurses provide the most direct patient care and are responsible for constant patient monitoring. Therefore, they are best-suited to initiate mobility. Additionally, mobilizing ICU patients is one of many decisions to be made within a particularly complex, fast-paced, and dynamic environment. We do not know how nurses make mobility decisions within the complex ICU environment.

This dissertation study began to address these critical gaps in the literature by: (1) investigating the characteristics of the ICU work system that affect nurses' ability to make patient mobility decisions, and (2) understanding nurses' information processing needs and cognitive workflows associated with patient mobility decisions. This study used Cognitive Work Analysis (CWA), a human factors engineering approach for systematically identifying elements that support or inhibit decision-making, to characterize these gaps in understanding of nurse decision-making about mobilizing ICU patients. CWA enables researchers to understand the "invisible" aspects of cognitive work processes in complex environments, such as decision-making, and make them visible. A sample of 20 ICU nurses was recruited from two ICUs in a Midwestern city. Observation and interview data were collected. Interview data were analyzed using directed content analysis, followed by a CWA focused on the Work Domain Analysis and Strategies Analysis frameworks. Findings from this study will inform future studies investigating new design approaches for nurse decision support and work system interventions to achieve improved nurse-led patient mobility and preserve patient functional outcomes during the ICU level of care.

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Introduction

Background and Significance

ICU-Acquired Functional Disability is a Major Health Problem. While advances in healthcare and technology have increased survivorship of patients in the intensive care unit (ICU), long-term outcomes demonstrate that up to 69% of ICU survivors have functional disabilities one year after discharge (Barrett, Smith, Elixhauser, Honigman, & Pines, 2014; Ehlenbach, Larson, Curtis, & Hough, 2015; Iwashyna, Ely, Smith, & Langa, 2010; van der Schaaf, Beelen, Dongelmans, Vroom, & Nollet, 2009). Functional disabilities include the inability to independently complete physical activities, such as self-care, walking, or performing housework. ICU-acquired functional disabilities produce substantial personal and public costs – 56% of ICU survivors need new institutionalization and/or physical rehabilitation and only 48% of previously employed adults return to work one year after ICU discharge; patients with ICU-acquired functional disabilities have higher healthcare-related costs and one-year mortality (Hermans et al., 2014; Needham et al., 2013).

Mobility Interventions Initiated in the ICU Improve Functional Outcomes. Duration of bedrest in the ICU is significantly and independently associated with development of functional disabilities during the ICU stay (Fan et al., 2014; Needham et al., 2014). Bedrest is common in ICUs, ranging from 4 to 10 days (C. Hodgson et al., 2015). Increasing mobility is well-established as a safe intervention to decrease the negative effects of bedrest and subsequent functional complications attributed to an ICU admission (Morris et al., 2008; Schweickert et al., 2009). Patients that engage in mobility early in their ICU stay have improved functional outcomes and reduced ICU and hospital lengths of stay, compared with patients who spend a majority of time in bed (Adler & Malone, 2012; Casey, 2013; Choi, Tasota, & Hoffman, 2008; Li, Peng, Zhu, Zhang, & Xi, 2013). Early mobility programs are initiated upon admission to the ICU and begin as soon as patients demonstrate sufficient cardiovascular and pulmonary reserve. These programs consist of exercises that begin in bed, progress to sitting on the edge of the bed, and

then ambulation, with the goal of patients reaching their pre-hospital mobility capability. Mobility interventions that begin after discharge from the ICU have reported variable results and post-hospital activity interventions extending several months after discharge have not been effective in improving functional outcomes (Connolly, Denehy, Brett, Elliott, & Hart, 2012; Cuthbertson et al., 2009). Therefore, it is critical that mobility interventions occur early in the ICU stay.

Multiple Barriers Influence the Delivery of Early Mobility. Despite empirical evidence on the benefits of early mobility, patients are not routinely receiving these interventions during their ICU stay. Only 45% of United States ICUs report implementing early mobility practices (Bakhru, Wiebe, McWilliams, Spuhler, & Schweickert, 2015). Studies in Australia, New Zealand, and Germany show that less than 25% of patients receiving mechanical ventilation are actively mobilized out of bed (Berney, Harrold, Webb, Seppelt, Patman, Thomas, et al., 2013; Nydahl et al., 2014). Multiple barriers to delivering early mobility interventions have been identified. Commonly reported barriers include staffing, patient safety, staff safety, time, and equipment (Bakhru et al., 2015; Barber et al., 2015; Dubb et al., 2016; Honiden & Connors, 2015; Hoyer, Brotman, Chan, & Needham, 2015). The multitude of barriers and continued low report of early mobility occurring indicates that initiating mobility in the ICU is a complex intervention.

The Role of the Nurse in Early Mobility Interventions is Not Clearly Defined. In spite of previous research identifying barriers, we still do not understand how nurses, who are frequently responsible for carrying out mobility, overcome these barriers and make decisions to mobilize ICU patients. Early mobility fits into several professional domains, with physical therapists (PT) and nurses providing the majority of early mobility interventions (Bakhru et al., 2015). However, nurses are not described as directly involved with patient activity in current early mobility programs. As a consequence, the activity level that nurses promote with patients is less strenuous than the activity level that PTs initiate for the same patient (Garzon-Serrano et al., 2011a). A limitation to existing interventions that

rely primarily on PT-driven early mobility is the scarcity of PT resources. Only 34% of US ICUs have dedicated PT (Bakhru et al., 2015). Furthermore, PTs report insufficient staffing and lower prioritization of ICU patients as significant barriers to providing ICU early mobility (Malone et al., 2015). Therefore, depending solely on PT to initiate early mobility will only perpetuate the problem of ICU-acquired functional disability.

Nurses are with patients for longer periods of time compared with any healthcare providers, and are more likely to detect early and subtle signs of change in patient condition. Awareness of subtle assessment changes is important to patient safety when assessing readiness for mobility. ICU nurses provide the most direct patient care and are responsible for constant patient monitoring. Nurses have expertise in interdisciplinary collaboration and coordinating patient care. Therefore, nurses are best-suited to determine patient ability to engage in physical activity and initiate early mobility (Doherty-King & Bowers, 2013). A significant gap in existing early mobility interventions is that current work has not accounted for how nurses are engaged in mobility decisions.

Decision-Making is a Critical Process to Understand. Decision-making is a precursor to action and is an essential process that occurs before initiating mobility. Prior work has demonstrated that understanding the decision-making process of health professionals is critical for identifying opportunities to improve patient outcomes (Fesler-Birch, 2005). Deciding whether or not to mobilize a patient is a complex task and is only one of the decisions made within the complicated and dynamic ICU setting. In general care settings, nurses consider multiple factors when deciding whether or when to mobilize patients; two important factors are level of perceived risk for injury to self or patients and availability of resources to assist with mobilizing patients (Doherty-King & Bowers, 2013). Due to the complex nature of the ICU setting, critical care nurses may experience an even higher level of complexity when deciding whether to engage patients in mobility. While guidelines have been developed to provide recommendations for types of patients to mobilize, there is not information about if and how nurses

incorporate guidelines with clinical judgment to initiate and progress patient mobility. We do not know how ICU nurses make decisions about patient mobility, such as identifying patients who are ready to become mobile, determining mobility duration, frequency, and intensity, or coordination with other providers or scheduled procedures.

Decision-Making is a Cognitive Process Influenced by the Work System. Nurse decision-making is significantly influenced by the work system (Thompson, Cullum, McCaughan, Sheldon, & Raynor, 2004). The ICU work system as defined by the Systems Engineering Initiative for Patient Safety (SEIPS) model includes nurses and other professionals performing tasks using tools and technologies in a physical environment within an organization (Carayon et al., 2006). The SEIPS model further describes that these features within the work system interact and influence each other, in addition to influencing outcomes of the system. Because of the highly complex nature of the ICU and its influence on decision-making, it is important to examine nurse decision-making about mobility within the domain of the ICU work system.

Examples of work system influences on ICU nurses' work include time pressure, resource and equipment availability, interruptions, and communication patterns (P. R. Ebright, Patterson, Chalko, & Render, 2003). Understanding the complex work system in which ICU nurses make decisions is needed to guide interventions (P. Ebright, 2010). Likewise, the work system within which ICU nurses work can affect patient outcomes. ICUs with better nurse work environments (staffing, unit culture, communication, and collaboration) experience lower patient mortality rates (Kelly, Kutney-Lee, McHugh, Sloane, & Aiken, 2014). The work system also influences the actions nurses choose, as the available physical and social resources impact nurse decision-making (Thompson et al., 2004; Vicente, 1999). Therefore, a research approach that focuses on the work system within which ICU nurses work and make decisions is necessary.

Conceptual Framework

Focusing on decision-making within the work system, one framework that has been used effectively to study decision-making in complex socio-technical systems is Cognitive Work Analysis (CWA). CWA is a cognitive engineering framework that systematically identifies different constraints or barriers in a work domain and which actions are appropriate (Vicente, 1999). A fundamental concept of CWA is that understanding the environment in which decisions are made, and the goals that provide direction, are essential analytical requirements because these factors influence appropriate actions (Roth & Bisantz, 2013). CWA enables researchers to understand the “invisible” aspects of cognitive work processes, such as decision-making, and make them visible. A framework is necessary because there may be elements of decision-making that are not immediately obvious, and so use of the CWA framework provides methodologies to guide researchers in conducting a comprehensive and through analysis.

CWA consists of five iterative phases of analysis, which are intended to systematically identify different constraints of a work domain (Figure 1). Constraints place limits on behavior, which in turn influence decisions (Naikar, 2014). Each phase evaluates different layers of the work environment to provide a comprehensive analysis and inform design recommendations. It is uncommon for all five phases to be applied to one project. Instead, the CWA phase or phases are chosen based upon congruence with the project goal and the level of analysis that a particular CWA focuses on (Roth & Bisantz, 2013).

Figure 1. Overview of CWA

Results of CWA are used to design improved systems. In healthcare CWA has been applied in multiple settings (Jiancaro, Jamieson, & Mihailidis, 2014). Specific to nurses, design recommendations

have included understanding environmental constraints on nurse decision making (Effken, Brewer, Logue, Gephart, & Verran, 2011), designing emergency department displays (Bisantz et al., 2010), and designing ICU clinical displays (Effken, Loeb, Johnson, Johnson, & Reyna, 2001). Use of CWA to examine the complexities of nurse decision-making and information needs for mobility within the ICU system is a novel application to an established and effective cognitive engineering framework.

Specific Aims

This dissertation presents a qualitative research study using directed content analysis and Cognitive Work Analysis frameworks to address critical gaps in the literature about ICU nurse decision-making when mobilizing patients.

The specific aims of this study are to:

1. Investigate the characteristics of the ICU work system that affect nurses' ability to make patient mobility decisions.
2. Understand nurses' information processing needs and cognitive workflows associated with patient mobility decisions.

Twenty nurses were interviewed for the study and a subset of four nurses were observed for two four-hour shifts to help inform interview questions. First, interview data were analyzed using directed content analysis to identify categories and sub-categories that describe nurse decision-making about patient mobility. Then, a Cognitive Work Analysis was conducted, with focus on the work domain and decision-making strategies frameworks. Codes from the directed content analysis, along with findings from observation, literature review, and input from content matter experts were analyzed using the Work Domain Analysis framework (Aim #1) and Strategies Analysis framework (Aim #2). Findings from this study will inform new design approaches for nurse decision support and work system interventions to achieve improved nurse-led patient mobility and preserve patient functional outcomes during the ICU level of care.

Methods

A descriptive design was used for the WDA and Strategies Analysis. Multiple methods of data collection informed the WDA and Strategies Analysis, including literature review, observation, interview, and input from content matter experts.

Setting and Participants

Two adult medical-surgical ICUs at two hospitals in Wisconsin were selected for observations and interviews. These sites were selected based upon the variety and complexity of medical and surgical patients typically admitted as well as each unit's prior experience with early mobility interventions. Fifteen participants were recruited from a 24-bed ICU in an academic tertiary care center (site 1) and five participants were recruited from a 12-bed ICU in an academically affiliated Veterans Administration hospital (VA) (site 2). The University of Wisconsin-Madison and the Veterans' Administration institutional review boards (IRB) approved the study.

Nurses with six months or greater of current ICU experience and working 20 hours or greater each week were eligible to participate. Participants were recruited in coordination with each ICU nurse manager using two techniques: 1) posted flyers, unit announcements, and emails, and 2) nurse managers provided names and contact information for expert nurses with experience mobilizing patients. A purposive sampling method was necessary to include a range of nurse experience levels, with particular emphasis on expert nurses who were routinely engaging in mobility activities. This sampling approach is consistent with principles that aim to understand real-world decision-making (Hoffman & Militello, 2012). Expert nurses are defined as those who are able to grasp a situation quickly, are skillful in managing complex and difficult situations, and are able to simultaneously manage multiple needs (Benner, Tanner, & Chesla, 1992). Twenty nurses participated, which is a sufficient sample size to achieve saturation of data in content analysis (Sandelowski, 1995).

Data Collection

Data were collected through direct observation and one-on-one interviews. Four nurses were observed for the first four-hour portion of two shifts (32 hours total) and then interviewed within one week of the final observation. Observation data provided context to participants' work, from seeing the physical work space to identifying influences on decisions that may be inherent, such as culture or well-established processes (Beyer & Holtzblatt, 1998). Therefore, observation data were used to inform interview questions. The specific process for data collection is presented in Chapters 2 and 3.

Twenty nurses, including the four observed nurses, participated in one-on-one interviews using a semi-structured interview guide. All interviews were audio-recorded and were conducted in a private office space at the nurses' place of work. At the completion of each interview, each participant was asked to complete an optional demographics questionnaire. Each participant was offered an honorarium of $30 for interview participation. The specific processes for interview data collection is presented in Chapters 2 and 3.

Data Management

Each audio-recorded interview was transcribed verbatim by a HIPPA and CITI certified transcriptionist. Participants were assigned a study identification number and any identifiable information was not included in the transcription. Dedoose software was used for interview data management (Dedoose 7.5.9, 2017). Observation and demographics data were entered into Excel for data management and descriptive analysis. Additional description of observation and demographics data is presented in Chapter 2.

Data Analysis

Interview data were analyzed using directed content analysis to identify categories and sub-categories that describe nurse decision-making about patient mobility. Additional discussion of directed content analysis is presented in Chapter 2. Next, a Cognitive Work Analysis was conducted, with focus

on the work domain and decision-making strategies frameworks. Codes from the directed content analysis, along with findings from observation, literature review, and input from content matter experts were analyzed using the WDA framework (Aim #1) and Strategies Analysis framework (Aim #2). The specific process for the WDA and Strategies Analysis is presented in Chapter 3.

Introduction to the Three Manuscripts

The following three manuscripts represent a cohesive body of work from the dissertation study. A literature review paper identifies the gap in science and two data-based papers describe results for the two specific aims of the study.

1. Chapter 1: Delivering Early Mobility in the ICU: A Literature Review Using the SEIPS Model.
   The first chapter is a systematic review of literature conducted to identify processes with delivering early mobility in adult ICU patients. The Systems Engineering Initiative for Patient Safety (SEIPS) model was used to organize a synthesis of findings. Application of the SEIPS model to literature review findings was an innovative approach to identify critical ICU work system and outcome gaps in the literature for the process of delivering early mobility.
2. Chapter 2: A Qualitative Analysis of ICU Nurse Decision-Making about Patient Mobility.
   The second chapter presents the directed content analysis method and results from the nurse interviews. After conducting the literature review and in planning the analysis for the study aims, it became apparent that a detailed description of the qualitative analysis method for the nurse interviews and description of the results was a necessary foundational manuscript. Therefore, the focus of this manuscript was to describe four main categories that influenced nurses' decision-making about mobility that were identified in the directed content analysis.
3. Chapter 3. Using Cognitive Work Analysis Methods to Understand ICU Nurse Decision-Making about Patient Mobility.
   The third chapter addresses the characteristics of the ICU work system that affect nurses' ability to make patient mobility decisions (Aim #1) and nurses' information processing needs and cognitive workflows associated with patient mobility decisions (Aim #2).

Chapter 1. Delivering Early Mobility in the ICU: A Literature Review Using the SEIPS Model

ABSTRACT

Objectives: To investigate processes for delivering early mobility interventions in adult Intensive Care Unit patients and outcome measures used in research studies.

Methods: A systematic review was conducted. Electronic databases PubMED, CINAHL, PEDro, and Cochrane were searched for studies published from 2000 to November 2017 that implemented an early mobility intervention in adult intensive care units. Included studies involved progression to ambulation as a component of the intervention, described the healthcare providers delivering the intervention, and reported at least one outcome measure.

Results: 34 studies were included in the final review. Studies consisted of randomized control trials, prospective, retrospective, or mixed designs. Early mobility was initiated by nurses, physical therapists, and nurse/therapist teams. Each model was successful in increasing activity levels in the ICU and implementation factors, such as forming interdisciplinary teams and focusing on communication were important characteristics of these mobility programs. Studies measured patient functional measures, time to activity, activity type, frequency, ambulation distance, and number of therapy consults.

Conclusion: Variation exists in the frequency, type, measurement of activity, and personnel who implement ambulation in the intensive care unit. Additional rigorous studies are needed to better understand the role of nurses in implementing early mobility in the ICU to maintain a patient's functional status.

Keywords: ambulation, critical care, exercise, functional status, intensive care, mobility, rehabilitation, review, systems-approach

INTRODUCTION

There is an urgent need to improve long-term outcomes for survivors of critical illness as up to 69% of patients have functional impairments one year after discharge from the intensive care unit (ICU) (Ehlenbach et al., 2015; Iwashyna et al., 2010; van der Schaaf et al., 2009). Functional impairments include the inability to independently complete physical activities, such as self-care, walking, or performing housework. These functional impairments produce significant personal and public costs; 56% of ICU survivors need new institutionalization and/or physical rehabilitation, only 48% of previously employed adults return to work one year after ICU discharge, and patients with ICU-acquired functional disabilities have higher healthcare-related costs and one-year mortality (Hermans et al., 2014; Needham et al., 2013).

Increasing mobility is a safe intervention to decrease the negative effects of bedrest and functional disabilities attributed to an ICU admission (Morris et al., 2008; Schweickert et al., 2009). Early mobility can begin as soon as patients demonstrate sufficient cardiovascular and pulmonary stability, ideally within 24-48 hours after admission to the ICU. Early mobility programs typically consist of exercises that begin in bed and progress to the end goal of ambulation. To date, six systematic reviews have found overall positive benefits of early mobility delivered in the ICU. These reviews have assessed functional outcomes and patient safety with early mobilization (Adler & Malone, 2012; Li et al., 2013); types and measurement of mobility interventions in older critically ill adults (Casey, 2013); outcomes of different types of mobility interventions in mechanically ventilated adults (Choi, Tasota, and Hoffman, 2008); and, physical therapy interventions in the ICU (Kayambu, Boots, & Paratz, 2013). In addition, guidelines describe recommendations for use of physical therapy in adult ICU patients (Gosselink et al., 2008) and algorithms for nurses and therapists to execute early mobility (Hanekom et al., 2011).

Despite empirical evidence on the benefits of early mobility, patients are not routinely receiving these interventions during in their ICU stay. Only 45% of United States ICUs acknowledge implementing

early mobility practices (Bakhru et al., 2015), and point prevalence studies in Australia, New Zealand (Berney, Harrold, Webb, Seppelt, Patman, Thomas, et al., 2013), and Germany (Nydahl et al., 2014) show variations in practice, with up to 24% of intubated patients being mobilized out of bed. Increasingly, barriers to early mobility are being identified and there is a recognition that multiple barriers often co-exist (Bakhru et al., 2015; Barber et al., 2015; Dubb et al., 2016; Honiden & Connors, 2015; Hoyer et al., 2015).

A systems approach can be useful in understanding broader, contextual factors of a process, such as barriers and actionable opportunities for improvement. The Institute of Medicine's report, "To Err is Human: Building a Safer Health System," notably described the need for systems-based approaches in health care to improve quality and safety (Kohn, Corrigan, & Donaldson, 2000). One systems approach is the Systems Engineering Initiative for Patient Safety (SEIPS) model, which is one of the most commonly used models to analyze and redesign work systems in healthcare (Carayon et al., 2014). The SEIPS model is based on Donabedian's health care quality model of using structure and process measures as a means to inform outcomes (Donabedian, 1978). The SIEPS model depicts how specific work system structures (person, tasks, technology and tools, environment, and organization) interact to impact processes and outcomes, and also emphasizes the role of feedback from processes and outcomes to inform work system re-design (Carayon et al., 2006). This model is particularly useful in providing a framework for identifying relevant elements within the healthcare work system that can be adapted to improve processes and outcomes.

In order to better understand early mobility research and the gap between existing evidence and current practice, this literature review aims to organize and summarize existing evidence on early mobility interventions from a systems perspective, using the SEIPS model. While published literature on early mobility in the ICU is growing, there is a significant gap in describing the role of the nurse in early mobility interventions. Because nurses are the largest providers of direct care in the ICU, it is vital to

address this gap in the science. Specifically, this systematic literature review will examine the processes for delivering early mobility interventions using the SEIPS model to summarize findings relevant to the structure of the ICU work system and outcomes reported.

METHODS

A systematic review of the literature was conducted to identify processes with delivering early mobility in adult ICU patients and outcome measures used in research studies. A review protocol was developed in advance of the literature search to guide study inclusion and analysis.

Search strategy

A comprehensive search of PubMED, CINAHL, PEDro, and the Cochrane Database from 2000 to November 2016 was conducted. The following medical subject headings (MeSH) and keywords were used: mobility OR early mobility OR progressive mobility OR ambulation OR early ambulation OR physical rehabilitation OR exercise AND critical care OR intensive care OR ICU. Limits were set to adults, publication dates January 1, 2000 to November 1, 2016, and English language. The search strategy was designed in collaboration with a professional librarian. Additional studies were identified though reference and citation review.

Study selection and inclusion criteria

Articles included in this review met the following inclusion criteria: provided a description of a mobility program initiated within the first seven days of ICU admission and included ambulation while in the ICU. Ambulation was defined to include walking in place, assisted ambulation, or independent ambulation. Studies were included if one or more patient or program outcomes was reported. Studies were excluded when the intervention started after transfer out of ICU or did not include ambulation as the intervention. Case studies were excluded. Two reviewers independently conducted initial screening for eligibility based on the title and abstract. Full text was then evaluated to determine final eligibility. Differences in screening between reviewers were discussed until consensus was reached.

RESULTS

Thirty-four studies meet the inclusion criteria (see Figure 1). Each study was then reviewed and these elements were extracted: a description of work system elements of intervention (person, tasks, technology and tools, environment, and organization), variables measured, patient outcomes, and key findings (see Table 1). The SEIPS model was used to organize a synthesis of the findings. Figure 2 provides a summary of findings in relation to the SEIPS model.

Work System: People

People are central in the work system component of the SEIPS model and this component represents the individual(s) performing the work. Nurses and physical therapists are the most frequently identified providers of mobility and multiple clinical models for early mobility interventions have been researched. The addition of staff to conduct mobility was common; however, the type and allocation of human resources to support mobility was mixed between studies. Early mobility was initiated by physical therapists (n=20), nurses (n=4), and nurse/therapist teams (n=10). The literature describes three different healthcare provider models to perform early mobility interventions: interdisciplinary, unit-based therapy, and nurse-led.

Unit-based physical therapist mobility programs. The most common model for early mobility programs was the addition of a physical therapist (see Table 1). Addition of a dedicated unit-based physical therapist has decreased the time between ICU admission and the first time ambulating and has increased the number of patients that ambulate during the ICU stay (Schweickert et al., 2009). A majority of these studies also implemented an automatic physical therapy consult upon admission to reduce the barrier of not having the order for receiving mobility interventions. The availability of physical therapy did vary among these programs. Needham et al. (2010) added full-time physical and occupational therapists to achieve seven-day-per week therapy coverage in a 16-bed medical ICU; however more commonly ICUs added a single full-time equivalent position. With the later model, Engel,

Tatebe, Alonzo, Mustille, and Rivera (2013) reported weekend and evening gaps in therapy coverage. However, both models improved the frequency of out of bed activities compared to the standard of care.

Nurse-led mobility programs. The more recent studies reviewed included nurse-led mobility programs (Dammeyer, Baldwin, et al., 2013; Dickinson, Tschannen, & Shever, 2013; Drolet et al., 2013; Hildreth et al., 2010). Each of these programs implemented clinical guidelines to support nurses in initiating and progressing patient mobility across diverse patient acuity levels from non-intubated patients (Hildreth et al., 2010) to complex intubated patients with neurologic injuries (Klein, Mulkey, Bena, & Albert, 2015).

Interdisciplinary mobility programs. Morris et al. (2008) used a dedicated mobility team comprised of a physical therapist, nurse, and aide focused only on mobility. All other interdisciplinary team models incorporated the patient's assigned nurse and physical therapist.

<u>Work System: Tasks</u>

Tasks may represent job responsibilities and related concepts, such as workload, time pressure, and skills required to complete tasks. Role clarity is an important consideration, especially in mobility, as multiple disciplines are likely involved. Roles were specified in approximately one-half of the interdisciplinary team studies, and included nurses, physical therapists, physiotherapists, and respiratory therapists. Nine studies defined the role of the nurse primarily during the preparation portion of mobility, such as sedation management for patients, rather than participating directly in early mobility.

<u>Work System: Organization</u>

The organization element describes the culture and structure of the organization. There have been multiple organizational components that promote mobility, such as availability of human resources and unit culture that focus on mobility (P. Bailey, Miller, & Clemmer, 2009; Dubb et al., 2016). The most common model for mobility programs was an interdisciplinary team. An interdisciplinary team model

needs to consider factors of successful teams, such as communication, role clarity, and trust; pre-planning is an essential step to improving teamwork (Salas, Wilson, Murphy, King, & Salisbury, 2008). Prior to implementation, twelve studies described establishing an interdisciplinary team to develop and implement early mobility (see Table 1). These teams were used to develop and implement mobility protocols, review ongoing data, and champion the process. Several studies also highlighted the importance of communication between nurses and physical therapists so that an activity plan was clear (Dammeyer, Dickinson, Packard, Baldwin, & Ricklemann, 2013; Dickinson et al., 2013; Hanekom, Louw, & Coetzee, 2013; Mah, Staff, Fichandler, & Butler, 2013).

The structure for implementing an early mobility program was commonly specified in quality improvement publications. Standards for quality improvement reporting recommend reporting the use of theories or frameworks, context in which the work was done, and the approach used to assess impact of the intervention (Ogrinc et al., 2015). The explicit use of a quality improvement framework or methodology was reported in five of these studies (Clark, Lowman, Griffin, Matthews, & Reiff, 2013; Drolet et al., 2013; McWilliams et al., 2015; Needham & Korupolu, 2010; Titsworth et al., 2012). Context was more commonly discussed. For example, one site had a hospital-based lift team that was available to assist unit nurses and physical therapists with mobility (Klein et al., 2015), others specified the amount of educational sessions held and number of staff that required education (Needham et al., 2010), or methods to engage staff, such as creating a slogan for the mobility program (Titsworth et al., 2012).

Work System: Technology and Tools

Health care systems use a variety of technologies and tools, such as electronic health records and medical devices. Usability of these tools is one critical concept within this element of the SEIPS model. Few studies described technologies and tools to support the process of mobility and specialty equipment was most commonly mentioned. Drolet et al. (2013) described the purchase of a custom

walker to promote mobility with patients requiring mechanical ventilation and Klein et al. (2015) included that the purchase of more patient chairs was a component of their early mobility program implementation. Studies also used computerized order sets, such as an automatic physical therapy order upon admission to trigger early mobility (Hildreth et al., 2010).

Work System: Environment

Environment focuses on the physical space in which care is provided. While physical space varies between ICU units, this element of the work system was not described in any of the articles.

Early Mobility Outcomes: Variables Measured & Outcomes Reported

ICU patients represent a heterogeneous population of patients, and likewise, early mobility programs typically consist of a range of activities that began in bed and progressed to ambulation. As a result, a wide variety of variables have been measured in early mobility studies and outcomes have been reported at several time points, from end of ICU admission, to one-year after ICU discharge.

Patient functional measures & outcomes. Activity abilities, such as sitting, standing, walking, were the most commonly reported functional measures. Specific to ambulation, it was commonly reported by either frequency of times ambulated or simply whether it occurred or not during the ICU stay. Reported frequency of ambulation varied from once daily to three times daily. Variation in the definition of daily was also noted with physical therapy models, where three studies specified that the intervention occurred seven days per week (Denehy, Skinner, Edbrooke, Haines, Warrillow, & Hawthorne, 2013; Morris et al., 2008; Moss, Nordon-Craft, Malone, Pelt, et al., 2016), and two studies mentioned physical therapists were present on the unit for eight hours per day, five days per week (Clark et al., 2013; Engel, Tatebe, et al., 2013). It is not known in physical therapist-only models if ambulation occurred when physical therapists were not present, therefore, patients may have missed multiple days of ambulation. Other descriptors for ambulation included distance or time duration. These objective measures are preferred, as Schweickert et al. (2009) defined ambulation as taking two or more

steps, whereas Leditschke, Green, Irvine, Bissett, and Mitchell (2012) use the term ‘active mobilization’ to describe marching in place for more than 30 seconds or taking steps away from the bed. One study included a target Borg scale score to indicate desired intensity of activity (Denehy, Skinner, Edbrooke, Haines, Warrillow, Hawthorne, et al., 2013). Regardless of activity descriptor, all studies that reported one of these variables increased after implementation of an early mobility program.

Patient functional measures to quantify strength or ability were included in nine studies (Table 1) and included one or more of the following items: six minute walk text, timed get up and go test, physical function in the ICU test (PFIT-s), number of functional independent activities of daily living (ADLs), Barthel Index, dominant hand dynamometry, Functional Independence Measure (FIM), Medical Research Council Score of muscle power (MRC), RAND 36-Item Short Form Health Survey measuring quality of life, Katz Activities of Daily Living Score, International Classification of Functioning, Disability, and Health (ICF), Manchester Mobility Score and ambulation distance.

The length of time that patient functional measures were assessed varied (Table 1). Fifteen of 34 studies reported patient functional measures during the ICU stay; an additional 15 studies reported ICU and hospital functional measures; and, four studies continued functional measures six to twelve months after hospital discharge. Studies that followed ICU patients for longer periods of time were more likely to report no changes in functional outcomes over time (Denehy, Skinner, Edbrooke, Haines, Warrillow, Hawthorne, et al., 2013; Hodgson et al., 2016).

Program outcomes. Program outcomes included time from admission to first out of bed activity (n=6), frequency of activity or frequency (n=11), and number of therapy consults (n=4). All models of early mobility (nurse-initiated, physical therapy-initiated, and interdisciplinary) reported decreased time to first activity and increased frequency of activity. Number of therapy consults was consistently improved after multiple studies implemented automatic physical therapy consults upon ICU admission.

Safety outcomes. Early mobility programs are safe in a variety of patient populations. Early safety studies assessed physiologic changes in respiratory and hemodynamic parameters, among general ICU patients (Stiller, Phillips, & Lambert, 2004), and specialty surgical patients, including abdominal surgery (Zafiropoulous, Alison, & McCarren, 2004), and liver transplant (Senduran, Yurdalan, Karadibak, & Gunerli, 2010). Each of these studies collected physiologic data, such as oxygen saturation, blood pressure, and respiratory parameters for patients on mechanical ventilation. Statistically significant changes in vital signs were noted, such as a decrease in oxygen saturation and blood pressure. However, these changes were transient, rarely required intervention, and as a result determined to not be clinically significant changes to limit early mobility interventions.

Most studies reported monitoring of adverse events. Overall, the occurrence of adverse events was low, typically less than 1% (P. Bailey et al., 2007; Needham et al., 2010). The most commonly reported adverse events were changes in vital signs that required intervention, such as temporarily increasing the level of oxygen delivery, or accidental tube dislodgement. Patient falls were rarely reported.

DISCUSSION

The majority of reviewed studies have shown that early mobility in the ICU is effective in improving ICU and hospital and functional outcomes using diverse health care provider models, physical therapists, nurses, and nurse/therapist teams, to deliver the intervention. There is a significant need for future study of interdisciplinary models, where physical therapists and nurses work together to support functional outcomes. Overall, these interdisciplinary models were successful in increasing activity levels in the ICU and implementation factors, such as forming interdisciplinary teams and focusing on communication were important characteristics of these mobility programs. However, less is known at the systems level how nurses and physical therapists work together to maintain functional outcomes for

the unit, specifically it is not known how nurses make decisions about providing a mobility standard of care and then identify high-risk patients that require physical therapy interventions.

The role of the nurse during mobility in these models was not clearly described. Therefore, it is not known in some settings if mobility occurs when PT is not present, such as more than one time daily, and on evenings, nights, and weekends. While the role of the nurse is clearer in preparing patients for mobility, it is not known how nurses prioritize mobility within a routinely busy shift. In addition, there are multiple patient considerations related to the process of mobility care, such as patient stability and patient availability that influence how tasks are prioritized. Better understanding about job responsibilities between providers is needed, as lack of role clarity between nurses and physical therapists results in patients receiving variable levels of activity (Garzon-Serrano et al., 2011b). Additional research is needed to learn how nurses make decisions about initiating mobility and increasing the dose of activity with increasingly complex populations.

Early mobility is one intervention within a complex ICU environment. Many studies reported results from quality improvement work, and included contextual factors related to implementing an early mobility program. Twenty-eight unique barriers to early mobility have been identified (Dubb et al., 2016). Reporting contextual factors can help other ICUs overcome local barriers in implementing and sustaining early mobility programs. There is a need for studies that use a systems-approach to contribute important information about early mobility interventions within the context of the ICU. A systems approach, with comprehensive, evidence-based implementation strategies, may help to identify that multiple interventions are needed. For example, one ICU reported an early mobility education intervention did improve nurses' knowledge about the benefits of mobility, but chart review of mobility occurrences did not demonstrate a change in behavior (Messer, Comer, & Forst, 2015); demonstrating that knowledge alone did not change practice, which is well documented in the literature (Grimshaw et al., 2001).

There are a wide variety of outcome measures reported, making comparisons and establishing a standard of care for early mobility difficult to determine. Overall, there is limited consistent measurement for the type, frequency, and duration of activity that benefits ICU patients. The addition of distance, time, and intensity descriptors allows better ability of clinicians and patients to track progress over time and improves communication about amount of ambulation that has occurred. Few functional measures have been developed and evaluated specifically with ICU patients (Parry et al., 2015). Leading researchers in ICU functional outcomes have recently published recommendations for the standardized use of valid functional assessment tools, such as the ICU Mobility Scale (Hodgson et al., 2014) and four-minute gait speed measure (Chan et al., 2016). The ability to walk and gait speed correlates well with functional status, and is an assessment that does not require special equipment (Chan et al., 2016). In addition, gait speed is an understandable assessment across disciplines, which promotes awareness of functional status within the interdisciplinary team.

Finally, feedback loops are an important element in the SEIPS model, yet methods to provide feedback to those performing early mobility interventions were not discussed. ICU nurses traditionally focus care on acute needs in a highly technical environment. These acute needs, such as maintaining airway, breathing, and circulation, provide immediate feedback. The outcome of early mobility interventions, such as a patient being able to walk independently at hospital discharge, is not currently visible to the ICU nurse. Even more immediate feedback loops, such as a culture of mobility on the unit that supports peer feedback about mobility occurrences is not consistent, as ambulation is one of the most frequently missed types of nursing care (Kalisch & Xie, 2014). Future work should focus on identifying relevant feedback loops to sustain mobility practice and provide nurses with information that reinforces the importance of early mobility as a critical patient intervention.

CONCLUSION

Early mobility is a broad term for a set of activity interventions. This review of literature on early mobility studies demonstrates a high level of variability in the frequency, type, measurement of activity, and personnel who implement early mobility in the ICU. The majority of studies that were included were single unit quality improvement projects with a range of intervention definitions and outcome measures that were used across studies. Therefore, the ability to generalize findings is limited. This review shows a need for more multi-site intervention and implementation research on early mobility in the ICU using the same measures.

For nursing in particular, the role in initiating patient early mobility is not well-defined. If we don't know how nurses are involved with early mobility, we do not know how nurses make decisions about initiating patient mobility in the ICU. More specifically, we do not know how nurses identify particular patients for mobility, how activities are coordinated with patients and among the interdisciplinary team, and the effective dose of interventions, including duration, frequency, and intensity. Additional rigorous studies are needed to better understand the role of nurses in implementing early mobility in the ICU to maintain a patient's functional status. Nurses need to provide a consistent standard of care to preserve patient's functional status and quickly recognize when physical therapist expertise is needed. One way to promote consistent practice is to ensure that the ICU work system is optimized to support mobility interventions. Less attention has been focused on the work system where the intervention is implemented. Systems-based research is needed to gain understanding of the context in which mobility occurs. This work is vital to understanding how early mobility can be consistently implemented into ICU culture, practice, and habit.

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Figure 1: Article selection process

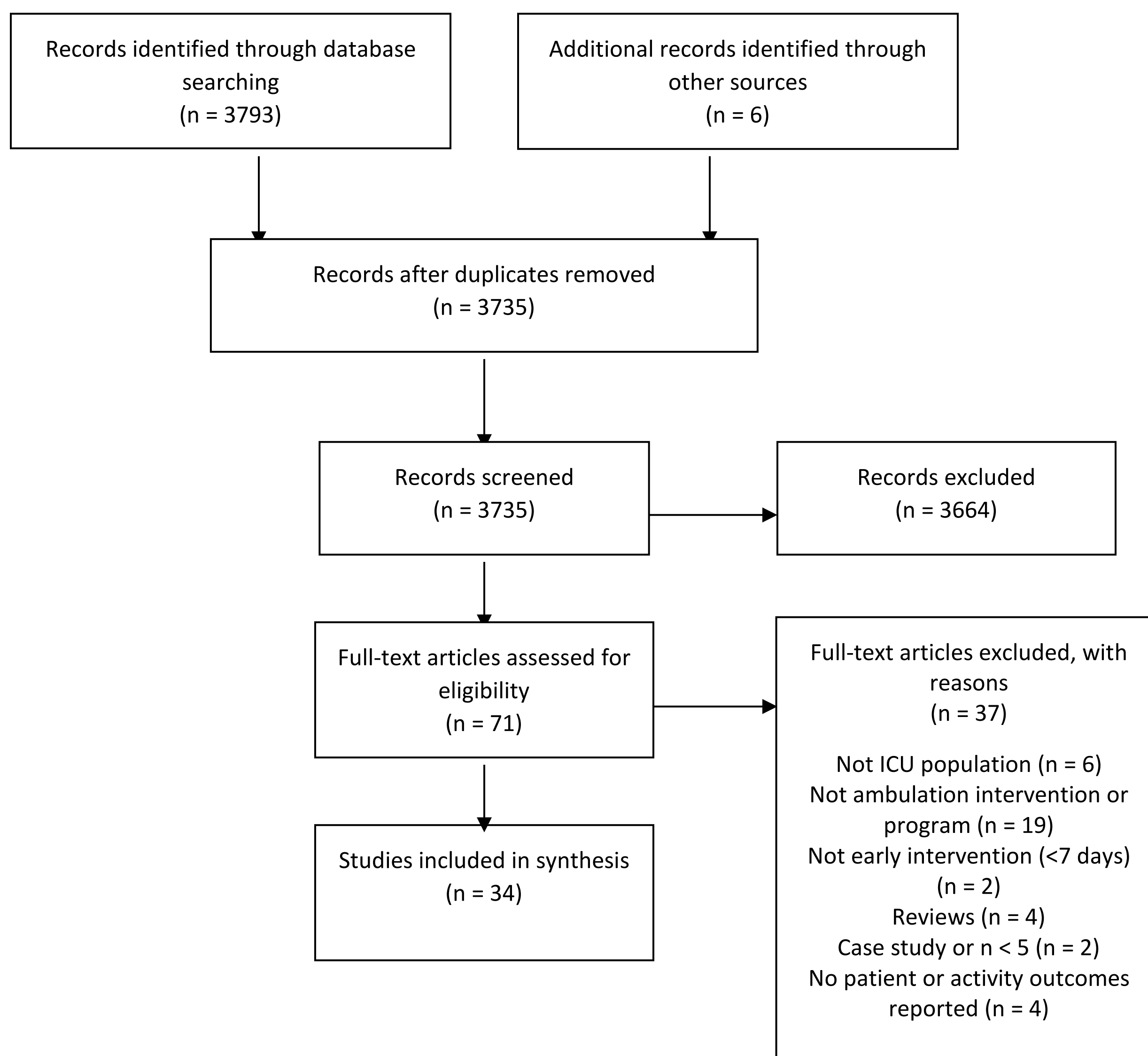

Figure 2. Summary of early mobility literature using the SEIPS model

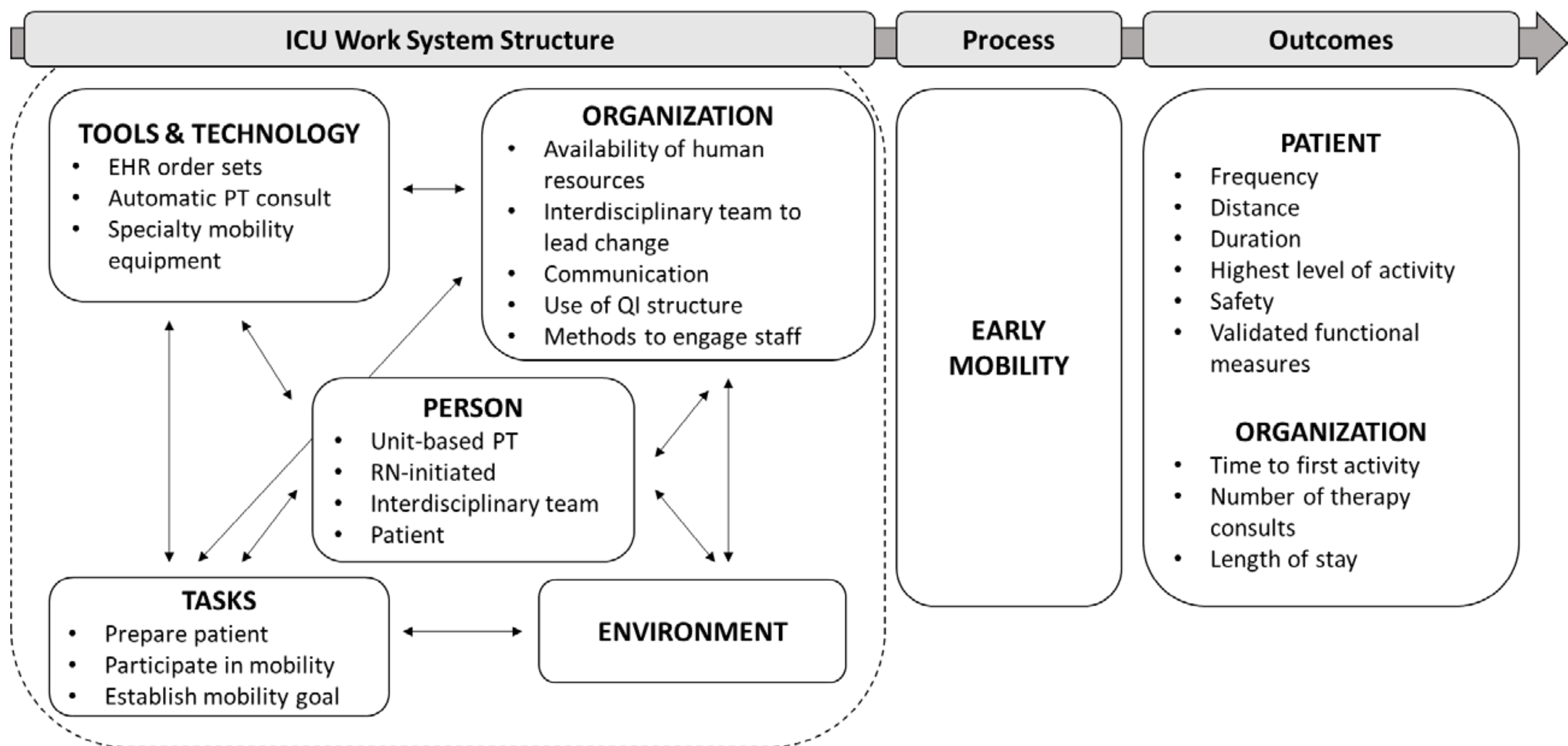

Table 1. Summary of included literature (n=34)

Author(s)	Activity Intervention	Duration, Frequency, Progression	Personnel Involved	Implementation Processes	Measures
Randomized Control Trials					

Author(s)	Activity Intervention	Duration, Frequency, Progression	Personnel Involved	Implementation Processes	Measures
Schweickert et al. (2009)	ROM, bed mobility activities, ADLs, transfer OOB, ambulation	Once daily Progression individualized based upon patient tolerance and stability	PT, OT	Automatic PT consult	Number of functional independent ADLs, Barthel Index score, dominant hand dynamometry, number of days w/delirium, vent free days. At discharge: Functional Independence Measure (FIM) ≥ 5, Medical Research Council (MRC) score, ambulation distance without assistance
Denehy, Skinner, Edbrooke, Haines, Warrillow, Hawthorne, et al. (2013)	Arm/leg active and resistance movements, sitting to standing, marching in place	15 minutes/day Progression individualized based upon target modified Borg scale score of 3-5	Physiotherapist	Exercise protocol specified at least 15 min of exercise, progressed per patient ability	Six-Minute Walk Test, Timed Up and Go Test, Physical Function in ICU Test, Health related QOL
Hodgson et al. (2016)	Physiotherapist-directed active physical exercises intended to maximize physical activity at the highest functional level the patient could achieve	Goal 1 hr/day in 1-2 sessions highest level of activity possible for that patient assessed by the ICU mobility scale	Physiotherapist, aide, and RN		ICU mobility scale, strength, ventilation duration, ICU and hospital LOS, and total inpatient (acute and rehabilitation) stay as well as 6-month post-ICU discharge HRQOL, ADLs, and anxiety and depression.
Moss, Nordon-Craft, Malone, Van Pelt, et al. (2016)	Daily PT for up to 4 weeks	7 day/wk PT in ICU for 30 min, 60 min on floor, 3 times weekly as outpatient	PT		Physical functional performance was assessed at 1, 3, and 6 months neuromuscular function was determined using MRC score dyspnea scale scores, hand-grip strength by dynamometry, and FIM bed mobility scores
Prospective Studies					
Stiller et al. (2004)	Sit EOB, transfer to chair, ambulation	Progressed per physiotherapist	Physiotherapist		HR, cardiac rhythm, BP, SpO2, physical assessment
Zafiropoulous et al. (2004)	Progression of activity from supine, to sitting over the edge of the bed, standing, walking on the spot for one minute, sitting out of bed initially, and sitting out of bed for 20 minutes.	Out of bed for 20 minutes	Physiotherapist		Respiratory and hemodynamic parameters were measured in each of the above positions and compared with supine

Author(s)	Activity Intervention	Duration, Frequency, Progression	Personnel Involved	Implementation Processes	Measures
P. Bailey et al. (2007)	Sit EOB, transfer to chair, ambulation	Twice daily Progressed using safety guidelines Goal ambulation > 100 feet before ICU discharge	RN, unit-PT, aide, RT	Identified a need for culture change to support mobility	Time from admission to activity, frequency and type of activity events, distance ambulated
Morris et al. (2008)	Passive ROM, turning, active resistance, sitting, transfers, ambulation	Daily, 7 days per week Progressed using activity protocol	RN, unit PT, aide, RT - all dedicated to mobility team	Automatic PT consult developed mobility protocol team	Proportion of patients at hospital discharge who received ICU PT, days OOB, ICU and hosp LOS
Thomsen, Snow, Rodriguez, and Hopkins (2008)	Sit EOB, transfer to chair, ambulation	Twice daily Progressed using safety guidelines	RN, unit-PT, aide, RT	Developed a protocol	Ambulation occurrence and distance, APACHE, vent LOS, discharge disposition
Hildreth et al. (2010)	Developed a nurse mobility protocol	Not specified other than had to be OOB at least once	Nurse-directed	Computerized mobility orders	Frequency of mobility orders, % mobilized
Needham et al. (2010)	Supine to sit, sitting EOB, transfer OOB, transfer from sit to stand, ambulation	Progressed using safety guidelines	Unit-based PT, OT	Multidisciplinary QI project, meetings to engage direct care providers and leadership, shared patient stories and videos to increase buy-in, modified order sets, added PT and OT	Number of treatments per patient, number of treatments per day, number of therapy consults, functional mobility
Senduran et al. (2010)	Protocol	Based on patient tolerance	Physiotherapist		HR, BP, SpO2, RR, pain were recorded before treatment, after, and at 5th min of recovery.
Garzon-Serrano et al. (2011b)	Bed mobility, EOB activities, transfer to chair, ambulation	Progressed by RN or PT using independent mobilization assessment Developed a standardized level of mobility tool	RN	Interdisciplinary team developed mobility categories	Level of mobilization assessed and achieved using standardized scale, barriers to further mobilization, nursing acuity score, vent days, adverse events
Leditschke et al. (2012)	Passive transfer OOB, active transfer OOB, or mobilization	Daily, 7 days per week Progression individualized	Physiotherapist		Number of patient days mobilized, activity type, adverse events

Author(s)	Activity Intervention	Duration, Frequency, Progression	Personnel Involved	Implementation Processes	Measures
Titsworth et al. (2012)	Positioning in bed, sitting EOB, standing, chair, ambulation	Activity planned 3 times per day for 30-60 minutes, ambulation goal of 20-150 ft. Ability to progress evaluated each shift using activity protocol	RN, PT, OT	Interdisciplinary mobility task force developed protocol and implementation toolkit (education, checklists) MD order to opt-out, otherwise auto inclusion	Mean I-MOVE mobility score, LOS, PU, HAI
Winkelman et al. (2012)	Bed exercise, sit in chair, ambulation	20 minutes of exercise daily for 2-7 days Progressed using an activity protocol	RN	Research staff delivered intervention	Time to first exercise, type and frequency of activity, MRC, Katz Activities of Daily Living Scale, patient report of pain and fatigue, IL-6 and IL-10 pre/post exercise on days 1-3, 7 and 14
Perme, Nalty, Winkelman, Kenji Nawa, and Masud (2013)	Mobility protocol	30-60 min	PT		Highest level of mobility, adverse events
Damluji et al. (2013)	Progressive mobility per PT	Ave treatment time 30-45 min	PT	Weekly rehabilitation meeting (PTs and MD) and monthly adverse event review meeting	Highest level of mobility, adverse events
(Drolet et al., 2013)	Ambulation	Progressed using activity protocol	RN, PT, OT, aide	Multidisciplinary team used PDCA, developed order sets, multidisc education, purchased custom equip vent walker Developed ambulation status report for distance ambulated daily	Ambulation frequency documented by nurse

Author(s)	Activity Intervention	Duration, Frequency, Progression	Personnel Involved	Implementation Processes	Measures
Dammeyer, Baldwin, et al. (2013)	Ambulation	Standard patient criteria for initiating and terminating a PT session Progression individualized	PT, unit-based. RN coordinated pre-ambulation preparation	automatic PT consult Interdisciplinary team used champions, defined roles, emphasized communication and coordination with PT and RN and discussion during rounds, shared safety data with staff to promote continued implementation	PT consults, activity events, VLOS, ICU LOS, d/c disposition
Davis et al. (2013)	ROM, bed mobility, sitting EOB, transfer OOB, ambulation	Progressed using activity protocol activity protocol involved education component for patient as well	PT, OT, RN and RT prepared patients for mobility	PT protocol	Number of therapy sessions attempted and completed, RAND 36-Item Short Form Health Survey (SF-36), Barthel Index score, hospital discharge location, adverse events
Dickinson et al. (2013)	Turning, ROM, positioning, dangling, resistance exercises, bicycling, OOB with sling, standing, transfer to chair, ambulation	Activity three times per day Ability to progress evaluated each shift using activity protocol	RN, PT	automatic PT consult multimodal education, included families as well Encouragement t/o to improve compliance with protocol	Mobility level, frequency of each mobility activity, RN compliance with mobility protocol
Hanekom et al. (2013)	Evidence-based protocol	Daily, weekend care prioritized to those determined to need it the most	Physiotherapist	Research therapists attended 1 day training, regular multidisciplinary team meetings to facilitate communication	Patient waiting time, frequency of treatment sessions, tasks performed and adverse events.

Author(s)	Activity Intervention	Duration, Frequency, Progression	Personnel Involved	Implementation Processes	Measures
Mah et al. (2013)	ROM, OOB to chair, sit at EOB, stand at EOB, transfer to chair, ambulation	Activity planned 2-3 times per day Progressed using an activity protocol	RN, unit-PT, aide, RT	PT and PT aide added for study, coordination occurred by direct communication with RN at beginning of day	Comparison of FIM at ICU admission, discharge, and hospital discharge; number of days to PT referral
Sricharoenchai et al. (2014)	Evidence-based protocol	Daily PT 6x/week as ordered	PT	PT driven program	Incidence of 12 types of physiological abnormalities and potential safety events associated with PT were evaluated for any additional treatment, cost, or LOS
Klein et al. (2015)	Progressive mobility protocol	daily upon admit	nurse-led	Nurse leaders developed protocol, lift team available, technician added to support mobility during intervention, APN reviewed protocol with RN every 12 hrs, additional chairs purchased, mobility protocol placed on clipboard in each room	highest mobility achieved, psychological profile, ICU and hosp LOS, discharge disposition, VAP, CLABSI, DVT, HAPU, APACHE, demographics, comorbidities
C. L. Hodgson et al. (2015)	Early mobility protocol		Physiotherapist		Mobilization during ventilation, RASS, co-interventions, duration of MV, ICUAW at ICU discharge, mortality at day 90, and 6-month functional recovery
Retrospective Studies					
Ronnebaum, Weir, and Hilsabeck (2012)	ROM, bed mobility, transfers, ambulation	Progressed using safety guidelines	PT	Established interdisciplinary team meetings (RN not present)	Ambulation distance, functional level at discharge

Author(s)	Activity Intervention	Duration, Frequency, Progression	Personnel Involved	Implementation Processes	Measures
Clark et al. (2013)	Sitting in bed, sitting EOB, standing, ambulation	Progressed using activity protocol	Unit-based PT	Interdisciplinary team implemented, used PDCA framework, PT provided nursing education, daily rounds	Frequency of PT treatments, PT billable units per days PT provided and per visit, adverse events
Engel, Tatebe, et al. (2013)	Bed mobility, edge of bed activities, transfer to chair, ambulation	Daily five days per week Progressed using activity protocol	Unit-based PT	Interprofessional group identified patients and wrote PT orders PT spent one year promoting 'mobility as medicine'	Frequency of PT referrals, time to PT evaluation, ambulation distance, level of assistance (International Classification of Functioning, Disability, and Health (ICF))
Olkowski et al. (2013)	Focused functional training and therapeutic exercise in more progressively upright positions	30-60 min	PT, OT	Multidisciplinary team developed Assessed daily by PT or OT	Safety and feasibility: early mobilization program sessions attempted, sessions where criteria to participate were met, sessions where criteria to participate were not met, and reasons why patients did not meet participation criteria
Genc, Ozyurek, Koca, and Gunerli (2012)	Per protocol		Physiotherapist		HR, BP, RR, SpO2 collected just prior, just after, and after 5 minutes recovery period. Respiratory reserve was calculated before and after the mobilization
McWilliams et al. (2015)	Rehabilitation team focused on promoting early and enhanced rehabilitation for patients at high risk for prolonged ICU and hospital stays	Individually tailored per PT	Physiotherapy-initiated with RN involvement in maintaining plan	Process based on 4Es - engage, educate, execute, evaluate	Manchester Mobility Score, ICU and post-ICU LOS, ventilator days, and in-hospital mortality
Wahab et al. (2016)	Rehab therapist advanced activity Additional therapist FTE added		PT and OT	Hired additional therapy staff ICU clinicians reviewed patients daily with PT and OT Weekly meetings to discuss implementation	Rehabilitation treatments, ICU and hospital LOS

Chapter 2. A Qualitative Analysis of ICU Nurse Decision-Making about Patient Mobility

ABSTRACT

Objectives: Early mobility is an evidence-based intervention that impacts patient functional outcomes. We studied ICU nurse decision-making and barriers that influence decision-making about patient mobility.

Design: An exploratory descriptive approach using observation and semi-structured interviews with nurses in two ICUs at two hospitals in the Midwest. Interviews were transcribed and analyzed using directed content analysis to identify categories that describe nurse decision-making about patient mobility.

Subjects: Nurses with 6 months or greater current employment in an adult ICU at each hospital were recruited to participate.

Interventions: None

Measurements and Main Results: One-on-one interviews were conducted with 20 nurses and a sub-set of 4 nurses were observed for a total of 32 hours of direct observation. Four main categories that influenced nurses' decision-making about mobility were identified in the directed content analysis: purpose of mobility; gathering information; establishing and activating the plan; and barriers to progressing the plan.

Conclusions: The decision to mobilize ICU patients is a multi-faceted, individualized nurse decision and is influenced by numerous patient, nurse, and unit factors.

Key Words: mobility; nurse; decision-making; interviews; qualitative research

BACKGROUND

Intensive Care Unit (ICU)-acquired functional disabilities are a significant long-term health concern, affecting up to 69% of ICU survivors one year after discharge (Ehlenbach et al., 2015; Iwashyna et al., 2010; van der Schaaf et al., 2009). Patients with ICU-acquired functional disabilities have higher healthcare-related costs and one-year mortality (Hermans et al., 2014). Over 50 percent of survivors require new institutionalization and/or physical rehabilitation and only 48% of previously employed adults return to work one year after ICU discharge (Needham et al., 2013). Studies have found that ICU patients who engage early mobility interventions have improved functional outcomes and reduced ICU and hospital lengths of stay, compared with patients who spend a majority of time in bed (Adler & Malone, 2012; Casey, 2013; Choi et al., 2008; Li et al., 2013). Early mobility interventions include progression of in-bed activity to out of bed activity. Yet, most patients are not receiving these critical interventions. If fact only 45% of ICUs in the U.S. report implementing early mobility practices (Bakhru et al., 2015).

Previous research has identified multiple barriers such as staffing, patient safety concerns, time, and equipment that preclude early mobility in ICU settings (Bakhru et al., 2015; Barber et al., 2015; Dubb et al., 2016; Honiden & Connors, 2015; Hoyer et al., 2015). Mobility is a complex intervention within a highly-acute and unpredictable setting. Yet, prior work has demonstrated that understanding the decision-making process of health professionals is critical for identifying opportunities to improve patient outcomes (Fesler-Birch, 2005). In spite of previous research identifying barriers, we still do not understand how nurses, who are frequently responsible for carrying out mobility, overcome these barriers and make decisions to mobilize ICU patients.

Early mobility interventions have utilized a variety of healthcare providers and models, with physical therapists (PT) and nurses providing the majority of early mobility interventions (Bakhru et al., 2015). Yet one of the major limitations of interventions that rely primarily on PT-driven early mobility is

the scarcity of PT resources (limited availability on evening and night shift and weekends). Further only 34% of U.S. ICUs have dedicated PTs (Bakhru et al., 2015). Additionally, PTs report insufficient staffing and lower prioritization of ICU patients as significant barriers to providing early mobility in these settings (Malone et al., 2015).

In contrast, nurses provide the most direct patient care in the ICU, but we do not know how nurses are engaged in early mobility, how they overcome barriers, or how they make decisions about mobilizing patients. In medical units, nurses consider multiple factors prior to deciding whether to ambulate patients, including assessing risk and opportunity, the purpose for ambulating the patient, and the unit expectation for ambulation (Doherty-King & Bowers, 2011). We do not know how nurses' make mobility decisions in a highly acute and rapidly changing setting. To improve patient outcomes, we first need to understand nurses' decision-making about patient mobility within the context of the ICU system. Decision-making is a precursor to action, thus, it is critical to understand decision-making about patient mobility, prior to implementing interventions to improve the delivery of patient mobility. The purpose of this study is to examine key components of nurse decision-making and barriers that influence decision-making about ICU patient mobility.

MATERIALS AND METHODS

Study Design

A qualitative study was conducted using directed content analysis to identify major themes related to ICU nurse decision-making for patient mobility. Directed content analysis is used for exploring and extending existing research, in this case, nurse decision-making about patient mobility.

Setting and Participants

This study was conducted at two adult medical-surgical ICUs at two hospitals in Wisconsin. Participants were recruited from a 24-bed ICU in an academic tertiary care center (N = 15) and a 12-bed

ICU in an academically affiliated Veterans Administration hospital (VA) (N = 5). The University of Wisconsin and the VA's institutional review board (IRB) approved the study.

Nurses with six months or greater of current ICU experience and working 20 hours or greater each week were eligible to participate. Participants were recruited in coordination with each ICU nurse manager using two techniques: 1) posted flyers, unit announcements, and emails, and 2) nurse managers provided names and contact information for expert nurses with experience mobilizing patients. A purposive sampling method was necessary to include a range of nurse experience levels, with particular emphasis on expert nurses who were routinely engaging in mobility activities, which is consistent with principles that aim to understand real-world decision-making (Hoffman & Militello, 2012). Twenty nurses participated, which is a sufficient sample size to achieve saturation of data in content analysis (Sandelowski, 1995).

Data Collection

Data were collected through direct observation and one-on-one interviews. Four nurses were observed for the first four-hour portion of two shifts (32 hours total) and then interviewed within one week of the final observation. Observation data provided context to participants' work, from seeing the physical work space to identifying influences on decisions that may be inherent, such as culture or well-established processes (Beyer & Holtzblatt, 1998). Therefore, observation data was used to inform interview questions. The first four hours of the shift were chosen because while mobility events are not predictable, elements of mobility decision-making, such as patient assessment, communication with others, and planning, are more likely to occur during the beginning of the nurse's shift. Participants were informed that observers were studying decisions about patient mobility; however, no direct interaction with participants during the observation occurred in order to maintain distance to reduce the threat of a Hawthorne effect. Based on a review of the literature and clinical expertise of the research team, a paper observation tool (Appendix 1) was developed to capture the sequence of observed tasks by

category (medication administration, assessment, communication, etc.). When a task related to mobility occurred, additional descriptors were captured, such as type of assessment performed or how mobility was coordinated. Field notes and observation of tasks were synthesized at the completion of each observation and used to further inform interview questions.

Twenty nurses, including the four observed nurses, participated in one-on-one interviews. Participants had a range of 2.5-19 years of ICU nursing experience, with a mean of 9.0 years (Table 1). Semi-structured questions focusing on the following domains: how nurses defined mobility for ICU patients, describing the nurse's role in patient mobility, how nurses make decisions about patient mobility, and barriers to mobilizing patients were used in the interviews. To specifically query about decision-making, participants were asked, "I'd like you to think of a particularly complex patient case or situation. Can you describe for me any activity you engaged the patient in that you identify as early mobility?" All interviews were audio-recorded and were conducted in a private office space at the nurses' place of work. Each participant was offered an honorarium of $30 for interview participation.

Data Analysis

Data was analyzed using Elo and Kyngäs (2008) 3-phase method of directed content analysis. In Phase 1, two investigators, with diverse expertise in critical care nursing (A.E.K.), and hospital ambulation interventions and qualitative methods (B.J.K.), independently performed open coding of each transcript to identify preliminary codes. Sections were coded in line-by-line sections. The research team met weekly to discuss coding. If there was a disagreement, original data was reanalyzed together until there was consensus. Together, the research team grouped open codes into higher order sub-categories (Phase 2), and collated sub-categories into main categories (Phase 3). Four categories and 16 sub-categories emerged from the data. Dedoose software was used for data management (Dedoose 7.5.9, 2017).

RESULTS

Overall, four key categories, *Purpose of Mobility, Gathering Information*, *Establishing and Activating the Plan, Barriers to Progressing the Plan*, describe how nurses make decisions about mobility in the ICU setting (Table 2). Purpose for mobility was described as preventing complications, meeting the unit standard, and assisting the patient in reaching the RN-predetermined goal. Nurses described multiple methods to gather information, which included verbal, watching, written, baseline testing, and knowing the patient. Establishing and activating the plan was described as being the first person to mobilize, determining the acuity and goal match, determining the response to activity, and coordinating the patient and resources. Barriers centered on limited resources, unit activity, patient availability, and variation in individual nursing practice. In addition to the four individual categories, the influence of unit culture was described within each of the categories.

Purpose for Mobility

Mobility was consistently described as a progression from in-bed (turning side to side, sitting at edge of bed) to out-of-bed (standing, transferring, sitting in chair, or walking) physical activities. Multiple purposes for both initiating and progressing mobility included meeting the mobility goal pre-determined by the nurse, meeting a unit standard for activity, and preventing complications.

Nurses described a variety of physical and psychological reasons for mobility. In-bed and chair-based activities (low-level mobility) were used to support patients to independently complete activities of daily living (ADLs) or to assist patients with repositioning. Such low levels of mobility served the purpose to promote independence and assess strength and ability. Reasons for engaging patients to move to a chair (passively or actively) also involved engaging a patient in their surroundings and providing psychologic support to patients.

> “It was as much emotionally and mentally for him to feel, ‘I’m going in the right direction’.” (RN 8).

Nurses described passive movement to the cardiac chair as the unit standard and most common type of out of bed activity. Passive movement required less staff time, and equipment was readily available.

> "I sometimes find it very challenging to mobilize patients beyond a cardiac chair because putting people in a cardiac chair in most cases is easy. It doesn't take extra time. You don't have to wait for the patient to be ready. You don't have to gather equipment, most of it, as we have the ceiling lifts in the room." (RN 6).

Passive movement to the cardiac chair was identified as a means to prevent immediate complications from bedrest, such as additional ventilator support, skin breakdown, and delirium. Subsequent patient assessment reinforced to nurses that passive movement prevented these potential complications.

> "His sats were 88 when I was standing him, but then he coughed a ton of secretions out. By the end of the day he never had a de-sat episode again." (RN 5).

There were some nurses, although few, that described the purpose for mobility was to prevent long-term sequela from immobility. Progressive mobility (standing, walking) was the means to prevent functional decline and assure the patient could return home. For some, seeing physical and physiologic improvements in patients was influential in their decision-making about ICU patient mobility.

> "A lot of people do come back and seeing someone who lost 30 liters of blood from a GI bleed and coming back, even if it's in a wheelchair, to see him physically doing well is a real benefit… it just reconfirmed that it's important to get people up sooner rather than later." (RN 8).

Gathering Information

To inform their decision about initiating patient mobility, nurses use multiple sources, verbal, observation, written, to gather information. Verbal (shift-to-shift report, other ICU nursing staff, taking to patient or family) sources were the predominant means to gather information. Types of mobility

information nurses listened for were related to: prior out-of-bed mobility activity, how patient tolerated mobility activity, level of physical support patient needed for activity, and need for any assistive devices. Nursing assistants were seen as vital sources of verbal information because they were the consistent staff members in the ICU that had assisted with or initiated patient mobility sometime during the patient's stay.

> "Nursing assistants are a wonderful because they're here a lot and will let you know how they did the day before." (RN 2).

Participants described how observing the patient's strength, mental status, and physiologic response to initial activity was critical information for deciding to maintain or progress activity. For example, nurses described actively testing a patient's lower extremity strength or by observing a patient's ability to support their trunk while sitting at the bedside. Mental status was assessed by the patient's ability to follow direction and physiologic response was assessed progressively, initially with movement in the bed, and prior to advancing to the next activity.

> "You're not going to get them out of bed if you can't lay them flat even." (RN 4).

> "I want to make sure that they can stand, pivot to the chair, and successfully get back to bed. That they have enough strength to maintain that before I think about taking them for a walk." (RN 2).

Watching the patient's ability was a means to further confirm or clarify information that was received in handoff report. Some nurses described hesitancy being the first person to mobilize a patient out of bed and to independently making the decision to initiate a mobility plan. In this instance, nurses either sought out confirmation from other providers (MD, PT), or defaulted to the lowest level of activity (using ceiling lift to move patient from bed to chair) for patient mobility.

Nurse's knowledge of the patient also influenced how they gathered information and made decisions about level of mobility and progression. If nurses cared for the patient over several days they

were keenly aware of patient tolerance to activity and physiologic stability, which seemed to influence their level of confidence with mobility decisions.

> "I am so much more confident in moving somebody that I've had for a day or two. Beyond even what I may have gotten in report." (RN 4).
>
> "I think that once you know the patient, it's a lot easier to direct how I think their mobility should go, and what I think they're capable of doing." (RN 9).

Knowing the patient also included information about the illness trajectory. An improving trajectory of physiologic stability was seen as favorable for mobility. Whereas worsening of physiologic stability was an indication that the patient should remain in bed.

> "His vent settings were back down to normal and I think he was waking up," (RN 1).
>
> "If they're looking, trending sicker, it's usually not somebody that you're pushing physically." (RN 4).

Written information from the patient's electronic health record was infrequently used as the primary source of information. Inaccurate nurse documentation, outdated activity orders, and time required to search in multiple locations for information deterred nurses from using this source.

> "I can't tell you it's always the resident or intern's priority to have mobility [orders]. They really live with the sickest of the sick and once they stop being a teaching patient in that regard, they aren't as quick to get on top of the orders." (RN 4).

Establishing and Activating the Plan

Synthesizing information and determining a mobility plan is a complex process that occurs quickly and early in the nurse's shift. Nurses described using assessment findings to determine patient acuity as it related to a mobility goal. The most critically ill patients in the unit did not have a mobility goal, as the primary goal for the shift was patient survival. Once patients' demonstrated hemodynamic stability, the goal for mobility was to maintain hemodynamic stability.

"I gauge if they're tolerating it. If they're not getting more hypotensive or anything like that. If they're looking in the chair how they looked in bed, then they're OK." (RN 9).

Fewer nurses described their role as progressing patients to ambulation. When nurses described progressing patient mobility, they already had worked with the patient for several days or the plan was influenced by a reliable source who knew the patient's physical abilities. An additional trigger for progressing the patient's activity to ambulation included an improving illness trajectory, such as having invasive lines removed.

"If I hear in rounds that they're looking good, let's start taking lines out, that's definitely a cue." (RN 8).

When mobility was initiated, the goal was described as either maintaining mobility or progressing mobility. Nurses described most patients as capable of participating in mobility (either maintaining or progressing mobility), and therefore established a plan for a majority of patients. Nurses working the day shift in particular, identified it as their role to initiate mobility to the chair.

"We're the one to initiate whether or not we're going to get a patient up in the chair." (RN 14).

Most commonly, nurses initiated or maintained low levels of activity to a chair as a means to assess the patient's initial response to being out of bed. The primary purpose of assessing the patient's initial response to being out of bed was to maintain patient safety.

For many nurses, initiating mobility to the chair in the morning was important. Many nurses grouped mobility activities in with existing activities when those resources were already available, such as after a bath.

"Assessment, bath, chair, get him up." (RN 1).

Finally, patients able to communicate and expressing motivation seemed to influence the nurse's mobility plan, which often lead to a more active level of patient movement.

"He was seriously motivated to get up and get out of that bed." (RN 8).

Initiating a plan to ambulate a patient took more time and assistance than mobility to the chair, and nurses described needing 30 to 60 minutes of time to prepare the patient, coordinate resources, and monitor the patient during ambulation. Preparing the patient involved anticipating and managing pain, supporting physiologic needs during mobility and eliminating unnecessary tethers.

"I had them bump up his FiO_2 on high flow oxygen 10 minutes beforehand." (RN 4).

Ensuring the patient was prepared was important for the patient to have a successful and safe mobility session. Preparation was also important for the efficiency of other staff requested to assist with mobility interventions, as most ICU patient mobility requires assistance of two or more staff members. Coordinating resources involved ensuring assistive equipment was available and gathering additional staff, including nursing assistants, respiratory therapy or other nurses.

The unit activity was also factored into the nurse's decision, as there was a culture to maintain the collective safety of the unit. Nurses would forgo or limit their own patient's activity based on overall unit needs. Nurses described not mobilizing patients based on anticipating the timing of a new admission and needing to help the admitting nurse stabilize the patient. Whereas other nurses used information from the charge nurse to plan the duration of a patient's activity.

> "We were going to prone a patient and we were getting two sick admissions, so I had to help him back to bed a little earlier than I wanted to." (RN 3).

Barriers to Progressing the Plan

Nurses described multiple barriers to progressing mobility including unit activity, limited resources, limited patient availability, and variation in nurse practice. Therefore, while the intention to engage the patient in mobility was planned, barriers in a highly acute and unstable environment did prevent mobility from occurring.

Increased activity on the unit, such as admissions or a rapidly deteriorating patient, reduced the number of staff available to assist with mobility, which delayed or prevented mobility from occurring.

> "We were moving everybody in, moving everybody out, getting people to procedures, people are coming and going from everywhere." (RN 4).

If staff were not available to help, the limited resources influenced the frequency and level of mobility, particularly with complex patients. Nurses described ICU patients as needing multiple assistants to support the patient and manage equipment in order to progress mobility.

> "There are days when we don't have a ton of extra staff and that makes it difficult because then you need to coordinate if you really need to get someone up, otherwise you end up moving around it." (RN 19).

Nurses quickly determined if staff was available to help with mobility by looking in the hallway to see if anyone was visible to assist. If help was not readily available, mobility was either deferred or limited to passive movement to the chair.

> "You need more hands if you plan to stand them which I think a lot of times if they're ventilated people just go right to the lift and they don't stand them on their own because it probably does take that extra person just to monitor." (RN 5).

Another significant barrier that every nurse described was availability of the patient. Unscheduled procedures and tests influenced the occurrence of mobility. Some nurses described strategies to plan mobility around procedures, such as contacting the dialysis unit or operating room to establish patient availability. If the nurse determined there was enough time before the patient's procedure, then mobility was initiated. However, other nurses deferred all mobility until after procedures or until the next day.

> "Because if it's not scheduled it can go one of two ways. You either leave them in bed until it happens or you just get them up and hope and pray they don't come right away." (RN 1).

While all nurses viewed mobility as an essential part of their role, the degree to which nurses' progressed activity was also based upon the individual nurse's decision. Nurses described being aware of the variation in decisions between nurses.

> "If it became more commonplace it would be a lot easier because people just feel like it's so much work but if it becomes commonplace it won't be. It's not nice to think that people are like ah, there's no way I'm doing all that again, it's not about that. It's just what you do. If it wasn't strange anymore." (RN 3).

> "A lot of times we slack because we don't know what to do next, so if someone hasn't made that assessment, not necessarily everyone would feel comfortable starting [mobility]." (RN 18).

Examples of individual perspectives that influenced mobility decisions included a fear of negative consequences of mobility or having the knowledge to progress the patient's activity safely. For example, nurses described a fear of pushing a patient too hard physically, and as a result influencing the healing ability. Consequently, some nurses described deferring active progression of complex patients primarily to PT.

> "We often feel like you're doing the best you can with the time and resources you have available and if someone in any way makes you nervous you're going to err on less mobility rather than really pushing them." (RN 4).

> "I kind of feel like he'd be OK, but I don't want to hurt him by deciding that too soon without somebody else who that's their main focus." (RN 2).

However, certain specialty populations within the same ICU had defined the standard of mobility as ambulation, which was routinely met.

> "They have to walk, they got a transplant, so we know that it's required." (RN 3).

The differences among nurses within the same unit represented a culture that did not identify the nurse's role as progressing mobility beyond the chair. When a unit culture doesn't require active

mobility progression, additional individual influences act as barriers. The influence of unit culture was present within each of the previous categories, and acted as additional barriers to progressing the plan. For example, when the unit culture defined the standard of ICU mobility as up to the chair, the focus was on in the moment needs of maintaining safety and getting patient's out of bed in an efficient manner.

> "I think sometimes we can be too apt to be like, oh, we'll just use the ceiling lift to get them up." (RN 2).
>
> "To be honest with you, I have a ventilated patient, I don't really think of walking whether they're awake, alert, I really don't, and I know that's something we should probably be striving for but I really don't." (RN 10)

Because the unit culture centered on mobility to the chair, most of the information passed between nurses was completion of the task of getting the patient to the chair. The information received informed if and how nurses progressed a mobility goal.

> "I don't think anyone sets it. I don't feel like nursing takes ownership of setting a mobility goal. It feels kind of out of our realm because there's so many components to why you would make that a goal." (RN 4).

DISCUSSION

Nurses' decisions about ICU patient mobility are complex and influenced by multiple patient, nurse, and unit factors. While all nurses described routinely being involved with patient mobility, nurses in the study commonly initiated lower levels of patient activity, limited to passive or active transfer to the chair. Other studies have reported that ICU patients mobilize at lower levels with nurses, compared to physical therapists (Garzon-Serrano et al., 2011b). This study offers new contextual possibilities for this difference. Nurses in this study reported that lack of knowledge on how to advance patient mobility

limited progression. As an alternative, nurses verbally sought out reliable sources of information about patient ability and maintained the current level of activity.

Another significant influence on decision-making to maintain activity was that active mobility required more resources. Nurses reported competing time demands, and therefore chose passive means to get patients out of bed. Decision-making research in other settings demonstrates that nurses make 'trade-off' decisions when there are limited resources (P. Ebright, 2010). This study found that assisting patients out of bed, even using a passive means, was a perceived benefit over leaving the patient in bed, when time or lack of human support was not available for higher levels mobility. Decisions based only on the here and now focus on getting ICU patients out of bed efficiently. Shifting decision-making to also recognize the long-term goal for engaging patients in active mobility is challenging, as ICU nurses are not able to experience the long-term impact of early mobility with patients. Researchers have started to suggest frameworks to shift ICU practitioner decisions toward focusing on long-term outcomes (Jackson et al., 2014). Yet, interventions to shift from here and now to a long-term focus have not been tested. One consideration in shifting ICU nurses toward a long-term perspective is to consider the workload of ICU nurses and the resources needed to progress activity, so that trade-offs to lower level activity are not the default decision.

In addition to limited nurse time and resources, participants in this study highlighted challenges with initiating mobility when patient availability was not known. All nurses reported unscheduled procedures as a significant barrier to planning mobility. While some nurses sought out scheduling information, e.g. call dialysis, other nurses deferred mobility until after procedures, potentially until the next day. Reports on missed nursing care identify ambulation as one of the most frequently missed nursing interventions (Kalisch, 2006). Yet, patient availability was not identified as a source of missed mobility. This study acknowledged a need for knowing patient availability, such as by establishing a

patient itinerary, so that scheduling mobility within a complex and highly variable environment can become efficient and transparent to the interdisciplinary team.

The influence of unit culture was present in each of the categories that influenced nurse decision-making. Multiple researchers have recognized the impact of unit culture on early mobility practices, and identify interdisciplinary teamwork, shared goals, and use of quality improvement framework as key influences of unit culture (Carrothers et al., 2013; Devlin & Pohlman, 2014; Engel, Needham, Morris, & Gropper, 2013; Hopkins, Spuhler, & Thomsen, 2007). This study identifies that mobility decisions (level, frequency, duration) are an individualized nurse decision, and are not part of the existing unit culture. While the shared unit goal for all patients was to maintain safety, the goal and purpose for mobility varied between patients. This study describes how the purpose for mobility drives the level of mobility that the nurse initiates. More research is needed to identify and measure cultural influences for early mobility and understand if there are influences that are unique to early mobility, compared with other ICU improvement efforts.

There are several limitations to this study. This study was conducted with nurses who worked in medical-surgical ICUs and only in two teaching hospitals. Other ICU settings, such as specialty surgical ICUs or community-based ICUs, may have different results because of differences in established activity requirements. In addition, both ICUs had some experience with implementing early mobility practices, but early mobility was not described as part of either unit's culture. Nurse decision-making might look different depending upon the unit's status with implementing early mobility practices and the presence of an early mobility culture. Future work is needed with ICUs in other stages of early mobility implementation.

This study had several strengths. Observation and interview data strengthened the analysis by allowing the researchers opportunity to clarify specific actions. In addition, we were able to recruit

predominantly experienced ICU nurses, which increased the depth and number of opportunities nurses used to describe their decision-making processes.

CONCLUSIONS

The decision to mobilize ICU patients is a multi-faceted, individualized nurse decision and is influenced by numerous patient, nurse, and unit factors. This study found that nurses are routinely involved with patient mobility, but default to lower levels of patient activity and few engage patients in higher levels of activity, such as active transfer or ambulation. Nurses described several purposes for mobility, and the purpose influenced the decision to maintain a patient's current level of activity as opposed to actively progress the patient's activity. It seems that unit culture influences how nurses make mobility decisions, particularly as it relates to the purpose of being out of bed versus actively progressing mobility. Future approaches that target unit culture from a nursing perspective are needed.

Yet, these interventions must be multi-component, as nurses described multiple barriers that prevented mobility or resulted in lower levels of patient activity. Two key barriers include lack of human resources and patient availability. Additional research is needed on how the impact of multi-component interventions that target unit culture and nurse-specific barriers to progressing mobility influence nurse decision-making in relation to actively progressing the mobility of patients in the ICU.

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Table 1. Participant Demographics

Characteristic	n = 20
Years of RN experience (ave., [range])	11.7 (2.5-32)
Years of ICU experience (ave., [range])	9.0 (2-19)
Highest degree (n[%]) ADN BSN MS/MSN	 1 (5%) 17 (85%) 2 (10%)
Critical care certification (n[%])	7 (35%)

Table 2. Results of 3-Phase Content Analysis

Phase 1: Open codes (sample)	Phase 2: Sub-categories	Phase 3: Categories
• Promote pulmonary function • Maintain sleep-wake cycle • Passive movement to cardiac chair • Maintain level of activity • Promote independence • Transfer out of ICU	• Preventing complications • Meet the unit standard • Assist patient in reaching RN-predetermined goal	Purpose for mobility
• Patient's baseline • Patient's previous activity and tolerance • Observing illness trajectory • Shift handoff report • Talk to PT • Ask patient and family • Watching in bed ability • Determining degree of instability • Orders • Therapy notes	• Knowing the patient • Verbal • Watching • Written • Baseline testing	Gathering information
• Looking for verification • Patient able to participate • Watching response to mobility • Involve patient and family • Communicate plan with RT, assistant • Cluster activities • Competing time demands	• Being the first person to mobilize • Determining the acuity and goal match • Determining response to activity • Coordinating the patient and resources	Establishing and activating the plan
• Need more than 1 person to assist patient • Number of staff available • Unit throughput • Unscheduled procedures • Defer progression to PT • Risk for injuring self	• Limited resources • Activity of unit • Limited patient availability • Variation in individual practice	Barriers to progressing the plan

Table 3. Categories and Subsequent Decisions

Categories	Supportive Quotes	Decision-Making Behavior
Purpose for mobility	"It was as much emotionally and mentally for him to feel, 'I'm going in the right direction'." (RN 8). "I sometimes find it very challenging to mobilize patients beyond a cardiac chair because putting people in a cardiac chair in most cases is easy. It doesn't take extra time. You don't have to wait for the patient to be ready. You don't have to gather equipment, most of it, as we have the ceiling lifts in the room." (RN 6). "His sats were 88 when I was standing him, but then he coughed a ton of secretions out. By the end of the day he never had a de-sat episode again." (RN 5). "A lot of people do come back and seeing someone who lost 30 liters of blood from a GI bleed and coming back, even if it's in a wheelchair, to see him physically doing well is a real benefit… it just reconfirmed that it's important to get people up sooner rather than later." (RN 8).	Passive movement to cardiac chair Actively progress patient Clarify information by seeking out reliable sources
Gathering information	"Nursing assistants are a wonderful because they're here a lot and will let you know how they did the day before." (RN 2). "You can just tell by looking at them… they're not moving at all, you do your first turn for the day and they don't do anything." (RN 1). "I can't tell you it's always the resident or intern's priority to have mobility [orders]. They really live with the sickest of the sick and once they stop being a teaching patient in that regard, they aren't as quick to get on top of the orders." (RN 4). "I am so much more confident in moving somebody that I've had for a day or two. Beyond even what I may have gotten in report." (RN 4). "I think that once you know the patient, it's a lot easier to direct how I think their mobility should go, and what I think they're capable of doing." (RN 9). "His vent settings were back down to normal and I think he was waking up," (RN 1). "If they're looking, trending sicker, it's usually not somebody that you're pushing physically." (RN 4).	

Establishing and activating the plan	"We're the one to initiate whether or not we're going to get a patient up in the chair." (RN 14). "I gauge if they're tolerating it. If they're not getting more hypotensive or anything like that. If they're looking in the chair how they looked in bed, then they're OK." (RN 9). "I try to read how they respond to my pushing, because I won't push them past their limit, but I will push them to where they have to work." (RN 19). "Assessment, bath, chair, get him up." (RN 1). "If I hear in rounds that they're looking good, let's start taking lines out, that's definitely a cue." (RN 8). "He was seriously motivated to get up and get out of that bed." (RN 8). "I had them bump up his FiO2 on high flow oxygen 10 minutes beforehand." (RN 4). "They have to walk, they got a transplant, so we know that it's required." (RN 3). "We need to get moving, even small steps at a time, and sitting back down. I told him my plan, he was able to, and it worked." (RN 20).	
Barriers to progressing the plan	"We were moving everybody in, moving everybody out, getting people to procedures, people are coming and going from everywhere." (RN 4). "We often feel like you're doing the best you can with the time and resources you have available and if someone in any way makes you nervous you're going to err on less mobility rather than really pushing them." (RN 4). "You need more hands if you plan to stand them which I think a lot of times if they're ventilated people just go right to the lift and they don't stand them on their own because it probably does take that extra person just to monitor." (RN 5). "There are days when we don't have a ton of extra staff and that makes it difficult because then you need to coordinate if you really need to get someone up, otherwise you end up moving around it." (RN 19).	

	"Because if it's not scheduled it can go one of two ways. You either leave them in bed until it happens or you just get them up and hope and pray they don't come right away." (RN 1). "If it became more commonplace it would be a lot easier because people just feel like it's so much work but if it becomes commonplace it won't be. It's not nice to think that people are like ah, there's no way I'm doing all that again, it's not about that. It's just what you do. If it wasn't strange anymore." (RN 3). "I kind of feel like he'd be OK, but I don't want to hurt him by deciding that too soon without somebody else who that's their main focus." (RN 2). "I think sometimes we can be too apt to be like, oh, we'll just use the ceiling lift to get them up." (RN 2). "A lot of times we slack because we don't know what to do next, so if someone hasn't made that assessment, not necessarily everyone would feel comfortable starting [mobility]." (RN 18). "To be honest with you, I have a ventilated patient, I don't really think of walking whether they're awake, alert, I really don't, and I know that's something we should probably be striving for but I really don't." (RN 10). "I don't think anyone sets it. I don't feel like nursing takes ownership of setting a mobility goal. It feels kind of out of our realm because there's so many components to why you would make that a goal." (RN 4). "We were going to prone a patient and we were getting two sick admissions, so I had to help him back to bed a little earlier than I wanted to." (RN 3). "We have one or two patients, but we could have one really sick patient and so that impacts how much time you have for the other person." (RN 20).	

Appendix 1. Observation Tool

ID# ________ Observer Initials ______ Time (start/stop) ________________ page ____/______

Observation Tool – Understanding ICU Nurse Decision-Making about Patient Mobility

Tasks Observed			RN Mobility Assessment	Mobility Coordination & Communication
Tasks: M = medication administration, A = assessment, I = intervention (non-mobility), IM = intervention, mobility, ADL = activities of daily living, R = rounds, C = communication, D = documentation, CC = care coordination, O = other			Physical strength, cognition, safety, pt engagement, EHR	Role, response, goal
Time	Room #	Task		

Overall Impression of the Unit	Observer Notes
Overall business as indicated by # beds occupied at start of observation ___ **Tone of unit (energy, noise, pace)** **Crisis events on unit**	

Chapter 3. Using Cognitive Work Analysis Methods to Understand ICU Nurse Decision-Making About Patient Mobility

1. Introduction

The intensive care unit (ICU) is a highly dynamic and complex environment for both healthcare providers and individuals that require care. Because of their 24-hour presence, nurses provide the largest amount of direct care in the ICU and can have a significant impact on patient outcomes. The complexity of ICU nursing work includes multiple types of demands, such as physical, emotional, and cognitive, with nurses often making decisions under time pressure and unpredictability (Carayon & Alvarado, 2007). The environment within which ICU nurses work can affect patient outcomes. ICUs with better nurse work environments (staffing, unit culture, communication, and collaboration) experience lower patient mortality rates (Kelly et al., 2014). The environment also influences the actions nurses choose, as the available physical and social resources impact nurse decision-making (Thompson et al., 2004; Vicente, 1999). Therefore, nursing interventions to improve ICU patient outcomes need to consider the complexity of the environment within which ICU nurses work and make decisions.

Functional disability is a common and significant negative outcome for ICU survivors, affecting up to 69% of survivors one year after discharge (Ehlenbach et al., 2015; Iwashyna et al., 2010; van der Schaaf et al., 2009). Early mobility is an intervention that has been shown to improve patient functional outcomes and reduce ICU and hospital lengths of stay (Adler & Malone, 2012; Casey, 2013; Li et al., 2013). Early mobility is a progressive activity intervention with the goal to have patients return to their pre-hospital level of function, such as walking, as soon as physiologically stable. For patients in the ICU, early mobility may include walking while receiving mechanical ventilation or other invasive interventions. Since ICU patients require physical assistance and monitoring, ICU nurses often participate in or initiate patient mobility. However, despite the benefits of early mobility, there is considerable variation in delivering these interventions. Only 45% of ICUs in the U.S. have implemented early mobility programs (Bakhru et al., 2015). Further, studies in Australia, New Zealand (Berney, Harrold, Webb, Seppelt, Patman, & Thomas, 2013), and Germany (Nydahl et al., 2014) show that less

than 25% of patients receiving mechanical ventilation are actively mobilized out of bed. A significant gap in existing early mobility interventions is that current work has not accounted for how nurses are engaged in mobility decisions within a complex environment.

This article presents the results of a systems approach used to describe ICU nurse decision-making about patient mobility and identifies opportunities for system design to improve the delivery of early mobility interventions. Previous research has focused on early mobility interventions (such as adding a physical therapist to the ICU or implementing a mobility protocol) in isolation from the dynamic properties of the patient and the nurse within the ICU environment. A systems approach is necessary because mobility is one complex intervention within the ICU. Patients in the ICU require frequent and multiple types of interventions. There are various approaches to accomplish mobility interventions, which may range from assisting a patient to sit at the end of the bed, to walking a patient that is receiving mechanical ventilation. In addition, mobility interventions in the ICU typically require more than one health care provider (nurse or nursing assistant) to be available to assist the patient and manage equipment. Without an understanding of the ICU system within which mobility interventions occur and an understanding of how nurses, whose role is vital to patient care and coordination, make patient mobility decisions, it is not possible to propose appropriate interventions to improve the delivery of early mobility.

2. Cognitive Work Analysis

One systems framework that has been used effectively to study decision-making in complex socio-technical systems, such as an ICU, is Cognitive Work Analysis (CWA). CWA is a cognitive engineering framework that systematically identifies different constraints or limitations in a work domain (Vicente, 1999). A fundamental concept of CWA is that understanding the environment in which decisions are made, and the goals that provide direction, are essential requirements in complex environments because these factors influence actions that should occur (Roth & Bisantz, 2013). CWA is

characteristically applied to complex systems and systems that require adaptability due to unanticipated conditions, which resonates well with the ICU setting. A framework is necessary because there may be elements of decision-making that are not immediately obvious, and so use of the CWA framework provides methodologies to guide researchers in conducting a comprehensive and through analysis.

CWA consists of five iterative phases of analysis that are intended to systematically identify different constraints of a work system (Figure 1). Constraints are defined as placing limits on behavior, and therefore decisions are influenced by the limits that are present (Naikar, 2014). While each phase evaluates different layers of the work system to provide a comprehensive analysis, it is uncommon for all five phases to be applied to one project; instead, the CWA phase or phases are chosen based upon congruence with the project goal and the level of analysis that a particular CWA focuses on (Roth & Bisantz, 2013).

Figure 1. Overview of CWA

Several healthcare studies have effectively applied the CWA framework. A recent review of the literature identified 28 applications of CWA in healthcare research (Jiancaro et al., 2014). The outcome of CWA includes design recommendations to facilitate appropriate decisions and improve outcomes, such as quality and safety outcomes. In healthcare studies design recommendations have included: a decision support tool to help nurse managers understand priorities among multiple unit initiatives (Effken et al., 2011), designing emergency department displays (Bisantz et al., 2010), and designing ICU clinical displays (Effken et al., 2001). Use of CWA to examine the complexities of nurse decision-making and information needs for mobility within the ICU system is a novel application to an established and effective cognitive engineering framework.

Based upon the complexity of mobility interventions and considerations nurses must make in deciding to engage a patient in mobility, the aims of this study were to: (1) investigate the characteristics of the ICU work system that affect nurses' ability to make patient mobility decisions, and (2) understand nurses' information processing needs and cognitive workflows associated with patient mobility decisions. Therefore, the Work Domain Analysis (WDA) and Strategies Analysis phases where chosen, as they are most closely related to the goals of this research study (Table 1). The WDA and Strategies Analysis key findings are presented along with a discussion of potential design opportunities.

Table 1. Overview of CWA Phases Used

CWA Analysis Phase	**Goals**	**Questions**	**Analytic Tools**
Work Domain Analysis (WDA)	Identify underlying functional structure and physical constraints of the system	What in the ICU work system affects nurses' patient mobility decisions?	**Abstraction-decomposition hierarchy**: a two-dimensional structure that identifies relationships between functions and available resources to achieve outcomes of the system.
Strategies Analysis	Identify the range of approaches around a decision-making process	What are nurses' information needs and cognitive workflows associated with patient mobility?	**Decision Ladder and Strategies Analysis Diagram**: a visual representation of the types and frequencies of strategies used for accomplishing patient mobility decisions.

Adapted from Bisantz and Burns (2009)

3. Methodology

A descriptive design was used for the WDA and Strategies Analysis. Multiple methods of data collection informed the WDA and Strategies Analysis, including literature review, observation, interview, and input from content matter experts. The University of Wisconsin-Madison and the Veterans' Administration institutional review boards (IRB) approved the study.

3.1 Site selection

Two adult medical-surgical ICUs at two hospitals in Wisconsin were selected for observations and interviews. These sites were selected based upon the variety and complexity of medical and surgical

patients typically admitted as well as each unit's prior experience with early mobility interventions. Site 1 was a 24-bed ICU in an academic tertiary care center and site 2 was a 12-bed ICU in an academically affiliated Veterans Administration hospital (VA).

3.2 Participants

Participants were recruited through posted flyers, unit announcements, email, and by nurse managers providing names and contact information for expert nurses with experience mobilizing patients. Nurses with six months or greater current ICU experience and working 20 hours or more each week were eligible to participate. Twenty nurses volunteered for the study (15 at site 1 and 5 at site 2). Participants' ICU experience was between 2.5 and 19 years (M = 9.0, SD = 5.85).

3.3 Observation

We observed four nurses for the first four-hour portion of two shifts (32 hours total) and then interviewed each within one week following the observation. While mobility events are not predictable, we chose to observe the first four hours of each shift, when elements of mobility decision making, such as patient assessment, communication, and planning, are more likely to occur. As part of informed consent, participants were told that observers would be looking for information related to nurse decisions about patient mobility. In order to reduce the risk of Hawthorne effect, observers did not verbally interact with nurse participants during the observation and distanced themselves to prevent disruptions in the nurses' workflow while still being able to view what nurses were doing.

Prior to observations, a paper observation tool and standardized definitions were developed based upon a review of the literature and clinical expertise of the research team. The observation tool was pilot tested on a similar ICU (not involved in the study) and based on the pilot test adjustments were made to the tool. One trained observer (AK) used the tool to capture the sequence of observed tasks by category (medication administration, assessment, communication, etc.). The observer documented additional assessment and communication details as free text on the tool each time a

mobility-related task occurred. Observation data provided a context to participants' work and informed interview questions and analysis of the selected CWA phases.

3.4 Interviews

Twenty nurses, including the four observed nurses, participated in one-on-one interviews. All interviews were held in a private office at the nurse's place of work. During the 1-hour semi-structured interviews, participants were asked to define mobility in the ICU and describe the nurse's role in mobilizing ICU patients. Further, participants were asked to describe in detail examples of how they mobilized routine and complex patients, barriers to mobility, and strategies used to overcome barriers. Table 2 provides example of interview questions. All interviewed were audio-recorded and transcribed verbatim. Each participant received an honorarium of $30 for interview participation.

Table 2. Examples of Questions by Cognitive Work Analysis Domain

Domain	**Question**
Work Domain Analysis	• What motivates you to initiate early mobility? • What do you need to coordinate before initiating early mobility?
Strategies Analysis	• I would like you to think of a particularly complex patient case or situation. Can you describe for me how you engaged the patient in early mobility? • What information did you need?

3.5 Interview Analysis

Two investigators with expertise in critical care nursing (A.E.K.), hospital ambulation interventions and qualitative methods (B.J.K.) analyzed the interview data. The analysis involved three steps: 1. Investigators individually performed open coding in line-by-line segments of each transcript to identify preliminary open codes. 2. Together, the research team grouped open codes into higher order sub-categories. 3. Sub-categories were then collated into main categories. The research team met weekly to discuss coding. For any disagreement, original data was reanalyzed as a team until there was consensus. Dedoose software was used for data management (Dedoose 7.5.9, 2017).

4. Work Domain Analysis

Work domain analysis (WDA) is the foundational phase of CWA. It focuses on the functional structure or purpose within the environment and describing possible actions, regardless of individuals or events that occur (Vicente, 1999). Studying the functional structure of the environment (physical, social, cultural) provides the basis for understanding behaviors, because as the functional structure remains relatively constant, but behaviors in a complex environment do not (Naikar, 2014). For example, constraints in the environment place limits on behavior, and therefore decisions are influenced by these constraints. Decisions are also influenced by information available, and so identifying constraints informs what information needs to be made visible to influence intended behaviors.

The abstraction-decomposition hierarchy is a WDA analysis tool, which uses a multi-level grid to identify relationships between purposes and available resources to achieve outcomes (Naikar, 2014). The abstraction dimension uses different conceptual levels, from abstract to physical, to describe the system. Our analysis used five abstraction levels (Naikar, 2014), which are defined in Table 3. Each level provides a particular perspective of the same system. Means-ends relationships connect the levels of abstraction. For example, for a purpose-related function, the reason *why* that function exists should be answered in the values and priorities level above. The means for *how* the purpose-related function is achieved is listed in the object-related function level below. The decomposition dimension describes the system in terms of whole-part relationships. Our analysis used four levels: nurse, patient, ICU, and hospital.

Table 3. WDA Abstraction Levels

Abstraction Level	Definition
Functional Purpose	The reason or purpose the system exists
Values and Priorities	The principles and priorities used to achieve the functional purpose
Purpose-related Function	Functions or processes that people in the system perform
Object-related Function	Capabilities needed to achieve the purpose-related function
Physical Objects	Physical objects needed to achieve the object-related functions

The WDA and resulting abstraction-decomposition hierarchy (Figure 2) for ICU nurse decision-making about patient mobility was conducted according to the principles outlined by Naikar (2014). Information on the abstraction-decomposition hierarchy (Figure 1) was organized to answer 'why', 'what', and 'how' mobility decisions are made within the context of four dimensions of the hospital work system. Sub-category and category codes from the directed content analysis (Chapter 2), along with findings from observation, literature review, and input from content matter experts, were populated into an abstraction-decomposition hierarchy to investigate the characteristics of the ICU work system that impact nurses' abilities to make patient mobility decisions.

4.1 The functional purposes

Nurses focus on providing high quality and safe patient care. For ICU nurses, the immediate safety needs are to stabilize and improve survival of highly acute patients. For the most severely ill patients, when short-term survival is not known, nurses' single priority is establishing and maintaining physiologic stability. Maintaining patient physiologic stability influences both the nurse and unit levels, as nurses maintain safety of the unit by being responsive to the immediate needs of all patients. Urgent safety needs of other highly unstable patients, such as assisting another nurse in responding to a unit code, influence how nurses prioritize interventions for their assigned patients and where resources may be concentrated during periods of unit instability.

Over time, as patients stabilize and are anticipated to survive the ICU admission, some nurses describe including interventions that improve long-term quality and safety outcomes, such as early mobility to maintain functional status. Some nurses, particularly those that had previous work experience in non-ICU settings, more readily described a broader purpose, which was to restore patients' health so they could return home. These nurses described their previous role outside the ICU as ensuring that prior to discharge, patients were able to maintain their safety at home. Therefore, progressing patient mobility to maintain the patient's pre-hospital functional status was a priority, as soon as physiologically stable. ICU nurses may be constrained by their immediate role, to stabilize patients. Thus, discharge needs beyond the ICU are invisible, influencing how ICU nurses prioritize patient mobility.

4.2 The values and priorities

Nurses provided high quality and safe patient care by incorporating organizational quality priorities in daily practice. Most nurses described organizational priorities that focused on improving patient outcomes, such as preventing patient falls and hospital-acquired infections. Nurses also described that preventing complications was important in providing high quality and safe care. However, complications were viewed differently between nurses who described their role as maintaining patient activity (for the shift) and nurses who described their role as progressing patient activity (ideal system state). Nurses who maintained patient activity focused on preventing immediate complications, such as increased time of mechanical ventilation, and therefore a lower level of mobility (using a ceiling lift, or transfer to chair) met their goal. For example, nurses described reducing duration of mechanical ventilation by passively moving intubated patients to the cardiac chair to change positioning and improve secretion clearance. In contrast, nurses who described progressing patient activity focused on maintaining patient strength to return home. These nurses described engaging patients in weight-bearing activities, such as pivoting to the chair, marching in place, and walking.

Having the competence to safely perform mobility was a priority requirement for nurses before they initiated higher-level activities, such as dangling and walking. Some nurses described using psychomotor skills to assist patients from lying in bed to sitting at the end of the bed. Nurses who did not have mobility psychomotor skills described deferring the first active mobility event out of bed to physical therapists, who were seen as mobility experts.

Unit and organizational culture also influenced ICU nurse mobility decision-making. Nurses described the unit standard of mobility care as getting patients out of bed and to a chair. This level of mobility could easily be performed using a ceiling lift, resulting in passive movement for patients. Additionally, the hospital priority of preventing falls enforced "safe" passive movement of patients. Therefore, few nurses described routinely engaging patients in active movement such as dangling at the side of the bed or ambulation. In addition, to maintain staff safety, each hospital has a safe patient-handling program, which provides a variety of equipment recommendations to nurses in how to move patients safely. The current state of these organizational initiatives shift the focus from maximizing patient functional abilities to maintaining staff and patient safety.

The unit priority of maintaining throughput and the organizational priority to provide effective care also influenced mobility decisions. Nurses described the routine, rapid turn-around of admitting highly unstable patients, stabilizing patients, and then transferring patients as soon as they met criteria for lower level of care. Upon transfer from the ICU, many patients had not yet returned to their pre-hospital level of function. Assisting peers with highly unstable patients was a priority to maintain safe and quality care. In ICU environments, patient mobility was not a priority.

4.3 The purpose-related functions

Nurses described mobility interventions as patient-specific, and determined based upon baseline functional abilities, trajectory of their illness to-date, and current assessment. Therefore, knowing the patient influenced their decision. For some nurses, they based knowing the patient on the

amount of time they had cared for the patient. Nurses stated that they felt more confident to progress activity on the second day of providing care, based upon their assessment of how the patient tolerated a lower level of activity the day prior. Specifically, they may have assisted the patient in pivoting to the chair the day before. Nurses also determined mobility interventions by watching the patient, which they are well equipped to do based on the amount of time they spend with patients.

The ability to identify barriers and adapt is a critical nurse attribute for mobility progressing. Nurses described few patient factors that were absolute barriers to progressing mobility (e.g. hemodynamic instability with in-bed movement). In contrast, multiple barriers required clarification or adaptation before progressing mobility. For example, specific to information, nurses spent time clarifying activity orders with the medical team, calling procedural units, such as dialysis to determine the patient's schedule, and asking family members about the type of assistive equipment a patient used at home.

The unit status also influenced mobility interventions. Nurses described the need for situational awareness to determine if unit throughput and activity was stable and if there were staffing resources to assist with mobility. ICU mobility is complex, with patients typically requiring physical support due to weakness and life support interventions to maintain physiologic stability. Therefore, mobility requires significant human resources and time. Nurses generally have to coordinate with other staff (e.g., nursing assistants and respiratory therapists) to assist with patient mobility. Therefore, coordinating with others increases time demands on nurses.

At an organizational level, adequate staffing is required for patient mobility. Lack of human resources was a commonly described constraint to both initiating and progressing mobility. Because mobility is one of many tasks to complete, nurses may decide against mobility because of limited resources. In addition, the health care provider role must match the patient's mobility needs. In some situations, nurses described needing a nursing assistant to provide additional set of hands to manage

equipment or assist the patient. Yet, for complex patients with weakness, instability, or the first time out of bed after bedrest, nurses identified a need for physical therapists (PTs) expertise and often waited for PTs to be the first person to get the patient out of bed.

4.4 The object-related functions

Nurses who made the decision to progress mobility used several attributes to support their decision. Nurses spent considerable time seeking information in order to gain knowledge about the patient. Nurses used several sources (nurse handoff report, patient report, assessment) for gathering information to inform their decision. Watching the patient's physiologic stability with movement also informed the degree of activity the patient might tolerate. In addition, patients who were motivated to get out of bed, influenced nurses' decisions to more quickly progress the level of activity.

Nurses who had experience with mobility techniques were more apt to describe how they progressed patient mobility. Techniques, such as instructing a patient how to sit at the side of the bed, or how to adjust a walker to fit the patient, were acquired either from previous work experiences, expert nurses on the unit, or by watching physical therapists. Nurses who described needing knowledge in mobility techniques more commonly described maintaining a patient's activity level, which was passive movement out of bed to the chair.

Mobility, particularly advancing patient mobility that involves active patient participation, requires time not only for the nurse, but also of other staff on the unit. Nurses factor the stability of their other patient and the unit acuity when determining if they have time available for mobility. Knowing the patient's availability also influenced the timing of mobility, as ICU patients typically have procedures and tests when they are unavailable to participate in mobility. Nurses described that while they commonly knew about upcoming procedures or tests via an order, the nurse or patient likely did not know the timing until immediately prior. Therefore, decisions to mobilize patients were usually delayed until after these events.

4.5 The physical objects

Nurses used multiple resources on the unit to inform their decision to progress patient mobility and then carry out the intervention. Nurses relied mainly on verbal information, starting with shift handoff report, and then talking with the patient and family, to establish a mobility goal for the shift. Specifically, nurses sought out information about the patient's last level of activity, tolerance, and assistance required. Nurses then used current assessment information, such as patient strength, cognition, and physiologic response to movement, to inform the plan for progression. Gathering information took considerable time. Nurses preferred verbal sources for information because they were timelier than sifting for information in the electronic medical record. Verbal sources, particularly from nurses or nursing assistants that had experience with the patient were described as more accurate and detailed than electronic documentation.

Availability of human resources, primarily nursing assistants or other nurses, and mobility equipment, such as a walker, also influenced mobility decisions. If resources were not readily available, mobility was deferred or a lower level of mobility, such as passive transfer to the chair.

5.0 Strategies Analysis

Following the WDA, we developed an overview of the decision-making activities used to achieve functions described in the WDA. Nurses described several sub-tasks that needed to be done to execute mobility interventions. A decision ladder information processing approach was used to identify the events and courses of action (Lintern, 2010; Rasmussen, 1986). While a decision ladder represents cognitive states and processes that might be used, it does not imply a specific sequence or required states for making a decision (Read, Salmon, Lenne, & Stanton, 2015). This approach is similar to decision-making findings in nursing literature, which describe that decision-making is different depending upon the knowledge and experience of the nurse (novice vs. expert), situation, and characteristics of the environment (Johansen & O'Brien, 2016). For example, novice nurses

characteristically follow a step-by-step decision-making approach whereas experienced nurses have developed shortcuts (Benner et al., 1992). Therefore, identifying the range of strategies available for mobility decision-making is important for future design opportunities.

The decision ladder was populated from sub-category and category codes that described types of information, goals, or types of action from the directed content analysis (Chapter 2). The decision to mobilize a patient may include several sub-tasks of gathering and evaluating information before completing the physical task of assisting with patient mobility (figure 3). In general, nurses activate the need for patient mobility based upon maintaining a unit standard or upon patient request. Nurses use multiple data sources to gather information about the patient's ability and tolerance for mobility and the ability of the unit to support the activity. The patient and unit information then influences how the nurse determines the goal to either maintain or progress patient mobility. Once the goal is established, nurses coordinate resources, prepare the patient, and assess tolerance during the activity in relation to the goal. Within this overall process, nurses described several cognitive and physical strategies for mobility decision-making. The Strategies Analysis will focus on cognitive strategies that emerged for mobility decisions, as they align with the study aim to understand nurses' information processing needs and cognitive workflows.

Strategies Analysis was used to understand nurses' information processing needs and cognitive workflows for patient mobility decisions. The goal of Strategies Analysis is to examine the range of approaches used to accomplish a process within the environment (Roth & Bisantz, 2013). This Strategies Analysis will focus on the ways that nurses gathered the two main sources of information from the decision ladder: (1) to know the patient, and (2) to know the unit state to support mobility. In addition, we will describe shortcuts in the decision workflow that nurses used for some mobility decisions. These areas of focus were chosen for their potential to inform future work process design or information display for decision support. The Strategies Analysis diagram was used to for clarity to organize the

range of approaches for the processes identified from the decision ladder to identify information processing needs and cognitive workflows specific to patient mobility (Cornelissen, Salmon, Jenkins, & Lenné, 2013).

5.1 Get to know the patient

Strategies to get to know the patient in order to establish a patient-centered mobility goal rely primarily verbal and visual sources of information. Because nurses described multiple strategies to know the patient, with some strategies occurring in succession and other strategies occurring in parallel, we created a Strategies Analysis diagram to differentiate how and when strategies might be used (Table 4). For example, while handoff report is an existing standard of care between all shift changes, some nurses described asking the off going nurse how the patient tolerated a mobility event and what equipment was used, only when it was handed off that the patient did participate in mobility. This strategy was used because the context of the previous activity was not efficiently found in the EHR. After shift report, nurses further completed an independent patient assessment to establish their own baseline of the patient's physiologic status and stability, confirming or refuting the accuracy of handoff information. Nurses typically described this two-step strategy as effective when the findings from each were consistent. However, nurses had to seek additional sources of information when there was a mismatch between two sources.

Nurses also used patient assessment as a strategy when there was a change in condition, particularly when the patient's illness trajectory was improving. For example, nurses described performing a focused assessment of lower extremity strength after the patient had been in bed for several days or if mental status quickly improved.

Seeking out patient information in the electronic health record (EHR) was not commonly viewed as an accurate or efficient strategy for knowing the patient. This strategy was more likely to be used if reliable sources of information (peers, family) were not available or the patient was not a reliable source

of information. Verbal strategies were able to more quickly 'tell a story' of the patient's mobility trend and illness trajectory, compared with absolute values documented in the EHR.

Table 4. Strategies Analysis for knowing the patient

Purpose-related function	Actionable verb	Physical Objects	Object-Related Processes	Criteria to determine if strategy is feasible and factors that influence it to be chosen
Knowing the patient	Ask	Handoff report*	Dynamic exchange of Information transfer	• Previous mobility event occurred • Context of event not in handoff or EHR • Timely information • Report is accurate
	Ask	Family	Information transfer	• Readily available • Reliable source of information • Conflicting information
	Ask	Colleague (RN, PT, nursing assistant)	Information transfer	• Previous mobility event occurred • Context of event not in handoff or EHR • Readily available • Recalls previous information
	Read	EHR	Information transfer	• Computer available • Documentation accurate • Activity order accurate • Note accurate • Not able to see trend information • Able to find quickly
	Assess	Patient assessment* (cognition, strength, physiologic response)	Physiologic stability of system(s)	• Establish internal baseline • Change in patient condition • Dynamic information • Patient able to respond to assessment • Need for RN's own assessment • Context not in EHR

* Existing ICU standard of care, but representation in this table indicates use at a deeper depth than standard of care

5.2 Knowing the unit

Mobility requires the support of others in the ICU and places additional workload on the unit. Knowing the types and availability of unit resources (human and equipment) was typically described to serve two purposes: to mobilize a patient immediately, or to establish a mobility plan for the near future. Strategies that serve each of these purposes are summarized in a Strategies Analysis diagram (Table 5). Nurses typically used strategies to quickly gather staff and resources for immediate mobility when the patient was motivated or if the nurse was clustering mobility with other currently occurring activities, such as after a bath or just prior to a meal. A common strategy used by nurses to determine availability of other staff was to step into the hallway to see if staff were visible in common work areas.

For complex patients nurses used different strategies, which required planning due to additional need for staff. To coordinate unit helpers, nurses described asking when they had available time and focused on ensuring at least one member from each needed role (e.g. PT, RT) was available for the duration of mobility. For example, prior to ambulating a mechanically ventilated patient, nurses described establishing a mutual time for mobility with the physical therapist, then the respiratory therapist, and nursing assistants. This approach takes considerable time, because while the nurse and therapist may have agreed upon a time, the respiratory therapist may have a scheduling conflict. If all members were not available, the nurse would have to re-start the strategy again until a mutual time was confirmed among all disciplines.

Prior to mobilizing a patient, nurses also described considering the activity and acuity of the unit, as this affected the availability of other staff. Nurses described asking the charge nurse if there were impending admissions or other staff needs to predict if help would be available. This strategy relied on the charge nurse being accessible to ask about anticipated unit workload.

Table 5. Strategies Analysis for knowing the unit

Purpose-related function	Actionable verb	Physical Objects	Object-Related Processes	Criteria to determine if strategy is feasible and factors that influence it to be chosen
Knowing the unit	Watch	Other staff (RN, PT, nursing assistant, respiratory therapist)	Time available	• Able to step away from the bedside • Staff in common work area • Mobility is imminent
	Ask	Other staff (RN, PT, nursing assistant, respiratory therapist)	Time available	• Staff in common work area • Readily available for duration • Role matches need • Competent • Established trust • Planning for mobility
	Ask	Charge RN	Time available in future	• Readily available • Have time to relay information • Planning for mobility
	Look	Equipment	Available	• Stored in anticipated location • Have time to gather equipment if mobility is imminent • Competence for use

5.3 Shortcuts

A decision ladder also recognizes shortcuts in decision-making based upon prior knowledge or skill. Nurses described previously knowing the patient as one shortcut in making a decision about mobility (Figure 4). Familiarly with the patient allows the nurse to more quickly assess the patient in relation to the known baseline and initiate activity, instead of gathering patient information by testing tolerance to activity. Nurses describe having confidence in the patient's ability to participate in mobility safely after knowing the patient. Another shortcut in the decision-making for patient mobility was habit or unit standard for specific surgical patients (Figure 5). Nurses described that the goal for specific patients was pre-determined and for these patients they scheduled mobility events during their shift to

ensure the goal was met. For example, nurses described required mobility for cardiac surgery and lung transplant patients. For these patient populations with pre-determined, expected goals, nurses didn't describe details of using assessment skills to determine level of mobility. Instead, for these patients, nurses described how they planned ahead during the shift to ensure the resources (e.g. respiratory therapist, nursing assistant) were available to achieve the pre-determined goal (e.g. ambulating a lung transplant patient on a ventilator).

6.0 Discussion

The WDA and Strategies Analysis illustrate both the complexity of the mobility nurse decision-making process and the various ways the ICU environment influences decision-making. In addition to the level of detail that the CWA frameworks provide, another significant value in using CWA is that the analysis provides design recommendations. Analysis is closely intertwined with design and evaluation, resulting in guidelines for making system changes, not simply an analysis (Vicente, 1999). Our completed WDA and Strategies Analysis demonstrate several opportunities and recommendations for improvement to support nurses in the decision to progress patient mobility.

One of the most significant constraints is the divide between the immediate purpose of the ICU, to establish and maintain the patient's physiologic stability, and a broader organizational purpose of returning to pre-hospital functional status. There are critical differences in patient outcomes when mobility is initiated in the ICU, compared with mobility that is initiated after ICU discharge. Mobility interventions that are initiated after ICU discharge have shown no improvements in functional outcomes (Walsh et al., 2015). However, mobility interventions that are initiated within 24 to 72 hours of ICU admission have demonstrated a reduction in ICU and hospital lengths of stay, and maintenance of functional abilities upon hospital discharge (Morris et al., 2008; Schweickert et al., 2009). Thus, framing early mobility as an ICU purpose in relation to patient physiologic stability is needed.

Nurses already routinely assess physiologic stability of several other systems, primarily hemodynamic, respiratory, and neurologic stability. The most common strategies nurses used included visual or verbal approaches. Because nurses provide patient surveillance and are aware of subtle changes, trending information in relation to the amount of physiologic support needed is used in decision-making in contrast with using absolute values. For example, one nurse described a decision to ambulate a patient with a lower oxygen saturation because the patient responded to an increase in oxygenation. However, if the decision to ambulate had been rule-based using a protocol with fixed physiologic values, the patient might not have met criteria to engage in mobility.

There are two critical design needs to provide information about patient physiologic stability to nurses and the ICU team. First, a trended display of patient stability for physiologic metrics that are currently used (hemodynamic, respiratory, and neurologic indicators) that also includes the amount of physiologic support the patient is receiving, may improve the efficiency in information seeking. WDA-informed information displays have demonstrated improved ability to detect patient changes over the existing EHR with nurses in ICU and ED settings (McGeorge et al., 2015; Miller, Scheinkestel, & Steele, 2009). While we identified two types of information, trend values for hemodynamic, respiratory, and neurologic indicators and, amount of physiologic support the patient is receiving, additional research on prototypes that effectively display the clinically meaningful information are needed.

The second information need is for the design of a new indicator for physiologic stability specific to mobility that fits within the nurse's existing decision-making framework. For example, nurses readily identify physiologic stability of the pulmonary system, in part, by using a range of oxygen saturation values and an established goal. This value is continually displayed at the patient's bedside and central monitor. In the same way, there are numerical scales validated to quantify either current ICU mobility status or patient's anticipated ability (Hodgson et al., 2014; Hoyer et al., 2016; Pandullo et al., 2015; Perme, Nawa, Winkelman, & Masud, 2014). Additional research is needed on how a numerical

representation of mobility status might inform awareness of patients' current and goal functional state in relation to nurse decision-making about mobility.

The WDA also demonstrates opportunities and recommendations for unit-level information needs. ICU mobility requires additional human resources, commonly extra nurses and nursing assistants. However, all ICU staff have existing work demands. Nurses described time-consuming strategies to find staff members and determine if the unit was able to support use of staff resources for the duration of a mobility event (potentially lasting 30-45 minutes). Currently, there are not efficient ways to determine when the unit is busy or projected to be busy. While ICU acuity tools exist, key elements that nurses described in our study, particularly throughput, are not in existing tools (Kidd, Kimberly Grove, Melissa Kaiser, Swoboda, & Taylor, 2014).

Finally, organizing relevant patient and unit information together may offer several benefits. For example, displaying this information simultaneously may assist with limited resource allocation by prioritizing patients who display a greater need for mobility, such as a patient that has a greater duration of inactivity. A unit display may also support a unit culture of accountability for mobility progression, as each patient's mobility status is visible to the ICU team.

The WDA and Strategies Analysis are by no means complete representations of ICU nurse decision-making about mobility. We chose to focus our analysis on the goal of informing future system design to support the nurse in progressing patient mobility. Therefore, our focus was on possible improvements in the system, such as information visibility, that could influence prototype designs, as opposed to physical improvements in the system, such as reconfiguring the structural layout of the ICU room, which might be cost-prohibitive.

7.0 Conclusions

In summary, this WDA and Strategies Analysis provided several important insights for understanding nurses' decision-making about patient mobility within the context of the environment.

The results of this study identify the need to integrate critical patient and unit-level information for informing patient mobility decisions. However, this analysis shows that interdependencies between patients, nurses, other members of the health care team, and unit resources are clear. Therefore, multi-component interventions that address additional barriers in the environment, such as lack of human resources and nurse workload, are needed. Systems-based approaches to improve delivery of mobility and patient outcomes must include interventions that are based upon how nurses make these complex decisions within their work environment.

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Figure 2. Abstraction-Decomposition Hierarchy

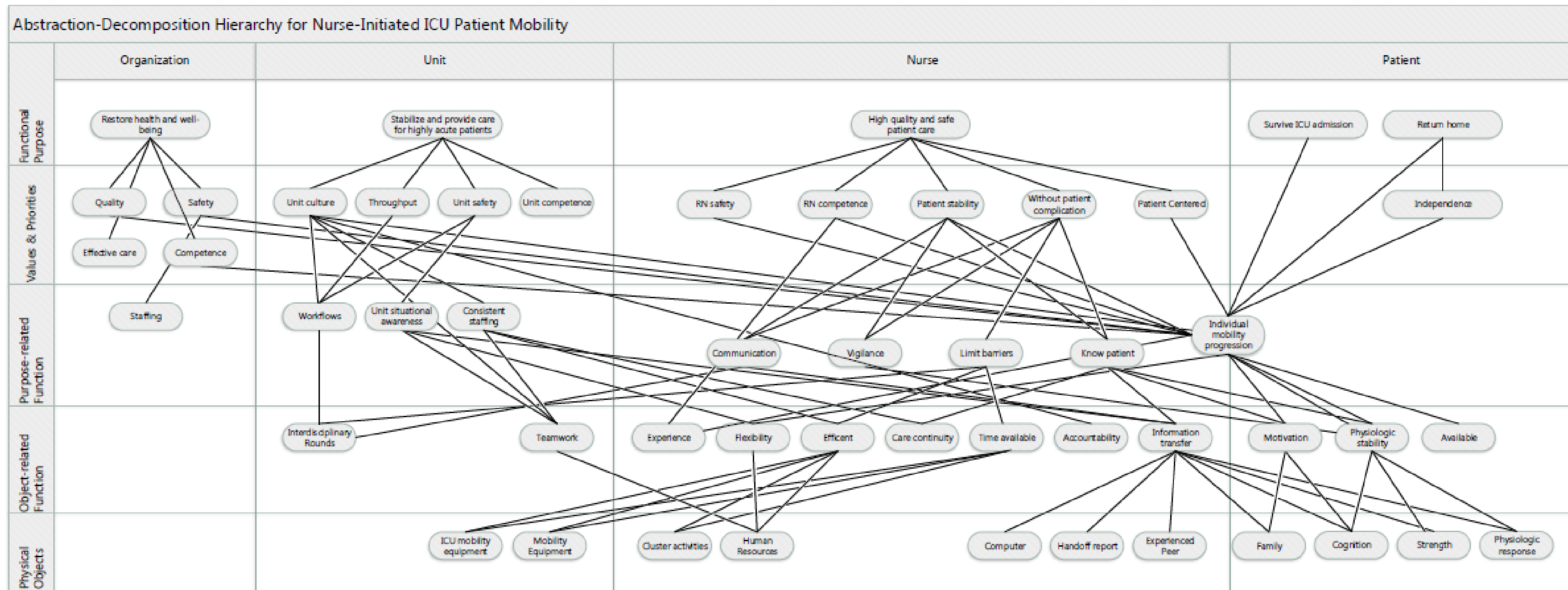


Figure 3. Mobility Decision Ladder

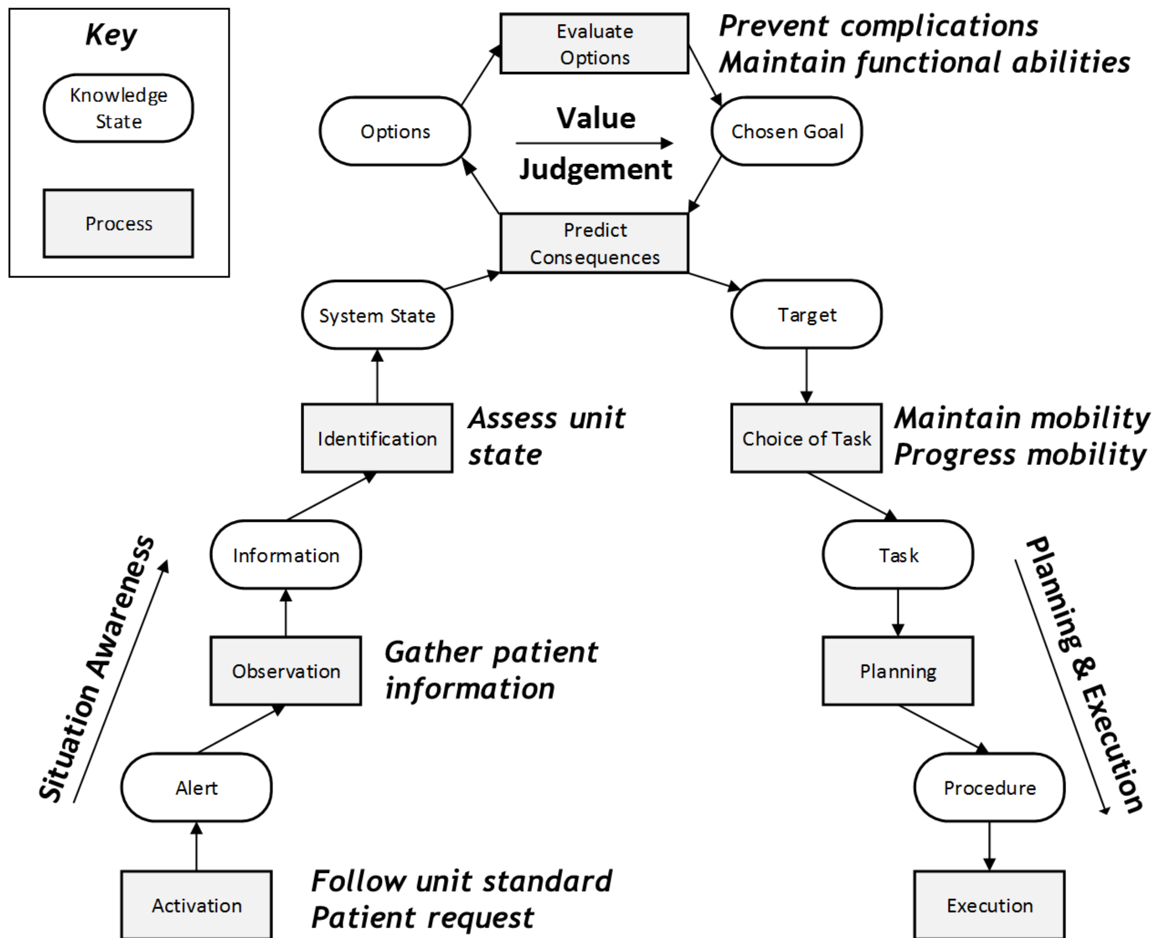


Figure 4. Mobility Decision Ladder for Knowing the Patient Shortcut

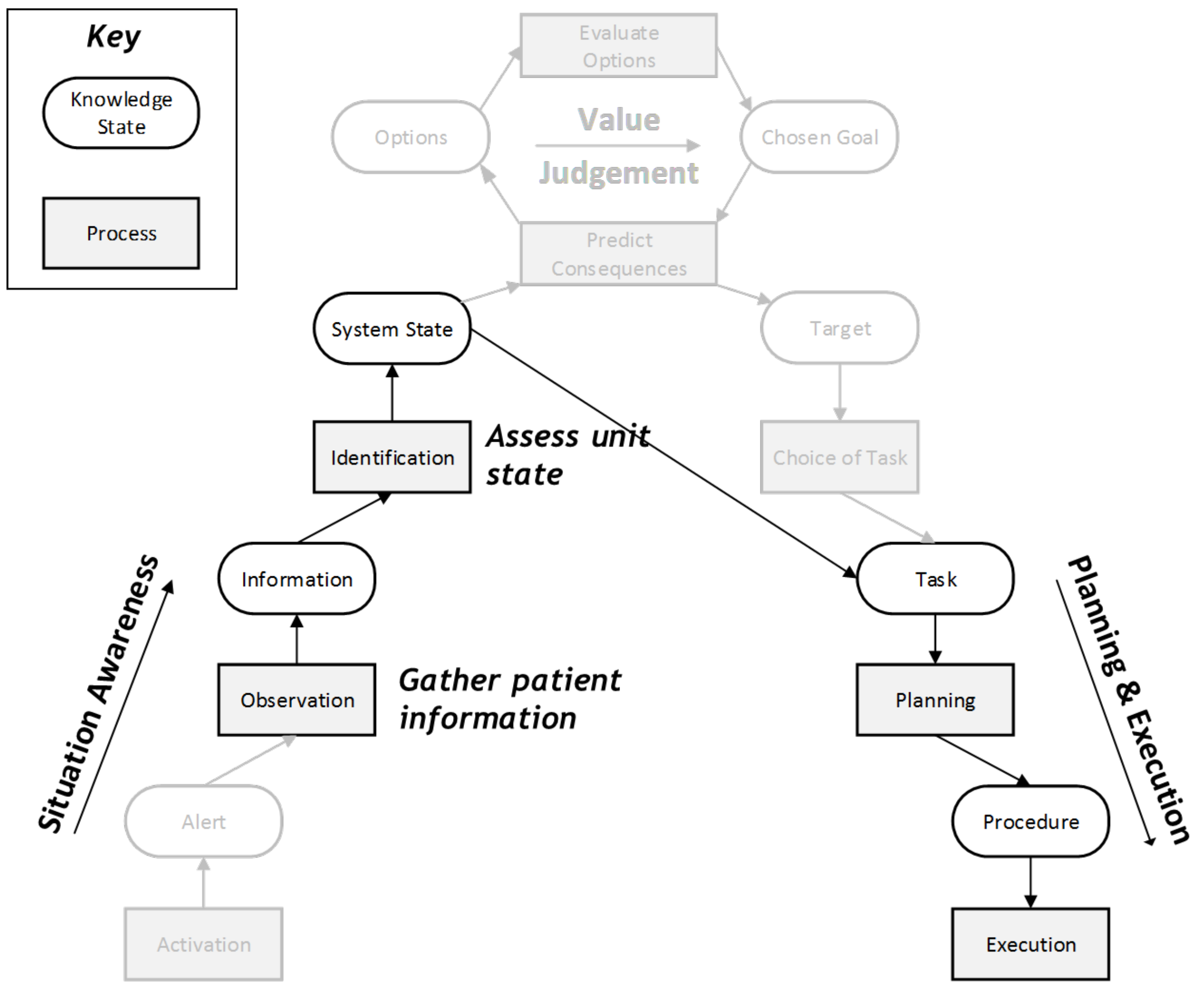
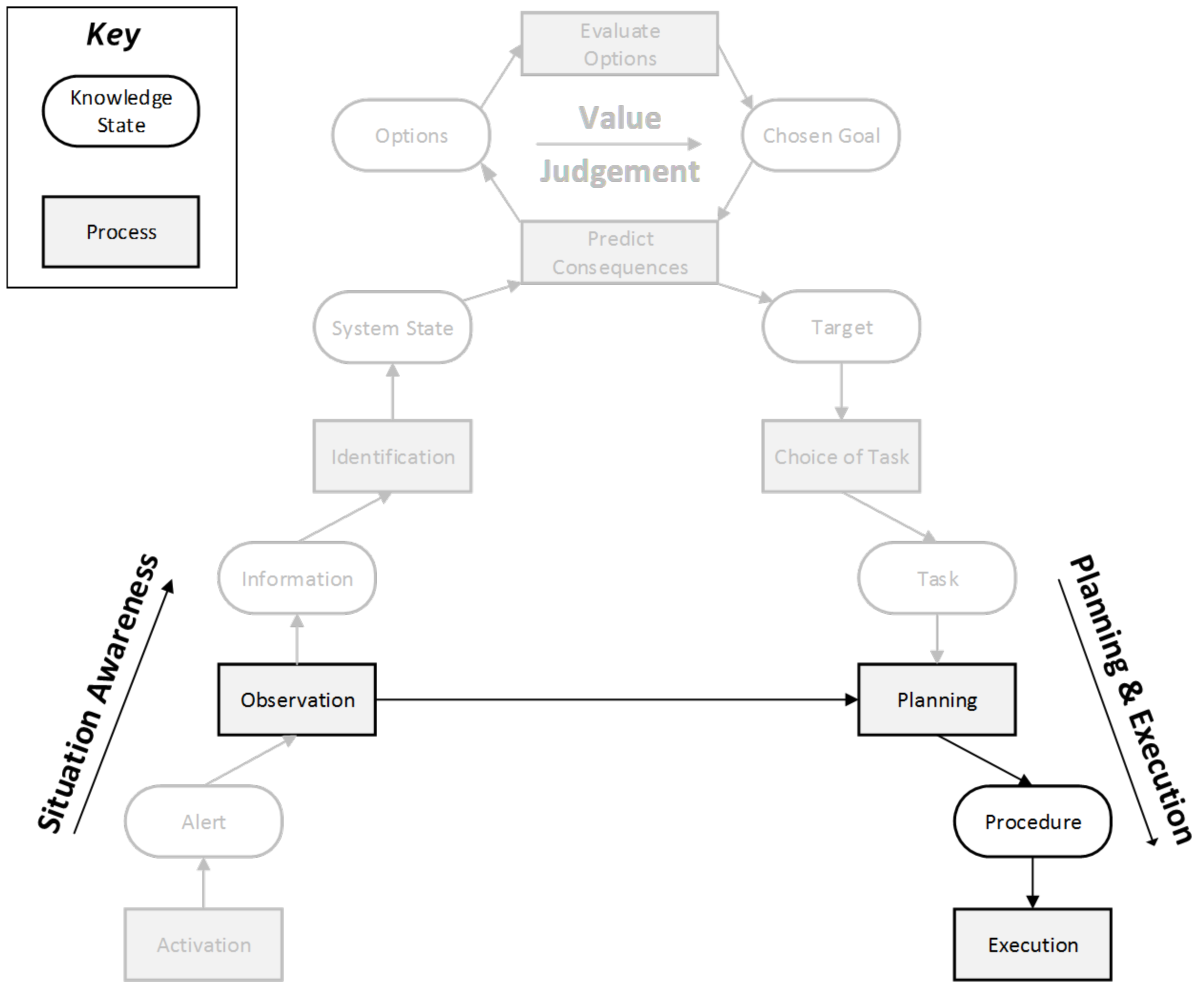


Figure 5. Mobility Decision Ladder for Habit Shortcut



Discussion

Overall, ICU early mobility is a complex intervention within a highly acute and unpredictable setting. The findings of this dissertation study contribute to the understanding of nurse decision-making about ICU mobility and provide a basis for future design and intervention research. First, the review of literature identified variation in the process of implementing and delivering early mobility interventions. Using the SEIPS model to organize findings identified a significant gap in understanding the role of the nurse in ICU early mobility interventions and the need for systems-based interventions to improve early mobility processes. Prior work has demonstrated that understanding the decision-making process of health professionals is critical for identifying opportunities to improve patient outcomes (Fesler-Birch, 2005). Therefore, the focus of subsequent papers was to understand nurses' decision-making about patient mobility within the context of the ICU system.

The results of this study offer one unique way of understanding decision-making about ICU early mobility from the nurse's perspective. This was the first study to use Work Domain Analysis (WDA) and Strategies Analysis methods from Cognitive Work Analysis (CWA) to provide a detailed understanding of the characteristics of the ICU work system that affected nurses' ability to make patient mobility decisions and nurses' information processing needs and cognitive workflows associated with patient mobility decisions. Applying CWA frameworks was relevant to study the complex process around ICU mobility, as the ICU represents a dynamic environment and there are many approaches that can be used to accomplish the goal of engaging patients in mobility.

Future work should consider applying additional levels of analysis from the CWA framework to further inform design interventions, which were beyond the scope and timeline for the dissertation study. The Social Organization and Cooperation Analysis of CWA focuses on coordinating and distributing work among workers (Vicente, 1999). Specific to mobility, this analysis would provide details about how mobility interventions can be organized based upon those who deliver early mobility

interventions, typically nurses, nursing assistants, and physical therapists (PTs). Previous studies have focused on one role as the early mobility intervention for the ICU. For example, a systematic review of PT in the ICU included 10 randomized control trials that investigated the effect PT (Kayambu et al., 2013). Fewer studies have focused on the role of the nurse (Garzon-Serrano et al., 2011a; Hildreth et al., 2010; Winkelman et al., 2012). Instead of one role for all mobility interventions, future work is needed to understand how to allocate the role that best matches the patient's need. In this study, most nurses identified types of patients they were comfortable initiating mobility with, (e.g. patients that had previously been out of bed, patients with adequate strength and able to follow direction), whereas other patients they deferred to PT (e.g. patients with weakness and longer duration of bedrest). Matching patient needs with the role best able to meet those needs may be one approach to effectively distribute limited nurse and PT resources. Likewise, additional systems design research is needed to understand best approaches for coordinating mobility, once the appropriate role is determined. In this study, nurses described the considerable amount of time and effort needed to coordinate mobility activities among other patient events, such as procedures, and care needs, such as finding additional staff for assistance. Findings from this study can provide context in partnership with operations researchers and systems engineers for designing improved mobility coordination and scheduling at the unit level.

The Worker Competencies Analysis is the final level of CWA analysis, and it builds from the preceding Social Organization and Cooperation Analysis to specify the competencies that workers need to achieve the identified work (Vicente, 1999). Findings from this study indicate that many nurses lack confidence in skills to assist and instruct patients in getting out of bed for the first time in the ICU. However, nurses with prior experience in non-ICU settings that routinely assisted patients out of bed or nurses that gained experience from watching physical therapists or other expert nurses with mobility had the confidence to initiate mobility. Therefore, nurse competencies that include hands-on practice

with patients and feedback from mobility experts may be a critical component for future nurse-initiated mobility interventions. Psychomotor skills training for nurses has been effective in increasing the frequency of ambulation and culture of nurse-initiated ambulation in an inpatient hospital setting (King, Steege, Winsor, VanDenbergh, & Brown, 2016). Nurse and nurse assistant competency needs in ICU settings to support patient mobility require further study.

While additional CWA analysis represents one direction for future study, the completed WDA and Strategies Analysis also offer several findings for future research. The results of this study indicate that the decision to mobilize ICU patients is a multi-faceted, individualized nurse decision and is influenced by numerous patient, nurse and unit factors as well as by interactions between factors. Therefore, taking a more holistic view of early mobility interventions that purposefully include the role of the nurse may be an appropriate direction to take in future work.

A culture that prioritizes mobility has been identified in the literature as foundational to implementing and sustaining an early mobility program, as unit expectations inform individual decisions (P. Bailey et al., 2009; Devlin & Pohlman, 2014; Dubb et al., 2016; Honiden & Connors, 2015; Hopkins et al., 2007). This study found that the decision to mobilize patients was primarily based upon the individual nurse. Nurses at both sites described strategies using patient assessment during movement along with amount of physiologic support required to determine the patient’s degree of instability. Patients that had physiologic changes with small movements, such as decreased blood pressure when sitting in the chair, or were receiving moderate levels of physiologic support, such as a higher dosage of vasopressor, were commonly assessed as unstable for active out of bed mobility. However, nurses at both sites described specific patient populations, typically surgical patients, with which nurses were likely to progress activity despite the patient’s relative high acuity. Nurses stated that particular patient populations had an expected level and frequency of mobility. For example, nurses described that lung transplant patients were required to ambulate in the unit four times daily to maintain their status on the

transplant list, or cardiac surgery patients were required to ambulate a specific distance and frequency prior to transfer out of the ICU. With these patients, mobility was discussed and reasons for not meeting these goals were required. The unit culture for these specific populations was driven by an established goal and routine interdisciplinary discussion of progress toward the goal. Conversely, medical patients with similar or higher acuity within the same ICU did not have the same shared unit expectation of prioritizing mobility and the decision to progress mobility was based upon the individual nurse.

Existing work has defined the use of change implementation models and local change leaders as factors to facilitate a unit culture of mobility (P. Bailey et al., 2009; Dubb et al., 2016; Honiden & Connors, 2015). One component within many change implementation models is having a shared vision (Kotter, 1995). Specific to mobility, the shared vision may be establishing a unit expectation for mobility for each patient. In this study, both the short-term expectation (e.g. activity goal for the day) and long-term consequence (e.g. removal from transplant list), were evident for specialty surgical populations, however both the expectation for mobility and consequence of bedrest for medical patients were invisible to ICU nurses. As a result, in a busy environment with high workload, mobility was not prioritized as a required intervention for every ICU patient. To advance the nursing science of early mobility and improve long-term ICU patient outcomes, additional research needs to focus on the following key areas: establishing an activity goal or dose of mobility, and communicating patient mobility goals at the unit level.

As summarized in the literature review, previous studies have defined the dose of mobility based upon frequency, distance, duration, or highest level of activity achieved. There is not a standard definition for minimum dose of mobility in the ICU. In internal medicine unit settings, researchers have identified that walking fewer than 900 steps per day is associated with functional decline (Agmon et al., 2017). Nurses in this study described reporting the patient's last activity during shift handoff, though distance was rarely reported as nurses stated challenges in calculating distance. Therefore, measuring

dose of mobility based upon steps per day is not feasible without accurate technology, such as an accelerometer. An alternate method to measure mobility dose that may better align with existing nurse strategies is duration of mobility. Hodgson et al. (2016) recently reported the effects of a goal-directed mobility intervention that targeted active mobility for 60 minutes per daily at the patient's highest level of mobility. The time could be completed in one session or divided to meet the minimum time over several sessions. Time-based goals may offer several benefits. For nurses, scheduling time for mobility within a busy shift may be more tangible and assist in finding additional staff to help with mobility if the expected duration is known. From a unit perspective, time is an element of workload. Workload is one of the most commonly described structural barriers to early mobility (Dubb et al., 2016). Quantifying the typical amount of mobility to deliver based upon number of staff needed per patient over time will help to better understand the amount of resources needed in the unit to support mobility.

In addition to establishing mobility goals, research is needed to understand how to communicate patient mobility goals at the unit level. Nurses in this study used primarily verbal and visual methods between one another to communicate about patient mobility. Finding this information takes time and time operates at multiple levels, as engaging in mobility requires nurse availability, patient availability, and time of others on the unit to provide support. There are no existing methods to communicate unit workload in relation to patient mobility needs. A central location for this dynamic information might offer several benefits. First, visual data would provide the unit with information to determine how to allocate resources that match the patient need with timing. Clarity around unit status provides crucial information to inform nurses' mobility decisions – what are the patient's needs related to mobility (visible goal) and are there resources to support the goal? The primary factor that nurses' describe in this study, and is consistent with nurses in in-patient settings, is maintaining patient safety (Doherty-King & Bowers, 2011). Nurses balance patient needs with available resources to maintain safety. Future studies are needed to test an intervention that provides information on patient needs

(mobility goal) and appropriate resources for mobility (unit workload) on the frequency and level of patient mobility.

Limitations of this study have been described in previous chapters. The primary limitation to this study was that the study was conducted in two medical-surgical ICUs at two teaching hospitals. Other ICU settings, such as specialty surgical ICUs or community-based ICUs, may have different decision-making processes and systems barriers because of differences in patient population or unit culture and available resources. In addition, both ICUs had some experience with implementing early mobility practices, but early mobility was not described as part of either unit's culture. Nurse decision-making might look different depending upon the unit's status with implementing early mobility practices, the presence of an early mobility culture, and existing resources in the ICU. Future work is needed to understand possible differences or similarities with ICUs in more advanced stages of early mobility implementation.

Finally, findings from this study have further clarified the importance of understanding decision-making using an approach that considers the influence of the work system prior to designing intervention research. Traditional strategies for decision support interventions are primarily rule-based and are not effective for supporting complex decision-making with variation and unpredictability. Approaches that integrate the work system and cognitive context into design, such as CWA and ecological interface design, have been used to support other complex nursing decisions (Jiancaro et al., 2014). Several WDAs have been conducted for understanding nursing work and designing guidelines for decision support, such as, nurse manager decision support tools (Effken et al., 2011), cardiac nurse triage decisions (Burns, 2009), and team interactions within a birthing unit (Ashoori, Burns, d'Entremont, & Momtahan, 2014). My experience in applying CWA has implications beyond early mobility decision-making in the ICU. Future research questions may aim to study early mobility decision-making using CWA in other settings, such as intermediate care, or other relevant nurse decision-making processes

within the ICU setting that aim to improve long-term patient outcomes, such as how nurses manage and prevent common ICU symptoms of pain, agitation, and delirium to maintain long-term cognitive, emotional, and quality of life outcomes.

My long-term research goal is to establish a research program focused on sustainable, systems-based interventions to improve long-term outcomes for patients in critical care environments. Knowledge about how nurses determine the most appropriate intervention is foundational information, as decision-making is a precursor to action. Thus, it is critical to understand decision-making processes prior to implementing interventions to improve the delivery of early mobility. Ideally, by gaining understanding of the ICU work system and how nurses make decisions within the work system, we can design ICU practice changes that the work system can support, are realistic for nurses to implement, and will improve long-term outcomes for patients that require ICU care.

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