NURSES' DECISION MAKING PROCESSES ABOUT LIGHTING DURING MEDICATION ADMINISTRATION

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DEDICATION

For all the healthcare practitioners that provide care for patients
with only the intent to safeguard, care for, and comfort.

This work is especially dedicated to Flower, who without realizing it, made me understand that I had to do more to improve the work environment of nurses.

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ABSTRACT

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We know that human vision has limitations, medication administration is a high risk activity, and some nurses work in environments that do not meet recommended lighting standards. Lighting and human performance have been linked for centuries, yet limited guidance specific to the nursing domain and safe lighting environments is available. While the United States Pharmacopeia admonishes against administering medications in low lighting conditions, low lighting conditions likely still occur. The goal of this study was to inform safe medication administration practices and add evidence for establishing guidelines for lighting decisions by understanding registered nurses' (RNs) decision making about lighting during medication administration.

Grounded theory methodology was used to identify and describe the processes and choices that RNs make as they decide to adjust or maintain the lighting environment when administering medications at the bedside in acute care. A theoretical sample of full time, acute care RNs from a variety of backgrounds and hospital settings participated in semi structured interviews. The results were presented in aggregate form to three experts for validation and comparison with their own experiences. Two of the researchers had significant expertise in medication administration errors.

Data analysis culminated in the substantive theory *It Depends*. This theory describes a process of frequently automatic decision making about lighting whose aspects include Assessing Variation, Balancing Safety and Healing, and RN Bias. All RNs expressed concerns about perceived risks in relation to lighting, but had difficulty describing how they confirmed when the correct decision about lighting was made. Implications for nursing practice and research are identified. The results may inform safe medication administration practices, add to the evidence to establish reasonable guidelines for lighting decisions, and guide additional research.

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CHAPTER I

INTRODUCTION

Focus of Inquiry

In the long chain of individuals within healthcare processes, inpatient nurses are often the final inspector for safety (Corrigan, Donaldson & Kohn, 2001). Consider the task of administering a patient's medication. Many hands and actions are at play during this process, from ordering to filling a prescription; however, nurses provide the final safety check in the administration process (Jennings, Sandelowski & Mark, 2011). Recent interventions have been put in place to help avoid drug interactions and other problems, e.g. computerized provider order entry, bar coding for drug verification, evidence based environmental design (Poon et al., 2010). The final step in this process is the nurse physically inspecting, verifying, and administering the drug. Thus there is a need to understand nurses' decision making process during the final critical step in medication administration.

One contributor to healthcare errors is the work environment. Specific contributors to error include interruptions and distractions, stress, fatigue, teamwork, noise, temperature, air quality, and other design considerations (Hickam et al., 2003; Ulrich et al., 2008). These and other factors within the environment of care may impact the nurses' ability to see and assess the medication administration the patient's response (Mahmood, Chaudhury & Valente, 2011). One issue that has not been closely studied is the quality

and quantity of environmental lighting at the point of medication administration in the acute care setting.

With the average age of the nurse increasing, along with the general population's age, (Beurhaus, Donelan, Ulrich, Norman & Dittus, 2006), the likelihood of nurses needing more lighting due to normal age related presbyopia and other degenerative eye diseases increases (Boyce, 2003). The lighting environment that nurses experience when administering medications is not well documented (Hendrich, Chow, Skierczynski & Lu, 2008). While the connection between lighting and visual acuity has been well studied in the general population (von Bommel & van den Beld, 2004), the findings have not provided enough evidence to guide nurses in their practice of controlling the lighting while administering medications. As a result, the decision making process of when and how nurses decide to alter the lighting environment when preparing to administer medications is not well understood. Therefore, it is difficult to encourage appropriate behaviors and develop support for adjusting the lighting environment for medication administration.

Technology and design interventions alone will not stop all potential problems in the medication administration process. Solutions must incorporate human strengths and weaknesses to impact both behavior and understanding. Human factors engineering (HFE) is a field of study that aims to bridge that gap. HFE is the multidisciplinary science dedicated to observing how humans interact with their environment and systems. Experts then use that data to redesign tasks, processes, and physical work areas to prevent human error (Carayon, 2007). HFE has been employed in industries such as aviation, nuclear

power production, and transit, with significant success in decreasing error rates and increasing productivity (Carayon et al., 2006). Examples of HFE changes that have been put in place in healthcare systems include medication bar coding, patient lifts, and removing dangerous drugs (e.g. concentrated potassium chloride) from nursing floor stock. While standards for lighting in hospitals exist, little is known about the lighting environments that nurses face or the factors that impact their decisions about lighting when administering medications.

Problem of Study/Statement of Purpose

The phenomenon of interest for this research is the decision making process nurses use as they decide to adjust or maintain the lighting environment when they approach a patient to administer medication. A grounded theory study was conducted to examine the narrative of nurses who are at the acute care bedside and routinely administer medication. The study was undertaken to inform the research question "What are nurses' decision making processes about lighting during medication administration?"

Rationale for the Study

Despite an international discussion, lasting more than a decade, on improving the quality of healthcare in the United States, little measurable improvement has been made (Shojania & Thomas, 2013; Wachter, 2010). There have been continuous calls to identify and mitigate the hazards to patients (e.g. Aspden, Wolcott, Bootman, Cronenwett, 2006; Committee on the Robert Wood Johnson Foundation Initiative on the Future of Nursing, 2011; Kohn, Corrigan & Donaldson, 2000). Many reviews tie the physical workplace to the quality and safety of care delivered. The work environment of nurses has been

identified as a contributor to many healthcare related injuries and accidents (Page, 2004). When healthcare related errors are reported and their contributing factors are evaluated, the work environment is often identified as a latent contributor (Corrigan, Donaldson & Kohn, 2001; Hickam et al, 2003). Lighting has been identified as one of those factors.

General standards for illumination in healthcare facilities (Illuminating Engineering Society of North America, 2006) and standards for areas of medication preparation exist (United States Pharmacopeial Convention [USP], 2010) but are not well known by clinicians (Grissinger, 2012). A literature review identified that few studies related to lighting and its connection to safety have been published within the nursing domain (Graves, Symes & Cesario, 2013). Additionally, clinicians may have difficulty determining the optimal lighting for a variety of reasons: they perform many different types of visual tasks as they deliver care; tasks must be performed under diverse physical conditions and in differing locations; and last, clinicians must account for the variation in lighting requirements related to their individual age and visual acuity (Anshel, 2007).

The continued emphasis on improving healthcare safety and the ubiquity of medication administration in acute care settings establishes a need to study and understand the process nurses follow as they make decisions about lighting, especially during medication administration. We know human vision has limitations, medication administration is a high risk activity, and that some nurses work in environments that do not meet recommended lighting standards (Hicks, Becker, Krenzischeck & Beyea, 2004; Simmons, Graves & Flynn, 2009). The study described here will assist in gaining an understanding of the lighting environments that nurses face and the factors that impact

nurses' decisions about lighting. The findings will develop a baseline of current knowledge, establish areas that need further research, and inform current practice. In addition, the findings should aid in the development of future policy that supports safe work and care environments and sets appropriate expectations for nurses and patients alike.

Researcher's Relationship to the Topic

The researcher has been an RN for more than 26 years and has worked in a variety of settings, including inpatient floors, outpatient clinics, hospital procedural areas, emergency departments, and home care settings. Within this range of practice settings she has experienced a broad range of lighting conditions from very bright to very dark. She has required corrective lenses for myopia and astigmatism since elementary school. Now in mid-life, the researcher continues to use corrective lenses for those conditions and age associated presbyopia. She constantly struggles in all areas of her life to ensure that the lighting is adequate and appropriate for the task at hand and wonders if and how other nurses deal with lighting issues.

Aside from personal experience related to lighting issues, the researcher has dedicated nearly half her nursing career to examining and improving the quality and safety of healthcare. She has participated in the review of numerous adverse events and has reviewed over 65,000 near miss reports in healthcare (Simmons, Graves & Mick, 2008). In addition, the researcher was part of a team that conducted a unique pilot study in the state of Texas to examine the systems contributors to errors attributed to nurses (Thomas, Simmons, Graves & Martin, 2007). The researcher enrolled in graduate school after one

specific adverse event revealed to her the importance of including nurses in state and national policy decisions intended to improve the delivery of safe care. Her primary focus of research is the impact of the physical environment on clinicians' ability to deliver safe care.

Study Assumptions

This study was based on the following assumptions:

1. Nurses perceive and perform their duties in a way that makes sense to them and reflects past experience and the culture of the organization within which they practice.
2. Nurses are able to describe their experience with medication administration in varying lighting conditions.
3. The interview process will elicit data to inform the research question.
4. Theoretical sampling will allow the researcher a broad and deep exposure to the nursing experience of decision making regarding lighting while administering medications.
5. Understanding the process of decision making regarding lighting will lead to the development of strategies for safer medication administration and potentially inform safety policy.

Philosophical Underpinnings

The philosophical underpinning for this grounded theory study is Symbolic Interactionism (SI). The term, SI, was coined by Herbert Blumer to name a method of study of humans, group life, and human contact (Blumer, 1969, p.1). Derived from a pragmatic perspective and frequently used in sociological studies, SI focuses on the dynamic and continuously interpretive creation and change of meanings and actions within society (Charmaz, 2006). Based on the teachings of George Herbert Mead and John Dewey, Blumer states three premises of his pragmatically based philosophy:

> 1) Humans act toward things on the basis of the meanings they ascribe to those things… 2) The meaning of such things is derived from, or arises out of, the social interaction that one has with one's fellows. 3) These meanings are handled in, and modified through, an interpretative process used by the person in dealing with the things he encounters (Blumer, 1969, p. 2).

Therefore, SI identifies meanings as products of social interaction "that are formed in and through the defining activities of people as they interact" (Blumer, 1969, p. 5).

While not described as a forth premise, Blumer elaborates that there are interdependent interlinking of actions within systems, such as social groups and institutions, that are not static. While actions may take place by a single individual or a group, the actor will remain attuned to the social situation in which she or he is acting (Blumer, 1969). This premise identifies the possibility for humans to change their interpretation of an act or symbol when interlinked with new experiences or different systems. That interpretive change may result in an alteration in the meaning ascribed to a

thing. In SI, each individual defines his own truth or reality based on prior experience, beliefs, values, and the systems within which they interact. It is the interactions and the interlinking of actions that result in a fabric of action and interaction.

When further developing Mead's point of view, Blumer points out that Mead identified a central scheme that includes 1) the self, 2), the act, 3) social interaction, 4) objects, and 5) joint action. That scheme was significantly different from the traditional philosophical assumption that human thought and consciousness were preexistent. Blumer asserted that when Mead allowed the human to perceive himself as a process with whom he could interact, a philosophical change occurred. That interaction with the self presents a process in which the individual can mold his own behavior as the act and the situation unfold (Blumer, 1969).

Blumer calls attention to the process of self-interaction that occurs. Unlike an automatic or physiologic response, the individual must establish a goal and an action plan, carry that out while noting the response of others, evaluate the resulting effects or position, and determine if a change in path or additional actions are required to meet the established objective (Blumer, 1969). In the present study, much of the focus is on the reflective process that the nurse takes to determine if there is adequate lighting to administer a specific medication via the specific route. Use of SI as the philosophical roots of the study required the researcher to examine and question the participant to understand the meanings of words, symbols, and their relation to the social behaviors of the actors. While the process varies based on the situation, other individuals, the setting,

and the self, the nurse was able to describe that process and the meanings associated with it and provide insight for the researcher.

Social Interaction revolves around interpretation. Blumer notes that symbolic interaction is a formative process that shapes human life and develops the ongoing character of human group life because the self continuously interprets and defines the acts of others in a multitude of relationships and associations. When Mead and Blumer refer to an object, they are referring to human constructs that do not have intrinsic properties. In other words, the object is assigned meaning by the self but can be transformed into another meaning in a different social interaction or setting. People will act on an object based on the meaning that they have assigned at that time.

Finally, we come to the joint action or social act that Blumer defines as “the distinguishing characteristic of society” (Blumer, 1969, p. 70). In a joint act, each self has a singular position and engages in the act with another in acts that fit together; the result must then be interpreted yet again by each self to understand the current relationship and determine the next act, be it individual or joint. Blumer is careful to point out that some joint actions may be interrupted or result in unintended consequences that may or may not align with the goal or the established social structure. The human response requires reflection on events to assign meaning to them. Nurses, as humans, develop an understanding of their actions and the role of interruptions and unintended consequences on the outcome of those actions within that reflection of events including episodes of medication administration.The researcher endeavored to understand the perspective of nurses who have been socialized both formally and informally to care for and safeguard

patients by identifying the guiding values, issues, and relationships that they use to interpret that social setting.

Blumer called for the "examination of the empirical social world" (1969, p. 34). For this study the social world is the environment in which acute care nurses administer medication. Using their descriptions, the researcher examined and categorized nurses' reports of their process of thoughts, beliefs, understandings, and responses to the situations of administrating medications to patients. SI and grounded theory methods assisted the researcher to probe for the meanings of the objects, interactions, and systemic issues that impact the nurses' decisions about lighting during medication administration through interview. The researcher engaged participants in semi-structured interviews resulting in an "in-depth exploration" (Charmaz, 2006, p. 25) of the topic among participants who share a common experience that has not, to this point, been well articulated or explored. A substantive theory arising from the content of those interviews identifies the participants' experiences, beliefs, and interactions that impact the decision to alter the lighting in the patient care environment during medication administration.

Summary

Healthcare is fraught with issues of less than perfect quality and safety. The dangers are related to the complexity of care, the uniqueness of each patient, and the variation that comes from inserting a human into any process. Improved application of HFE is one way to produce enhanced care quality and safety. But in order to know what changes need to be made, a baseline understanding of the thinking process related to lighting and medication administration must be established. This grounded theory study was designed

to explore the subject from the perspective of bedside nurses to guide future policy and practice environments with the goal of improved patient care and the safer administration of medications on acute care units.

CHAPTER II

LIGHT FOR NURSES' WORK IN THE 21ST CENTURY: A REVIEW OF LIGHTING, HUMAN VISION LIMITATIONS, AND MEDICATION ADMINISTRATION

A Paper Published in

The Journal of Nursing Care Quality

Krisanne Graves, Lene Symes, and Sandra K. Cesario

Abstract:

A literature review was conducted to determine the state of the science related to medication errors and light. The limited literature is discussed in relationship to human vision and light needs. Little systematic action has been taken to increase nurses' awareness of the connection between lighting and potential medication errors. Implications for nursing practice and research about light conditions are provided. Interventions from other industries may aid nursing in making decisions about light conditions.

Key words:

health facility environment, human factors, lighting, medication errors, nursing, safety, vision

INTRODUCTION

Many literature reviews have tied the environment to the quality and safety of care delivered as well as to patient outcomes.[1-5] Lighting is one aspect of that physical work environment. The effects of lighting on human vision have been studied for at least 5 centuries.[6] Anshel notes that "lighting and vision are interdependent."[7(p414)] While it is self-evident that light and visual acuity are linked, the effects of artificial lighting conditions and rapid transitions in intensity of lighting on visual function are not as obvious and are of interest in human factors engineering, which is the multidisciplinary science dedicated to understanding of how humans interact with their environment within a system.[8] In 2007, Anshel[7] argued that despite existing guidelines for lighting specific to health care, clinicians may have difficulty determining optimal lighting conditions. This difficulty is a result of their performing many different types of visual tasks while delivering care; the tasks are performed under diverse physical conditions and in differing locations; and clinicians must account for the variation in individual lighting requirements related to their personal age and visual acuity. Several publications note the lack of empiric evidence about lighting and medication in health care.[9-12]

The majority of workers in health care are nurses,[4] and they are frequently identified as the final inspector for safety in a long chain of individuals in health care processes.[13] Many working registered nurses report anecdotally that they frequently enter patients' rooms at night to administer medications and complete patient assessments while using a pen light. The practice of administering medications to patients in low-lighting conditions adds to the potential for harm to patients[11] and is contrary to the recommendations of

standard setting agencies. These bodies include the Illuminating Engineering Society of North America,[14] which establishes general standards for illumination in health care facilities based on known limitations to human vision and impact of light on visibility and visual discomfort. In addition, the United States Pharmacopeial Convention established specific standards for illumination of medication preparation,[15] which states:

> Proper lighting is also essential at the point of care. Attempting to be patient-and family-friendly may run contrary to the necessary lighting conditions for safe medication administration. Administration of medication at night under low luminance to avoid disturbing the patient or family is an unsafe practice. Task or spot lighting must be available, so that visual confirmation of the correct patient (reading armband), medication, and administration site is not compromised.[15(p3)]

Experts have suggested that health care practitioners should be included in the design process of health care spaces.[16-18] However, there is little "evidence in the literature of the involvement of service users in the design of inpatient spaces."[17(p113)] Unfortunately, little systematic action has been taken within health care to increase awareness about the connection between poor lighting and the potential for patient harm in the medication administration process. Most literature considers lighting as one of many environmental factors that can impact patient safety.[5,19] The limitations of human vision in poor lighting have been identified. However, most studies and reviews focus on areas of medication preparation rather than administration.[12,20]

Current literature ties the physical environment of care, and specifically lighting, to patient outcomes and medication safety,[20,21] accepts the tie between lighting and sight,[7]

acknowledges the increasing average age of nurses and the likely need for increased light for nurses older than 40 years,[22-24] and recognizes the complexity of medication administration and patient care. Researchers attempting to understand the experience of nurses administering medications rarely consider the lighting environment.[25-29]

The purpose of this literature review was to prepare nurse managers and bedside nurses to be valuable contributors and participants in the design of health care spaces by ensuring that they are aware of current knowledge about the health care environment and factors that affect nurses' decisions about altering lighting for medication administration. This review summarizes the evidence compiled about the tie between lighting environments and medication safety, the limitations of human vision that have been identified and compensated for in other industries, and the likely impact of inadequate lighting on medication administration safety.

METHODS

The following Web sites and databases were searched: The Agency for Healthcare Research and Quality, the Center for Health Design Web site (http://www.healthdesign.org), CINAHL, DTIC.mil, Google, Google Scholar, MEDLINE, PsycINFO, ProQuest Dissertations & Theses, Science Direct, Scopus, and the Transportation Research Board. The search included texts, scientific reports, peer-reviewed journals, and theses and dissertations published after the 2004 seminal report "The Role of the Physical Environment in the Hospital of the 21st Century: A Once-in-a-Lifetime Opportunity."[5] Only work in English concerned with concept of visual acuity in relation to environmental lighting was included in the review. Search terms included the

following: lighting, light, illumination, environment, vision, visual acuity, visibility, human vision, hospital design, patient safety, safety, nurse, nursing, health care error, hospital, acute care, medical error, treatment error, error, medication error, medication administration, adverse event, drug administration, medication, and administration. Additional manual searches were conducted through bibliographies.

RESULTS

This search resulted in 11 review articles,[2, 7, 9, 11, 12, 15, 19-21, 30, 31] 3 editorial pieces,[32-34] and an additional 7 empiric studies[35-41] that included some mention of both lighting and the medication process. Content related to visual perception or the impact of natural light on circadian rhythms and well-being was excluded as well as general surveys of the environment that did not include lighting. Only a small, nonexperimental, observational study examining pharmacists' dispensing performance in varying lighting conditions[42] was cited in all 11 reviews. Many of the findings may seem obvious to the reader but have never been highlighted in the context of medication administration. These include the following: the nursing population is aging and with aging comes presbyopia and the need for more light[2,11,15,21,36]; increased computer, "near work," and task complexity can cause eye fatigue, which may increase the need for lighting[2,7,15,19,21]; and finally, the size of visual elements, contrast with the background, glare, reflection, and shadows can have an impact on visual comfort and performance.[2,7,15] A summary of all 21 publications identified for this review can be found in the Supplemental Digital Content Table 2.1 (available at: http://links.lww.com/JNCQ/A49).

Many of the cited studies recognize the importance and positive impact of natural light on human vision. However, in many hospital situations, natural light may not always be an option. There are a variety of artificial lighting alternatives available. These include incandescent bulbs, gaseous discharge lamps, and LEDs (light emitting diodes). The incandescent bulbs conduct electricity through a filament to produce a glowing light, and halogen lamps are incandescent bulbs that burn hotter and longer because of placement of the filament in a high-pressured halogen capsule. Gas lamps pass the electricity directly through a gas (ie, mercury, metal halide, or sodium), causing the gas itself, rather than a filament, to glow. Finally, LEDs are small electronic devices developed in the computer industry that emit light themselves when powered with electricity.[43] Artificial lighting varies in the amount and color of light produced and in its efficiency, as some artificial lights produce significantly more heat than others. The established guidelines and standards from the Illuminating Engineering Society of North America and United States Pharmacopeial Convention can help inform those designing or redesigning facilities to identify the proper light for each patient care and medication preparation area.

DISCUSSION

Human vision and its limitations

The eye is the complex receptor organ for human vision; it is the combination of the eyes and the brain that provide humans with the ability to see.[44] The structure vital to image acquisition is the retina. Like brain cells, retinal cells are not replaced when injured or damaged.[45] The retina contains 2 different types of photoreceptors for sight: the rods

and cones. The combination of rods and cones allows the human eye to see in broad ranges of lighting conditions, from very dim to very bright sunlight.[44,46,47] There are important differences between the 2 cell types: the level of illumination that each type responds to and the density of distribution on the retina.[6,44,45]

The cones function in a broad range of light wavelengths. Cones contribute resolution of fine detail and color discrimination.[44,45] The rods provide vision when lighting is dimmer than moonlight, provide object recognition, and identify motion and the general size of objects, but they do not afford fine detail or color vision. Placement of the rods on the retina results in a unique problem of a central blind spot in dim lighting conditions. Fix on a point, there is the possibility of not seeing an object hidden within the central blind spot. Pilots, sailors, truckers, and others are trained to overcome this blind spot by scanning the visual field for objects and, when an object is present, to focus slightly to the side, above, or below to ensure that the object is perceived adequately.[44,46]

Light adaptation

In lighting conditions typical of twilight, both rods and cones are active but neither functions at its most efficient level.[46,47] The visual system is constantly adapting to the light conditions by regulating the amount of light allowed into the globe of the eye. These adjustments are made through 3 physiologic processes: a change in pupil size (muscular), neural interactions, and photochemical changes.[44,48] It is important to note that the time required for adaptation is dependent on the magnitude of the change in lighting. Should the change in lighting require the visual system to move cones to rods, full adaptation may take up to an hour.[44] In these cases, perception of objects, fine details such as color,

or object movement may be limited. Examples of situations where there are large changes in illumination include entering a darkened movie theater on a bright, sunny day[49] or at initiation of emergency lighting during a power failure.[50]

Once the eye has become dark-adapted, sudden exposure to bright lighting can be disruptive to sight. Military pilots receive training about the human limitations of visual capabilities as they apply to flight training.[46,51] Lessons include visual capability by variation in lighting level, discussions of the physiologic and nighttime blind spots, and the limitations during fully dark- adapted vision. During nighttime vision (fully dark adapted), there are normal limitations to vision. These limitations include alterations to depth and color perception, as well as visual illusions. Once a pilot has adjusted to night vision, sudden exposure to bright light may result in flash blindness, after images, and glare defects.[52] Pilots are taught compensatory techniques to successfully maneuver an aircraft despite these vision deficits.[51] While our review uncovered recommendations for special situations where visual dark adaptation is required, such as control rooms and cockpits,[53,54] crew ready rooms,[46,5]3 and movie theaters while a film is showing,[49,53] no guidance for nursing on how to compensate for sudden lighting transitions such as entering a fully darkened patient room from a lighted hallway or for ensuring proper task lighting when caring for patients was found.

Other changes to vision

In addition to normal age-related presbyopia, people are also subject to progressive disorders that may subtly impact their vision and their responses to light. These include diabetic retinopathy, glaucoma, cataracts, macular degeneration, retinitis pigmentosa, and

neuroretinitis. These progressive problems can result in visual impairments, including blurred images, loss of portions of the visual field, reduction or loss of visual acuity, reductions in the ability to adapt to darkness, changes in response glare, changes or loss of color perception, and night blindness.[55]

Medication errors as they relate to lighting

McBride-Henry and Foureur[56] have identified that system issues, including physical environments, can be contributing factors to medication errors. Boyce[44] related that less than optimal lighting conditions (too much or too little lighting, veiling reflections, glare, and flicker) may cause eyestrain and irritation. Eye irritation can result in a breakdown of vision and possible patient safety risk, particularly in highly visual tasks such as medication administration. McBride-Henry and Foureur[56] have also suggested that a lack of understanding about how errors can occur is one of many potential professional issues. A lack of understanding about errors and lighting may be contributing to medication administration errors.

Medication errors can occur at any stage of the medication process: ordering, documenting, dispensing, administering, and monitoring.[57] Several studies have been published with a focus on drug administration errors.[58-61] Each of these studies highlight that there are administration errors related to the timing of a dose (including dose omission) and administration errors that are not related to time. Nontiming errors include the following: improper dose or quantity, wrong administration rate, extra or unauthorized doses, wrong route, incorrect administration technique, wrong drug preparation, wrong dose form, or incorrect patient. Some nontiming errors may be related

to the lighting conditions. The United States Pharmacopeial Convention MEDMARX database reviewed voluntary medication event reports received from 1999 to 2006. Poor lighting was identified as a contributing factor in approximately 1% of all errors reported.[41,57] However, it is important to note that with awareness of lighting as a potential contributor to error, it could easily be rectified.

The work of nursing occurs 24 hours a day in a host of lighting conditions, often depending on the environment of care and the individual facility. Many working registered nurses enter patients' hospital rooms at night to administer medications and complete patient assessments in less than optimal lighting conditions. Simmons et al[11] posited that the practice of assessing the patient and the environment and administering medications in low-lighting conditions is contrary to published guidelines, adding to the potential for harm to patients. Nurses report that this practice is the result of hospital administrations' focus on patient satisfaction scores that frequently include complaints of being awakened at night.[62] Adequate light conditions are needed to verify that the correct patient is in the correct bed and to verify 2 patient identifiers as suggested by The Joint Commission, the Institute for Safe Medication Practices, and other safety organizations. Once verification that the proper patient and the proper time, drug, dose, form, and preparation are in play, other administration errors can still occur. For example, an intravenous catheter that is no longer patent or intravenous fluid that has leaked into the surrounding tissues may be missed.[63] Finally, many patients have multiple tubings into multiple body systems with the ubiquitous Luer connector. Clinicians cannot distinguish

these tubing by touch alone, but they need to be able to confirm by sight and by tracing the catheter to the insertion site.[64]

Implications for nursing practice and research

Nursing leaders and bedside nurses must be aware of the tie between lighting and vision. Nurses in possession of that knowledge will be more likely to ensure adequate, appropriate lighting and visual contrast for the complex and detailed task of administering medications. For example, establishing a combination of light with proper contrast and reducing shadow or glare will assist a nurse in identifying possible intravenous drug precipitates or visually verifying that correct drug is at hand. Fatigue, normal presbyopia, and progressive optic diseases may result in the need for additional light or magnification to detect errors. Nurses will recognize the need to alter lighting conditions for systems issues such as small font sizes on medication labels, computer screens, and patient identification bands. Informed nurses moving from very light to very dark areas (or the reverse) will allow adequate time for light adaptation, planning their work so that tasks requiring greater adaptation will be left until visual adaptation occurs. Nurse leaders will ensure that proper adaptive equipment is available for safe medication administration. They will also ensure that the light from fixtures, which can deteriorate with age or dust, are routinely monitored, cleaned, and replaced, as needed.

The scarcity of discussion about the lighting environment in patient care areas in the nursing literature is significant. There is also a lack of information about how nurses meet the competing demands of having adequate lighting for tasks and the comfort and rest needs of their patients. The lack of information calls for further study into the lighting

environments that nurses in acute care areas encounter, as well as the decisions that nurses are making about lighting about medication administration and patient care.

CONCLUSION

This literature review revealed that there is limited knowledge, specific to nursing work, to guide the establishment of a light environment for tasks critical to patient safety. Nursing is a 24/7 role, with varying environmental conditions. Nurses and their leaders must be conscious of the science behind lighting and visibility, aware of the lighting and safety guidelines, and armed with the expectation that the lighting in a patient's room may require alteration to ensure safe administration of medications. Considering the critical role that nurses have in patient care, there is a need to understand how nurses adapt in clinical situations where changing the lighting is contradictory to patients' desires. Future research that increases our understanding about the interaction of nurses' work environment with the variations and limitations of human visual performance is needed to guide the development of safer patient care. While there are many environmental considerations related to patient care, illumination of the task at hand is imperative.

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Table 2.1: Study Descriptions and Findings: Lighting and Medication Administration

Article (Citation)	Study description	Findings
Anshel JR (7).	Review of visual function and its role in workplace productivity	-Increased task complexity increases the need for light. -Increased computer and "near work" can result in physical symptoms if lighting does not fit the task. -Computer work requires less ambient lighting than reading from paper.
Chaudhury H, Mahmood A (20).	Review of literature to understand the impact of environmental factors on nursing efficiency, errors, and other outcomes.	-Inappropriate lighting (too much or too little) can impede visual task performance. -Bright lights improve patient outcomes. -Natural light exposure results in improved health for patient and staff.
Chaudhury H, Mahmood A, Valente M (9).	A review of the research on environmental factors that contribute to staff fatigue, stress, burnout, and potential errors	-Higher lighting levels result in fewer errors. -Exposure to daylight has positive effects on patients and staff.
Dunn H, Anderson MA, Hill PD (35).	Observational, descriptive study designed to measure the total time ICU patients are exposed to night time artificial lighting, the sources of that light and the activities	.Artificial light conditions occurred at the beginning and end of shifts. -There was some evidence that light use by nurses was individualized.

Article (Citation)	Study description	Findings
	occurring when artificial lighting is present, n= 21 (3 rooms over 7 nights)	
Grissinger M (33).	Editorial	-Recommendations include: fluorescent cool white lamps; adjustable task lighting with positioning to limit glare on computer screens; routine cleaning of light fixtures; availability of magnifying lenses; and routine luminance measurement in areas where medications are stored, prepared, and administered.
Grissinger M (34).	Editorial	-Calls for awareness of the impact of the physical environment on the medication use process, including low lighting levels.
Henriksen K, Isaacson S, Sadler BL, Zimring CM (2).	Review of evidence based design recommendations for the environment of care to improve quality and safety	-Visual task performance is impacted by lighting, the size and quality of the visual element, background contrast. -Visual performance decreases with age due to physiologic changes -People demonstrate a preference for controlling the source and amount of lighting for different tasks.
Joseph A, Rashid M (31).	Review of recent research on the impact of hospital design on patient safety	-Performance of visual tasks improves at increased light levels. -Seasonal variations in medication errors have been documented.
Joseph A. (21).	Review to identify the impact of light on	-Task performance is impacted by the task as well as the

Article (Citation)	Study description	Findings
	human health, performance, and health outcomes in the healthcare setting.	amount, color, and distribution of light. -The need for light increases with age. Inadequate light can lead to stress and the potential for errors.
Joseph, A (19).	Review of literature regarding the physical and organizational environment and its impact on the healthcare team, effectiveness of care, and patient/practitioner satisfaction	-Task performance improves with increased light levels.
Kamali NJ, Abbas MY (36).	Mixed methods pilot to evaluate the impact of lighting on nurses' performance of tasks, n=120	-Nurses over age 40 reported the need for increased lighting.
Mahmood A, Chaudhury H, Gaumont A (31).	Review of research on effects of physical and organizational environment in long term care settings on medication and nursing errors	-Lighting levels and the type of lighting can impact the frequency of medication errors. -Natural light can reduce staff stress and fatigue and potentially decrease errors.
Mahmood A, Chaudhury H, Gaumont A, Rust T (38).	Mixed methods review of research on effects of physical and organizational environment in on medication and nursing errors, including focus groups, observations and a	-Staffing, organizational, social, and physical issues, including lighting, contributed to medication errors.

Article (Citation)	Study description	Findings
	staff survey, n=54 from 4 long-term facilities	
Mahmood A, Chaudhury H, Valente M (37).	Survey of nurses' perceptions of the impact of the physical environment on medication errors, n= 84	-Lighting was identified as problematic by 5% participants.
Schulmeister L (32).	Editorial	-Use of magnifying lenses and adequate lighting throughout the medication process is encouraged.
Simmons D, Graves K, Flynn EA (11)	A review of USP guidelines for the physical environment to promote safe medication use	-Poor lighting design can negatively impact visual performance and visual comfort of workers. -Presbyopia affects the vast majority of the population by age 65. -Perceptions of color can change in different lighting environments, so color coding should not be the single distinguishing factor
Sitzman KL, Leiss JK (39).	Survey mailed to registered nurses working in home care or hospice measuring environmental hazards that increase the potential for occupational blood exposure. n=833	-Nurses reported "usually" or "always" encountering poor lighting in homes 30% of the time.

Article (Citation)	Study description	Findings
Ulrich RS, Zimring C, Zhu X, et al. (12).	Review of research on evidence-based design and implications for improved design	-Visual inspection performance declines at lower lighting levels.
United States Pharmacopeial Convention (15).	Describes the optimal physical environment characteristics to promote accurate medication use	-Prescription filling accuracy is positively impacted by increased lighting. -Light needs increase with visual fatigue -Lighting requirements vary with the visual task and with the age of the worker. -Lighting levels should be measured routinely to verify that aging fixtures are producing adequate light levels.
Varadarajan R (40).	Direct observation of 7 nurses over 45 days in a long term care facility in three different lighting conditions (baseline, 100, and 145 foot candles)	-Increased lighting decreased medication error rates in a long term care setting.
Wolf ZR, Hicks R, Serembus JF (41).	Secondary analysis of reported medication errors attributed to student nurses, n=1,305	-Poor lighting contributed to three reported medication errors.

CHAPTER III

METHODS

Procedure for Collection and Treatment of Data

This study used the qualitative research design of grounded theory to examine and explore nurses' decision making processes about lighting during medication administration. Grounded theory methods aim to identify a theory or theoretical construct as it emerges inductively from the participants and the data that they provide. The theoretical construct goal is identified using constant comparison of the emerging theory and the new data. The results of comparing and contrasting the developing theory with the new data drives the collection of additional data until theoretical saturation is achieved (Corbin & Strauss, 2008). Symbolic interactionism (SI) emphasizes that there is an interdependent interlinking of actions within systems. If the act or symbol occurs in a different interlinking setting, its meaning may change. Therefore, the meaning of any object or word is learned, not intrinsic to the object or from the person alone. Each individual defines his own truth or reality based on prior experience, beliefs, values, and systems within which they operate.

Lack of definition around a process invites the use of grounded theory methods (Speziale & Carpenter, 2003). Given the scant research related to the lighting environment for bedside nurses (Graves, Symes & Cesario, 2013), grounded theory methods and the philosophical underpinnings of this study supported the researcher while

gathering and interpreting data about the process bedside nurses follow when making decisions about the lighting environment during medication administration.

Charmaz (2006) identified that the research problem should guide the methods of data collection. In this study, interviewing bedside acute care nurses was the primary method used to elicit data to explicate the decision making process about the lighting environment during medication administration. A semi-structured interview guide (Appendix D) was used to elicit the data the researcher analyzed when developing an understanding of the process.

Setting

This study was conducted in the state of Texas. Data collection occurred during audio recorded interviews that were either face-to-face or via telephone, based on the participant's preference. Participants were bedside nurses who practice on inpatient, hospital acute care floors in Texas. The interviews were conducted at a mutually agreeable date and time. When interviews were face-to-face, the locations were selected to ensure auditory privacy during the interview.

Participants

The sample of participants met the following criteria:

Table 3.1:

Participant Criteria

Inclusion Criteria	Exclusion Criteria
• Licensed to work in the State of Texas as Registered Nurses; • Currently working at least half time; • Practice on an acute care, adult inpatient unit; and • Deliver medications on the acute care unit.	• Nurses affiliated with non-acute care or outpatient units as these units are less likely to have lighting that can be modified. • Nurses affiliated with long term care or nursing home facilities. • Nurses who work with the researcher.

Potential participants were identified when they contacted the researcher after receiving information about the study from her personal contacts in the nursing community. Contacts were made in person, by telephone, and by email. The researcher requested that contacts forward an email (Appendix A) or verbal information about the study to possible participants. This snowball sampling technique exponentially increased the potential participant pool. Theoretical sampling was used to ensure that participants with diverse characteristics and experiences related to lighting and medication administration were represented. As participant recruitment progressed, consideration was given to ensure the inclusion of RNs who represented a range of age groups, lengths

of experience as nurses, various types of nursing units and shifts worked, and the presence or absence of any eye disorder, ocular surgeries, or vision correction. All participants had experiences with the lighting environment and medication administration in an acute, adult care, inpatient setting.

The recruitment email included information about the study, participant inclusion criteria, and contact information for the researcher. Potential participants had the option of contacting the researcher via email, telephone, or in person. After an RN contacted the researcher, he/she was informed of the purpose of the study, the inclusion criteria, the time commitment, and the data collection methods of the study. In addition, the researcher answered any of the possible participant's questions and determined study eligibility. After the participant agreed to an interview, an interview modality, date, time, and a mutually agreeable location with auditory privacy were be identified.

Protection of Human Subjects

Institutional Review Board approval from Texas Woman's University was obtained for this study. If a participant selected a telephone interview, the consent was reviewed and sent to the participant. Upon receipt of the signed consent, an interview time was mutually agreed upon. At the agreed upon interview time, the researcher again reviewed the purpose of the study, the inclusion criteria, the time commitment, potential risks, the data collection methodology, and the informed consent in detail. Signed informed consent (Appendix B) was obtained from the participant prior to the interview and after any remaining questions had been answered. Each participant was reminded that they could take rest periods during the interview and choose to end participation in the study

at any time with no penalty. In addition, participants were provided with contact information for both the researcher and her adviser to contact to ensure that they could find assistance in the event that they felt the need after the interview. Participants received a $20 gift certificate as a courtesy acknowledgement of participation in the interview.

Data Collection

After signed informed consent was obtained, the participant completed a brief demographic questionnaire (Appendix C). The questionnaire focused on simple demographic data; information about the RN's training and work experience; information about the facility, unit, and normal work hours; any history of disorders of the eye; and the RN's need for corrective lenses.

Each interview was audio recorded. The interviews were conducted using a semi-structured interview. Each interview lasted no more than one hour. The interview guide consisted of questions about medication administration, including the physical environment and the participant's thoughts, behaviors, and decisions about lighting when administering medications. It had six broad, open-ended questions and numerous specific and general probing questions to clarify participant responses and ensure the researcher achieved a clear understanding of the meaning of their responses (Appendix D).

The audio recordings remained in the possession of the researcher until securely transmitted to the transcriptionist. A second copy of the recording was maintained under double lock in the researcher's home, along with the signed consent form and the demographic data form. The demographic data form did not contain the participant's

name, but was coded for confidentially. In addition, the form was treated as identifiable data due to the small sample size, and therefore remained in the possession of the researcher until it was placed under double lock within the researcher's home.

Each interview was transcribed by a transcriptionist with human subjects training and certification. Any identifying information was removed from each transcription by the researcher before analysis. The researcher reviewed each transcription while listening to the recording to confirm the accuracy of the transcription. If there was any question related to the transcription, the researcher could contact the participant by telephone to clarify content, either because a statement was ambiguous or some part of the recording was inaudible. Additional contact was not required. The interview transcript files were then imported into the analysis tool, NVivo 10 (QSR International, 2012). The recordings were maintained in a double locked cabinet in the researcher's home until the completion of data analysis to allow the researcher to return for assessment of participant tone and to permit double checking transcription accuracy. All recordings and all identifiable information will be destroyed no later than September 2015.

Data Analysis

Data analysis for this study was concurrent with data collection, using the constant comparative method. Pandit (1996) describes the process of grounded theory development in five analytic phases, most of which occur in a cyclical and concurrent fashion: research design, data collection, data ordering, data analysis, and literature comparison. Data collection, ordering, and analysis continued in a cyclical manner with three types of data coding utilized: open, axial, and selective (Pandit, 1996). This process

resulted in the development of a theory about the decision process under study. Charmaz explained the theory development process by stating:

> throughout the research and writing processes, grounded theorists follow interests, leads, and hunches that they find or identify in the data. Then they may gather more data, ask more questions, and check their developing categories. Their emergent categories explain and conceptualize (1) the data, (2) common sense understandings of these data, and, likely, (3) other theoretical interpretations (Charmaz, 1990, p. 1162).

The process of the grounded theory methodology is to follow iterative steps until a theory emerges. Should concepts remain poorly defined, or if a portion of desired sample is missing from the participant pool, the researcher might utilize purposeful snowballing techniques to recruit additional participants. Theoretical sampling and the constant comparative methods of analysis continue until no new data emerges from the interviews, indicating that saturation has occurred (Corbin & Strauss, 2008). For this study, data from interviews were continually analyzed for common themes and patterns. An audit trail was established to ensure credibility of the findings.

To strengthen the scientific rigor and the findings of this study before finalization of the emerging theory, it was presented in aggregate form to three experts for validation and comparison with their own experiences. Expertise was sought in three areas: the nursing process, medication processes, and cognitive psychology. The expert reviews occurred individually at the convenience of the experts.

Scientific Rigor

Lincoln and Guba (1985) argue that when conducting or evaluating naturalistic, qualitative studies it is more appropriate to search for trustworthiness in place of the validity, reliability, and objectivity that is key in positivist work. They identify trustworthiness as possessing four components: credibility, dependability, confirmability, and transferability. Lincoln and Guba add a burden to the reader of qualitative studies, stating that it is often the consumer (1985, p. 328) of reported findings who must determine the trustworthiness of qualitative science. While this lays some of the burden for validating results on the reader and user of the study, the original researcher must also meet the standard and provide adequate information to the reader. The efforts made within the present study design to maintain scientific rigor and establish trustworthiness are described herein.

Polit and Beck stress that credibility is the "overriding goal of qualitative research" (2008, p. 539). To ensure credibility, the researcher must design and complete a study that "enhances believability" (Polit & Beck, 2008, p. 539) and demonstrates those efforts. This study was designed to facilitate credibility through theoretical sampling, a semi-structured, audio recorded interview, and the constant comparative analysis to ensure adequate inquiry, checking of findings with additional participants, and analysis for negative cases. The addition of a final review by subject matter experts in three areas, nursing process, medication process, and cognitive psychology, also enhances the credibility of this study. Dependability refers to the ability to replicate findings, while confirmability refers to the probability that the findings are the result of the participants

and the study, as opposed to the biases of the researcher. Both dependability and confirmability are supported through the detailed audit trail and close supervision by a faculty adviser. For additional dependability and confirmability, the emerging theory was validated with subject matter experts and is supported by the voice of the participants. Transferability is ensured by adequately describing the sample and corresponding data to allow readers to determine if the findings can be applied elsewhere (Polit & Beck, 2008). Transferability was aided by thick descriptions of the sample, the study design, and progressive development of the emerging theory.

CHAPTER IV

IS THERE LIGHT? WELL IT DEPENDS – A GROUNDED THEORY STUDY OF NURSES, LIGHTING, AND MEDICATION ADMINISTRATION

A Paper Submitted to

Nursing Forum

Krisanne Graves, Lene Symes, Sandra K. Cesario, and Ann Malecha

Abstract

Objective: We know that human vision has limitations, medication administration is a high risk activity, and some nurses work in environments that do not meet recommended lighting standards. The goal of this study was to inform safe medication administration practices and add evidence for establishing guidelines for lighting decisions by understanding registered nurses' (RNs) decision making about lighting during medication administration.

Methods: Grounded theory methodology was followed (n=16). Theoretical sampling was used to ensure that participants represented a variety of backgrounds and hospital settings. Results were validated by three expert researchers. Two of the researchers had significant expertise in medication administration errors.

Results: Data analysis culminated in the substantive theory *It Depends.* This theory describes a process of frequently automatic decision making about lighting whose aspects include Assessing Variation, Balancing Safety & Healing, and RN Bias. All RNs

expressed concerns about perceived risks in relation to lighting, but had difficulty describing how they confirmed when the correct decision about lighting was made. **Conclusions:** Nurses are often unaware of their reasons for lighting decisions and there is a need for education and other measures to increase the likelihood that lighting decisions that enhance patient safety are made by nurses.

Key words: lighting, medication administration, decision making, automatic mode, patient safety

Introduction

In the inpatient setting, the multistep medication process includes a final bedside safety check by nurses (Jennings, Sandelowski & Mark, 2011). Clinicians may have difficulty determining optimal lighting while providing care for a several reasons: they perform many different types of visual tasks; tasks must be performed under diverse physical conditions and in differing locations; and last, clinicians must account for the variation in lighting requirements related to their individual age and visual acuity (Anshel, 2007). We know that human vision has limitations, medication administration is a high risk activity, and some nurses work in environments that do not meet recommended lighting standards (Hicks, Becker, Krenzischeck& Beyea, 2004; Simmons, Graves & Flynn, 2009). Minimal research has been conducted to establish a baseline understanding of the lighting decisions that nurses make when administering medications in acute care patient rooms.

The aim of this grounded theory study is to describe the decision making process acute care registered nurses (RNs) follow for adjusting the lighting environment during medication administration and to identify factors that impact that process. This paper describes the processes and choices that RNs make as they decide to adjust or maintain the lighting environment when administering medications at the bedside in acute care. The results may inform safe medication administration practices, add to the evidence to establish reasonable guidelines for lighting decisions, and guide additional research.

Literature Review

A literature review was conducted to identify the state of the science related to medication errors and lighting. The major finding was that while lighting and human performance have been understood as linked for centuries (von Bommel & van den Beld, 2004), limited guidance specific to the nursing domain and safe lighting environments, particularly in regard to medication administration, is available. There is a need for increased understanding of how nurses adapt to varying clinical settings. Full findings of the literature review are published elsewhere (Graves, Symes & Cesario, 2013).

Methods

In order to identify and describe the RNs' decision making process, a grounded theory study was conducted (Corbin & Strauss, 2008). Lack of process definition invites the use of grounded theory methods (Charmaz, 2006). Given the scant research related to the lighting environment for bedside nurses (Graves, Symes & Cesario, 2013) and the lighting decisions that are made, grounded theory methods supported the study of lighting decisions in the acute care setting. With philosophical underpinnings in Symbolic Interactionism, grounded theory is focused on understanding the experiences and interpretations participants use to understand and interact with their environment through a cyclical process of data collection, analysis, and interpretation (Charmaz, 2006).

After approval was obtained from the university Institutional Review Board, the researcher informed personal contacts in the nursing community about the study in person, by telephone, and by email, using a standardized script to invite them to participate. A snowball sampling strategy was used to reach additional participants by

asking those contacts to pass the information along to their nursing contacts (Polit & Beck, 2008). Following initial contact, the study process included explanation of the study, consent, and completion of a face-to-face or telephone interview. For telephone interviews, consent forms were sent, signed, and returned prior to scheduling. Locations for face-to-face interviews were selected to ensure auditory privacy. Participants received a $20 gift certificate at the completion of the interview.

Semi-structured interviews began with the query, “Tell me about an experience administering medications to a patient where you specifically noticed the lighting of the environment.” After the initial description of a participant selected remembrance, participants were asked further questions (Table 4.1). In addition, probing questions were used to elicit further details about people, equipment, tasks, and environments involved in the medication administration process. Consistent with grounded theory methods, questions were modified to clarify new findings and verify emerging findings to develop an understanding of the experiences of the participants through cyclical data collection, analysis, and theoretical interpretation (Charmaz, 2006; Pandit, 1996).

Sample

A purposive sample (n=16) was recruited for one-on-one semi-structured interviews. The participants met the inclusion/exclusion criteria listed in Table 4.2. All but one were staff RNs working full time on acute care hospital floors. One was an Assistant Manager who usually carried a full patient load. Theoretical sampling ensured that educational backgrounds, years of practice, facilities worked in, ages, and use of corrective lenses were varied. Relatively late in the recruitment process, when only white, Hispanic, and

Asian females had volunteered to participate, the researcher elicited help from colleagues to recruit the one male and one African American participant (Table 4.3). The results of those interviews, which were consistent with results from other interviews, supported that data saturation was achieved. There was no reason to suspect that experiences related to lighting and medication administration differed by gender or race/ethnicity and participant recruitment was halted.

Data Collection and Analysis

The semi-structured interviews were digitally recorded. Following transcription, each file was stripped of any identifiers and the researcher verified the content. Data was then imported into NVivo 10 (QSR International, 2012), which served as the platform for data management during data analysis.

Coding. Within NVivo, transcripts were reviewed line by line. Data from individual interviews were coded and then compared with previous coding to identify similarities and differences in RNs' experiences. The initial coding schema was reorganized into categories of similar factors. The constant comparative method was used to analyze the transcripts for similarities and differences, then interpretations were confirmed in the interviews which followed. Cyclical data collection through interviews, analysis, and interpretation continued as a theory emerged from the data (Charmaz, 2006; Pandit, 1996). As analysis progressed, theoretical sampling was used to further inform the development of findings relevant to a variety of individuals and settings. Data saturation was suspected by the thirteenth interview; however, data collection continued to determine if new information would be revealed. No additional substantive information

was identified in the last three interviews resulting in the conclusion of theoretical saturation (Corbin & Strauss, 2008; Polit & Beck, 2008).

Before finalization, the emerging theory was presented in aggregate form to three experts for validation and comparison with their own experiences. Expert researchers in the area of nursing process, medication processes, and cognitive psychology reviewed the emerging findings and confirmed that they are consistent with established work. The nursing and pharmacy researchers had at least a decade of experience analyzing medication errors. Their comments and suggestions resulted in renaming one of the concepts and reconsidering the ordering of some factors. These changes were consistent with the data.

Trustworthiness

Trustworthiness has been identified as possessing four components: credibility, dependability, confirmability, and transferability (Lincoln & Guba, 1985). Credibility was established through study design, theoretical sampling, semi-structured audio recorded interviews, and constant comparative analysis. Both dependability and confirmability were supported through the detailed audit trail provided within NVivo and close supervision by faculty. For additional dependability and confirmability, the emerging theory was validated with subject matter experts and is supported by the voices of the participants. Transferability was aided by thick descriptions of the sample, the study design, and progressive development of the emerging theory (Polit & Beck, 2008).

Findings

Data analysis culminated in the emerging theory *It Depends* (Figure 4.1). One doctorally prepared RN explained: “The question is not do I have enough light to administer the medication, the question is do I have enough light to assess my patient and his need for the medication or his response to the medication? And the answer to that is—I'm sorry, it depends.” In 13 of the 16 interviews. the words “depends” or “dependent” were used when describing the factors that influenced decisions about altering the lighting to administer medications.

It Depends is a complex nonlinear process of decision-making that is often automatic. Nurses interviewed had a difficult time explicitly describing their decision making process about lighting and medication administration. The process of assessing the lighting in a patient’s room is routine, familiar, and a very common task. When the room is very light or very dark, the decision about lighting is an easy one and likely occurs unconsciously: there is either enough light or no light at all. James Reason (1990) described the automatic mode as a level of cognitive function where familiar tasks are performed with skill and ease.

Not one of the participants articulated a conscious, step-by-step process of decision making about adapting light conditions for medication administration. They described a general understanding of lighting needs, but none could describe how they knew if they had sufficient light. All expressed clear concerns about risks that they perceived in relation to lighting, yet they had a difficult time describing how they confirmed that they had made the right decision about lighting. One participant tentatively responded: “I

guess its knowing whether or not you got your job performance done right." Another relied on perfect performance: "If I've done everything correctly and I don't have any mistakes."

The substantitive theory, *It Depends,* has three major interrelated aspects, Coping with Variation, Balancing Safety & Healing, and RN Bias. Each of these aspects is a response to factors that drive lighting decisions during medication administration. Optimally, the interaction of the three will balance RNs' lighting decisions to ensure safe medication administration, but the findings suggest that is often not the case. Nurses respond to other factors, such as available light sources, presence of visitors, route of drug they are preparing to administer, and patient expectations for rest. *It Depends* is an overarching framework in which one or many of these aspects may come into play for the RN when making a lighting decision. Each of the aspects and the related factors is described below.

Coping with Variation

Nurses routinely face variation in patients and the care environment. They face situational variants with every encounter. In the interviews, RNs commonly identified multiple sources of variation that might impact their lighting decisions. These include lighting sources and the environment of care, patient characteristics, the presence or absence of visitors, drug characteristics, and personal changes. Some participants reported that, despite an assessment for need for additional lighting, other factors may also have an impact on their light decisions and may lead to unsafe lighting conditions. "Someone who might have just had a horrible night and has been sick all night or

whatever, I might not come in and rip the blinds open. You know I might turn on one of the dimmer lights for them."

Light sources. Participants described using many light sources, including the lights in the patient room, patient bathroom, hallway, and other sources such as computer screens, care equipment screens, and flashlights. Decisions about lighting sources may or may not be optimal for safety. For example, a nurse said, "If I know what I am giving and it is a little [intravenous (IV)] push, I have a glow-watch. You know you can find it, you can clean the hub, and you just go." in responding to her assessment of the light source as adequate, which led to a dangerous decision of low lighting levels.

Other environmental characteristics. RNs said that the care environment could have an impact on their decision or ability to turn on specific light fixtures. In many aging healthcare facilities, rooms were not designed to accommodate much of the currently available equipment or the continual presence of family members. Light switches or fixtures may be inaccessible with the addition of extra equipment or people. One nurse, with two and one half years' experience, said that she had to get creative simply to turn on a light.

> Sometimes the light switch—you can't reach it because some of our rooms are really small, and it's important to get [our patients] up, out of bed, ambulate them after surgery. There's like a sleep-type chair on one side of the bed, and that's for the family. The patient can't sit it in. It's too low to the ground. Then there's the bed. Then there's a nightstand, and the bedside table. You have to drag a recliner in the room, and it goes right there where the IV pole, light switches, everything

> is. When you can't get to the light switch you either have to climb—you know—squeeze behind the chair and turn it on or just use another source of lighting such as the bathroom or the windows.

Participants also said that rooms on the same unit may differ in the type of lighting that is available or needed. They reported that some rooms are inherently darker than others, always requiring some form of artificial lighting even at the height of the day. A fixture's light output can also vary: "[The light from this fixture is] different in every room, which is very frustrating, because it is a different intensity of the light. So, sometimes, I will tell them "close your eyes" …Because I don't know which one is which."

Patient characteristics. RNs on both day and night shifts reported that variations in patient age, condition, or mood might influence their decision about light. Nurses reported needing more light in instances such as having a patient with dysphasia or one who has difficulty seeing. Nurses sometimes intentionally choose a lower lighting level than indicated by the task.

> What's going on with the patient, what time of day is it, did they just come out of surgery or a procedure and they're resting? Someone who might have just had a horrible night and has been sick all night or whatever, I might not come in and rip the blinds open. You know I might turn on one of the dimmer lights for them.

Presence of visitors. RNs who worked the night shift versus the day shift differed in their perception of the impact of visitors on lighting decisions. Day shift RNs reported that a visitor's presence made little impact. In contrast, night shift RNs expressed

reluctance to turn on lights out of concern for the rest and wellbeing of the visitors. They described being referred to as “mean” when they lit a room to administer medications. They described making sure they had just enough light to avoid tripping over a sleeping relative. In these situations, because of the presence of visitors or the RN’s prior experiences, they may have chosen a lower lighting level

Drug characteristics. A great deal of variation was identified in how medications are acquired, initially verified, and prepared. It was not uncommon for participants to describe times when medications were mixed or drawn up in the patient’s room rather than in the medication room. In at least three instances, this practice was the reported norm.

In relation to the drug, the route of administration seemed the most important driver in the RNs’ lighting decision. Some of the RN participants mentioned the need to assess the IV site prior to infusion of medications, and two mentioned the need to monitor IV pushes for precipitates. Four RNs said that pills are more difficult to tell apart in low lighting; therefore they were sure to have brighter lights. They said this was of particular importance when the patient might drop the drugs. Some discussed the difficulty of preparing small liquid doses in the darkened patient room such as small volume oral drugs or insulin syringes with needle capping devices. They reported needing to use additional lighting or a flashlight to ensure that doses were correct. In many cases, the RNs reported using lower levels of lighting with IV medications. Still others believed that the use of bar coding technology would prevent an administration error. One long time nurse said, “Pills, I know. If I scan it, and it says it’s okay, I’m good.”

RN characteristics. Presbyopia due to aging was the most prominently reported variant in RN characteristics, with eye fatigue a close second. Younger RNs report that their older colleagues require more light than they do. "…especially the ones that wear the reading glasses. They need more light than I do. I tell them, "Oh, I can see," and they're like, "It's too dark. I can't really see." They turn on a brighter light." RNs aged 45 and older most frequently commented that they used more lighting than they did at a younger age. "I'm telling you, age does make a difference. It makes a big difference. When I was younger I could see 20/20. I can see 20/20 with my glasses, but I have bifocals and I think lighting affects me. Tiredness affects me."

While older nurses did complain that drug label font sizes are often too small to read in dimly lit areas, many of the vision and lighting issues identified in the literature review were not prominent findings. Others discussed the volume of reading and computer work required in routine nursing care that often results in eye fatigue. RNs who wore glasses or had Lasik surgery reported increased glare, but none indicated that that it impacted their lighting decisions.

Balancing Safety and Healing

RNs emphasized the importance of developing positive, trusting relationships with patients. In addition, they frequently discussed the desire to ensure that the environment that patients experience is restful and healing. Nurses experience significant pressure to complete their work (Morath, 2011). "There are some moments you're just kind of thinking more time-wise—like, "I need to get these things done." Participants frequently identified that balancing the need for safety with the need to ensure a healing and restful

environment is not always an easy one. One nurse said “It’s generally never a good decision to turn the lights on in a sleeping patient’s room.”

Establishing rapport and educating patients. RNs reported that increased lighting ensures they can see the patient when interacting and educating. “[If you do not turn on the lights] you will not be able to create a rapport with your patient, a living thing; you have to interact with them before you give them a medication.” Those interactions include patient education about medications. All participants incorporated patient education about each drug when discussing the medication administration process.

Several participants discussed setting expectations with patients so that they will fully understand hospital processes. One young nurse explained the way that she discusses the competing goals of safety and rest in this way: “If the patient is not happy with me turning on the light… they believe they’re in the hospital so they’re going to rest. And you’re kind of like, “Actually this is the worst place for you to rest. You’re going to be bothered and poked a lot.” This nurse recognized the importance of ensuring safety over patient rest.

Cultural pressures. RNs said that they experience pressure to maintain a restful and healing environment and that may result in a decision to use less light. That pressure can originate from several sources: organizational management, from other nurses, and from the RNs themselves. Four nurses discussed recent administrative pressure to maintain or improve the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey scores (Centers for Medicare & Medicaid Services, n.d.). One RN revealed that she feels that pressure from all three reported sources: “I think I get more

pressure from my fellow nurses who say, “They said they did not sleep a wink last night,” Or I would say just like a lot of the culture around the patient population about like sleep is healing… We are a specialty hospital where we talk about sleep a lot… I think that maybe I put that pressure on myself more than anything. I know sleep is healing, and you just look at somebody and they are just clearly are dog tired. And you have to keep waking them up… I feel bad, I take that on myself and “I want you to sleep, but I have to give you this medicine, and I am going to try to do this as quickly as possible, as efficiently as possible, so that you can go right back to sleep.”

RN Bias

Interview responses revealed three internal biases that can impact an RN’s decision about altering lighting for medication administration. A fear of needle sticks increases the likelihood that a nurse will increase lighting while administering medications. However, the nurse’s prior patient care experiences and trust or distrust of bar coding technology drives the RN’s lighting tendencies in either direction, depending on their bias.

Prior patient care experience. All of the participants discussed the possibility of medication errors in very general terms. All RNs mentioned concern about harming patients or committing a medication error; several identified that a medication error could cause a death. Direct knowledge of past adverse events seemed to heighten nurses’ awareness of the possibility of patient injury. One RN discussed an experience early in her career of walking in at the beginning of a shift and finding patient who was dead. She attributed the experience to the prior nurse not completing an adequate assessment or turning on the lights. She related that she is particularly careful about lighting during

patient assessments, but also during medication administration by stating her thoughts when entering a patient room: “OK, I need to be sure that you are breathing, that you are ok, and everything looks good.” Other RNs discussed knowledge of past events where IV infusion caused long term patient harm due to extravasation. They reported that they were particularly careful with IV drugs that are known to be vesicants. Another reported an event when a patient had significant blood loss, because a connection was made without adequate lighting: “She came back up the hall a little bit later yelling for us to come down and help. We go in there, and there’s blood everywhere.”

Fear of needle sticks. The wide spread use of needleless IV systems has decreased the likelihood of needle sticks with IV piggy backs, pushes, or primary lines. However, every single participant indicated that they use more light with intramuscular or subcutaneous administration routes. RNs mentioned the need to visualize the site of administration, but were predominantly concerned with the possibility of sticking themselves and fluid exposure. One RN stated: “Giving subcutaneous or intramuscular injections, I need to be able to visualize the site, and also it helps me not stick myself, if I have adequate lighting.”

Reliance on Bar Code Administration technology. Nine of the participants worked at facilities where Bar Code Administration (BCA) technology was in use. Many RNs described experiences when the BCA system correctly indicated that a dose was incorrect. Only one RN recognized that despite an indication from the BCA that a drug was correct, she still needed to complete the step of visual verification to ensure that the drug was correct for safe medication administration. Most RNs using BCA expressed

great confidence in the technology's ability to prevent errors. Nurses with both short and long years of experience and with various education levels expressed belief that the technology would stop an administration error. "If they are like, "I have a headache. I need Tylenol." And you---just scan it—you'll see it pops up okay, and you'll sign off and not really have to turn on any lights." A nurse with an advanced degree did not recognize that the technology is only one means of error detection in an expected string of error defense steps. "The barcode is a very, very effective means of preventing medication error."

While not encountered in this sample, the pharmacy expert identified that there have been reports of the BCA machine being too large to fit into the patient room, which leads to work-arounds. For example, the nurse may take the wireless reader into the room and hear a beep for the patient and a beep for the medication. The nurse may not recognize that the auditory cue from the BCA does not change between correct and incorrect drugs. Only after administration, might the RN recognize that the drug or dose administered was incorrect from a visual indicator.

Discussion

The participants' difficulty in describing a linear decision making process about lighting decisions during medication administration is not surprising. As with other routine and familiar healthcare processes, for example connecting enteral feeds in an infant care unit (Simmons, Symes, Guenter & Graves, 2011), the decision making process is likely unconscious to the RNs and is a demonstration of automatic mode cognition (Reason, 1990). With careful probing questions, the researcher was able to

elicit some factors that influenced the RNs' processes of adjusting lighting during medication administration (Table 4.4). These findings provide the grounding for a conversation to identify when and how nurses, patients, and healthcare leaders determine adequate lighting during medication administration. These discussions are needed both in training and patient care settings.

Some findings from the Graves, Symes and Cesario (2013) literature review were confirmed: older nurses mentioned the need for more light as they age, computer work or longer shifts may result in eye fatigue, and small font sizes on medication labels were identified as problematic by some participants. Aging light bulbs may indeed be problematic in some facilities resulting in significant variation in lighting from fixtures from room to room. All shifts experience some natural light, and use it as a light source when available and palatable to the patient.

Other findings include that nurses must continually be aware of their surroundings and ensure the ability to access lighting fixtures and their switches and that equipment does not block access to those controls. However, unlike fire doors, no accrediting body is surveying for accessible lighting switches. Participant descriptions of interactions with patients and visitors demonstrate the need to set appropriate expectations with patients and visitors prior to night time medication administration to ensure that safe lighting conditions are met. Some participants described weighing more heavily the patient's need for comfort and rest or pressure from peers to meet patient expectations for sleep, which resulted in choosing lower, and perhaps unsafe, lighting levels.

This study found that ensuring adequate lighting is not an explicitly defined task. RNs reported no recollection of discussions about lighting for medication administration in school or on the job. Routine vision checks are not done in places of employment. Not one of the respondents interviewed was aware of national lighting standards. Nor did any of the participants report recollection of an organizational orientation specific to lighting for safe patient care.

One issue brought to the forefront in this study was the concern about potential injury to the RN through needle sticks. This is a problem that continues despite the use of needleless intravenous systems and federal laws in place designed to reduce this type of injury (Patrician, Pryor, Fridman & Loan, 2011). This concern deserves additional study and work to decrease the incidence of injury.

We know that human performance is not always perfect (Reason, 1990). We know that many errors in healthcare go unreported and even unnoticed (Noble & Pronovost, 2010). In a retrospective study of reported medication errors, Samaranayake, Cheung, Chui, and Cheung (2012) found that while BCA can eliminate many medication errors, some errors still occur related to poor interfaces, improper procedures or work-arounds, and incorrect labeling. While nurses in this study trusted the medication administrative technology, RNs should not blindly trust the BCA technology. A final visual check is still required to ensure that the proper drug and dose reach the proper patient at the proper time. The reasons for work-arounds in the medication process should continue to be examined.

Further study is needed to identify an explicit process to assist nurses in making conscious choices about safe lighting levels for bedside medication preparation and administration. One potential barrier to implementation is that RNs believe that they have a safe protocol in place – "I turn on the lights." However the reality is that there are many factors that have an impact on whether and which lights they do turn on. As evidenced by the interviews conducted for this study, situations in which lighting is not at optimal levels for medication administration should be expected. Nurses must learn to recognize and control the factors identified in this study that do impact the decision making process.

Limitations and Strengths

This study was designed to be an early descriptive study and the findings should be generalized with caution due to the small sample and single state location. Limitations include that interviews were conducted in a predominantly female population. The racial makeup of the participant population under sampled African American RNs as compared to the RN population of the state. Likely the most significant limitation is the inclusion of only nurses from acute care floors. There are many other levels of care including nursing homes, skilled nursing facilities, procedure areas, and intensive care units. Many of these care settings have not only darkened rooms, but dark hallways and nurse's stations as well as significant variation in staffing levels. Strengths of the study include the geographical distribution and variety of facilities represented. The qualifications of the reviewers and their agreement with the resulting model also add strength to the study.

Implications for Practice

- Discuss lighting needs for medication administration in nursing school

- Discuss lighting needs for medication administration upon hire and on the patient care units
- Train nurses to observe for placement of lighting fixtures or switches and consistency of lighting and to report safety issues to their supervisors
- Establish a script for clinical staff to use to explain to patients and family members the need for adequate lighting when administering medications to assist with patient education and establishing patient expectation
- Routinely check the vision of nurses, a very inexpensive screening method, to ensure that nurses have acceptable vision
- Establish a routine maintenance schedule of lighting fixtures for bulb cleanliness and measure bulb output
- Establish policies that ensure that medications are prepared, mixed, or measured in areas that meet explicit lighting standards (USP, 2010)
- Include bedside nurses in the early planning stages of care environment renovations or designs to ensure inclusion of the nursing practice perspective and the value of standardizing lighting fixtures, switches, and lighting
- Establish policies that ensure that medications are administered in light conditions that ensure the nurse is able to complete the procedure safely and to assess the patient
- Establish policies that ensure that incident reports for medication errors include relevant light conditions

Implications for Research

- Objectively measure actual light output in patient care areas to understand the lighting environment that nurses face, and the association of light conditions with patient outcomes
- Evaluate the impact that establishing light conditions standards for preparation, administration, and patient assessments has on patient outcomes

Conclusions

The United States Pharmacopeial Convention (USP) admonishes that "administration of medication at night under low luminance to avoid disturbing the patient or family is an unsafe practice" (USP, 2010). This study reveals that unsafe lighting practices may occur. While RNs may believe they a have a process to ensure administering medications under safe conditions, the data from this study reveals that practices vary. Clear, conscious decision making criteria about lighting decisions and medication administration have not been internalized by the profession. Much work is yet to be done to fully understand the obstacles in the nursing environment that drive unsafe decision about lighting during medication administration.

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Table 4.1.

Interview Guide

Top level queries from the semi-structured interview guide
1. Tell me about an experience administering medications to a patient where you specifically noticed the lighting of the environment. 2. Tell me about a time that was different (changed lighting if didn't in first example or didn't change if did in first example)? 3. In general, how do you decide when you have enough lighting? 4. Have any recent changes in your work environment (the additions of computers on wheels, unit renovations, etc.) had any effect on your decisions about lighting and medication administration? 5. What concerns do you have about administering medication because of the difficulty with lighting? 6. Based on your experience, is there anything more I should consider about lighting and medication administration?

Table 4.2.

Participant Criteria

Inclusion Criteria	Exclusion Criteria
• Licensed to work in the State of Texas as Registered Nurses; • Currently works at least half time; • Practices on an acute care, adult inpatient unit; • and delivers medications on the acute care unit.	• Nurses affiliated with non-acute care or outpatient units as these units are less likely to have lighting that can be modified. • Nurses affiliated with long term care or nursing home facilities. • Nurses who work with the researcher.

Table 4.3:

Participant and Facility Demographics

Participant and Facility Age Group	Nursing Experience (Years)	Highest Nursing Degree	Shift	Vision Correction Used	History of Ocular Disease or Surgery[a]	Ethnicity	Practice Unit	Facility Location	Facility Type	Teaching Facility	Facility Ownership
35-44	5.5	BS	Night	Yes	*	Hispanic	Med-Surg Telemetry	Urban	General	Yes	Not for profit-Religious
45-54	25	ADN	Day		*	Hispanic	Med Surg	Urban	General	Yes	Not for profit-Religious
25-34	5.5	BS	Night	Yes	*	White	Specialty	Urban	Specialty	Yes	Public-State
25-34	2.5	BS	Day	Yes		Hispanic	Med-Surg Telemetry	Urban	General	Yes	Not for profit-Secular
25-34	2.5	BS	Day			White	Med-Surg Telemetry	Urban	General	Yes	Public-Federal
25-34	3	BS	Day	Yes		Asian	Specialty	Urban	Specialty	Yes	Public-State
45-54	20	BS	Night	Yes		Asian	Med Surg	Suburban	General	Yes	Not for profit-Religious
55-65	11	ADN	Day	Yes		White	Med Surg	Rural	General		Not for profit-Secular
35-44	9	BS	Day		Yes	White	Telemetry	Urban	General	Yes	Not for profit-Religious
35-44	22	ADN	Night	Yes		White	Medical	Rural	General		Public-Local
55-65	38	Advanced	Night		Yes	White	Medical	Urban	General		Not for profit-Secular
25-34	8	BS	Day			White	Med-Surg Telemetry	Urban	General	Yes	Not for profit-Religious
55-65	12	BS	Day	Yes		White	Medical	Rural	General		Public-Local
35-44	16	BS	Night			Asian	Med Surg	Suburban	General		Not for profit-Religious

Participant and Facility Age Group	Nursing Experience (Years)	Highest Nursing Degree	Shift	Vision Correction Used	History of Ocular Disease or Surgery[a]	Ethnicity	Practice Unit	Facility Location	Facility Type	Teaching Facility	Facility Ownership
55-65	41	Diploma	Day	Yes	Yes	White	Float to acute care	Urban	General	Yes	Not for profit-Religious
45-54	28	Advanced	Day	Yes		African American	Med Surg	Urban	General	Yes	Public-Federal

Note. Yes/No categories with empty cells =No. [a] *=indicates question not asked.

Figure 4.1

It Depends, A Substantive Theory

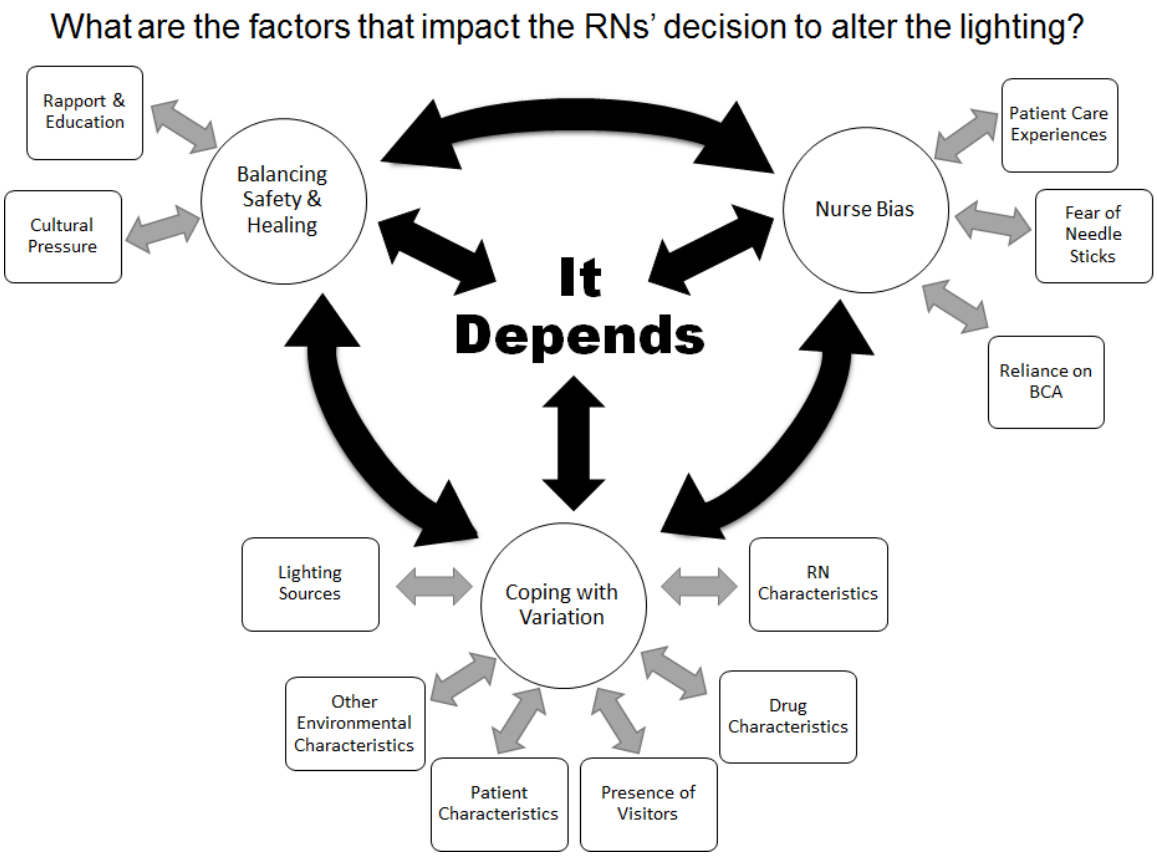

Table 4.4.

Barriers and facilitators to enhancing lighting conditions

Barriers to enhancing lighting conditions	**Facilitators to enhancing lighting conditions**
• Patient room crowded with equipment or people • Unpredictable lighting from fixtures • Younger patients • Patients with unrealistic expectations of rest/sleep • Nighttime visitors • Intravenous medication route • Production pressure • RN reluctance to wake up a patient or visitor • Administrative pressure about HCAHPS survey scores • BCA technology in use	• Availability of lighting alternatives • Predictable lighting from fixtures • Patient condition (i. e. dysphasia, sight difficulty) • Older patients • Medication labels with small fonts • Intramuscular or subcutaneous medication routes • RNs over age 45 • RN's desire to establish rapport with patient • Prior negative patient outcomes associated with low lighting • Fear of needle sticks

CHAPTER V

SUMMARY OF THE STUDY

The purpose of this descriptive grounded theory study was to describe the decision making process acute care registered nurses (RNs) follow for adjusting the lighting environment during medication administration and to identify factors that impact that process. This chapter presents a summary of the study, conclusions, implications for practice, and recommendations for further research.

Summary

This grounded theory study explored the experiences of acute care RNs and their decision making processes about lighting during medication administration. One to one, semi-structured interviews were conducted to identify the decision making process and the factors that impact that decision. A voluntary, purposive sample of 16 full time RNs was interviewed. As data collection progressed, theoretical sampling was used to recruit additional nurses with diverse demographics. Before finalization, the emerging theory was presented in aggregate form to experts in the areas of nursing process, medication processes, and cognitive psychology for validation and comparison with their own experiences. Their comments and suggestions were consistent with the data and resulted in the substantive theory, *It Depends*.

It Depends is a complex decision-making process that is often unconscious. *It Depends* is an overarching framework with three major, interrelated aspects, Coping with

Variation, Balancing Safety & Healing, and RN Bias. The interaction of one or many of the identified factors may impact the RN's lighting decision. Optimally that interaction will balance RN's lighting decisions to ensure safe medication administration, but the findings suggest that is often not the case.

Nurses face situational variants with every patient encounter. Many sources of variation that might impact lighting decisions were discussed. These include lighting sources and the environment of care, patient characteristics, the presence or absence of visitors, drug characteristics, and personal vision changes. Despite an assessment for the need for additional lighting, some respondents reported that other factors might have an impact on their lighting decisions and may lead to unsafe lighting conditions.

Nurses experience pressure to complete their work, yet they emphasized the importance of developing positive, trusting relationships with patients. Moreover, they discussed a desire to ensure that the patient environment is restful and healing. Participants frequently identified that balancing the need for safety with the need for a healing environment is not always easy.

Three internal biases that can impact an RN's decision about altering lighting for medication administration were identified in the data. A normal fear of needle sticks increases the likelihood that a nurse will increase lighting while administering medications. However, the nurse's prior patient care experiences and trust or distrust of bar coding technology may drive lighting tendencies in either direction.

Discussion

The decision making process about lighting during medication administration is likely unconscious to the RNs, demonstrating James Reason's (1009) automatic mode cognition. Some findings from the Graves, Symes and Cesario (2013) literature review were confirmed: older nurses recall needing more light as they age, computer work and longer shifts can result in eye fatigue, and small font sizes on medication labels are problematic for some participants. Aging light bulbs may result in variation in lighting fixture output from room to room.

One issue brought to the forefront in this study was the concern about potential injury to the RN through needle sticks. Needle sticks remain a real and ever present potential injury to healthcare workers and does seem to influence nurses when they are preparing to administer an injection (Patrician, Pryor, Fridman & Loan, 2011). This concern deserves additional study and work to decrease the incidence of injury.

A retrospective study of reported medication errors confirmed that BCA does not eliminate all medication errors (Samaranayake, Cheung, Chui & Cheung, 2012). Somewhat alarming, in this study nurses reported having high trust in the medication administrative technology, RNs should not blindly trust the BCA technology. A final visual check is to the final requirement to ensure that the proper drug and dose reach the proper patient at the proper time.

Conclusions

Conclusions derived from this study include:

1. Much like other routine and familiar healthcare processes, the decision making process about lighting during medication administration is likely unconscious to the RNs and is a demonstration of automatic mode cognition.
2. A nurse's assessment that more light is needed for medication administration does not always result in increased illumination.
3. There is little discussion about the impact of low lighting environments on patient safety among nurses or the profession.
4. The aging population will require more light for optimal reading and medication verification tasks.
5. Bar code administration technology does not take the place of the final visual verification by the nurse.
6. Appropriate expectations about lighting and safety should be discussed with patients and visitors prior to night time medication administration.

Implications for Practice

Based on the findings of this study, the following recommendations for nursing practice are included:

- Discuss lighting needs for medication administration in nursing school and include inadequate lighting situations in medication administration simulations
- Discuss lighting needs for medication administration upon hire and on the patient care units

- Train nurses to observe for placement of lighting fixtures or switches and consistency of lighting and to report safety issues to their supervisors
- Establish a script for clinical staff to use to explain to patients and family members the need for adequate lighting when administering medications to assist with patient education and establishing patient expectation
- Routinely check the vision of nurses, a very inexpensive screening, to ensure that nurses have acceptable vision
- Establish a routine maintenance schedule of lighting fixtures for bulb cleanliness and measure bulb output.
- Establish policies that ensure that medications are prepared, mixed, or measured in areas that meet explicit lighting standards (USP, 2010)
- Include bedside nurses in the early planning stages of care environment renovations or designs to ensure inclusion of the nursing practice perspective and the value of standardizing lighting fixtures, switches, and lighting
- Establish policies that ensure that medications are administered in light conditions that ensure the nurse is able to complete the procedure safely and to assess the patient (USP, 2010)
- Establish policies that ensure that incident reports for medication errors include relevant light conditions

Implications for Research

Based on the findings of this study, recommendations for further research include:

- Objectively measure actual light output in patient care areas to understand the lighting environment that nurses face, and the association of light conditions with patient outcomes
- Evaluate the impact that establishing light conditions standards for medication preparation, administration, and patient assessments has on patient outcomes

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APPENDIX A

Recruitment Email

Greetings! I am Krisanne Graves, a Registered Nurse and a doctoral student at Texas Woman's University on the Houston Campus. I am conducting a study for my dissertation and am currently recruiting participants.

Study Title: Nurses' decision making processes about lighting during medication administration

Purpose of the study: To explore the decision making processes that nurses use about lighting during medication administration

You may meet criteria to participate if:

- You are licensed to work in the State of Texas as a Registered Nurse (RN);
- Currently work at least half time;
- Practice on an acute care, adult inpatient unit;
- and deliver medications on that unit.

If you meet the above criteria and are interested in participating in this research study, please contact the researcher: Krisanne Graves @ kgraves@twu.edu or 713.305.9191. If you are not interested or do not qualify for the study, I would greatly appreciate it if you would consider passing this information along to other possible RN participants by email or word of mouth.

Additional details: Participation includes an audio recorded interview. The interview should take about an hour and you may take breaks or stop the interview at any time you wish without penalty of any kind. If you decide at any time that you do not want to participate in the study, you may, and again without penalty.

The only compensation that you would receive for participation in this study is a $20 Amazon gift card, my gratitude, and the hope that the information developed over the period of the study will help to improve patient care.

Best regards,

Krisanne Graves, RN, MSN, CPHQ
kgraves@twu.edu
713.305.9191

APPENDIX B

Informed Consent

TEXAS WOMAN'S UNIVERSITY
CONSENT TO PARTICIPATE IN RESEARCH

Title: Nurses' decision-making processes about lighting during medication administration

Investigator: Krisanne Graves .....kgraves@twu.edu 713/305-9191
Advisor: Lene Symes, PhD .....lsymes@twu.edu 713/794-2151

Explanation and Purpose of the Research

You are being asked to participate in a research study for Ms. Graves' dissertation at Texas Woman's University. The purpose of this research is to identify nurses' decision-making processes about lighting during medication administration. You have been asked to participate in this study because you are a Registered Nurse who works at least half time on an acute care, adult, inpatient unit and who administers medications.

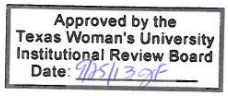
Description of Procedures

As a participant in this study, you will be asked to spend approximately one hour in a one-to-one, audio-recorded interview with the researcher. You may select either a telephone interview or a face-to-face interview at a mutually agreed upon location with auditory privacy. The researcher will ask you questions about your experiences administering medications and the decisions that you make about lighting while doing so. The interview will be audio recorded and then transcribed so that the researcher can be accurate when studying what you have said. If there is any confusion about the written version, the researcher may contact you by telephone to clarify your words or meaning. In order to be a participant in this study, you must be at least 18 years of age and be a Registered Nurse, licensed in the State of Texas and currently working at least half time on an acute care, adult, inpatient unit where you administer medications.

Potential Risks

The researcher will ask you questions about your experiences with light conditions when administering medications and the decisions that you make about lighting while doing so. A possible risk in this study is fatigue during the interview. If you become tired, you may take breaks as needed. You may also stop answering questions at any time and end the interview without penalty.

Another risk in this study is loss of confidentiality. As you have the option to communicate with the researcher by email, there is a potential risk of loss of confidentiality in all email, downloading, and internet transactions. Confidentiality will be protected to the extent that is allowed by law. The interview will be held at a location that you and the researcher have agreed upon that has auditory privacy. The audio recording and any papers with identifying information will be stored in a double-locked cabinet in the researcher's home. Only the researcher and her advisor will hear the recording. The recording and any papers with identifying information will be destroyed within 2 years after the study is finished. The results of the study will be reported in scientific magazines or journals but your name or any other identifying information will not be included.



Initials of Participant
Page 1 of 1

The researcher will try to prevent any problem that could happen because of this research. You should let the her or her faculty advisor know at once if there is a problem and they will help you.

Participation and Benefits

Your involvement in this study is voluntary and you may withdraw from the study at any time. Following the completion of your interview, you will receive a $20 Amazon gift card for your participation. If you would like to know the results of this study the researcher will email or mail them to you.*

Questions Regarding the Study

You will be given a copy of this signed and dated consent form to keep. If you have any questions about the research study you should ask the researcher; her phone number, and that of her faculty advisor, are at the top of this form. If you have questions about your rights as a participant in this research or the way this study has been conducted, you may contact the Texas Woman's University Office of Research at 713-794-2480 or via e-mail at IRB@twu.edu.

_____ _____

Signature of Participant Date

*If you would like to know the results of this study tell us where you want them to be sent (Please identify your preference by checking the appropriate box):

☐ Email: _____
or

☐ Address:

_____

_____

_____

Researcher Assigned Code: _____

Approved by the
Texas Woman's University
Institutional Review Board
Date: 9/25/13 JF

APPENDIX C

Demographic Data Collection Form

Demographic Data Form **Code:**

Question	Response
Highest Nursing Degree	Diploma ADN BS MS Doctorate
Years nursing experience	
Facility Location	Urban Suburban Rural
Facility Service Type	General Teaching Specialty
Facility Ownership Type	Public-Federal Public-State Public-Local Public-Prison Not-for Profit: Secular Not-for Profit: Religious For-Profit Physician-Owned
Practice Unit Type	
Years on Current Unit	
Average Hours per week worked	
Normal shift worked	
Age in years	
Gender	
Ethnicity	
Do you require corrective lenses for distance?	
Do you require corrective lenses for reading?	
Do you use corrective lenses at work?	
Have you ever had any ocular diseases or eye surgeries?	

APPENDIX D

Semi-Structured Interview Guide

Semi-Structured Interview Guide

Thank you again for agreeing to this interview. As a reminder, we are here to discuss your experiences with light conditions when administering medications and the decisions that you make about lighting while doing so. If you become tired, you may take breaks as needed and you may also stop answering questions at any time and end the interview without penalty. So, let's begin…

1. Tell me about an experience administering medications to a patient where you specifically noticed the lighting of the environment.
    1.1. Describe the steps you went through in administering the medication.
        1.1.1. What did you do first?
            1.1.1.1. What was happening with the light?
                1.1.1.1.1. What did you do about the light?
        1.1.2. What did you do next?
            1.1.2.1. What was happening with the light?
            1.1.2.2. What did you do about the light? (repeat this sequence as needed)
        1.1.3. How did you decide if you had enough light to perform a task well?
            1.1.3.1. What about the task effected that decision?
            1.1.3.2. What about the place you were doing the task effected that decision?
            1.1.3.3. What about your visual acuity influenced your decision?
            1.1.3.4. How did you know if your decision was a good one?
        1.1.4. How did the patient or the patient's condition affect your decision?
        1.1.5. How did the patient's family or visitors affect your decision?
        1.1.6. How did the medication that you were administering affect your decision?
            1.1.6.1. The drug itself?
            1.1.6.2. The route?
            1.1.6.3. The packaging?
2. Tell me about a time that was different (changed lighting if didn't in first example or didn't change if did in first example)?
        2.1.1. What did you do first?
            2.1.1.1. What was happening with the light?
                2.1.1.1.1. What did you do about the light?
        2.1.2. What did you do next?
            2.1.2.1. What was happening with the light?
                2.1.2.1.1. What did you do about the light? (repeat this sequence as needed)
        2.1.3. How did you decide if you had enough light to perform a task well?
            2.1.3.1. What about the task effected that decision?
            2.1.3.2. What about the place you were doing the task effected that decision?
            2.1.3.3. What about your visual acuity influenced your decision?

2.1.3.4. How did you know if your decision was a good one?
2.1.4. How did the patient or the patient's condition affect your decision?
2.1.5. How did the patient's family or visitors affect your decision?
2.1.6. How did the medication that you were administering affect your decision?
2.1.6.1. The drug itself?
2.1.6.2. The route?
2.1.6.3. The packaging?

3. Thank you for the specific examples. In general, how do you decide when you have enough lighting?
   3.1. How does the task effect that decision?
   3.2. How does the room itself influence that decision?
   3.3. How has your aging influenced that decision?
   3.4. How does your visual acuity influence that decision?
   3.5. How does the patient or the patient's condition shape that decision?
   3.6. How does the patient's family or other visitors impact that decision?
   3.7. How does the medication that you were administering affect that decision?
      3.7.1. The drug itself?
      3.7.2. The route?
      3.7.3. The packaging?
4. Have any recent changes in your work environment (the additions of computers on wheels, unit renovations, etc) had any effect on your decisions about lighting and medication administration?
5. What concerns do you have about administering medication because of the difficulty with lighting?
6. Based on your experience, is there anything more I should consider about lighting and medication administration?

Probes

- That is interesting, tell me more…
- Give me an example.

APPENDIX E

Institutional Review Board Approval Letters

TWU
TEXAS WOMAN'S UNIVERSITY
DENTON DALLAS HOUSTON

Office of Research
6700 Fannin Street
Houston, TX 77030-2343
713-794-2480 Fax 713-794-2488

August 21, 2012

Ms. Krisanne Graves
College of Nursing
6700 Fannin Street
Houston, TX 77030

Dear Ms. Graves:

Re: Nurses' decision making processes about lighting during medication administration (Protocol #: 17091)

Your application to the IRB has been reviewed and approved.

This approval lasts for one (1) year. The study may not continue after the approval period without additional IRB review and approval for continuation. It is your responsibility to assure that this study is not conducted beyond the expiration date.

Any modifications to this study must be submitted for review to the IRB using the Modification Request Form. Additionally, the IRB must be notified immediately of any unanticipated incidents. If you have any questions, please contact the TWU IRB.

The signed consent forms, as applicable, and final report must be filed with the Institutional Review Board in the Office of Research, IHS 10110, at the completion of the study.

Sincerely,

Carolyn Kelley, PT, DSc, NCS
Institutional Review Board - Houston

TWU
TEXAS WOMAN'S UNIVERSITY
DENTON DALLAS HOUSTON

Office of Research
6700 Fannin Street
Houston, TX 77030-2343
713-794-2480 Fax 713-794-2488

July 25, 2013

Ms. Krisanne Graves
College of Nursing
6700 Fannin Street
Houston, TX 77030

Dear Ms. Graves:

Re: Nurses' decision making processes about lighting during medication administration (Protocol #: 17091)

The request for an extension of your IRB approval for the above referenced study has been reviewed by the TWU Institutional Review Board (IRB) and appears to meet our requirements for the protection of individuals' rights.

If applicable, agency approval letters must be submitted to the IRB upon receipt PRIOR to any data collection at that agency. A copy of the approved consent form with the IRB approval stamp is enclosed. Please use the consent form with the most recent approval date stamp when obtaining consent from your participants. A copy of the signed consent forms must be submitted with the request to close the study file at the completion of the study.

This extension is valid one year from July 25, 2013. Any modifications to this study must be submitted for review to the IRB using the Modification Request Form. Additionally, the IRB must be notified immediately of any unanticipated incidents. If you have any questions, please contact the TWU IRB.

Sincerely,

Carolyn Kelley, PT, DSc, NCS
Institutional Review Board - Houston

cc. Dr. Karen Lyon, College of Nursing - Houston
Lene Symes, PhD, College of Nursing - Houston
Graduate School

APPENDIX F

Manuscript Acceptance Letter

Via email:

Aug 18, 2013

RE: JNCQ-D-13-00101, titled "Light for Nurses' Work in the 21st Century: A Review of Lighting, Human Vision Limitations, and Medication Administration"

Dear Ms, Graves,

I am pleased to inform you that your manuscript has been accepted for publication in the Journal of Nursing Care Quality with minor revision. Please find the comments of the reviewers and editor listed below. Submit your signed copyright releases with your revised manuscript (carry them over to the final submission).

The revisions should be completed by Oct 17, 2013 to avoid being considered as a new submission. To submit a revision, go to http://jncq.edmgr.com/ and log in as an Author. You will see a menu item called "Submission Needing Revision." Please click on this item to obtain your submission record and begin the revision process.

Sincerely,

Marilyn H. Oermann, PhD, RN, FAAN
Editor
Journal of Nursing Care Quality

APPENDIX G

Manuscript Submission Acknowledgement

Via email:

11-Mar-2014

Dear Ms. Graves:

Your manuscript entitled "Is There Light? Well It Depends – A Grounded Theory Study of Nurses, Lighting, and Medication Administration" has been successfully submitted online and is presently being given full consideration for publication in Nursing Forum.

Your manuscript ID is NF-03-14-OA-0475.

Please mention the above manuscript ID in all future correspondence or when calling the office for questions. If there are any changes in your street address or e-mail address, please log in to Manuscript Central at http://mc.manuscriptcentral.com/nf and edit your user information as appropriate.

You can also view the status of your manuscript at any time by checking your Author Center after logging in to http://mc.manuscriptcentral.com/nf.

Thank you for submitting your manuscript to Nursing Forum.

Sincerely,
Nursing Forum Editorial Office