THE EFFECT OF LIGHTING ON THE CAREGIVERS’ SATISFACTION IN A NEONATAL INTENSIVE CARE UNIT

By

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To my Mom, Nahid, my Dad, Mohammad and my Sisters, Romina & Roya Mozaffarian
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>4</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>10</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>11</td>
</tr>
<tr>
<td>LIST OF ABBREVIATIONS</td>
<td>13</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>14</td>
</tr>
<tr>
<td>CHAPTER</td>
<td></td>
</tr>
<tr>
<td>1 INTRODUCTION</td>
<td>16</td>
</tr>
<tr>
<td>Research Purpose</td>
<td>19</td>
</tr>
<tr>
<td>Research Questions</td>
<td>20</td>
</tr>
<tr>
<td>Summary</td>
<td>20</td>
</tr>
<tr>
<td>Definition of Terms</td>
<td>21</td>
</tr>
<tr>
<td>2 LITERATURE REVIEW</td>
<td>22</td>
</tr>
<tr>
<td>Healthcare Design</td>
<td>22</td>
</tr>
<tr>
<td>Neonatal Intensive Care Unit Design</td>
<td>23</td>
</tr>
<tr>
<td>Lighting Design in NICU</td>
<td>24</td>
</tr>
<tr>
<td>IESNA Lighting Recommendations</td>
<td>33</td>
</tr>
<tr>
<td>General Lighting vs. Task Lighting</td>
<td>33</td>
</tr>
<tr>
<td>Color Rendering Quality</td>
<td>34</td>
</tr>
<tr>
<td>Circadian Rhythm vs. Vision</td>
<td>34</td>
</tr>
<tr>
<td>Day Shift vs. Night Shift</td>
<td>35</td>
</tr>
<tr>
<td>Control, Glare, Shadow and Vertical Surfaces</td>
<td>37</td>
</tr>
<tr>
<td>Conclusion</td>
<td>37</td>
</tr>
<tr>
<td>3 RESEARCH METHODS</td>
<td>38</td>
</tr>
<tr>
<td>Study Design</td>
<td>38</td>
</tr>
<tr>
<td>Case Selection Criteria</td>
<td>38</td>
</tr>
<tr>
<td>Setting</td>
<td>39</td>
</tr>
<tr>
<td>NICU II</td>
<td>42</td>
</tr>
<tr>
<td>Newborn Care Area II</td>
<td>42</td>
</tr>
<tr>
<td>Support Areas in NICU II</td>
<td>45</td>
</tr>
<tr>
<td>NICU III</td>
<td>45</td>
</tr>
<tr>
<td>Newborn Care Area</td>
<td>45</td>
</tr>
<tr>
<td>Support Areas in NICU III</td>
<td>52</td>
</tr>
<tr>
<td>Participants</td>
<td>56</td>
</tr>
</tbody>
</table>
Research Instruments ........................................................................................................ 57
  Observation ............................................................................................................... 57
  Documentation ............................................................................................................ 57
  Survey ...................................................................................................................... 58
  Interview .................................................................................................................. 60
Pilot Study ..................................................................................................................... 60
Sampling and Data Collection ........................................................................................ 61
  Informed Consent ...................................................................................................... 61
  Observation and Documentation ............................................................................... 62
  Survey ....................................................................................................................... 62
  Interview .................................................................................................................. 63
Data Analysis .................................................................................................................. 63
Problems and Limitations .............................................................................................. 63

4 RESULTS ...................................................................................................................... 65
Characteristics of the Participants .................................................................................... 65
Comparison of the Observation and Documentation Findings (Existing
  Conditions of Shands NICU) with the IESNA Recommended Standards .................. 68
  Newborn Care Areas .................................................................................................. 68
    NICU II: .................................................................................................................... 68
    NICU III ................................................................................................................... 68
  Support Areas ............................................................................................................ 73
    Support areas in NICU II ......................................................................................... 73
    Support areas in NICU III ....................................................................................... 74
Summary of Observation and Documentation Findings .................................................. 75
Survey Findings .............................................................................................................. 75
  Lighting Satisfaction Analysis by Groups .................................................................... 76
    Doctors’ satisfaction with newborn care areas ....................................................... 76
    Doctors’ satisfaction with support areas ............................................................... 77
    Summary .................................................................................................................. 77
    Nurses’ Satisfaction with newborn care areas ........................................................ 78
    Nurses’ satisfaction with support areas ................................................................. 79
    Summary .................................................................................................................. 80
    Families’ satisfaction with newborn care areas ....................................................... 81
    Families’ satisfaction with support areas ............................................................... 81
    Summary .................................................................................................................. 81
Comparison of Caregivers’ Satisfaction ......................................................................... 82
Interview Findings ........................................................................................................... 91
  General Lighting ........................................................................................................... 92
  Task Lighting and Natural Lighting ............................................................................. 93
  Controllability ............................................................................................................. 93

5 DISCUSSION ............................................................................................................... 94
Research Question One- To What Extent, If Any, Does Shands NICU Existing
  Lighting Condition, Meet The IESNA Recommended Standards? ............................. 94
General Lighting ........................................................................................................ 94
Task Lighting ........................................................................................................... 99
Natural Lighting ..................................................................................................... 100
Controllability ....................................................................................................... 101

Research Question Two- How Satisfied Are the Caregivers from the Existing Shands NICU Lighting Conditions? ................................................................. 103
What are the Visual Tasks that Each Group of Caregivers Do While Spending Time in NICU? ......................................................................................... 103
What Is Caregivers’ Satisfaction Level With The General And Task Lighting? ........................................................................................................... 104
What Is Caregivers’ Satisfaction Level with the Natural Lighting? ...................... 112
What Is Caregivers’ Satisfaction Level With Lighting Controllability? .............. 114

Conclusion and Further Research ........................................................................ 115

APPENDIX

A  IRB APPROVAL ........................................................................................................ 118
B  CONSENT FORM .................................................................................................... 119
C  RESEARCH AND INFORMATION PRIVACY AT THE UNIVERSITY OF FLORIDA CERTIFICATION .................................................................................. 120
D  CONFIDENTIALITY STATEMENT ........................................................................ 121
E  SURVEY INSTRUMENT 1 (DOCTORS, NURSE PRACTITIONERS & RESIDENTS) ............................................................................................................. 122
F  SURVEY INSTRUMENT 2 (NURSES, RESPIRATORY THERAPISTS & TRANSPORT TEAM) ............................................................................................ 126
G  SURVEY INSTRUMENT 3 (PARENTS AND FAMILIES) ....................................... 129
H  INTERVIEW INSTRUMENT 1 (DOCTORS, NURSE PRACTITIONERS & RESIDENTS) ............................................................................................................. 133
I  INTERVIEW INSTRUMENT 2 (NURSES, RESPIRATORY THERAPISTS & TRANSPORT TEAM) ............................................................................................ 134
J  INTERVIEW INSTRUMENT 3 (PARENTS AND FAMILY) .................................... 135
K  PARTICIPANTS’ COMMENTS ............................................................................... 136
L  FREQUENCY FOR PARTICIPANTS’ LIGHTING SATISFACTION IN INTERVIEW ............................................................................................................ 153

LIST OF REFERENCES .............................................................................................. 155
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1</td>
<td>Sample of IESNA lighting recommendations for NICU</td>
<td>36</td>
</tr>
<tr>
<td>4-1</td>
<td>Characteristics of the staff participants</td>
<td>66</td>
</tr>
<tr>
<td>4-2</td>
<td>Characteristics of the family participants</td>
<td>67</td>
</tr>
<tr>
<td>4-3</td>
<td>Comparison of Shands existing general lighting in NICU to IESNA recommended standards</td>
<td>70</td>
</tr>
<tr>
<td>4-4</td>
<td>Comparison of Shands existing general lighting in NICU support areas to IESNA recommended standards</td>
<td>72</td>
</tr>
<tr>
<td>4-5</td>
<td>Comparison of Shands existing task lighting in NICU to IESNA recommended standards</td>
<td>73</td>
</tr>
<tr>
<td>4-6</td>
<td>Comparison of Shands existing natural lighting in NICU to IESNA recommended standards</td>
<td>73</td>
</tr>
<tr>
<td>4-7</td>
<td>Mean (M) and Standard Deviation (SD) scores for caregiver’s satisfaction</td>
<td>84</td>
</tr>
<tr>
<td>4-8</td>
<td>Mean (M) and Standard Deviation (SD) scores for staff’s level of satisfaction with light supporting their tasks in their used spaces</td>
<td>87</td>
</tr>
<tr>
<td>4-9</td>
<td>Mean (M) and Standard Deviation (SD) scores for families’ level of satisfaction with light supporting their tasks in their used spaces</td>
<td>87</td>
</tr>
<tr>
<td>4-10</td>
<td>Mean (M) and Standard Deviation (SD) scores for staff’s level of satisfaction with light control</td>
<td>88</td>
</tr>
<tr>
<td>4-11</td>
<td>Mean (M) and Standard Deviation (SD) scores for families’ level of satisfaction with light control</td>
<td>88</td>
</tr>
<tr>
<td>4-12</td>
<td>Frequency for participants’ comments on lighting dissatisfaction in surveys</td>
<td>89</td>
</tr>
<tr>
<td>4-13</td>
<td>Mean and standard deviation for lighting satisfaction (Post-HOC test)</td>
<td>90</td>
</tr>
<tr>
<td>4-14</td>
<td>Mean and standard deviation for lighting satisfaction (ANOVA test)</td>
<td>91</td>
</tr>
<tr>
<td>K-1</td>
<td>Caregivers’ Comments in Surveys</td>
<td>151</td>
</tr>
<tr>
<td>L-1</td>
<td>Frequency for participants’ lighting satisfaction in interview</td>
<td>153</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-1</td>
<td>Shands NICU ceiling/lighting plan</td>
<td>41</td>
</tr>
<tr>
<td>3-2</td>
<td>Shands NICU floor plan (zoning diagram)</td>
<td>41</td>
</tr>
<tr>
<td>3-3</td>
<td>Shands NICU furniture and equipment plan</td>
<td>42</td>
</tr>
<tr>
<td>3-4</td>
<td>The isle along NICU II</td>
<td>43</td>
</tr>
<tr>
<td>3-5</td>
<td>NICU II general lighting</td>
<td>43</td>
</tr>
<tr>
<td>3-6</td>
<td>NICU II ceiling plan</td>
<td>44</td>
</tr>
<tr>
<td>3-7</td>
<td>NICU II floor plan</td>
<td>44</td>
</tr>
<tr>
<td>3-8</td>
<td>Newborn care area III floor plan</td>
<td>46</td>
</tr>
<tr>
<td>3-9</td>
<td>Newborn care area III floor plan</td>
<td>46</td>
</tr>
<tr>
<td>3-10</td>
<td>Typical bed spaces in NICU III</td>
<td>47</td>
</tr>
<tr>
<td>3-11</td>
<td>Typical bed spaces in NICU III</td>
<td>47</td>
</tr>
<tr>
<td>3-12</td>
<td>Typical general lighting for bed spaces in NICU III</td>
<td>48</td>
</tr>
<tr>
<td>3-13</td>
<td>Emergency lights (spot light)</td>
<td>49</td>
</tr>
<tr>
<td>3-14</td>
<td>Warmer with task light</td>
<td>50</td>
</tr>
<tr>
<td>3-15</td>
<td>Old task lights</td>
<td>50</td>
</tr>
<tr>
<td>3-16</td>
<td>New task lights (girrafe)</td>
<td>51</td>
</tr>
<tr>
<td>3-17</td>
<td>General lighting in hallways</td>
<td>53</td>
</tr>
<tr>
<td>3-18</td>
<td>Lighting in on-call room</td>
<td>54</td>
</tr>
<tr>
<td>3-19</td>
<td>Lighting in the lobby (waiting room)</td>
<td>55</td>
</tr>
<tr>
<td>3-20</td>
<td>Lighting in pump room</td>
<td>55</td>
</tr>
<tr>
<td>4-1</td>
<td>A bed space with no general or task lighting</td>
<td>69</td>
</tr>
<tr>
<td>4-2</td>
<td>Task area with no general or task lighting</td>
<td>71</td>
</tr>
<tr>
<td>4-3</td>
<td>Covering isolates with sheets to prevent direct light exposure to babies’ eyes</td>
<td>71</td>
</tr>
</tbody>
</table>
4-4 Frequency of usage for spaces used by “doctors” group (showed in percentage) .............................................................................................................................. 78
4-5 Frequency of usage for spaces used by “nurses” group (showed in percentage) .............................................................................................................................. 80
4-6 Frequency of usage for spaces used by “family” group (in percentage) .......... 82
4-7 Frequency of visual tasks done by staff (showed in percentage) ....................... 83
4-8 Frequency of tasks done by families (showed in percentage)............................. 84
4-9 Comparison of the means of level of light quality satisfaction for all three groups of caregivers ............................................................................................................. 86
4-10 The frequency of caregivers’ usage of the controllable lighting features they have access to.................................................................................................................. 86
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRI</td>
<td>Color Rendering Index</td>
</tr>
<tr>
<td>IESNA</td>
<td>Illuminating Engineering Society of North America</td>
</tr>
<tr>
<td>IRB</td>
<td>Institutional Review Board</td>
</tr>
<tr>
<td>LED</td>
<td>Light-Emitting Diode</td>
</tr>
<tr>
<td>NICU</td>
<td>Neonatal Intensive Care Unit</td>
</tr>
<tr>
<td>PICU</td>
<td>Pediatric Intensive Care Unit</td>
</tr>
</tbody>
</table>
Abstract of Thesis Presented to the Graduate School of the University of Florida in Partial Fulfillment of the Requirements for the Master of Interior Design Degree

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By

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The concept of healing environment in healthcare has been of great importance in the past few years. One of the departments of hospitals that can greatly benefit from this theory is NICU. Newborns and caregivers are in a tense and critical situation and providing a soothing and at the same time practical environment for them has a great impact on both the healing of newborns and caregivers’ health and job performance. One of the design aspects that can contribute to achieve this goal is lighting; especially in NICU, lighting has great importance since the level of lighting needed by newborns is different than that by caregivers (Dalke et al., 2005).

This study is a case study of the NICU department in Shands Hospital at the University of Florida and focuses on caregivers’ lighting satisfaction in NICU as well as providing a comparison of the existing lighting condition of Shands NICU and the IESNA lighting recommendations. A total of 96 doctors, nurses and families randomly participated in this study. They were given a questionnaire that asked for their demographic questions, their tasks and their satisfaction level with different aspects of lighting in Shands NICU. The aspects of lighting quality were majorly categorized as
general lighting, task lighting, natural lighting and controllability. The participants were also asked to volunteer in an interview and 10 people in each group participated in it.

The results show different levels of satisfaction based on groups’ demographic, their tasks and the aspect of lighting quality being evaluated. The major difference was between nurses and family members; this could be mainly because of the difference in their age and tasks. The results also show that following the recommended standards does not necessarily guarantee caregivers’ satisfaction. This study recommends some improvements in the IESNA recommended standards. For example, some of the recommendations by IESNA are too general and need to be proposed more in depth and details based on each group of caregivers, their tasks and demographics. Results also show that Shands NICU lighting needs some improvements such as focusing more on the quality of task lighting so that the general lighting is used only for navigation and minimal levels of facial recognition. This way the problem of newborns needing dim light for their circadian rhythm and caregivers needing bright light because of their tasks, can be solved. The issues of controllability and direct light exposure to the newborns’ eyes are very importance in Shands NICU.

Further researches could expand the number of case studies in order to come up with a more detailed recommendation for NICU lighting design and also to be able to generalize the results for all NICU’s. Also, the issue of effects of environmental factors on job satisfaction can be looked at in more details in future studies. The impact of natural lighting on caregivers stress and satisfaction can be also studied more in depth by choosing a healthcare environment that relies on natural lighting more than Shands NICU.
CHAPTER 1
INTRODUCTION

For the past decade, reducing environmental impacts has been the goal of healthcare industry; they pursue this goal by engaging in a transformation of design, construction, and operational practices. Today, Hospitals and healthcare environment represent an essential societal function with the fundamental goal of caring for and healing the sick (Guenther et al., 2006). Recent reviews and books (e.g. Devlin & Arneill, 2003; Verderber & Fine, 2000) have documented the evolution of the health care environment and the role that physical design may play in health and well-being.

What is of fundamental importance in this, is that the physical environment might be considered either as a source of stress or as a source of coping resources. Study has frequently found that physical and psychological elements interact in their effect on well-being (Leather et al., 1998). The concept of healing environments suggests that the physical environment of the healthcare settings can affect the healing process and patients’ feelings of well-being in a positive way. However, conclusive evidence in scrutinizing the effects of specific environmental stimuli is still very limited and difficult to generalize (Dijkstra et al., 2006). Study shows (Dijkstra, 2006) that physical environmental stimuli that turn healthcare facilities into healing environments is being challenged; also, the focus on healthcare is more as a “curing machine” for medical conditions, rather than as an environment to promote wellness for the individual (Arnell & Devlin, 2002).

The framework proposed by Rashid & Zimring (2008) groups the physical environmental variables into two categories: indoor environmental variables and interior design variables. Indoor environmental variables include noise, lighting, ambient
temperature, and air quality, whereas interior design variables include the use of space, furniture, fixtures and equipment, finishing materials, color, artwork, natural views, and environmental graphics. Previous investigations suggested that not enough evidence and research exist in the area of lighting. The existence of very old and limited research articles, such as that by Mehrabian and Russell (1974) or Dijkstra and colleagues (2006), indicate the need for the evaluation of the importance of features like lighting. Lighting has been of a great importance in healthcare environment since color and lighting can have an impact on people’s perceptions and responses to the environment and also affect patient recovery rates, improving the quality and overall experience of patients, staff and visitors.

According to Kenner and Lott (2007), one section of hospitals that requires specific attention to its lighting is Neonatal Intensive Care Unit (NICU). NICU is defined as intensive care unit designed for premature and ill newborn babies, by Med Term website. Based on March of Dimes, approximately 3,000,000 babies are born each year in the United States and 543,000 of them, or 1 in 8, are born prematurely. This figure is growing fast due to rapid growth of population of the United States which has been about 1.1% each year since the year 2000 (U.S. Census website: http://quickfacts.census.gov/); therefore the need for NICU continues to increase as well as the number of parents and family members who use spaces in NICU. Along with that the need for more caregivers such as doctors and nurses increases. On the other hand, the challenge of maintaining staff effectiveness will be increasingly important as the number of nurses is decreasing and the aging population is increasing (Ulrich et al., 2008). Jobs by nurses, physicians, and other healthcare workers often include direct
patient care, critical communications, charting, accessing technology and information, and other tasks. A lot of these tasks are visual tasks that need proper lighting and need a level of lighting that is different than that by caregivers (Carlson et al., 2006). Newborns need lower lighting level but the doctors and nurses need a higher level of illumination for their tasks. So, the lighting needs in NICU are almost bipolar (Ulrich et al., 2008); therefore, lighting design is of a great importance in NICU design and lighting matters are not only related to newborns wellbeing but also the caregivers’ wellbeing and ability to work well as well as the family of the newborns.

Also, changes are needed in NICU (Carlson et al., 2006) to keep caregivers satisfied. Newborns are the center point of the NICU and that is why most researches have studied the needs of the newborns and how to design NICU to improve the environment for them but we need satisfied and healthy caregivers to take care of the babies; therefore it is time to focus on the caregivers as much as newborns and make changes in NICU design to meet their needs. A growing body of evidence on the developmentally appropriate healing environment for neonates also suggests that changes are needed in NICU design. One good reason for this, suggested by Ulrich and colleagues (2008) is that the growth in the number of premature babies causes problems like admitting more babies than their bed spaces and not having adequate lighting for each baby which can often increase staff anxiety and reduce effective care delivery. So even though the job requirements and volume has changed for the caregivers, many hospitals have not been redesigned. There have been recommended standards for NICU design on different aspects including lighting by Illumination Engineering Society of North America (IESNA), but hospitals are rarely able to follow
these standards (Dalke et al., 2005). The Consensus Committee to Develop Recommended Standards for NICU Design has developed recommended lighting standards for the NICU, based on IESNA standards.

Although there have been studies about lighting needs of newborns in NICU, not enough study has been done to focus on the caregivers’ need. Study shows lighting in NICU is often poorly maintained, concentrating only on basic requirements for task illumination resulting in a poor visual environment for caregivers (Dalke et al., 2005). Therefore, this study seeks to explore the effect of lighting as an environmental stimulus on caregivers’ satisfaction in NICU, in order to help them have a higher satisfaction and better job performance.

**Research Purpose**

Little is known about the effects of lighting on caregivers’ satisfaction; also, a few bodies of evidence are available that studied about the adequate lighting required for caregivers as well as newborns. We are still in an evolutionary phase of NICU design because the optimal lighting environment has not yet been defined (White, 2000).

The purpose of this study is to investigate the existing lighting conditions in Shands NICU as a case study and to compare it with the IESNA lighting recommendations for NICU; also, to measure the caregivers’ satisfaction with this lighting condition. Based on Rea (2004), the word caregivers include doctors, nurses and families of newborns and that is what this word is used for in this study.

Lighting perceptions are how lighting is perceived along dimensions of lighting quality: brightness and color of light. Lighting preference is defined as people favoring one lighting condition over another (Rea, 2000). Lighting satisfaction is how caregivers are satisfied with the lighting conditions including illumination, direction of light, type of
lighting and their level of control and adjustment of light, etc. Control is defined as control of illumination and adjusting ability across the recommended range of lighting levels. This study results in finding out the weaknesses and strengths of Shands lighting design as a case study in order to suggest some practical guidance to designers responsible for the lighting in the NICU and eventually an optimum lighting environment for this hospital and other NICU's for improvement.

**Research Questions**

1. To what extent, if any, does Shands NICU existing lighting condition, meet the IESNA recommended standards?

2. How satisfied are the caregivers from the existing Shands NICU lighting conditions?
   
   2.1. What are the visual tasks they do while spending time in NICU?
   
   2.2. What is their satisfaction level with the general lighting?
   
   2.3. What is their satisfaction level with the task lighting?
   
   2.4. What is their satisfaction level with the natural lighting?
   
   2.5. What is their satisfaction level with lighting controllability?

**Summary**

The concept of healing environment in healthcare has been of great importance in the past few years. One of the departments of hospitals that can greatly benefit from this theory is NICU. Newborns and caregivers are in a tense and critical situation and providing a soothing and at the same time practical environment for them has a great impact on both the healing of newborns and caregivers and the practicality of staff.

One of the design aspects that can contribute to achieve this goal is lighting; especially in NICU, lighting has great importance since the level of lighting needed by newborns is different than that by caregivers (Dalke et al., 2005); This can cause a conflict between keeping the light at a level that is not harmful to the newborns and at the same time is enough for caregivers to do their job. Previous studies have mostly
focused on the optimum level of lighting for newborns and not the caregivers. This study researches the existing lighting condition of Shands Hospital in Gainesville, FL and compares that to the recommended standards provided by IESNA. It also measures the level of satisfaction of the caregivers from the existing lighting condition.

**Definition of Terms**

- **LUX**: Measuring unit for the amount of light that falls on a surface within a one-foot radius of the source (Winchip, 2008).

- **Diurnal lighting cycles**: 24-hour, day-night cycles with brighter lighting for a portion of the 24-hour period (usually at least 12 hours), and dimmer lighting for the remainder of the 24-hour period (White, 2000).

- **Zeitgeber**: Or a “time-giver” is a stimulus that “sets” the circadian clock (White, 2000).

- **Visual performance**: The speed and accuracy of processing visual information (White, 2000).
CHAPTER 2
LITERATURE REVIEW

This chapter reviews the literature containing studies about these topics: 1) Healthcare Design, 2) Neonatal Intensive Care Unit Design and 3) Lighting Design in NICU and Caregivers Satisfaction. This section is followed by explaining IESNA lighting recommendations which include: comparison of recommended general lighting versus task lighting, color rendering and luminaire and the lighting level needed for circadian rhythm versus vision, lighting at dayshift versus night shift, lighting control, glare and shadow, and vertical surfaces and artwork. This information is provided to familiarize the reader with these recommendations since they will be used several times in this study. The IESNA recommendations were mainly obtained from the summary of recommended standards provided by White (2007) but it was also compared with the Lighting handbook by Rea (2000) to find further details.

Healthcare Design

Health care leaders are continually trying ways to improve their care services, become financially feasible, and retain quality caregivers. These goals seem impossible in today’s competitive environment. The incorporation of a healing environment into the health care setting not only improves clinical care and outcomes, it also optimizes staff satisfaction, morale and retention (Altimier, 2004). At the same time, a major growth in hospital construction is occurring in the United States and several other countries. The U.S. healthcare system is facing the challenge of the need to replace old 1970s hospitals, population shifts, the graying of the Baby Boom generation, and the introduction of new medical technologies (Jones, 2007).
Some of the most important findings relating the environment to human health and wellbeing come from studies in environmental psychology and healthcare environment research. For instance, the degree of environmental ‘fit’ and the ability of the environment to provide beneficial elements are highly related to the occurrences of physiological symptoms (Parsons et al., 1998). The evidence indicates that well-designed physical settings play an important role in making hospitals safer and more healing for patients, and better places for staff to work (Ulrich et al., 2008). It has been shown that views of nature, natural light, soothing colors, therapeutic sounds, and the interaction of family members can enhance healing. These elements must be balanced with staff needs when designing critical care environments (Altimier, 2004).

**Neonatal Intensive Care Unit Design**

The global literature shows that the Intensive Care Unit (ICU) is a stressful place, where patients experience physical and psychological discomfort due to the environment characteristics, characterized by a large amount of equipment, professionals and procedures that interrupted the circadian cycle, hindering the patients’ sleep and welfare (Rosa et al., 2010). Intensive care units built for newborn infants are a relatively new type of hospital unit. About 30 years ago, most neonatal intensive care units were located in converted patient rooms. These converted spaces were rooms along a hallway; their only modification was the elimination of walls to create units. It was not until the late 1970s and 1980s that NICU’s designed and built only for caring for critically sick neonates became common (Floyd, 2005).

The NICU is described in the literature as part of a hospital that admits newborns in need of critical care or serious medical attention at birth. Approximately 10 to 15% of newborns require this type of care and are admitted to a NICU where advanced
technology and healthcare professionals provide these fragile infants with the specialized care they need. Some NICUs also give intermediate or continuing care for less critical infants that are also in need of specialized nursing care (Neonatal Intensive Care Unit, 2009). A few studies found out that environmental factors important in NICU include noise, light, and single versus multi bed patient rooms; they documented the importance of light in modulating circadian rhythms and thereby improving the adjustment to night-shift work among staff but not enough studies have been done on caregivers’ satisfaction of lighting in NICU (Harris et al., 2006).

**Lighting Design in NICU**

Defining good lighting requires understanding that lighting is not only important for the infants in the NICU but also plays significant roles for adults in the NICU (Rea, 2004). First, lighting supports visual processes (e.g., acuity, color vision, visual performance). Second, lighting affects circadian regulation (e.g., alertness, sleeping, and hormone production). Finally, lighting communicates a message to professional staff as well as families about the level of care and sophistication provided by the hospital (Rea, 2004).

Healthcare providers, especially nurses, experience a high level of work stress (Jayaratne & Chess, 1984; Pines & Maslach, 1978; Siefert et al., 1991; Tummers et al., 2001). Studies indicate that satisfaction and stress have a direct correlation to employee burnout and a decision to leave the job (Barrett & Yates, 2002; Pines & Maslach, 1978; Topf & Dillon, 1988). Despite a large number of evidence on the negative impact of stress and satisfaction on healthcare workers, especially ICU nurses, relatively few studies have examined how the physical environment contributes to caregivers’ stress.
and satisfaction (Ulrich et al., 2008). Caregivers are defined as both medical staff and families by Rea (2004).

As Maslow suggested in his Hierarchy of needs pyramid, when the physiological needs of an individual is met and the individual feels safe and important by the people in charge of his environment, then he has more confidence in the jobs he is performing; so by thoughtfully addressing all three roles of lighting mentioned above, the lighted environment in the NICU can support the productivity and wellbeing of the professional staff, the health and safety of patients, as well as the profitability of the NICU.

Although there is considerable evidence on the negative effects of dissatisfaction on healthcare workers, relatively few studies have examined how the physical environment contributes to staff satisfaction. Several descriptive studies on staff stress have assessed the possible effects of the characteristics of intensive care environments, such as blinking lights, alarms, and equipment noise (Corr, 2000; Donchin & Seagull, 2002; Dyson, 1999). A review paper by Corr (2000) identified the healthcare physical environment as one of the causes of work dissatisfaction, along with the job itself and the organization. Several studies of non-healthcare workplaces such as commercial offices have found that environmental factors associated with stress include noise, crowding, poor ambient conditions (light, air quality, and temperature), and lack of control over the environment such as lighting (Baum et al., 1981; Evans & Cohen, 1987). However, little research has evaluated the impact of these various environmental factors on staff satisfaction in healthcare settings.

We gather most of what we know about the world around us through our eyes and the visual system (Schuman, 2002) and several studies have documented the
importance of light in reducing depression, modulating circadian rhythms, and improving sleep quality (Ulrich et al., 2008). Healthcare environment studies indicate that such psychological responses could elicit additional physiological disorders (Ulrich et al., 2004); such as helping to adjust to night-shift work among staff by controlling the body’s circadian system (Baehr et al., 1999).

Three studies show that providing cycled lighting (reduced light levels in the night) in neonatal intensive-care units results in improved sleep and weight gain among preterm newborns (Blackburn & Patteson, 1991; Mann et al., 1986; Miller et al., 1995). In one study (Miller et al., 1995), 41 preterm newborns in structurally identical critical care units were provided either cycled or non-cycled lighting (constant light levels during the day and night) during a lengthy hospital stay. Compared to newborns in the non-cycled lighting condition, newborns assigned to the cycled lighting condition had a greater rate of weight gain, were able to be fed orally sooner, spent fewer days on the ventilator and on phototherapy, and displayed enhanced motor coordination. Based on this study, it doesn’t seem very practical to use sheets to provide cycled lighting for newborns. On the other hand the importance of proper lighting for newborns in NICU has been proved several times.

One study looked at intensive care babies admitted into the control or experimental environment immediately after birth, and manipulated only the lighting environment, with sound levels the same in both rooms. They showed that weight gain, length of stay, and scores on the Brazelton motor cluster, were improved at the time of discharge for the group cared for in the room where lighting levels were reduced at night (White, 2000). Continuous darkness, such as the fetus would ordinarily experience in
uterine environment isn't the optimal lighting environment for premature newborns because it is known that the fetus is ordinarily exposed to diurnal lighting cycles of a number of maternal hormones and activity, which could act as a zeitgeber to synchronize its own developing diurnal cycles of hormones and activities. When the maternal zeitgeber is removed, it may be advantageous to the premature newborn to have an external zeitgeber available (Miller et al., 1995). These studies talk about the effect of lighting on the newborns’ circadian rhythm but as we know lighting has effects on the caregivers’ circadian rhythm as well and it is especially important for the night shift staff.

Light has two effects on the circadian system: acute effects and phase-shifting effects. Acute effects can be shown after exposure to light during the circadian dark phase, which is nighttime for those people entrained to a wake-during-the-day/ sleep-during-the-night life style. Brain activity, cognitive performance, body temperature, and subjective feelings of alertness all increase slightly after exposure to light of the right intensity and spectrum at night (Iwata et al., 1997). Figueiro and colleagues showed positive acute effects on night-shift nurses who were exposed to bright white light (2500 LUX on the task plane) during their break periods. Depending on the time of exposure the circadian clock can be advanced, leading to earlier rise times from sleep, or delayed, leading to later rise times from sleep, in the next sleep cycle. Humans are a diurnal species, genetically programmed for sleep at night, and it is very difficult and unnatural for us to invert this process. Humans are also a social species and despite the importance of one’s profession, we naturally desire gregarious relationships with our families and friends who are almost always awake during the day and asleep at night (Crowley et al., 2003). Consequently, it is unusual to find a night-shift health care
professional whose circadian clock is not following the normal wake-during the-day/sleep-during-the-night cycle, at least for the first few night shift periods. Obviously, this disparity between lifestyle and circadian phase makes sleeping and waking difficult for the night-shift personnel (Ulrich, 2008).

Circadian light exposure from daylight during the morning serves as the primary entrainment stimulus for day-shift personnel. Daylight during the day from windows and clerestories in the NICU and low light levels from incandescent lamps at home during the evening are normal, practical, and recommended light exposures for day-shift personnel. Important to consider in these recommendations are the findings from animal studies that the circadian system is more concerned with the relative light levels between night and day than with the absolute levels. Extrapolating from these animal studies, “dim” light levels may be seen by the human circadian system as “night” if the daytime light levels are very high, whereas that same light level may be seen as “day” if the nighttime light levels are very low. An attempt has been made to consider both systems in these recommendations (Horowitz et al., 2001).

Lighting makes an impression on people, consciously if one is a designer or an architect and subconsciously if the person is a health care professional or a parent. These impressions are formed at two levels, perceptual and psychological. At the perceptual level people prefer bright spaces that show variety in the light distribution. Because humans walk erect and their retinas are oriented vertically, the brightness of walls, ceilings, faces, and objects are extremely important for conveying a perception of brightness in the NICU (Boivin & James, 2002). Some direct lighting luminaires, designed to provide maximum illumination on horizontal surfaces while minimizing the
brightness of the luminaires (to avoid reflections in computer screens), produce dark walls and ceilings and can leave faces and three-dimensional objects in shadow. These luminaires, despite their claims for energy efficiency, are usually not suited for the NICU because so much of the work and interactions with people in the NICU are not associated with head-down work on horizontal surfaces or with intensive computer use. In addition to brightness, it is important that lighting provide some luminous highlights in the space (Leppamaki et al., 2003). At the psychological level, lighting can convey different associations and evoke different behaviors. Naturally, associations are formed between the relaxing home environment and the warm, incandescent table lights, whereas very different associations can be formed between the stressful and anxiety-producing office or hospital environments and the cool, fluorescent lighting in the ceiling. Many spaces within the NICU are designed to provide a warm, inviting atmosphere for anxious parents by using color, soft objects, rocking chairs, and family pictures. Yet all too often, inexpensive, fluorescent direct luminaires are found in these same spaces. Without question they provide good visibility at a modest cost, but the “message” these fixtures send to parents is probably not the one intended (Boivin & James, 2002).

One study with 87 female night-shift nurses examined whether repeated, brief exposure (4x 20 minutes) to bright light (over 5,000 LUX) during night shifts improved their well-being during and after night work (Leppamaki et al., 2003). Results showed that light significantly lessened the caregiver’s anxiety associated with night shift work, in both summer and winter. Bright light (over 2,500 LUX) is used for the treatment of seasonal affective disorder in winter (Partonen & Lonnqvist, 1998). A recent study by Partonen and Lonnqvist (1998) found that bright light exposure has a positive effect on
mood even in healthy people. Another study found that staff with more than three hours of daylight exposure during their shift had higher job satisfaction and less stress than staff with less daylight exposure. However, the findings are complicated by the factor of types of nursing activities: nurses from ICUs, EDs, or ORs were mostly exposed to daylight for less than 3 hours, while nurses from inpatient units mostly had an exposure of more than 3 hours. More research is needed to understand the impact of natural light on staff stress (Alimoglu & Donmez, 2005).

Jobs by nurses, physicians, and other healthcare workers often include direct patient care, critical communications, charting, accessing technology and information, and other tasks. Many hospitals have not been redesigned, although jobs have been changed, and as a result, hospital environments often increase staff anxiety and reduce effective care delivery. The challenge of maintaining staff effectiveness will be increasingly important as the number of nurses is decreasing and the aging population is increasing. While much research in the hospital setting has been about patients, there is a growing and convincing body of evidence suggesting that improved hospital design can make the jobs of staff easier. Lighting levels may have an impact on staff effectiveness, but relevant studies are still limited (Ulrich et al., 2008).

There have been studies in manufacturing showing a positive effect of higher lighting levels on the speed of production (Juslen et al., 2007). However, none of that was specifically related to healthcare environments. A small pilot study was conducted in a nursing home to evaluate the usefulness of providing LED lighting triggered by motion sensors for nighttime lighting. The 17 staff members in the study reported that they found these lights convenient and useful for conducting nighttime rounds without
disturbing residents’ sleep (Taylor, 2005). There are several studies that have evaluated the effect of bright light (2,500 LUX) and set sleep schedules on staff working the night shift (Horowitz et al., 2001). These studies report that the most significant positive effect is seen only when these factors are used in combination (Ulrich et al., 2008). Also the fact that mature adults need more light to perform routine tasks plays an important role in lighting design for caregivers (Schuman, 2002), since Lomperski (1997) indicates that as individuals age, their lenses develop a yellow coloration which causes a loss in sensitivity to both light and color and this effects the ability to read. Therefore, in a life-and-death situation, it is sound practice to provide relatively high light levels from white light sources.

Excellent care will hardly happen with unsatisfied hospital staff. Job satisfaction is known to be influenced by many nonphysical working conditions, such as autonomy (O’Rourke et al., 2000), compensation (Best & Thurston, 2006), and performance (Douglas et al., 1996). Lack of support from the physical environment can make already stressful working conditions worse (Ulrich et al., 2008). Investments in the environment to increase staff satisfaction could potentially reduce the cost of staff turnover, which can cost more than $62,100 per nurse replaced. However, not many studies have examined the effects of environmental factors on job satisfaction (Jones, 2004).

Mrockzek and colleagues (2005) conducted a residence survey of staff working in a newly constructed facility and found that natural light in the new facility had the most positive environmental impact on work life, followed by live music in the atrium. Another study by Alimoglu & Donmez (2005) found that staff with more than 3 hours of daylight exposure during their shift had higher job satisfaction than staff with less
daylight exposure. However, the findings are complicated by the types of nursing activities performed by each group. In addition, new healthcare facilities might not increase job satisfaction if they are not carefully designed. In a study comparing an old and a new ward in a mental healthcare facility (Tyson et al., 2002) concluded that the new ward resulted in no increase in job satisfaction, probably because of the isolation of nurses caused by the larger space and separated observation wings, and understaffing in the new acute ward and the fact that the new design did not change the amount of daylight they were receiving. Therefore, site planning and the orientation of healthcare facilities should be carefully designed to ensure enough daylight and avoid situations where some buildings block light for others. Larger windows in patient rooms not only provide natural light, but they also have the potential benefit of offering views of nature and should be considered in the design process. The amount and timing of light in healthcare settings should be suitable for the activities that take place in them. In general, sufficient lighting is beneficial to both patients and staff. Bright lighting is preferred in areas where staff performs critical tasks such as medication dispensing.

Caregivers are rewarded for efficiency, technical skills, and measurable results, while their concern, attentiveness, and human engagement go unnoticed within their professional organizations and institutions (Phillip Benner from Georgetown University).

Although considerations of the perceptual and the psychological effects of lighting are the least “scientific,” they are, perhaps the most important to hospital administrators. Thoughtful attention to these issues will help to minimize the anxiety experienced by health care professionals and by the parents in the NICU for a relatively modest investment (Ulrich et al., 2008). The IESNA Lighting Handbook is a good
reference for exploring how lighting can communicate a caring environment to health care professionals and to visitors and parents.

IESNA Lighting Recommendations

For nearly 100 years the Illuminating Engineering Society of North America (IESNA), North America's lighting technical society, has been providing consensus-based lighting recommendations to support visualization in health care environments (White, 2006). These recommendations have been predicated on the assumption that health care professionals need high light levels and good color rendering to see the critical visual tasks they perform in hospitals. A great deal of research has shown that visual acuity, color perception, and visual performance improve with higher light levels (White, 2007).

White (2007) mentions that although the IESNA has always informally recognized the importance of lighting criteria other than light level and color rendering, formal recognition of other lighting criteria has appeared only in the IESNA Lighting Handbook written by Rea (2000). That is the version used in this study as the reference and the following are recommendations for good lighting in the NICU obtained from this reference.

General Lighting vs. Task Lighting

Provide layers of light from different types of luminaires. For general, general lighting provide no more than 500 LUX. For task areas provide local lighting up to 1000 LUX with tight optical control that prevents glare at other locations. The light source and procedure lighting for infant areas should be separated. The general lighting in newborn care area should be adjustable between 10-600 LUX and should pay attention to the color rendering index of the light. There should not be any direct view of electric light
source or the sun in this area, so that the newborns don’t have a direct line of sight to the fixture. None of the newborns should be too close to windows and the windows should have an easily controlled shading device. Custom LED luminaires (\(\text{kmax} = 470\) nm) should be acquired that provide blue light, over 30 LUX at the eye in the evening, and wear yellow tinted glasses in the morning. Minimize daylight exposure during the day (phase-shifting effect).

**Color Rendering Quality**

Provide good color rendering lamps with a color rendering index of at least 80. It is required to install luminaires that connote this desired effect. As recently as 2000, the IESNA recommended that good color rendering lamps (CRI > 80) provide 1000 LUX on critical visual tasks found in health care environments. It is now known that light levels this high are never needed throughout the facility; they are only needed in specific task areas associated with critical care for the infant (Rea, 2000).

**Circadian Rhythm vs. Vision**

Impact of light on human circadian system should be considered very carefully in conjunction with authorities on the topic of circadian regulation. Although light entering the eye provides both visual and circadian information, the characteristics of the light important to these two systems is radically different. Consequently, good lighting for circadian regulation is quite different than good lighting for vision. Significantly higher light levels of white light are required to stimulate the circadian system than the visual system. Light levels adequate for good vision can be one-tenth of those needed to stimulate the circadian system effectively. The circadian system is tuned to a different part of the electromagnetic spectrum than the visual system. Whereas the visual system is maximally sensitive to middle wavelengths (555 nm: yellow-green) light, the circadian
system is maximally sensitive to short wavelengths (450 nm: blue) light (White, 2007). As almost all commercially available light sources are tuned to maximize visual response, there are few electric light sources suitable for circadian regulation, unless very bright white lights (at least 10 times that normally found in the NICU) are used. Importantly, Figueiro and colleagues showed that much lower light levels from blue LEDs (30 LUX of 470 nm at the eye) could be used to stimulate the circadian system. Although the visual system is essentially equally sensitive to light throughout the 24-hour day, the circadian system responds to light differently over the course of the solar day. Depending on the time of day or night, the circadian system can be more or less sensitive to light, and that light can either advance or delay the timing of the biologic clock. The visual system is very fast in its response to light, on the order of a few milliseconds, whereas the circadian system may require several minutes to respond to light. These fundamental differences in the response characteristics of the visual and the circadian systems to light significantly complicate recommendations for good lighting for the circadian system. And unlike recommendations for good lighting for vision, there are no formal consensus-based recommendations available for good lighting for the circadian system from the IESNA or from any other body.

**Day Shift vs. Night Shift**

IESNA recommends that the lighting in night shift should Keep health care professionals awake and productive by applying light of different intensities, spectra, and timing in addition to those important for good vision. Also provide bright white illumination (2500 LUX) on task surfaces in break rooms, but shield the light source from glare (acute effect). For day shift, provide access to daylight to help entrain
circadian rhythms to the solar day, particularly in the morning; and provide opaque blinds or shades, not tinted windows, to minimize glare from sunlight.

**Table 2-1. Sample of IESNA lighting recommendations for NICU**

<table>
<thead>
<tr>
<th>Newborn Care Area</th>
<th>General Lighting:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• 10-600 LUX</td>
</tr>
<tr>
<td></td>
<td>• Separate source of general light and task light.</td>
</tr>
<tr>
<td></td>
<td>• No direct view of the electric light source (including procedure lighting)</td>
</tr>
<tr>
<td></td>
<td>• Fixture, easy to clean</td>
</tr>
<tr>
<td></td>
<td>• No glare</td>
</tr>
<tr>
<td></td>
<td>• Stay awake-different intensities, timing</td>
</tr>
<tr>
<td></td>
<td>• Create an inviting and productive environment for parents and staff.</td>
</tr>
</tbody>
</table>

**Task Lighting:**
- 1000 LUX (min) at the plane of the infant bed
- Separate procedure lighting for EACH infant bed
- Temporary increases in illumination necessary to evaluate a baby or to perform a procedure should be possible without increasing lighting levels for other babies in the same room.
- Adjustable in intensity, field size and direction

**Natural Lighting:**
- No direct view of the sun to the newborns
- Be situated at least 2 feet (0.6 meter) away from any part of an infant's bed to minimize radiant heat loss.
- Be equipped with shading devices that are neutral color or opaque to minimize color distortion from transmitted light.

**Controllability:**
- Control of illumination and adjusting ability
- multiple light switches AND a master switch for immediate darkening of the room
- Dimmers

<table>
<thead>
<tr>
<th>Support Areas</th>
<th>15 minute/shift exposure to White light: 300-500 LUX</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Where public area meets Newborn care area: Separate light sources, Independent switches</td>
</tr>
<tr>
<td></td>
<td>Highlight artwork and architectural features.</td>
</tr>
</tbody>
</table>
Control, Glare, Shadow and Vertical Surfaces

It is recommended to include dimming and switching lighting controls for flexibility and energy efficiency. It is important to note that the role of switching (and dimming) to accommodate the variety of tasks performed in the NICU at different times has always been recognized as important in the IESNA lighting recommendations (White, 2007b). Define the geometries between the light source, the task, and the observer. Control the optical distribution of the luminaires; luminaire optics should always hide a direct view of the light source from normal viewing positions to avoid shadows on work surfaces and faces and to anticipate reflected glare from incubators and visual displays (e.g. computer monitors). Use matte, high-reflectance surfaces to scatter light throughout the space and to diffuse reflected images from light sources. Light vertical surfaces to provide brightness in the space. Highlight artwork and architectural features (Overall feeling about the space they work in).

Conclusion

The review of literature shows that even though there are many studies about NICU, a few of them study the environmental design aspect of the NICU. Lighting is very important in NICU because the level of light needed by newborns is different than that by caregivers. The studies about lighting design in NICU mostly focus on the lighting needs for newborns and not the caregivers’ lighting needs and satisfaction. These gaps in literature show a need of studying the lighting design in NICU, focusing on caregivers’ satisfaction; a type of study that links hospital physical environments with healthcare outcomes.
CHAPTER 3
RESEARCH METHODS

Study Design

This study is a Case study which is an approach to studying a social phenomenon through analysis of an individual case as well as Cross-Sectional Study or one that collects data only (Kumar, 2005). This study is a combination of quantitative and qualitative methods that employ the use of a closed and open ended Questionnaire as well as interview and observation. To gather an in-depth understanding of caregivers’ satisfaction on lighting conditions in NICU at Shands, the study employed the qualitative method including in-depth interview and observation techniques.

Case Selection Criteria

Shands Hospital at University of Florida, which is one of the top 50 hospitals in 8 specialties was built in 1958 (Shands hospital website: https://ufandshands.org) and contains two NICU units; NICU II & III. NICU II is less intensive and admits newborns in less critical conditions, whereas NICU III is more intensive. According to Shands facilities management, NICU II has not been renovated since 1999 but NICU III was renovated around 2005 (Obtained from Shands facilities management).

When visiting the Shands NICU, it was realized even though this building is among the semi-modern hospitals; it still needs improvements in its environmental design and specifically in lighting design. They generally had to use a sheet over the newborns in order to make the level of lighting needed for their growth and to prevent the direct exposure of bright general lighting into newborns’ eyes. In other areas of Shands NICU like NICU II, the level of general lighting was too low for the caregivers to do the necessary procedures. The term medical procedures in Shands NICU, in
general, means tasks like pulling out or putting in IV’s, putting in tubes and checking
the babies for Jaundice. Studies suggest that the general lighting level in the NICU be
sufficiently bright so that nurses can do their work comfortably and accurately. Babies
can be protected from lighting levels that might be optimal for nurses’ performance by
covering their eyes or incubators. Nurses should also have access to a bright light
source (“light shower”) of at least 2500 LUX (about 250 foot candles) in their lounge or
work area for at least 15 minutes at the start and middle of their shift, if they find it useful
(White, 2000).

There were some sections of the Shands NICU, like the staff lounge that didn’t
have natural lighting at all. Study shows that adequate and appropriate exposure to
natural light is critical for health and well-being of patients as well as staff in healthcare
settings. A combination of daylight and electric light can be the optimum solution to this
problem. Finally, some of the lights in Shands NICU were not useful and could be used
in other places. These facts and observations plus the convenient location of Shands
hospital, made it a proper site for this research. It also shows the need of a lighting
quality evaluation in Shands NICU.

Setting

The study is done in the NICU of Shands Healthcare Center at the University of
Florida in Gainesville, FL. The NICU consists of a level 3 nursery (NICU III) as well as a
level 2 nursery (NICU II). The NICU III is a 22-bed unit that provides tertiary care to
newborns within the State of Florida and areas of South Georgia, based on diagnosis
and availability of resources. The NICU II is an inpatient sister unit to NICU III and has a
bed capacity of 30. Both units operate twenty four hours a day. According to Shands
building documents obtained from the facilities management, NICU department was
Admissions for both units are routinely taken from labor and delivery, referring hospitals, and newborn nursery. Patients are transferred between the NICU II and III based on patient acuity. NICU III is focused on the stabilization and critical care needs of the neonate and the family. NICU II focuses on the intermediate or recovery phase of the care needs of the neonate. The NICU II and III are both located on the 3rd floor adjacent to the Labor and Delivery areas as well as the post-partum area.

All patient newborn care areas are equipped with newborn care area monitors, with alarms, which have the capabilities of monitoring heart rate, respiratory rate, blood pressure, and oxygen saturation levels. There is an intercom system in place that provides for newborn care area communication. Bed spaces are equipped with an emergency alarm to the clerical areas. In the event of an emergency each bed space in NICU II is equipped with a Code Blue alarm that connects directly to NICU III. This system connects NICU III with II and newborn nursery and in the event of its activation requires the response of the Neonatal Team. Newborns in NICU II that are in bassinets are banded with security devices. When the devices are detached, they will provide alarms and door lock down. In addition there is camera surveillance that monitors the primary entrance to NICU II.

Available support services for Neonatal patients include: Pharmacy, Respiratory Therapy, Physical Therapy, Occupational Therapy, Nutrition Services, as well as Patient and Family services (Shands Hospital website: http://nursing.jobs.ufandshands.org). Shands NICU is made of three major areas: Newborn care areas, Offices and Support
Areas (Public Areas). This study just focuses on the Newborn care areas and support areas. These are the areas mainly used by doctors and nurses.

Figure 3-1. Shands NICU ceiling/lighting plan

Figure 3-2. Shands NICU floor plan (zoning diagram)
In order to better understand the organization of Shands NICU, this space will be further explained based on the information obtained by the researchers’ observation. In these explanations, the two NICU's (NICU II and III) are divided into two major areas: the newborn care area and the support areas. Then each area will be explained based on the aspects of lighting quality.

**NICU II**

**Newborn Care Area II**

This area has an isle in the middle that all monitors are scattered on it and is used as a charting area for nurses (Figure 3-4). The beds are placed on both sides of this isle, and also along the windows. There are recessed lights along this isle that are used as both general light and task light (Figure 3-5). The general lighting includes the same Fluorescent lights in NICU III but the difference is that these lights are located on a straight line and a dimmer switch turns on every-other light (Figure 3-5).
Figure 3-4. The isle along NICU II

Figure 3-5. NICU II general lighting
Figure 3-6. NICU II ceiling plan

Figure 3-7. NICU II floor plan
Support Areas in NICU II:

The storage (called the “garage”) is to store supplies and equipment. It is very lit by few sets of fluorescent lights. Family room is a space that parents can stay in and rest and its general consists of a set of 2 by 2 fluorescent lights. The hand-washing area has one covered linear florescent for illumination.

NICU III

Newborn Care Area

This area consists of one open area in the middle and two isolation rooms. The total number of bed spaces designated for this area is 22, including the isolation rooms. The open area consists of 3 semi-private bed spaces in the corner (have three glass walls and a curtain) but there is no priority for the newborns to be located there. Eight of the bed spaces are by the windows. Newborns are either in a bassinette or an isolate. The difference between them is that isolates are closed on top and are for babies in more critical conditions.

The space in the middle has one main nurse station and some scattered computers on the countertops that serve as a nurse corner for charting and documentation. There is also transport team desk in the hallway of this section. The x-ray viewing desk is in this hallway across from the transport team desk. The medication room and the physician’s room are located in this area as well which will be explained further when explaining the support areas in NICU III. Physician’s room is called a fish tank because two of the walls of this room are glass walls that allow this room to benefit from the general lighting of the newborn care area.
Figure 3-8. Newborn care area III floor plan

Figure 3-9. Newborn care area III floor plan
Where the monitors are typically placed; Switches are behind the monitors (Figures 3-11)

Figure 3-10. Typical bed spaces in NICU III

Figure 3-11. Typical bed spaces in NICU III
General lighting: There is a repeated pattern of general lighting on top of each bed space, shown in Figure 3-12; as shown in this picture, the general lighting for each bed space consists of recessed lights that are controlled by dimmers. Each dimmer switch controls two of the recessed. There are also three spot lights that are used for emergency and are controlled by an on/off switch; direction of these emergency lights can be adjusted but the problem is they are up on the ceiling and a person should climb up a chair in order to adjust them (Figure 3-13). There are two center points in this area that have some of the bed spaces around them. These center points illuminate its surrounding by an indirect light (Figure 4-16).

Figure 3-12. Typical general lighting for bed spaces in NICU III
Task Lighting: The pattern of task lighting is not consistent for each bed. Some of the old isolates have a heater that has a light installed in it; this light is used as task lighting that is not adjustable and has only two levels of illuminations (figure 3-14). Some of the old isolates also have another task light that is flexible but because of its weight and built, is hard to move (Figure 3-15).

The new isolates, on the hand, have a task lighting called “the Giraffe”. This task lights are built in a way that are very easy to move and adjust. They have three levels of illumination which makes it much easier for caregivers to adjust the illumination based on their needs (Figure 3-16).
Figure 3-14. Warmer with task light

Figure 3-15. Old task lights
Figure 3-16. New task lights (giraffe)

Natural lighting: The natural lighting affects the general lighting for this area especially for the bed spaces next to the window. The NICU windows structure has an overhang that prevents direct sun light entering the unit. The blinders are closed most of the time and very few caregivers use the natural light for their tasks.

Isolation rooms: Isolation rooms are for the babies who are in a fragile state who need to be away from public. Their general and task lighting pattern are the same as the main section of the newborn care area. The advantage in these rooms is that the space is only for one newborn so staff and family can control the lighting without the hesitation of weather they are bothering other newborns. There are glass sliding doors for each of these rooms that slightly help them to benefit from the general lighting in the main section of the newborn care area.

Semi-private bed spaces and bed spaces next to windows: These are the areas that are partially closed on the sides by glass walls. They have the same general and
task lighting pattern as described in the main section of the newborn care area. The walls are white paint except the wall behind the bed space which is light blue. Eight designated bed spaces by the windows. The reason some of the babies are located next to the windows is just because that space was available; but a newborn is not located next to the window if he is too young or not in a very critical condition since they need an environment that is more similar to the womb.

Support Areas in NICU III

Nurse stations, staff lounge and hallways: There is one main nurse station in NICU III that has its own general lighting on top of the desk; but nurses mostly use the counters by the beds as their station for charting. These are the spaces where the monitors are located at. Some of the monitors face the windows and some have their back to the windows. Staff lounge has seating for 10 people. General lighting in this area is a combination of linear fluorescent and recessed compact fluorescent light. There is also an indirect fluorescent lighting on the walls. There is separate general lighting for the kitchen area.

Transport team desk, x-ray viewing station, physicians’ room (fish tank):
Transport team desk is located in the hallway of NICU III; they basically use the hallway general lighting for their tasks. X-ray viewing station is located in the same hallway across from the transport team desk. Physicians’ room has two glass walls, one toward the hallway and the other toward the main newborn care area; that’s why it is called a “Fish Tank”. This room gets a part of its general illumination from the newborn care area and the glass walls make it easier for the users to have a view of the newborn care area.
Figure 3-17. General lighting in hallways. A) NICU III hallway. B) NICU II hallway. C) NICU III hallway. D) NICU III offices hallway.

On-Call/sleep rooms and multipurpose room (Fran’s room): On-call rooms are used by doctors and attendees who work at night shift. As you can see in Figure 3-18, the general lighting consists of a set of 2 by 2 covered linear florescent lights. There is a night light next to the bed and a fluorescent light on top of the hand washing sink. Multipurpose room has seats for 6 people and is used for resting and privacy purposes. The general light here is a set of 2 by 2 linear fluorescent lights; there are two lamps there that can be used either as task light or a more soothing general light.
Figure 3-18. Lighting in on-call room.  A) General lighting.  B) Side lamp.  C) Sink lamp.

Lobby (waiting room), pump room (breast feeding room) and conference room: Lobby has seats for about 17 people. As shown in Figure 3-19, the general lighting consists of recessed compact fluorescent lights. There is an architectural feature in the middle of the ceiling in that simulates a skylight and illuminates the room by artificial lights. This helps to create the feeling of having natural lighting there. There are three adjustable spot lights for the artworks and a wall sconce. The pump room has two private areas for pumping (Figure 3-20); each area has its own general lighting that consists of recessed fluorescent light. There is a linear fluorescent lamp on top of the sink. There is no task lighting in the pump room. The general lighting in conference room is 2 sets of 2 by 2 linear fluorescent lighting which are controlled by dimmers.

Figure 3-20. Lighting in pump room. A) Pumping space lighting. B) Sink lighting.
Participants

An application and authorization form was submitted to the University of Florida's Institutional Review Board (IRB) for research involving human subjects prior to the start of the screening and selection of participants (Appendix A). The other requirement was “Research and Information Privacy at the University of Florida” certification (Appendix C), followed by completing the “Confidentiality Statement” (Appendix D).

NICU III has one nurse per two patients, including the charge nurse whereas NICU II has one nurse per 3 or 4 patients (Retrieved from Shands hospital website: http://nursing.jobs.ufandshands.org). A charge nurse is designated for each shift. Unit clerical coverage is also available 24 hours a day for each unit. The NICU's are under the medical direction of a Neonatologist, a Nurse Manager, 2 Clinical Coordinators, and an Administrative Assistant which are assigned on day shift five days a week. The Team Coordinators provide off-shift and on weekend's administrative assistance. The staffing plans for the Registered Nurse are consistent for all shifts.

The study population is comprised of 96 caregivers, including doctors, residents, nurses practitioners, nurses, respiratory therapists, transport team, & parents and family of the patients. The participants were divided into three groups: 1-Doctors group that include: doctors, residents and nurse practitioners; 2- Nurses group, includes: nurses, respiratory therapists and transport team; and finally 3- Families group that includes: parents and family of the patients.

According to the information obtained from Shands NICU management, there are 65 doctors including residents, 14 nurse practitioners, 125 nurses, 23 respiratory staff, 9 transport team members; therefore, there are 79 people in group one (doctors) and 157 people in group two (nurses). There are 700 to 750 newborns admitted to Shands NICU.
annually. There were 60 newborns admitted at the time of research. The 96 participants included 20 participants in doctors’ group, 42 participants in nurses group and 34 participants in Families group; which gave a good turnout of about +/- 30 % participants per group. Out of all the participants willing to take part in an interview, 10 in each group were chosen randomly; so there were 30 people interviewed in total.

Research Instruments

The research instruments used for this study are: Observation, Documentation, Survey and Interview. These instruments were all approved by IRB after the pilot study and prior to starting the data collection.

Observation

Field notes were taken from all areas of NICU II and III. Notes included the demographic of the users of different spaces at the time of observation, focal points and visual attractions, observing the level of control and ease of access users have with switches and lighting levels, the overall mood of the space at the time of observation, materials used in the space, if there is any natural lighting in that space and if yes, is it possible to control the level of natural lighting in that space and finally if the level of lighting in that space is enough for way finding and security. The information gathered was used to illustrate the possible factors that influence each participant’s behavior and explore whether their location within the unit affected their satisfaction. The methods of observation were obtained from Sommer & Sommer (2002).

Documentation

The information documented in each space includes: Type of lighting in that space (Ambient, Task, Natural, Emergency, Exit), the type of lamp used for each of these and if it is easy to replace, the illumination level (Foot Candle which then was
converted to LUX) for ambient and task lighting in each space. The method of gathering information during documentation and organizing the data was obtained from Winchip (2008).

Survey

There are three groups of survey made for the three groups of participants mentioned earlier (doctors, nurses and families). The surveys for doctors and nurses were web-based and created using http://www.SurveyMonkey.com. Since the number of participants in online survey was very few, the researcher handed out most of the surveys to collect the desirable amount of data. The survey for parents was handed out to them in person. All of the surveys are contained of three sections; the demographic question, a chart containing a series of questions to find out the most used space by the participant and the tasks they do while in that space, as well as measuring their level of satisfaction with the lighting level and controllability in those spaces. The last part has supporting questions for the second part containing evaluation of the participants’ satisfaction level with general lighting, task lighting, natural lighting, visual comfort and controllability. The survey for doctors and nurses, all contain 7 questions in the demographics section and 7 questions in the last section (Appendix E and F). The survey for families contains 6 questions in the demographic section and 8 questions in the last section (Appendix G). Each section of the survey is explained below in more details:

First section: This section contains the demographic questions. It asks the participants about their gender, age, their title or relationship to the patient, what shifts they work at and how much time they spend in the NICU. The age categorization in this section is based on the relation between age and eyesight level reported by Julie Moller
(2008). The shift, length of work in Shands NICU and number of hours worked in a week are all categorized based on the information obtained from the management and administration in the NICU center; the length of newborns’ stay in NICU has been obtained from the same source. Demographic questions were asked to determine the relationship of the study variables and participants’ information to exclude extraneous variables including age & visual impairment related to age, the length of stay in NICU and previous NICU experiences.

Second section: This section asks the participants about the spaces they mostly use, the length of time they spend there, the tasks they do while spending time in those areas and their level of satisfaction with the lighting in these areas, as well as how much the lighting level of these areas support their tasks. The time table for the length of stay in a space per week is obtained from the information provided by Shands NICU management and administration. The visual tasks mentioned in this section were based on the observation done by the researcher prior to conducting the survey. The scale is based on the 7-point likert scale ranging from -3 as being “strongly disagree” to +3 as being “strongly agreed”.

Third section: In this section the main objective was to assess user satisfaction. The questions include asking participants’ satisfaction of the major lighting issues mentioned by IESNA recommendations such as natural lighting, general lighting, task lighting and controllability and were on a seven-point rating scale ranging from 1 meaning “Very Satisfied” to 7 meaning “Very Dissatisfied.” The last question in this section asks the participants if they are willing to participate in an in-depth interview.
Interview

Interview questions were also designed based on each group of participants (doctors, nurses and parents). These questions get into more in depth evaluation of caregivers satisfaction with the existing lighting conditions in Shands NICU (Appendix H, I and J). Similar to the survey, interview questions ask about satisfaction of lighting levels, control, night shift vs. day shift, newborns’ lighting need vs. caregivers’ need and the conflict it can cause and finally their satisfaction and suggestion on all the support areas they use. The interview form for doctors and nurses contain 10 questions and the one for parents has 5 questions. The researcher attempt was to interview participants at the space mostly used by them and at the shift they usually work at.

Pilot Study

Prior to sending the research instruments to IRB to obtain approval, a pilot study was done to assure the accuracy and clearness of survey and interview questions and also to detect any defects such as issues with wording or terminology, and to check the experimental procedure’s timing and sequencing.

The pilot study was administered to 15 caregivers in the Pediatric Intensive Care Unit (PICU) at Shands Hospital. There were 5 participants of each category of caregivers (doctors, nurses and families). This department was used because the researcher would not lose any participants in the NICU department and also this department had the closest ambient to the NICU. All fifteen of the participants took an average of 15 to 20 minutes on the survey and 10 to 15 minutes for the interview after which they were asked if anything was confusing or anything about the survey or the experience could be improved. Pilot study participants made some useful suggestions
on the survey wording which were then employed in that instrument. Participants did not express any confusion or difficulty with the interview questions and no changes were made for that content.

**Sampling and Data Collection**

Based on Kumar (2005), random sampling is when each element in the sample population has an equal and independent chance of selection in the sample. Selection of the qualified participant in this research employs a random sampling in which staff and families randomly volunteered to participate in a questionnaire. At the end of the questionnaire, they were all asked if they could participate in an in-depth interview, so they randomly volunteered for that.

The data collection was done in three weeks in December of 2011. Based on Ulrich and colleagues (2008), the typical length of stay in NICU for newborns is 3 weeks; therefore the data collection was designed to be done in 3 weeks so that there was a higher possibility of observing all stages of a newborn’s stay in NICU. The researcher had to obtain a badge to enter the NICU’s. The badge was received from the Shands Facilities Development management by providing identification and referral from the Nursing Council in Shands.

**Informed Consent**

Participants were presented with an informed consent form to obtain their written permission to complete the study. The form also informed them that study posed no risks to participants and they could withdraw at any time. The participants were given the opportunity to consider all options and ask questions about the process. Their signature was required; however, it was not associated with the participant’s name.
Observation and Documentation

To obtain the maximum data as far as different lighting levels and caregivers' behavior, the observation and documentation were done in four different shifts: 2am to 6am, 6am to 11am, 12pm to 5pm and 8pm to 12am. This division of time was based on the suggestions made by nurses in a meeting with Shands NICU Nursing Council. Their rational behind this was that this division provides the researcher with the most variety of data. The primary observation of NICU also helped the researcher to arrange this time division based on the level of artificial lighting used in different times of the day and the level of natural lighting. In order to make the process easier and more organized for the researcher, each NICU was divided into two segments: Newborn care area and support areas (Figure 3-2).

The researcher observed caregivers' behavior such as how often they change the lighting level, how much control they have over this change, how accessible the lighting switches are, what spaces they mostly use and its relationship to the lighting level. A Light meter was used to document the illumination level of different spaces at different time frames mentioned above. The type of lamps and their locations were documented.

Survey

An e-mail was sent to all the 65 doctors, 14 nurse practitioners, 125 nurses, 23 respiratory staff and 9 transport tram members, with a link to the survey; since only a few of them participated in the online survey, the researcher approach them in person randomly and handed out the surveys. Parents were approached in person too. When it seemed proper to approach a family member, the researcher asked for a few minutes of their time and explained what the research is about and asked if they were willing to fill
out a survey. At the end of the survey, the participants had the option of choosing if they wanted to participate in an in depth interview. The information was not in any form attached to the survey in order to keep the surveys anonymous.

**Interview**

The participants, who decide to take part in an Interview, were contacted by the researcher with the information they provided. This information was either e-mail address or their phone number. All the interviews were taken place in the space used by the participant and also in the shift they usually work. For example, a nurse who worked in the night shift only was given the survey and was interviewed during the night shift; and also in the newborn care area in which she spent most of her time in. A recorder was used to record the interview after asking for the participants’ permission. The average length of each interview was about 15 minutes. The interviews were then linked to the related survey by a code.

**Data Analysis**

The data was obtained through observations and documentations, surveys and interviews, which were then analyzed. The survey was analyzed, using SPSS software. The interviews were analyzed using content analysis. The observation and documentations were organized and then compared to the IESNA recommended standards.

**Problems and Limitations**

The limitations of this study can be the method of study design (case study) since this approach rests on the assumption that the case being studied is typical of cases of NICU in hospitals so that, through intensive analysis, generalizations will be made from the result of this study to other cases. The other limitation can be the number of
participants, as well as the possibility of the findings only being generalized to cities of similar size and climate. Another Limitation is the fact that the documentation was specific to that moment of collecting data and could change at any moment by turning a light on or off. Even though the documented illumination levels were averaged, they would still be different if collected at a different time frame. It is important to mention that for night-shift personnel, who are still trying to lead a normal wake-during-the-day/sleep-during-the-night lifestyle, it is much more difficult to make truly satisfactory recommendations. If the night-shift person wants to maintain a normal lifestyle, caffeine and bright white light during the night shift will provide some mitigation of the effects of a body that wants to sleep.
CHAPTER 4
RESULTS

This chapter presents the results of data collected from both Neonatal Intensive Care Units (NICU’s). It starts with the characteristics of the participants and answers to questions like what the most used spaces by each category of participants are and what are their visual tasks while being in those spaces. It follows by three sections: observation and documentations findings and comparing them with the IESNA standards; survey findings and interview findings.

Characteristics of the Participants

For the purpose of this study, the caregivers are divided into two major groups: staff and family. Staff includes two major groups: doctors and nurses whereas family includes newborns’ parents and relatives. A total of 96 adult subjects volunteered in this study. There were 20 in the “doctors” group (doctors, nurse practitioners and residents), 42 in the “nurses” group (nurses, respiratory therapists and transport team), and 34 in the “family” group (parents and relatives). Table 4-1 presents the frequency distribution of the general characteristics of the staff and Table 4-2 presents family.

As shown in both Tables 4-1 and 4-2, females were much more than males in all groups. Doctors and families were mostly 18 to 35 years old versus nurses who were between 46 to 55 years old. No one was above 65 years old. Dayshift is different for each group; for doctors it is 6:30 AM to 5:30 PM, for nurses it is from 7 AM to 7 PM. Night shift is also different for each group. Doctors’ night shift starts from 5:30 PM and can be as long as till 6:30 AM the next morning whereas for nurses it starts from 7:00 PM to 7:00 AM.

Families can stay in NICU all day and night with the exception of half an hour in between each shift for nurses and doctors to do the needed procedures; so family can stay in NICU from 7:30 AM to 7 PM and from 7:30 PM to 7:00 AM. Procedures done by
doctors and nurses in Shands NICU, in general means tasks like pulling out or putting in IV’s, putting in tubes and checking the babies for Jaundice and needed. Results show that families are mostly present in NICU during the day but there is a small difference between the number of people who stay in NICU during the day and the ones who stay there during both day and night. And finally the results show that doctors and nurses mostly work both shifts.

Table 4-1. Characteristics of the staff participants

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Doctors (N=20)</th>
<th>Nurses (N=42)</th>
<th>Total (N=96)</th>
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</tr>
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<td>18-35 Years</td>
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<td>36-45 Years</td>
<td>4</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>46-55 Years</td>
<td>4</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td>56-65 Years</td>
<td>4</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>Shift</td>
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</tr>
<tr>
<td>Day</td>
<td>7</td>
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<td>37-48 Hrs</td>
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<td>More Than 48 Hrs</td>
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</table>
Results (Table 4-1) showed that most doctors (8 of them, 40%) and nurses (27 of them, 64.28%) have worked in Shands NICU for more than 10 years. Most doctors (14 of them, 70%) have worked in another NICU. Doctors spend more time in NICU (37 to 48 hours) than nurses who mostly spend 25 to 36 hours there.

<table>
<thead>
<tr>
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</tr>
</thead>
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<td></td>
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<td><strong>Age</strong></td>
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<td>36-45 Years</td>
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<td>46-55 Years</td>
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</tr>
<tr>
<td>56-65 Years</td>
<td>3</td>
</tr>
<tr>
<td>Above 65 Years</td>
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</tr>
<tr>
<td><strong>Shift</strong></td>
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</tr>
<tr>
<td>Day</td>
<td>17</td>
</tr>
<tr>
<td>Night</td>
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</tr>
<tr>
<td>Both</td>
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<td><strong>Newborn In NICU</strong></td>
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<tr>
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<tr>
<td>More Than 3 Weeks</td>
<td>20</td>
</tr>
</tbody>
</table>

To summarize demographic results, it can be concluded that most staff have worked in Shands NICU for more than 10 years, most of them haven’t worked in another NICU and most of them work in NICU, between 25 to 36 hours per week (Table 4-1); most of the newborns have been in Shands NICU for less than a week (Table 4-2); and overall, females are much more than males among all caregivers, most of the caregivers are between 18 to 35 years of age (except nurses) and most of them are present in NICU during both shifts.
Comparison of the Observation and Documentation Findings (Existing Conditions of Shands NICU) with the IESNA Recommended Standards

In this section the results of observations and documentations will be explained based on the two main sections of NICU’s (newborn care areas and support areas). These findings will be categorized based on the lighting issues such as general lighting, task lighting, natural lighting and controllability. A major part of the observations was explained in chapter 3 for a better understanding of the Shands NICU setting; only the important issues observed will be explained in the following section. These results will also be compared to the IESNA recommended standards.

Newborn Care Areas

NICU II:

This area has an isle in the middle that all monitors are scattered on it. Nurses use this counter as their charting station (Figure 3-4). There are no task lights on this counter but there are recessed general lightings on top of it that is used for task lighting as well (Figure 3-5). The beds are placed on both sides of this isle, plus along the windows (figure 3-7). The general lighting includes the same fluorescent lights in NICU III but the difference is that these lights are located on a straight line and a dimmer switch turns on every other light. The average illumination here during the day time was 70 LUX and it was 30 LUX during the night time. The illumination level along the windows was 111.6 LUX during the day. This recommendation for the general lighting is 10 to 600 LUX. Task illumination level was about 1900 LUX compared to IESNA recommendation which is 2000 LUX.

NICU III

This area is for babies with more critical conditions than NICU II. This area consists of one open area in the middle and two isolation rooms. The total number of bed spaces designated for this area is 22, including the isolation rooms; but it was
observed that some babies were located in a space that was not meant to be a bed space due to not having any more enough space; these spaces may not have any general lighting or task lighting for the baby (Figure 4-1). The open area consists of 3 semi-private bed spaces in the corner and 8 bed spaces by the windows. Newborns are either in a bassinette or an isolate. The difference between them is that isolates are closed on top and are for babies in more critical conditions.

Figure 4-1. A bed space with no general or task lighting

General lighting: The general lighting in the main open area consists of four recessed lighting which is controlled by dimmers. There is a repeated pattern of general lighting on top of each bed space (Figure 3-12); there is one dimmer switch that controls two of the recessed lights and the other two each has its own dimmer switch. There are also three spot lights that are called emergency lights and have only one on and off switch; these spot lights, called emergency lights, are adjustable but the problem is they are up on the ceiling and a person should climb up a chair in order to adjust them (Figure 3-13). These lights are supposed to be just for emergencies while caregivers are doing some procedures but it was observed that sometime the task illumination is
either not enough or not easy to adjust so caregivers have to use these emergency lights for their daily visual tasks; sometimes they leave them on, wasting energy and creating too much heat. There are two architectural columns in the newborn care area III that illuminate the area by an indirect lighting. These two columns are the anchor for the designated bed spaces in NICU III newborn care area.

Table 4-3. Comparison of Shands existing general lighting in NICU to IESNA recommended standards

<table>
<thead>
<tr>
<th>IESNA Recommendations</th>
<th>Existing Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newborn Care Area</td>
<td>NICU II- Daytime: 69.8 LUX</td>
</tr>
<tr>
<td></td>
<td>NICU II- Night time: 30 LUX</td>
</tr>
<tr>
<td></td>
<td>NICU III- Daytime: 73 LUX</td>
</tr>
<tr>
<td></td>
<td>NICU III- Night time: 85 LUX</td>
</tr>
<tr>
<td>Separate source of general light and task light.</td>
<td>Done</td>
</tr>
<tr>
<td>No direct view of the electric light source (including procedure lighting)</td>
<td>Direct light is an issue-Solution: a small sheet on head or isolate</td>
</tr>
<tr>
<td>Fixture, easy to clean</td>
<td>No</td>
</tr>
<tr>
<td>No glare</td>
<td>It is an issue</td>
</tr>
<tr>
<td>Stay awake-different intensities, timing</td>
<td>Nurses complained about low level of lighting specially in NICU II that makes them sleepy</td>
</tr>
<tr>
<td>Create an inviting and productive environment for parents and staff.</td>
<td>Results don’t show a high level of satisfaction of the ambiance of the NICU.</td>
</tr>
</tbody>
</table>

It was observed that one nurse was trying to look at the color of PH paper and she had to move to find a lit space; she had a hard time to read it because there was no general or task light in this space (Figure 4-3). The other nurse was doing a procedure on one of the newborns, while there was a cover on top of the isolate and the task light was shining on that; she wanted to prevent the direct light exposure to the baby’s eyes and the fact that the task illumination was too much for the baby, she had to
compromise it with covering the isolate. The newborn in by the window and the blinders are open so the nurse is using some of the natural light for her procedure (Figure 4-2). The other observation shows that one baby was under the Bilirubin light and had blindfolds on (Figure 4-2).

Figure 4-2. Task area with no general or task lighting

Figure 4-3. Covering isolates with sheets to prevent direct light exposure to babies’ eyes. A) NICU III. B) NICU II.
Table 4-4. Comparison of Shands existing general lighting in NICU support areas to IESNA recommended standards

<table>
<thead>
<tr>
<th>IESNA Recommendation for Support Areas</th>
<th>Existing Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 minute/shift exposure to White light: 300-500 LUX</td>
<td>Lounge:</td>
</tr>
<tr>
<td></td>
<td>All Fluorescent</td>
</tr>
<tr>
<td></td>
<td>Daytime: 260 LUX</td>
</tr>
<tr>
<td></td>
<td>Night time: 140 LUX</td>
</tr>
<tr>
<td>Where support area meets Newborn care area: Separate light sources, Independent switches</td>
<td>Done</td>
</tr>
<tr>
<td>Highlight artwork and architectural features.</td>
<td>Done, in the waiting room</td>
</tr>
</tbody>
</table>

Task Lighting: The pattern of task lighting is not consistent for each bed. Some of the old isolates have a heater that has a light installed in it; this light is used as task lighting that is not adjustable and has only two levels of illuminations (Figure 3-14). Some of the old isolates also have another task light that is flexible but because of its weight and built, is hard to move (Figure 3-15). The new isolates, on the hand, have a task lighting called “the Giraffe”. They have three levels of illumination and very easy to move and adjust (Figure 3-16). It was observed that nurses and doctors had to constantly adjust their position on top of the newborn to avoid shadow. The illumination level for task lights was between 1200 to 1900 LUX which is even more than the recommended illumination level.

Natural lighting: The natural light has some effect on the general lighting for this area especially for the beds next to the window which will be explained below. The blindsers are closed most of the time and very few caregivers use the natural light for their tasks. It was observed that a nurse was doing a procedure on a baby next to the window but the blindsers were closed; she did not use the natural light for her procedure. Also based on the information obtained from nurses, there is no priority as to which baby is positioned next to the window; it is just the matter of available space. There is
restriction only for babies who are in very critical and fragile condition; they need an environment that is very similar to the womb and are not positioned next to the window.

Table 4-5. Comparison of Shands existing task lighting in NICU to IESNA recommended standards

<table>
<thead>
<tr>
<th>IESNA Recommendations</th>
<th>Existing Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Newborn Care Area</strong></td>
<td></td>
</tr>
<tr>
<td>1000 LUX (min) at the plane of the infant bed</td>
<td>1200-1900 LUX depending on the task light</td>
</tr>
<tr>
<td>Separate procedure lighting for EACH infant bed</td>
<td>Some newborns are not in a space designed as a bed space so don’t have any lighting and have to borrow from other newborn care areas</td>
</tr>
<tr>
<td>Temporary increases in illumination necessary to evaluate a baby or to perform a procedure should be possible without increasing lighting levels for other babies in the same room.</td>
<td>Possible for new isolates (with Giraffes) Old ones only two illumination levels.</td>
</tr>
</tbody>
</table>

Table 4-6. Comparison of Shands existing natural lighting in NICU to IESNA recommended standards

<table>
<thead>
<tr>
<th>IESNA Recommendations</th>
<th>Existing Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Newborn Care Area</strong></td>
<td></td>
</tr>
<tr>
<td>No direct view of the sun to the newborns</td>
<td>This barely happens to the babies next to the windows and it is controllable. This was applied in Shands NICU</td>
</tr>
<tr>
<td>Be situated at least 2 feet (0.6 meter) away from any part of an infant’s bed to minimize radiant heat loss.</td>
<td>Done</td>
</tr>
<tr>
<td>Be equipped with shading devices that are neutral color or opaque to minimize color distortion from transmitted light.</td>
<td></td>
</tr>
</tbody>
</table>

Support Areas

Support areas in NICU II

The Storage (the “Garage”), family room and hand washing area: The storage is to store supplies and equipment. It is very lit by few sets of fluorescent lights. There are
two recliner sofas in the family room that parents can stay in and rest. The general lighting consists of a set of 2 by 2 fluorescent lights. Hand washing area in NICU II is similar to NICU III and has one linear fluorescent for illumination which is covered and illuminates up to 718 LUX when the surrounding is about 275 LUX. IESNA recommends 300-500 LUX for the surrounding while the task can go up to 1500 LUX.

Support areas in NICU III

Nurse stations, staff lounge and hallways: There is one main nurse station in NICU III; but nurses mostly use the counters by the beds as their station for charting. These are the spaces where the monitors are located at. Some of the monitors face the windows and some have their back to the windows. Staff lounge has seating for 10 people. General lighting in this area is a combination of linear fluorescent and recessed compact fluorescent light. There is also an indirect fluorescent lighting on the walls.

Transport team desk, x-ray viewing station, physicians’ room (fish tank):

Transport team desk is located in the hallway of NICU III; they basically use the hallway general lighting for their tasks. X-ray viewing station is located in the same hallway across from the transport team desk. Physicians’ room has two glass walls, one toward the hallway and the other toward the main newborn care area; that’s why it is called a “Fish Tank”. This room gets a part of its general illumination from the newborn care area.

On-Call/sleep rooms and multipurpose room (Fran’s room): On-call rooms are used by doctors and attendees who work at night shift. The general lighting consists of a set of 2 by 2 covered linear fluorescent lights. There is a night light next to the bed and a fluorescent light on top of the hand washing sink (Figure 3-18). Multipurpose room has seats for 6 people and is used for resting and privacy purposes. The general light here
is a set of 2 by 2 linear fluorescent lights; there are two lamps there that can be used either as task light or a more soothing general light.

Lobby (waiting room), pump room (breast feeding room) and conference room: Lobby has seats for about 17 people. The general lighting consists of recessed compact fluorescent lights. There is an architectural feature in the middle of the ceiling in that simulates a skylight and illuminates the room by artificial lights. This helps to create the feeling of having natural lighting there. There are three adjustable spot lights for the artworks and a wall sconce (Figure 3-19). The pump room has two private areas for pumping (Figure 3-20); each area has its own general lighting that consists of recessed fluorescent light. There is a linear fluorescent lamp on top of the sink. There is no task lighting in the pump room. The general lighting in conference room is 2 sets of 2 by 2 linear fluorescent lighting which are controlled by dimmers.

Summary of Observation and Documentation Findings

The average general lighting level in both NICU’s falls within the lower level of IESNA recommended standards. The average level of general light in NICU II is lower than NICU III especially at night. The task light illumination level is higher than the recommended standards but its level of flexibility is an issue. The caregivers’ information about light switch placement and figuring out which switch controls which light, is not enough. Switch placements also need improvement since some of them are hidden behind the monitors. Support areas mostly meet the recommended standards; but the type of lighting in spaces like the staff lounge or the conference room is not suitable for the visual task and type of ambient needed for that space.

Survey Findings

In this section, survey findings for each group of participants (doctors, nurses, and families) will be described. There were 20 participants in the doctors’ group, 42 in
nurses group and 34 in family group. These results show the frequency of use for different spaces (Figures 4-4 through 4-6), visual tasks done in each group’s most used space (Figures 4-7 and 4-8) and lighting satisfaction as far as how much the lighting supports their visual tasks in these spaces (Tables 4-8 and 4-9), how much control they have over lighting there (Tables 4-10 and 4-11) and overall lighting quality satisfaction (Table 4-7). In the following part of this section, the researcher compares the survey results among all three groups of participants. The last part is a summary of all the findings from surveys.

**Lighting Satisfaction Analysis by Groups**

**Doctors’ satisfaction with newborn care areas**

Based on Table 4-7, doctors are mostly satisfied with the level of information they have about the controllable features to adjust the light in newborn care area. These features are shown in Figure 4-10; based on this figure, doctors mostly use light switches. A very small number of doctors claimed that they either don’t use any of the control features to adjust the light or they don’t change the lighting at all. Comparison of the level of doctors’ satisfaction with lighting control in the newborn care area II (Mean=4.09) and III (Mean=4.25) verses their level of satisfaction with the information they have to adjust the light (Mean= 5.2), shows they are more satisfied with their level of information than actually being able to control the light. General lighting and visual comfort are the second most satisfactory aspects of lighting for doctors. So, in summary doctors are most satisfied with their level of information about where the features for controlling light is and they are least satisfied with the natural lighting.

There are 25% of the doctors who spend less than 5 hours per week in newborn care area II; whereas 30% of them spend 5 to 10 hours there (Figure 4-4). The tasks done by doctors in this area are reading in general, reading labels, viewing x-rays, and
writing, using computers and performing procedures on the patients. The task “Reading” was divided into two tasks, the reading in general and reading the labels. The reason is that labels are in smaller fonts and harder to read and the researcher wanted to make sure the participants’ evaluation of the visual comfort is done as detailed as possible. The mean of their satisfaction with the level that lighting supports their tasks in this area, is 4.09 (Based on the 7 point Likert Scale, 1=very dissatisfied, 7= very satisfied) and the mean of their satisfaction with the level of control they have here, is 4.09 (Based on the same Likert scale).

There are 15% of the doctors who spend less than 5 hours per week in newborn care area in NICU III; 20 % spend 5 to 10 hours, 5 % spend 11 to 25 hours, 10 % spend 26 to 35 hours and finally 10 % spend more than 35 hours per week in newborn care area III. Their tasks are the same as newborn care area II and their satisfaction of lighting support for these tasks has a mean of 4.5. Their level of satisfaction with lighting control has a mean of 4.25.

**Doctors’ satisfaction with support areas**

Physician's room is one of the offices in NICU III. There are 5% of doctors who spend less than 5 hours in this space and 25% spend 5 to 10 hours per week. Visual tasks are reading, working on the computers and writing. The mean of their satisfaction with lighting support here is 5 and this number for controllability is 3.83.

**Summary**

Figure 4-4 shows that the most used spaces for doctors are newborn care area II and III. They may use other spaces for a longer period of time in different occasions but if both factors are combined (number of users and the length of use) these two areas will be the most used spaces by doctors.
Based on Figure 4-5, the visual task doctors mostly do while in the two newborn care areas (their mostly used spaces) is using computers and the one done least by them is reading labels. Doctors are mostly satisfied with the level that light supports their visual tasks in offices in NICU III followed by offices in NICU II and then physician’s room and least satisfied with the newborn care areas (they are less satisfied with newborn care II compared to III). This group is mostly satisfied with the level of lighting control they have in office III followed by newborn care area III and then II; so between the two most used areas by doctors, newborn care area III has slightly better lighting adjustment controllability, in their opinion.

![Bar chart showing hours per week spent in different areas](image)

Figure 4-4. Frequency of usage for spaces used by “doctors” group (showed in percentage)

**Nurses’ Satisfaction with newborn care areas**

Table 4-7, shows that nurses are mostly satisfied with the level of information they have about the controllable features in their most used spaces. Nurses mostly use light switches to control the light and use desk lamps the least (Figure 4-10).
Comparison of the level of satisfaction with control that nurses have in the newborn care area II (Mean=4.3) and III (Mean=4.48) verses their level of satisfaction with the information they have to adjust the light (Mean= 5.41), shows they are more satisfied with their level of information than actually being able to control the light. So, in summary nurses are most satisfied with their level of information about where the features for controlling light are and they are least satisfied with the natural lighting.

About 14 % of the nurses use newborn care area for less than 5 hours per week whereas 5 % use for 5 to 10 hours, about 24 % use for 11 to 25 hours, about 14 % for 26 to 35 hours and 17 % for more than 35 hours per week. Tasks done in these areas are reading in general, reading labels, viewing x-rays, writing, using computers and applying procedures. The mean satisfaction level for how much the lighting quality in this area supports these visual tasks is 3.58 among nurses; this number for their satisfaction level with the controllability over lighting is 4.3. Five % of the nurses use this area for less than 5 hours, 7 % for 5 to 10 hours, 33 % for 11 to 25 hours, 17 % for 26 to 35 hours and 12 % for more than 35 hours. Tasks are the same as Newborn care area II. The mean for lighting support satisfaction is 3.77 and it is 4.48 for controllability satisfaction.

Nurses’ satisfaction with support areas

There is one main nurse station in NICU III and several scattered ones throughout both newborn care area II and III. About 12 % of the nurses spend less than 5 hours here, 9.5 % spend 5 to 10 hours and about 2 % for 11 to 25 hours per week. Tasks done are this area are reading in general, sometimes reading labels and of course using computers. The satisfaction mean for lighting support in this area is 5.1 and it is 4.5 for controllability. The transport team desk is located in NICU III and used by transport team who are a part of the “nurses” group in this research. About 5 % of
transport team spends less than 5 hours in this area and about 7 % spend 11 to 25 hours per week here. The tasks done here are the same as offices. The mean for lighting support satisfaction is 5.57 and it is 5.75 for controllability.

Figure 4-5. Frequency of usage for spaces used by “nurses” group (showed in percentage)

Summary

The most spaces used by “nurses” group are the two newborn care areas as clearly shown in Figure 4-2. As described for doctors, even though nurses may use other spaces than newborn care areas for a longer period of time, but if both factors are combined, the number of users and the length of use, these two areas will be the most used spaces by nurses.

Based on Figure 4-7, the visual task nurses mostly do while in the two newborn care areas (their mostly used spaces) is using computers and the task they least do is viewing x-rays. Nurses are mostly satisfied with the level that light supports their visual tasks in transport team desk. They are least satisfied with the newborn care areas, especially newborn care area II. Nurses group is mostly satisfied with the level of
lighting control they have in transport team desk and the least in offices in NICU II; so between the two most used areas by nurses, newborn care area III has slightly better lighting controllability, in their opinion (Figure 4-10).

**Families’ satisfaction with newborn care areas**

In general families reported that they use light switches among all the light controllability features; the frequency in which they use the switches somehow is less than doctors and nurses. There are some family members that reported no lighting control at all (figure 4-10). Families are mostly satisfied with the visual task and general lighting in their mostly used spaces (newborn care areas).

As shown in Figure 4-8, family members spend most of their time in newborn care areas performing tasks like changing diaper, reading, writing and using the computers; but the task mostly done by them is changing diapers. Mean of family satisfaction of the lighting support for their visual tasks in newborn care areas is 5.75 and it is 4.31 for controllability.

**Families’ satisfaction with support areas**

Family Room is a room designated for parents and family to rest in or stay overnight. There are two family rooms in Shands NICU, one in NICU II, called Fran’s room and the other one in NICU III. About 6% of family members spend less than 5 hours in these areas and the same number of people spends 11 to 25 hours in this area. Visual tasks done by families, here are reading, writing and using computers. The mean for family’ satisfaction with the level of lighting support for their visual tasks is 4; this number for lighting controllability is 3.5.

**Summary**

There are 38.22 % of the family members who use Newborn care area II and 61.74 % use Newborn care area III for more than 35 hours per week; 11.76 % uses
family room for maximum of 11 to 25 hours (Figure 4-4). This result shows that families mostly use the two newborn care areas. Based on Figure 4-6, the most done task by this group is changing babies' diaper. Families are mostly satisfied with the level that light supports their visual tasks and also controllability, mostly in newborn care area II; they are least satisfied with the family rooms. This group is mostly satisfied with the level of lighting control they have in newborn care area II; family rooms are in the last place.

Figure 4-6. Frequency of usage for spaces used by “family” group (in percentage)

**Comparison of Caregivers’ Satisfaction**

Findings from survey showed that most used spaces for doctors, nurses and families are the two newborn care areas in NICU II and III. So as mentioned earlier the satisfaction levels that are not specified to a certain space in analysis are basically for the participants’ most used space; their opinion about common areas was evaluated in the interview questions and was analyzed further, using content analysis.
Figures 4-7 and 4-8 show the frequency of visual tasks done by caregivers in Shands NICU. The way questions were asked in the survey, gave the participant the chance to individually choose the task they do in each of the spaces, therefore one task could be chosen more than once by one participant; this caused the high percentiles in some of the results. Doctors and nurses use the computers more than any other task. Changing babies' diapers is the visual task mostly done by families while present in their newborn's bed space (Figure 4-8).

Figure 4-7. Frequency of visual tasks done by staff (showed in percentage)

Table 4-7 and Figure 4-9 go hand in hand to show the mean of the caregivers’ satisfaction from the aspects of lighting quality mentioned above. The evaluation for this question in survey was based on a 7-point Likert scale. In this scale, number 1 means not satisfied at all or better said, very dissatisfied and 7 means very satisfied. The Standard Deviation (SD) was calculated to show the variety of the replies that resulted in these means. As shown, staff (doctors, nurses) is most satisfied with the level of information they have of where the switches are; on the other hand this is the aspect
that family are least satisfied with. Families are the most satisfied with the general lighting, among caregivers. Nurses on the hand are the least satisfied. Staff are least satisfied with the natural lighting.

Figure 4-8. Frequency of tasks done by families (showed in percentage)

Table 4-7. Mean (M) and Standard Deviation (SD) scores for caregiver’s satisfaction

| Table 4-7. Mean (M) and Standard Deviation (SD) scores for caregiver’s satisfaction |
|---------------------------------|----------------|----------------|
| General Lighting Satisfaction   | Doctors (N=20) | Nurses (N=42)  | Family (N=34) |
| M*                             | SD             | M             | SD           | M   | SD |
| 4.55                           | 1.39           | 3.59          | 1.77         | 5.3 | 1.34 |
| Task                           |                |                |              |     |    |
| (1) Task Light Satisfaction    | 3.83           | 1.34           | 3.45         | 1.90 | 5.03 | 1.2 |
| (2) Task Performance           | 4.10           | 0.71           | 3.57         | 1.79 | 4.85 | 1.09 |
| Natural Lighting Satisfaction  | 3.35           | 2.01           | 3            | 1.82 | 5    | 1.53 |
| Visual Comfort                 | 4.5            | 1.43           | 3.95         | 1.86 | 5.32 | 1.41 |
| Information About-             |                |                |              |     |    |
| Controllable Features          | 5.2            | 1.83           | 5.41         | 2.08 | 4.06 | 2.11 |

*M= Based on the 7 point Likert Scale, 1=Very Dissatisfied, 7= Very Satisfied

In order to better analyze the caregivers’ level of information for lighting control and adjustment, one of the questions in the survey was about what controllable features they have access to and use. The results are summarized in Figure 4-10. The available
features in both Shands NICU’s were observed and they were light switch, under
cabinet light, desk lamp, window blinder, light dimmer and night light. Obviously each
caregiver doesn’t have access to all of these and some of them don’t try to adjust any of
the features around them so the researcher gave them the “None” option in the
questionnaire; families have the highest percentage for not changing the lighting in the
bed space. The most used features by all caregivers are obviously the light switches
followed by light dimmers.

As mentioned above, caregivers’ level of satisfaction with how much lighting
supports their task performance, and their control over the lighting in their used spaces
was asked twice in the questionnaires. Tables 4-8 through 4-11 show the mean of
caregivers’ satisfaction level with these two aspects; the difference is that this time, it is
analyzed for all the spaces the caregivers’ use and not only for their most frequent used
space. These tables give out useful details like caregivers’ level of satisfaction of each
of the newborn care areas separately (newborn care area in NICU II and the one in
NICU III), instead of a combined result. Families were analyzed separately because the
spaces they use are very different than the ones used by staff.

Nurses are mostly satisfied with the controllability of the light features at nurse
stations (both the main nurse stations and the scattered ones around NICU II and III)
and transport team desk (the desk used by the transport team who are a part of the
nurse group); both doctors and nurses are least satisfied with the newborn care areas
whereas families are most satisfied with them. Between the two newborn care areas,
NICU II is less desirable among doctors and nurses but more desirable among families
(Tables 4-8 and 4-9).
Figure 4-9. Comparison of the means of level of light quality satisfaction for all three groups of caregivers.

Figure 4-10. The frequency of caregivers’ usage of the controllable lighting features they have access to.
Table 4-8. Mean (M) and Standard Deviation (SD) scores for staff’s level of satisfaction with light supporting their tasks in their used spaces

<table>
<thead>
<tr>
<th>Spaces</th>
<th>Doctors (N=20)</th>
<th>Nurses (N=42)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M*</td>
<td>SD</td>
</tr>
<tr>
<td>Newborn Care Area II</td>
<td>4.09</td>
<td>1.88</td>
</tr>
<tr>
<td>Newborn Care Area III</td>
<td>4.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Office II</td>
<td>5.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Office III</td>
<td>6.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Physician’s Room</td>
<td>5</td>
<td>0.82</td>
</tr>
<tr>
<td>Nurse Station</td>
<td></td>
<td>5.1</td>
</tr>
<tr>
<td>Transport Team</td>
<td></td>
<td>5.57</td>
</tr>
<tr>
<td>Control-Charting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Front Desk</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*M= Based on the 7 point Likert Scale, 1=Very Dissatisfied, 7= Very Satisfied

Table 4-9. Mean (M) and Standard Deviation (SD) scores for families’ level of satisfaction with light supporting their tasks in their used spaces

<table>
<thead>
<tr>
<th>Spaces</th>
<th>Family (N=34)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M*</td>
</tr>
<tr>
<td>Newborn Care Area II</td>
<td>6.08</td>
</tr>
<tr>
<td>Newborn Care Area III</td>
<td>5.75</td>
</tr>
<tr>
<td>Fran’s Room</td>
<td>4</td>
</tr>
<tr>
<td>Family Room III</td>
<td>4</td>
</tr>
</tbody>
</table>

*M= Based on the 7 point Likert Scale, 1=Very Dissatisfied, 7= Very Satisfied

As far as the control over lighting, doctors are most satisfied with offices in NICU III, nurses with the transport team desk and the nurse stations and families with newborn care areas. Doctors and nurses are more satisfied with the level of control they have in newborn care area III than newborn care area II; and this result reverses for family. Some of the questions in the survey gave the participant the option to explain their answers further. These comments were analyzed using content analysis and the result of their replies is summarized in Appendix K, Table K-2. Table 4-12 shows the frequency of participants’ comments for each category of questions. All the written comments were about their dissatisfaction with the related category and no positive
comment about their satisfaction was written. Doctors mostly talked about their job performance; one of the doctors (D1) said: “Spot lighting is often insufficient for procedures” (Appendix K). Nurses talked about their dissatisfaction with natural lighting, general lighting and task lighting. Family mostly talked about general lighting; even though natural lighting seems to be an important matter for them as well. One of the family members (P1) said: “I think they could use a little more sunlight. It is good for the baby” (Appendix K).

Table 4-10. Mean (M) and Standard Deviation (SD) scores for staff’s level of satisfaction with light control

<table>
<thead>
<tr>
<th>Spaces</th>
<th>Doctors (N=20)</th>
<th>Nurses (N=42)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M*</td>
<td>SD</td>
</tr>
<tr>
<td>Newborn Care Area II</td>
<td>4.09</td>
<td>1.44</td>
</tr>
<tr>
<td>Newborn Care Area III</td>
<td>4.25</td>
<td>1.23</td>
</tr>
<tr>
<td>Office II</td>
<td>3.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Office III</td>
<td>5.25</td>
<td>0.83</td>
</tr>
<tr>
<td>Physician’s Room</td>
<td>3.83</td>
<td>2.27</td>
</tr>
<tr>
<td>Nurse Station</td>
<td>4.5</td>
<td>1.75</td>
</tr>
<tr>
<td>Transport Team</td>
<td>5.75</td>
<td>1.09</td>
</tr>
</tbody>
</table>

Control-Charting

Front Desk

* M= Based on the 7 point Likert Scale, 1=Very Dissatisfied, 7= Very Satisfied

Table 4-11. Mean (M) and Standard Deviation (SD) scores for families’ level of satisfaction with light control

<table>
<thead>
<tr>
<th>Spaces</th>
<th>Family (N=34)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M*</td>
</tr>
<tr>
<td>Newborn Care Area II</td>
<td>4.38</td>
</tr>
<tr>
<td>Newborn Care Area III</td>
<td>4.31</td>
</tr>
<tr>
<td>Fran’s Room</td>
<td>3</td>
</tr>
<tr>
<td>Family Room III</td>
<td>4</td>
</tr>
</tbody>
</table>

* M= Based on the 7 point Likert Scale, 1=Very Dissatisfied, 7= Very Satisfied
A one-way ANOVA was used to test for satisfaction differences among the three caregivers’ group for lighting conditions at NICU’s (Table 4-13). Post-Hoc test HSD (Honestly Significant Differences) tests were conducted when significant one-way ANOVE results were obtained (Table 4-14). This test shows that the difference between the satisfaction levels of the three groups of caregivers is significant for all the lighting aspects except their level of information of the light control features. In order to better understand the significance of difference between each group of caregivers specifically, the result of Post-Hoc test is shown in Table 4-14. Based on these results, there is a significant different between the level of satisfaction for nurses versus families. This difference is true for all the aspects of lighting such as general lighting, task lighting, natural lighting, job performance and visual comfort. The results of this study shows that families and nurses have the most difference in their lighting satisfaction since their visual tasks are different and their level of responsibilities and the level they need to change the lighting in NICU is very different. Post-Hoc results show that this difference is significant. The results obtained from the Post-Hoc test reinforce the results of this study.
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Table 4-14. Mean and standard deviation for lighting satisfaction (ANOVA test)

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**Interview Findings**

In this section, interview findings will be described based on lighting factors (general lighting, task lighting, natural lighting and controllability). There were 10 people participating from each group. Questions in interviews covered issues of lighting such as frequency of caregivers’ satisfaction of daytime lighting, nighttime lighting, lighting factors in general, newborn focused factors and the overall general lighting condition of the support areas used by each group (Appendix H, I and J). Each group’s comments and suggestions have also been gathered from the interviews and will be talked about in each section (Appendix K).
General Lighting

Families talked about general lighting illumination more than the other two groups; all the groups were mostly unsatisfied with this factor as well as other aspects of general lighting. This result is the same as general lighting satisfactory report at nighttime with the difference that doctors and families mostly talked about it. Doctors and nurses were mostly unsatisfied with the glare, shadow and contrast; they were satisfied with the visual comfort in NICU III than NICU II; families did not mention anything about this factor. As far as preventing direct light exposure to the newborns’ eyes, all the groups that mentioned this, were mostly satisfied with the way they cover newborns’ eyes or isolates; there was one issue that came up by one of the doctors, he mentioned that he didn’t like the sheets; they hindered what he was doing and that it might fall down and get contaminated. When the same question was asked of a nurse and was mentioned that one of the doctors does not like this way of preventing direct light, she mentioned that this was an affordable and convenient way and if for any reason the cover they use got contaminated, for example fell on the floor, they immediately sent them to the laundry room; with the exception that if the cover was provided by the family members. All the groups were unsatisfied of the level that light was individualized for each newborn’s bed space. All the groups were mostly satisfied with the public areas they use.

In general doctors were more unsatisfied with the general lighting in both daytime and night time; also with the lighting factors and factors that relate to the newborns’ comfort. The number of doctors who are satisfied with the glare issues in newborn care areas is the same as the ones who are not satisfied. On the other hand, doctors are mostly satisfied with the general lighting in the support areas; the only exceptions are the conference room and the Call room.
Among the lighting factors, glare, shadow and controllability most bothers the nurses; followed by the placement and accessibility of the light switches. Nurses who talked about the public areas were mostly satisfied with the general lighting and visual comfort there. Family members were mostly unsatisfied with the general lighting in both day and night time; all the ones who talked about lighting factors in general and newborn focused factors, were unsatisfied.

**Task Lighting and Natural Lighting**

Task lighting was more toward unsatisfactory as well; mostly doctors and nurses mentioned the issues of task lighting. Overall, nurses were more satisfied with the task lighting in their mostly used spaces (the newborn care areas) than the general lighting there; and more satisfied with NICU III visual comfort level than II. Families’ opinion of the task lighting was more toward satisfactory. Natural lighting was mentioned by all the groups and they were mostly unsatisfied.

**Controllability**

The issue of controllability was mentioned by all the groups; doctors were mostly satisfied. Switch placements were not easily accessible for the doctors and nurses. One family member talked about this who was not satisfied as well. The only aspect of lighting doctors are more satisfied with than being unsatisfied is controllability and the way there is to prevent direct light exposure to the newborns eyes.
The purpose of this study is to investigate the existing lighting conditions in Shands NICU as a case study and to compare it with the IESNA lighting recommendations for NICU; also, to measure the Shands NICU caregivers’ satisfaction with the existing lighting condition. Based on Rea (2004), the caregivers in this study include doctors, nurses and families of newborns.

This chapter is organized to discuss each research question. In order to do this clearly, the aspects of lighting have been divided into four categories: general lighting, task lighting, natural lighting and controllability of lighting. The general and task light are combined for discussion because the existing lighting condition of Shands NICU sometimes forces caregivers to use the general lighting for their tasks; for example nurses need to be able to read the charts while they are moving from one newborn care area to another or sometimes they just use the general light to perform minor procedures. The term medical procedures in Shands NICU, in general, means tasks like pulling out or putting in IV’s, putting in tubes and checking the babies for Jaundice.

**Research Question One- To What Extent, If Any, Does Shands NICU Existing Lighting Condition, Meet The IESNA Recommended Standards?**

**General Lighting**

Findings show that the level of general illumination in NICU II and III falls within the lower level of the recommended illumination range by IESNA. Recommended range by IESNA is 10 to 600 LUX; results show that the existing general lighting in Shands NICU is 69.8 LUX for NICU II during daytime and 30 LUX during the nighttime whereas it is 73 LUX for NICU III during daytime and 85 LUX during nighttime. As mentioned above, the average illumination in NICU II was lower than NICU III, especially at night. Based on Rea (2004), lighting supports visual processes such as acuity, color vision
and visual performance so having adequate level of lighting in NICU is important for caregivers specially staff who have to perform visual tasks such as procedures.

One of the IESNA recommendations mentions that there shouldn’t be any direct view of the electric light source (Rea, 2000). IESNA does not clarify if this recommendation is specifically for newborns or caregivers; but findings of this study show that this matter was majorly an issue to the newborns. The general lighting could bother the babies’ eyes because there was no control on the direction and distribution of the general lighting. To prevent this problem, the caregivers were using sheets draped over the babies’ eyes or the isolate. It was not expected that caregivers would be satisfied with this method because it does not seem like a professional approach to solving the problem of direct light exposure into baby’s eyes. It was expected that caregivers would desire to look for a better solution for this matter; but the results show that most of the doctors and nurses are actually satisfied with this method (4 doctors out of 7 and 7 nurses out of 9 who talked about this issue). One doctor mentioned this method hindered his job performance and his other concern was that if these sheets get contaminated by; for example falling on the floor and it was dangerous for the babies’ health. This concern was brought into two nurses’ attention; they both mentioned that if a sheet fell down, it would immediately go to the dirty hold unless the sheet is brought by family members. Regardless of satisfaction of the caregivers with having a sheet draped over the babies’ isolates, this method is not the best solution as a design view point. We may have to look into furniture design exclusively for NICU to solve this issue. For example, an individual bed can be designed in a way that has its own adjustable task and general light carried with it or it can have its own canopy to shield the light to the babies’ eyes.
There are some IESNA recommendations that are not met by Shands NICU; for example, the light fixtures are not easily accessible to be cleaned and can cause changes in lighting quality and discomfort for caregivers’ health. One of the staff mentioned that the light on top of the front desk has not been cleaned for ages and they can actually see the difference it makes on the level of illumination. The solution can be either to have more accessible general lighting or to maintain the lights in a better fashion. Preventing glare is another recommendation by IESNA. In Shands NICU, glare is majorly caused by general lighting, task lighting and slightly by natural lighting. This is related to the direction of the light and its controllability. If caregivers were able to control the direction of light, they could avoid glare and problems caused by it more easily.

Some of the IESNA recommendations are too general and need more details and elaboration in order to be useful. For example, IESNA recommends creating an inviting and productive environment for parents and staff (White, 2007) but does not explain what inviting and productive environment means. Rea (2004) mentioned that lighting communicates a message to professional staff, as well as parents and visitors, about the level of care and sophistication provided by the hospital. So, this matter can cover a lot of details as far as what is inviting and productive for each of the groups of caregivers, based on their tasks, needs and time of day they are in NICU. These details need to be mentioned in IESNA recommendations.

The IESNA recommends that the general lighting should have different intensities at different times (White, 2007). General lighting in Shands has dimmers for the recessed down lights which can be adjusted according to the users’ needs. The problem is that adjusting the lighting on top of one bed space can affect other one next to it. This can cause discomfort for other babies especially if the newborn is not in a
designated bed space due to higher volume of admitted babies to newborn care area; therefore some of the babies occupy the same illumination zone and if one bed space needs to increase or decrease the illumination level, the other one will be affected by it. So the general lighting level is dimmable but the illumination zone needs to be flexible. If the illumination zone is flexible, the caregiver can just move the general light to one bed space and use it specifically for that newborn without bothering the newborns around it. The best solution is to rely on task lighting instead of general lighting. If the general lighting is only used for navigation and minimal levels of facial recognition, then there is no need to adjust the general lighting. Instead, the task light covers the illumination needed for visual tasks.

This is another indication that IESNA recommendations are too general and need to investigate different aspects of each recommendation; they also need to propose the recommendations based on different situations and environments in different NICU’s. Another example to support this argument is that IESNA recommends general lighting to have different intensities but it doesn’t mention that it has to be controllable too. If the light is not easily adjustable, caregivers will face problems such as glare, exposure of direct light to the babies’ eyes, etc.

The findings indicate that one of the problems night shift nurses had, was the low level of general lighting in NICU’s, especially in NICU II; this made night shift nurses sleepy and they also couldn’t perform their visual tasks easily. White (2000) recommends that bright lighting is preferred in areas where staff performs critical tasks such as medication dispensing. The IESNA also recommends lighting at night should be lit enough to keep nurses awake (White, 2007). On the other hand babies need less general lighting at night for their circadian rhythm. So, the level of lighting needed by caregivers to perform their tasks at night time is different than the level of lighting
needed by newborns. Findings also showed that even though there are two main nurse stations in Shands NICU, most nurses do the majority of their charting on the monitors located on the counters by newborn’s newborn care area; also based on nurses comments, it is hard for nurses and doctors to read the charts while walking toward a bed space, so they have to look for a lit space and this frustrates them. Studies indicate that satisfaction and stress have a direct correlation to employee burnout and a decision to leave the job (Barrett & Yates, 2002). One might suggest installing task lighting for each charting station next to the newborn care areas. This does not solve the issue with general lighting since we will be using task lighting to solve a general lighting issue. A better solution could be to change the general lighting to a level that is enough for navigational purposes and routine visual tasks like reading and using the computer and instead, focusing on making task lighting more accessible and controllable. Also, it is necessary for IESNA to narrow down its recommendations for general lighting (The IESNA recommendation for general lighting is 10 to 600 LUX). One suggestion for these general lighting recommendations is to change this range to minimal illumination level for navigational purposes and instead have more specific and detailed task lighting requirements.

IESNA recommends that staff should be exposed to either natural light or white light (300-500 LUX) at least 15 minutes a day (White, 2007). This is important for staff’s circadian rhythm and their vitamin D intake (Rea, 2004). Shands staff doesn’t have this opportunity unless they stand by the windows and have the blinds open; this doesn’t happen often because they don’t want to bother the babies with the direct sun exposure and also the windows are not easily accessible since newborns’ beds are placed next to the windows. Accessing windows is even harder in NICU II because there is a counter right by the windows and there are monitors and charting materials on it. Besides, the
newborn care area is designed to primarily suit the newborns’ need and natural light exposure for staff is not necessarily a main design aspect of this area. So, staff should be able to obtain the natural light somewhere other than the newborn care area.

The best place to accommodate white light for staff is the staff lounge. Study shows that staff exposure to bright light (5000 LUX for about 15 minutes) lessened the caregivers’ anxiety associated with night shift work (Leppamaki et al., 2003). The most economical source for white lighting is full spectrum fluorescent light and this can be suggested for Shands NICU lounge area. White light is especially useful for the nightshift staff since it stimulates their body to stay awake and be more alert; this can be recommended for NICU lounges in general and is not specific to Shands NICU.

Another aspect that needs to be considered in NICU lounges in general is that lounge should be a place for relaxation and comfort. Even though white light is necessary for the staff, it might be necessary to have another type of lighting that creates a soothing and relaxing environment; for example indirect lighting. An economical solution is to provide a type of white light that can be easily adjusted to an indirect light. The day shift staff may benefit from the indirect light more than night shift because dayshift staff are already stimulated by the natural light and the higher level of illumination in the newborn care areas and need a more soothing environment in lounge to relax in; on the other hand night shift staff can benefit from the direct white light for their circadian rhythm and gaining back their alertness. Therefore, NICU lounge general lighting can be designed in a way that accommodates both types of lighting at the same time.

**Task Lighting**

The task light illumination level almost meets the standards recommendation but illumination level is not the only aspect of task light that is important for task
performance. One of the task lighting issues in Shands NICU is the difference between the task lighting for the new isolates compared to the old isolates; as shown in the results, the task lighting in the old isolates is hard to manage and adjust. The task lighting of the new isolates called “the giraffe” is flexible and easy to manage; they can be adjusted for different intensities. It is ideal to replace all the NICU beds with the a new design that can provide both the general and task lighting individually for that bed; this might not be economical for all the NICU's, therefore another recommendation can be to remodel the existing beds by replacing their task lighting with a more flexible ones such as the “Giraffes” in Shands NICU; they are flexible and very easily to handle and control, based on caregivers' feedback.

Results show that an increase in specific locations of task lighting for newborn care area and for families is needed in Shands NICU. For example, providing a task light specific to the chair used by family members by the bed could invite the families to change the level of illumination based on their needs without asking for permission. Also task lighting needs to be installed where the nurses and doctors do the charting by the bed spaces. This is usually done on the counter next to the bed space.

**Natural Lighting**

The IESNA recommends that there should not be any direct view of the sun to the newborns eyes (White, 2007). This is not of much concern in Shands NICU because windows are designed in a way that there is an exterior overhang which prevents direct exposure of natural light into the newborn care areas; the blinds are also closed most of the time and nurses can open them by preference. Having accessible blinds is a useful way of controlling natural lighting in Shands NICU. Another IESNA recommendation is that babies are situated at least 2 feet away from the windows and this is done in Shands NICU (Rea, 2000).
Even though Shands NICU does not rely on natural lighting, there could still be areas that simulate natural lighting just to provide a more natural ambiance. Horowitz and colleagues (2001) recommended that daylight from windows is normal, practical, and recommended light exposures for day-shift personnel. One recommendation to fill in the lack of natural lighting in Shands NICU was mentioned earlier and was the white light and indirect light in the lounge; the other recommendation can be a design in the ceiling that simulates a skylight. This is done in Shands NICU waiting room and can be a good model for the rest of the NICU. It was also recommended by one of the nurses who used to work in NICU of another hospital; she mentioned that the other NICU designed the ceiling of the newborn care area in a dome shape that simulated a very large skylight. They integrated lights in the ceiling in a way that represented stars at night and natural light during the day. LED lamps can very well be used for this purpose. Natural light should be incorporated into lighting design in Shands NICU, not only because it is beneficial to patients and staff, but also because it is light delivered at no cost and in a form that most people prefer (Joseph, 2006).

**Controllability**

Results of this study show that there are some controllability issues in Shands NICU. For example, controlling the direction of the general lighting or the level of task lighting is not easy in Shands NICU according to the caregivers. IESNA recommends that there must be control of illumination and adjusting ability (White, 2007) but does not talk about each specific type of lighting and also how each group of caregivers need different levels of controllability based on their tasks. For example the results show that nurses need the most controllability of lighting versus the families who need the least. This goes back to their visual tasks. Nursing care is focused on the assessment, diagnosis, planning, treatment and evaluation of patients requiring acute care. Nursing
interventions in both units address alterations in the physiological function of the neonate and alterations in the family processes. The job description of nurses identifies the population served, equipment utilized, skills performed, and clinical parameters as well as putting in tubes or pulling out IV’s. They are the ones who prepare everything for the procedures. Each nurse has the authority and accountability for decision making and total care for assigned patients for a shift as opposed to 24 hours responsibility. The nursing staff is committed to patient advocacy and innovative patient care. Families on the other hand either prefer not to change the lighting or they don’t need to since their tasks mostly do not require a high level of illumination; if they want the illumination level to be changed, they prefer to ask the nurses to do so. This explains the fact that nurses talked about their need of controllability much more than families in the interviews. The suggestion is that IESNA investigates these kinds of details to make its recommendations more specific and related to each group of caregivers.

Another IESNA recommendation is that there must be multiple light switches and a master switch for immediate darkening of the room (White, 2007). This is done in Shands NICU but the problem is that switches are usually hidden behind the monitors and not easily accessible for the caregivers. Mostly nurses know about the switch placement but it is hard for them to figure out which switch controls which light or which way the dimmers should be turned to change the illumination level. Families have the least information of the switch placement. They did not complain about this matter since they prefer to have the nurses adjust the light for them. The placement of switches and informing the caregivers of their placement and the proper way of using the switches is something that was not considered in the IESNA recommendations.
Research Question Two- How Satisfied Are the Caregivers from the Existing Shands NICU Lighting Conditions?

This question embeds more specific questions such as: What are the visual tasks caregivers perform in Shands NICU? What is their satisfaction level with the general lighting? What is their satisfaction level with the task lighting? What is their satisfaction level with the natural lighting? And what is their satisfaction level with lighting controllability? As we mentioned in the introduction, the discussion for answering questions 2-1 and 2-2 has been combined since general lighting in Shands NICU is used for task performance as well as general illumination.

What are the Visual Tasks that Each Group of Caregivers Do While Spending Time in NICU?

Results show that doctors and nurses mostly work on computers. For doctors, using computers is followed by viewing x-rays, performing procedures and reading, in that order; whereas for nurses, it is reading, performing procedures and writing. Families’ reported that the visual task they mostly engage with while by their baby’s newborn care area, is changing the diaper followed by reading, writing and using the computers.

What is important here is the difference between doctors’ and nurses’ visual tasks compared to families. Lighting quality is more critical for doctors and nurses tasks than families. Nurses deal with lighting changes the most since they do some procedures themselves and have to prepare everything including lighting levels and directions for procedures done by doctors. Nurses are also asked by families to change the illumination levels (based on families’ interview results). Families on the other hand either do not need to change the light or prefer not to; this way they avoid the possibility of bothering staff and other babies.
What Is Caregivers’ Satisfaction Level With The General And Task Lighting?

Among three groups, families were the most satisfied with the general lighting. This could be because according to the families, they prefer a dim lighting for the babies’ comfort and also for bonding with the baby. One of the parents mentioned that she preferred dim light because the harsh fluorescent light takes away from the intimacy needed for bonding with the baby. So, even though the level of general lighting in both NICU II and III are in a lower range of the IESNA recommendations, parents prefer it that way; one of the can be the fact that families’ tasks are not relied on illumination level as much as doctors’ and nurses’ tasks. It is possible that if the general lighting was a soft and soothing light, parents would prefer higher level of illumination since a couple of parents said that they needed more light but softer light so it is not harsh for the baby’s eyes. Individualized lighting for families can change the atmosphere and mood of that space by providing intimacy and privacy. Jeannette Price findings in her thesis study show that privacy is one of the important issues in NICU for the parents and family members, especially when the mother is breast feeding the newborn. We can recommend achieving privacy by lighting design based on our findings. If we design individualized lighting for each bed space in a way that is controlled by dimmers and easily controlled by families, they can change the lighting level in their space based on the level of privacy they need. An example of this could be installing a task light by each seat next to the bed side, in a way that can be easily controlled by parents.

Nurses on the other hand are the least satisfied with general lighting. As mentioned earlier, nurses are the ones who deal with the lighting issues more than other groups. This could be the reason they are least satisfied and they are the ones who talked about the issues of general lighting more than the other two groups. One nurse said “I wish I could turn more lights on without bothering babies and other staff”.

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This could be accomplished at the task level if more effective task lighting were employed at all task locations in the newborn care area. A few other nurses mentioned that they noticed their eyesight had changed due to low level of illumination. They explained that the contrast between monitors and the surrounding general lighting hurts their eyes in a way that they cannot look at the monitors for long. Juslen and colleagues (2007) showed a positive effect of higher lighting levels on the speed of production for nurses’ tasks.

Results also show that nurses are mostly unsatisfied with the distribution of the general as well as the illumination level. This means that they are not satisfied with how much of their task surface is covered by illuminated; also the illumination is not uniform. This is an indication that nurses use the general lighting for some of their task performances such as reading on monitors, reading charts, feeding the baby, changing the baby and some procedures. So the existing general lighting in Shands NICU is not only important for the ambiance in the newborn care area in Shands but also for task performance. It is necessary to have a uniform distribution of both general and task light for visual tasks; this is one of the aspects that contributes to caregivers’ visual comfort. A better solution to this problem would be to design the lighting in a way that general lighting is only for navigation purposes; therefore enough task lighting should be provided for the visual task specially the ones performed by nurses.

Distribution of light is one of the issues that are not mentioned in IESNA recommendations. This shows another gap in the standard recommendations. IESNA could have considered different aspects of general lighting such as distribution and talked about each of them and recommended standards specifically for each of the lighting attributes. This gap in IESNA recommendation can generate the illusion that all the problems related to general lighting is related to illumination level and that the
caregivers dissatisfaction with general lighting is only related to illumination level; but this study’s results show that this conclusion can be incorrect and that dissatisfaction can be related to issues other than illumination level (such as distribution).

The issue of aging eyes is of a great importance. Schuman (2002) talked about the fact that the nurses’ average age is increasing in healthcare environment and that they need more light to perform routine tasks. Ulrich and his colleagues (2008) also mentioned that the challenge of maintaining staff effectiveness will be increasingly important as the number of nurses is decreasing and the aging population is increasing. The results of this study also showed that nurses’ average age is higher than doctors and family members, in addition to that, nurses deal with changing the light levels more than the other two groups; so general light level is very critical for them. Some nurses mentioned this problem, one of them said: “as you get older you need more light for things like visualizing monitors from across the room”; so it is necessary that Shands NICU pay more attention to the nurses’ lighting requirements in their design. It is necessary that Shands NICU evaluates the visual tasks for nurses and provide adequate lighting for their tasks by providing strategically located task lighting in order to be able to keep the general lighting at the minimum level needed for navigation. This method of design will provide a suitable general lighting for newborns’ comfort and circadian rhythm as well as providing adequate task lighting for caregivers’ tasks.

A large number of nurses and doctors talked about glare, shadow and contrast, caused by the direction of the general lighting. This is especially important when they are doing procedures on the babies. One nurse mentioned that “Sometimes there is a glare from the overheads onto the isolates that make it difficult to see the patient clearly”. They also mentioned glare from the monitors. This is another indication of the need to move the main lighting layer down to the task level. The problem is that
caregivers cannot adjust the general lights in the NICU even though they are adjustable; the reason is that they are on the ceiling and hard to reach. It is necessary that Shands NICU makes a use of having adjustable recessed lights; without them being accessible, their adjustability doesn’t make a difference. One suggestion for preventing glare from the monitors is to use OLED lamps in the monitors. OLED lamps have been approved by the FDA to be used for monitors in the healthcare; some of their advantages are wider viewing angles and improved brightness and better power efficiency; they are an indirect light source so they don’t cause direct glare. Their cost is not low now but will decrease in the near future (Obtained from www.Wikipedia.org). The pattern of nurses being least satisfied and families the most satisfied, is seen in the flexibility and adjustability issues of lighting too. Again, this can be related to the difference between nurses’ and families’ visual tasks as well as their lighting preferences. Even though families had the highest level of satisfaction with the lighting in Shands NICU, some of them mentioned the glare from isolates bothering them while trying to look at the baby.

We also have the issue of lighting level needed by night shift staff. The results show that the illumination level in both NICU II and III are very low at night compared to the recommended standards (An average of 30 LUX in NICU II and 85 LUX in NICU III compared to the recommended 10-600 LUX). One doctor mentioned that he had to use a flashlight to pull the IV’s from one baby’s vein. This issue is at the level of task lighting not general lighting. If the doctor had adequate task lighting, the level of general illumination would not be very important. This issue is even more serious in NICU II since the level of lighting is generally lower than NICU III. As previous studies suggest (Leppamaki et al., 2003), repeated and brief exposure (4x 20 minutes) to bright light (over 5,000 LUX) during night shifts improves the well-being of night shift staff during and after night work. Barrett and Yates (2002) showed that satisfaction and stress have
a direct correlation to employee well-being. So, considering issues like staff exposure to bright light can have a noticeable effect on increasing the staff satisfaction and as a result, improving their job performance. This can be provided in staff lounge especially for night time since staff might be tired and sleepy. Creating an interesting environment by lighting might stimulate their brain and increase their alertness. Study done by Taylor (2005) showed an increase in staff satisfaction by using LED lighting triggered by motion sensors for nighttime lighting. They found these lights convenient and useful for conducting nighttime rounds without disturbing residents’ sleep. Also Ulrich and colleagues (2008) mentioned that bright light exposure has a positive effect on mood even in healthy people.

Families on the other hand are relatively more satisfied with the lighting in NICU II than doctors and nurses, which can be related to preferring dim light for their babies instead of the bright, direct fluorescent light and having a more intimate environment to bond with the baby. Research done by Ulrich and colleagues (2008) showed that babies need to be exposed to lower levels of illumination during the night in order to trick their circadian rhythm into a night mode; so dim light is healthier for babies’ circadian rhythm and their well-being during the night.

It is important to have a space where the lighting design creates a soothing environment for caregivers to relax in. Shands NICU has family rooms that family members can stay in to rest and relax especially if they are spending the night in Shands NICU. Some nurses suggested using indirect lighting for this purpose. Ulrich (2008) suggests that lighting from indirect luminaires alone can create an uninteresting space. A little sparkle, color, and highlighting of objects in the space can create an interesting, pleasing environment. Wall sconces integrated into the architecture and accent lighting for illuminating photographs and artwork will enhance the appeal of the
space significantly. Even colored light, used in combination with white-light illumination, can provide an environment that is interesting, pleasing, and memorable. There are also rooms called “Call rooms” for nurses and doctors who work at night shift. Based on caregivers’ feedback, only one room called the multipurpose room (Fran’s room) in NICU III has the soothing environment provided by night lights and proper type of lighting. According to caregivers, this room has the incandescent light that is more soothing for the users; the others use the fluorescent lighting.

One of the reasons healthcare environments use mostly fluorescent light is for the purpose of saving energy as well as economic matters. The problem with this is that usually having a soothing general lighting as well as proper lighting (as far as spectrum and color rendering) for visual tasks are sacrificed for saving energy and money. As mentioned earlier, what can be done to compromise between both saving energy and providing an inviting environment for caregivers is to use full spectrum fluorescent lamps with high level of CRI or to use LED lamps. Shands in particular, can decrease the illumination level in storage room (“Garage”) and supply room. The lights in these spaces are always on; Shands can also use energy saving bulbs for these areas as well as other areas in Shands. Sensors could also be used in spaces like storage and supply room but based on staff comments, this might not make a noticeable difference in energy saving since the traffic is high in these two areas, specially the storage that is used as a passage between NICU II and III.

The color quality of lighting in Shands was another unsatisfactory aspect of lighting in NICU. The caregivers’ dissatisfaction is related to the ambiance created by the general lighting and also their job performance. Two of the doctors mentioned that it is hard for them to distinguish baby’s skin color for diagnosing Jaundice. Jaundice is common between newborns especially the premature newborns and needs to be
diagnosed immediately for treatment. This important issue is currently dealt with at both general and task lighting level in Shands NICU, meaning doctors and nurses use both general and task light to diagnose jaundice. One suggestion could be to provide proper task lighting with high Color Rendering Index (CRI) so that staff doesn’t have to use the general light for critical task like this. This way, the general light can remain at the suitable level for newborns while doctors and nurses are performing their tasks. This can be provided with both fluorescent and incandescent light as long as it has a proper CRI.

Parents also mentioned that fluorescent lights [with low CRI] take away from the intimate ambience with their child as well as it being too harsh for their babies. Studies show that there is a direct association between the relaxing home environment and the warm incandescent lights (Ulrich et al., 2008). One suggestion could be to install a task light for to the seat by the newborn care area. This approach also sends a message that family is free to control and adjust this task light without asking permission.

Some direct lighting luminaires, designed to provide maximum illumination on horizontal surfaces while minimizing the brightness of the luminaires (to avoid reflections in computer screens), produce dark walls and ceilings and can leave faces and three-dimensional objects in shadow. These luminaires, despite their claims for energy efficiency, are usually not suited for the NICU because the work and interactions with people in the NICU are not only associated with head-down work on horizontal surfaces or with intensive computer use, it also includes staff interaction among themselves or with families. It was observed that sometimes nurses and doctors meet by the newborn care area to discuss a baby’s evaluation; all these interactions need proper lighting at the horizontal level as well as vertical. This issue of causing shadow by direct illumination of horizontal surfaces can add to the problem of diagnosing
jaundice as well. It might be necessary to have indirect lighting for general lights and some adjustable direct lights for task purposes. The flexible general lighting can be adjusted to indirect lighting when it is not needed for task performance.

Even though, the level of task illumination in Shands NICU almost meets the recommended standards (Task illumination levels vary between 1200 to 1900 LUX, compared to recommended 1000LUX by IESNA), the satisfaction with task lighting has the same pattern as the general lighting, nurses are the least satisfied (mean=3.45) and families are the most satisfied (mean= 5.03) but the overall caregivers’ satisfaction with task lighting is higher than the general lighting. There are still some issues that are important to mention; for example quite a few of the staff mentioned the new task light feature called as “Giraffe” (the giraffes) versus the old ones. Caregivers emphasize that the “giraffe” light fixtures make their tasks much easier due to flexibility and different light intensities.

There are problems with glare, shadow and contrast can be also related to task light. One doctor mentioned, “In the Unit [NICU II and III newborn care area] some of the bright procedure lights are not adjustable, so if the baby’s bed is not in the designated bed space, the lights are not directed at the bed and it causes shadows.” When a baby is in a space that was not originally designed as a bed space, they either don’t have any general or task lighting which means in order to lit the space for visual task and procedures, they have to borrow task lights from other beds; or they might have only the fixed task lighting that reflects directly into the baby’s eyes and causes discomfort. This dislocation also causes shadow and glare and makes it hard for caregivers to work on the babies. Having individualized task lighting that is flexible and has adjustable intensity is strongly recommended for NICU’s in general since task
lighting is used for critical procedures and diagnosis on babies. Once again, these results support an argument for diminishing general lighting and amplifying task lighting.

Caregivers addressed their preference about task lighting during the interview. For example, one family member suggested using a screen or shade to prevent direct light exposure to the babies’ eyes. This shield or screen needs to be flexible and easily removable from the isolator for the cycled lighting intake that babies need for their circadian rhythm. A nurse mentioned to have more flexible task lights: “If all of them could be like the giraffes [the new task lighting features], it would be great.” Another suggestion was to have more than one type of adjustable task lighting, so they have more option to control the task lighting. It can be suggested that instead of having several task lights with varieties, there can be one task light that has the enough flexibility and intensities that covers all the illumination levels needed for all groups of caregivers.

What Is Caregivers’ Satisfaction Level with the Natural Lighting?

Newborn care areas are the only spaces in both NICUs that get some natural lighting from the south facing windows. Families have the highest satisfaction of natural lighting and nurses have the lowest among all three groups of newborn care area users; the same pattern as general lighting and task lighting. Some nurses mentioned glare caused by natural lighting. Nurses work on the monitors in newborn care area for a long time and change the condition of natural lighting by opening or closing the window blinders, so the issue of controlling the natural lighting is more critical for them compared to other caregivers. This might be the reason that nurses talked about natural lighting in the interviews more than other groups of caregivers. Having windows is not only important for receiving natural light but also providing good view to the outside and important for regulating the circadian system. Windows provide occupants with visual
information about the outside environment (Ulrich, 2008). However, windows can also be sources of visual discomfort and disability, especially when direct sunlight penetrates in. Glare from sunlight can be extremely uncomfortable and can make electronic display completely unreadable. Therefore, providing flexible, occluding treatments to windows to limit all types of glare is essential. Tinting the windows will not accomplish the desired effects because daylight and sunlight are so bright that even dark window tints cannot prevent disabling or uncomfortable glare.

One study by Mrockzek and colleagues (2005) shows that providing natural lighting has the most positive environmental impact on work life. Another study found that staff with more than 3 hours of daylight exposure during their shift had higher job satisfaction than staff with less daylight exposure. It was observed that the windows in Shands NICU had an exterior overhang which provided shading effects and prevented direct lighting entering the newborn care area. The advantage of this design is preventing direct sun shining on the babies but it also means that caregivers need another source of natural lighting since the amount of natural lighting in newborn care area should be adjusted based on babies’ needs because of their critical state. One of the ways to compromise this bipolar need of natural lighting is by creating spaces for caregivers that either have natural light or a type of lighting that simulated natural lighting; for example designing staff lounge, as discussed earlier, could be a beneficial design to staff health and satisfaction. A combination of daylight and electric light is the ideal lighting design for NICU’s in general because natural light is light delivered at no cost and in a form that most people prefer (Joseph, 2006).

It is important to mention that according to some doctors and nurses, the reason that some babies are located next to the windows, is just because that space was open. Although, if a baby is in a very fragile state, it is preferred to be placed further from the
windows since they need a darker environment for their healing, that resembles the womb.

**What Is Caregivers’ Satisfaction Level With Lighting Controllability?**

The controllability of general lighting and the caregivers’ knowledge of switch placement is an important aspect of lighting. Doctors reported that they mostly deal with light switches when it comes to controlling light whereas nurses deal with both switches and window blinders. These two groups have about the same level of satisfaction with the level of information they have about where the switches are and how to control them. Even though this is not a low number for these two groups in survey results, the interview shows that a lot of doctors and nurses are not satisfied. The difference between survey and interview results for this matter could be because the participants did not understand the question well while filling out the surveys or since they have the opportunity to discuss their answers more in depth, they expressed their opinion more clearly and accurately. Also, since the interview is done after the participants fill out the survey, the survey questions could make them realize the aspects of lighting they never thought about; so we may be able to conclude that the replies to the interview questions were more premeditated. One of the doctors said: “a lot of the switches are behind the beds and hard to reach”, one nurse said: “Switches are not in a place that is easily reachable, or we don’t know which is for which light”.

The caregivers who had problems with the placement of switches suggested that they should be placed in a more visible place and also be labeled so they don’t have to try different switches and turn unwanted lights on and off and bother the babies and people around them in order to figure out the right switch. Changing the monitor’s position might help with another problem brought up by caregivers and that is: the monitors are placed too up high (on the countertop). One of the nurses suggested
putting general lighting on tracks so they can be adjustable but to make sure the height is accessible to the caregivers. But the best solution could be eliminating the need to control the general illumination and focusing on more accessible and adjustable task lighting for doctors and nurses.

Families’ results on the other hand, show that they barely change the lighting level and use the switches. This could be because they are not provided with proper information about controlling the light in their baby’s space and they are also not comfortable with changing the lighting. One parent said that each time they need to change something about lighting; they need to ask the staff so they prefer not to bother them. They also mentioned that they don’t change anything because they don’t need to. Survey results show that Families have a distinguished lower level of information about the controllable features. This supports the fact that family members do not change the light condition in their baby’s newborn care area. Another question in the survey asked about the level of satisfaction of controllability of light in each of the newborn care areas. Doctors, nurses and families, all had close satisfaction level for this matter. The highlight of these results is that doctors and nurses had a slightly higher satisfaction with NICU III than NICU II whereas this was reverse for families. This issue could be solved by providing a task light for the families in each bed space.

**Conclusion and Further Research**

In conclusion, the level of satisfaction among caregivers varies based on all the lighting variables, their demographics, the space they use mostly, and the shift they work in. Shands NICU follows some of the recommended standards but not all. Following the exact recommended standards does not always affect the caregivers’ satisfaction since for example, the general lighting level of newborn care areas in Shands NICU is in the recommended range by IESNA but the level of satisfaction with
general lighting in this area is not high. This shows that there are other aspects of light such as direction and distribution that IESNA needs to consider as well as the level of illumination. Also, the task done by each group of caregivers effects their lighting needs; results show that the major reason of the difference between nurses satisfaction and families satisfaction of lighting quality is the difference between their visual tasks. These are indications for highly suggesting IESNA to investigate the lighting needs of each group of caregivers based on their visual task prior to recommending standards. Most recommendations by IESNA are generally addressed and do not distinguish which group of caregivers they are talking about.

Another aspect of IESNA recommendations that needs consideration is that ranges of desirable illumination level provided by IESNA are too wide and need to be narrowed down. For example it is suggested that the general lighting illumination level be between 10 to 600 LUX. This is a very wide range and is not useful for distinguishing a proper light level for NICU’s in general. IESNA does not indicate if this range shows the range of illumination provided by dimmers or just by the step dimmers. In general, this study supports the previous studies as far as lighting design in NICU. As mentioned earlier, we suggest that NICU’s in general use the general lighting only for navigation and minimal levels of facial recognition; therefore it is preferred the general lighting is not adjustable. Then all controllability can live at the task level which solves many of these general illumination issues. This suggestion can be provided by IESNA for general NICU lighting design.

It might be necessary for Shands NICU to consider more accessible and easily adjustable task lighting that has variable illumination intensity. The new task lighting fixtures in Shands (giraffes) can be a good model for task lighting in NICU’s in general. Bed design can be one of the suggestions for NICU’s; for example have beds with
canopies to prevent direct light exposure to the babies’ eyes instead of using sheets on the isolates or having individualized general and task lighting attached to each bed for better control and adjustability. An economical solution is to renovate the existing beds by replacing the old task lights with new ones like the “Giraffes”. It is also necessary for all NICU’s to integrate natural light in the common areas used by staff such as staff lounge; if integrating natural lighting is not possible then use of adjustable white light in a way that can be adjusted into soothing or stimulating (based on night shift and day shift needs) is necessary. Switch placements in Shands are not easily accessible and visible and caregivers are not properly informed about them.

Further researches could expand the number of case studies in order to come up with a more detailed recommendation for NICU lighting design and also to be able to generalize the results for all NICU’s. Literature also mentions that there are not many studies that have examined the effects of environmental factors on job satisfaction (Douglas et al., 1996). This issue can be looked at in more details in future studies. Also the impact of natural lighting on caregivers stress and satisfaction can be studied more in depth (Ulrich, 2008). So, one suggestion for further studies is to choose a healthcare environment that relies on natural lighting more than Shands NICU.
DATE: August 24, 2011

TO: Rozita Mozaffarian

FROM: Ira S. Fischler, PhD; Chair
University of Florida
Institutional Review Board 02

SUBJECT: Approval of UFIRB # 2011-U-0790
Caregivers’ Satisfaction with Lighting in a Neonatal Intensive Care Unit

SPONSOR: None

I am pleased to advise you that the University of Florida Institutional Review Board has recommended approval of this protocol. Based on its review, the UFIRB determined that this research presents no more than minimal risk to participants. Your protocol was approved as an expedited study under category 7: Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Given this status, it is essential that you obtain signed documentation of informed consent from each participant. Enclosed is the dated, IRB-approved informed consent to be used when recruiting participants for the research. If you wish to make any changes to this protocol, including the need to increase the number of participants authorized, you must disclose your plans before you implement them so that the Board can assess their impact on your protocol. In addition, you must report to the Board any unexpected complications that affect your participants.

It is essential that each of your participants sign a copy of your approved informed consent that bears the IRB approval stamp and expiration date.

Your approval is valid through August 23, 2012. If you have not completed the protocol by this date, please telephone our office (392-0433), and we will discuss the renewal process with you. It is important that you keep your Department Chair informed about the status of this research protocol.

ISF:dl
Informed Consent

Title: Caregivers’ Satisfaction with lighting in a Neonatal Intensive Care Unit

Purpose of the research study: To evaluate the quality of lighting in NICU of Shands Hospital based on recommended standards and figure out its relation to caregiver’s satisfaction.

What you will be asked to do in the study: You will be asked in a survey and brief interview to evaluate the quality of lighting conditions in NICU of Shands Hospital.

Time required: 15-20 minutes

Benefits: This study may result in finding out the weaknesses and strengths of Shands lighting design as a case study in order to suggest some practical guidance to designers responsible for the lighting in the NICU and eventually an optimum lighting environment for this hospital and other NICU’s for improvement.

Confidentiality: Your identity will be kept confidential to the extent provided by law. Your name won’t be asked in any of the questions asked. Your information will be assigned a code number. Your response will be anonymous and not connected to your name in anyway. Your name will not be used in any reports.

Voluntary participation: Your participation in this study is completely voluntary. There is no penalty for not participating.

Right to withdraw from the study: You have the right to withdraw from the study at anytime without consequence.

Whom to contact if you have questions about the study: Rozita Mozaffarian, University of Florida, Department of Interior Design, Master’s Student.

Whom to contact about your rights as a research participant in the study: IRB Office, Box 112250, University of Florida, Gainesville, FL 32611-2250; phone 392-0433.

Agreement:

I have read the procedure described above. I voluntarily agree to participate in the procedure and I have received a copy of this description.

Participant: ___________________________ Date: ___________________________

Principal Investigator: ___________________________ Date: ___________________________

Approved by
University of Florida
Institutional Review Board 02
Protocol # 2011-U-0750
For Use Through: 08-23-2012
APPENDIX C
RESEARCH AND INFORMATION PRIVACY AT THE UNIVERSITY OF FLORIDA CERTIFICATION

Congratulations!!

Certificate of Completion

This is to certify that

Rozita Mozaffarian

has successfully completed the

Research and Information Privacy at the University of Florida

on 3/31/2011

This Privacy Training Completion has been electronically recorded. Print a copy of this certificate for your records. If you have trouble printing the certificate, close this window and return to the Privacy Homepage. Click on Get Your Certificate and print your certificate from there.

Print

Don’t forget to complete your Confidentiality Statement. When you close this window, follow the link to the statement in the menu on the left.

If you have any questions, contact Everall Peele, Training Coordinator in the Privacy Office at 352-273-5096 or epeele@ufl.edu

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http://privacy.health.ufl.edu/training/Research08/certificate.asp?id=35343507&quiznumbe... 3/31/2011
CONFIDENTIALITY STATEMENT

I acknowledge that this statement applies to all members of the workforce, including but not limited to, employees, volunteers, students, physicians, resident physicians, and third parties, whether temporary or permanent, part or full-time, visiting, or designated as associates, who are employed by, contracted to, or under the direct control of the medical components of the University of Florida (UF). The medical components include the Health Science Centers located in both Gainesville and Jacksonville, and all their direct support organizations, designated as affiliated entities (affiliates) in the Privacy Manual of the University of Florida.

I acknowledge that UF has formally stated in the UF Privacy Manual its commitment to preserving the confidentiality and security of health information, whether it is maintained or distributed in paper, electronic, video, audio, or any other medium or format. I understand that I am required, if I have access to such health information, to maintain its confidentiality and security.

I understand that access to health information created, received, or maintained by UF or its affiliates in any location is limited to those who have a valid business or medical need for the information or otherwise have a right to know the information. I understand that there are many administrative, physical, and technical safeguards in place to protect the privacy and security of this health information, and that any attempt to bypass or circumvent these safeguards is a violation of federal and state laws and the privacy and security policies of the University of Florida.

I understand that anyone who is authorized to access electronic health information within UF and its affiliates systems will be issued a unique user identification and password, and that any person who knowingly discloses their user ID or password to others, uses, or discloses another individual's user ID or password, or accesses any electronic protected health information without authorization is subject to disciplinary action, up to and including dismissal. In addition, I understand that all UF and affiliate workforce members must comply with applicable Information Technology Security Policies.

I understand that apparent methods and purposes for access to, uses and disclosures of, and requests for, any and all protected health information created, received, or maintained by UF and its affiliates are limited to those described in the University of Florida Privacy Manual policies and procedures. I further understand that, with the exception of purposes related to treatment, access to, use, and disclosure of, and requests for an individual's health information, must, to the extent practicable, be limited to the minimum necessary to accomplish the intended purpose of the approved use, disclosure, or request.

I understand that any known or suspected violation of the confidentiality or security of health information must be reported to my immediate supervisor or to the Privacy Officer immediately.

I have read the UF Confidentiality Statement and I understand that violation of this policy may result in disciplinary action, up to, and including, dismissal by the University or its health care affiliated entities, in accordance with UF policies, UF PHIPPA policies, and Rules 6C-1.000, 6C-5.047, 6C-4.546 and 6C-7.018 of the Florida Administrative Code, as applicable.

I have read the University of Florida Health Information Policy.

Name: Rachelle Nozafarian  Date: 3/31/2011 12:18:38 AM

UF ID#: 

College/Dept: DCP- Interior Design /

Signature:

Confidentiality Statements are signed annually (within every 12 months). They may be stored on-line or a paper copy may be placed in the personnel, student, or personal file of the sender.
1. Your gender?
(1) Male       (2) Female

2. What is your age?
(1) 18 – 35 years
(2) 36 – 45 years
(3) 46 – 55 years
(4) 56 – 65 years
(5) Above 65 years

3. What is your position/title:
(1) Attendee
(2) Resident
(3) Nurse Practitioner

4. What shift(s) do you work at?
(1) 6:30AM – 5:30PM
(2) Other (Please Specify):

5. Approximately how long have you worked in the Shands NICU?
(1) Less than a year
(2) 1-5 Years
(3) 5-10 Years
(4) More than 10 years

6. Have you ever worked in another NICU, other than in Shands Hospital?
(1) Yes       (2) No

7. During a typical week, how many hours do you spend working in the NICU?
(1) Less than 12 hours
(2) 13-24 hours
(3) 25-36 hours
(4) 37-48 hours
(5) More than 48 hours

Please go to the back of the page
<table>
<thead>
<tr>
<th>Which work space(s) do you spend most of your time in while working at NICU? (You can choose more than one)</th>
<th>How many hours per week do you spend in these spaces?</th>
<th>Which tasks do you participate in while in these spaces?</th>
<th>How well the lighting in these spaces support your visual tasks?</th>
<th>What level of control do you have over the lighting adjustment in these spaces?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>☐ Less than 5 hours  ☐ 5-10 hours  ☐ 11-25 hours  ☐ 26-35 hours  ☐ More than 35 hours</td>
<td>☐ Reading (e.g. Charts, Books, ...)  ☐ Reading Medical Supply Labels  ☐ Viewing X-rays  ☐ Writing  ☐ Using Computers/Monitors  ☐ Any other activities (please specify):</td>
<td>☐ -3, Not at all  ☐ -2  ☐ -1  ☐ 0  ☐ 1  ☐ 2  ☐ 3, Very much</td>
<td>☐ -3, Not at all  ☐ -2  ☐ -1  ☐ 0  ☐ 1  ☐ 2  ☐ 3, Very much</td>
</tr>
<tr>
<td>Newborn care area</td>
<td>☐ Less than 5 hours  ☐ 5-10 hours  ☐ 11-25 hours  ☐ 26-35 hours  ☐ More than 35 hours</td>
<td>☐ Reading (e.g. Charts, Books, ...)  ☐ Reading Medical Supply Labels  ☐ Viewing X-rays  ☐ Writing  ☐ Using Computers/Monitors  ☐ Any other activities (please specify):</td>
<td>☐ -3, Not at all  ☐ -2  ☐ -1  ☐ 0  ☐ 1  ☐ 2  ☐ 3, Very much</td>
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<tr>
<td>Other (Please Specify):</td>
<td>☐ Less than 5 hours  ☐ 5-10 hours  ☐ 11-25 hours  ☐ 26-35 hours  ☐ More than 35 hours</td>
<td>☐ Reading (e.g. Charts, Books, ...)  ☐ Reading Medical Supply Labels  ☐ Viewing X-rays  ☐ Writing  ☐ Using Computers/Monitors  ☐ Any other activities (please specify):</td>
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<td>☐ -3, Not at all  ☐ -2  ☐ -1  ☐ 0  ☐ 1  ☐ 2  ☐ 3, Very much</td>
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<td>Newborn care area</td>
<td>☐ Less than 5 hours  ☐ 5-10 hours  ☐ 11-25 hours  ☐ 26-35 hours  ☐ More than 35 hours</td>
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<td>☐ -3, Not at all  ☐ -2  ☐ -1  ☐ 0  ☐ 1  ☐ 2  ☐ 3, Very much</td>
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<tr>
<td>Physician’s Room</td>
<td>☐ Less than 5 hours  ☐ 5-10 hours  ☐ 11-25 hours  ☐ 26-35 hours  ☐ More than 35 hours</td>
<td>☐ Reading (e.g. Charts, Books, ...)  ☐ Reading Medical Supply Labels  ☐ Viewing X-rays  ☐ Writing  ☐ Using Computers/Monitors  ☐ Any other activities (please specify):</td>
<td>☐ -3, Not at all  ☐ -2  ☐ -1  ☐ 0  ☐ 1  ☐ 2  ☐ 3, Very much</td>
<td>☐ -3, Not at all  ☐ -2  ☐ -1  ☐ 0  ☐ 1  ☐ 2  ☐ 3, Very much</td>
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<tr>
<td>Other (Please Specify):</td>
<td>☐ Less than 5 hours  ☐ 5-10 hours  ☐ 11-25 hours  ☐ 26-35 hours  ☐ More than 35 hours</td>
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<td>☐ -3, Not at all  ☐ -2  ☐ -1  ☐ 0  ☐ 1  ☐ 2  ☐ 3, Very much</td>
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</tbody>
</table>
1. Which of the following do you have the ability to control/adjust in your workspace? (Check all that apply)
   Please indicate the space: _________________________
   1) Light Switch
   2) Under Cabinet Light
   3) Desk Lamp
   4) Window Blinders
   5) Light Dimmers
   6) None of the above
   7) Other (Please Specify):

2. How well-informed do you feel about using the features you indicated above? (Choose one):
   Not well   ○ ○ ○ ○ ○ ○ ○ very well
   Informed   1  2  3  4  5  6  7 informed

3. How satisfied are you with the amount of natural lighting available in your workspace?
   Please indicate the space:
   Very dissatisfied 1 2 3 4 5 6 7 very satisfied
   Please explain why:

4. How satisfied are you with the existing ambient/general lighting condition in your workspace?
   Please indicate the space:
   Very dissatisfied 1 2 3 4 5 6 7 very satisfied
   Please explain why:

5. How satisfied are you with the existing task lighting condition in your workspace?
   Please indicate the space:
   Very dissatisfied 1 2 3 4 5 6 7 very satisfied
   Please explain why:

   5-1. Does your workspace lighting enhance or hinder your ability to do your job efficiently?
   greatly  ○ ○ ○ ○ ○ ○ ○ greatly enhanced
   hindered 1 2 3 4 5 6 7 greatly enhanced
   Please explain why:

6. How satisfied are you with the visual comfort (i.e. glare, shadow, contrast) in your workspace?
   Please indicate the space:
   Very dissatisfied 1 2 3 4 5 6 7 very satisfied
   Please indicate why:

7. Please describe any issues you may be experiencing with your lighting that may not have been addressed above.

8. Thank you for participating in the recent survey. I would like to conduct a 30 minute interview to learn about your ideas and suggestions related to this matter.
Please let me know when would be a good date and time:

Also, please indicate your e-mail address/phone number if you plan to participate in this interview:

Thank you once again for your participation and I look forward to our interview!

Rozita Mozaffarian
University of Florida, Department of Interior Design
Master’s Student
APPENDIX F
SURVEY INSTRUMENT 2 (NURSES, RESPIRATORY THERAPISTS & TRANSPORT TEAM)

1. Your gender?
   (1) Male       (2) Female

2. What is your age?
   (1) 18 – 35 years
   (2) 36 – 45 years
   (3) 46 – 55 years
   (4) 56 – 65 years
   (5) Above 65 years

3. What is your position/title:
   (1) Nurse
   (2) Respiratory Therapist
   (3) Transport Team

4. What shift(s) do you work at?
   Nurses:
   (1) Daytime (7AM – 7PM)
   (2) Night time (7PM – 7AM)
   (3) Evening (3PM – 11PM)
   (4) Other (Please Specify):

   Respiratory Therapist and Transport Team (Please indicate your shift(s)):

5. Approximately how long have you worked in the Shands NICU?
   (5) Less than a year
   (6) 1-5 Years
   (7) 5-10 Years
   (8) More than 10 years

6. Have you ever worked in another NICU, other than in Shands Hospital?
   (1) Yes       (2) No

8. During a typical week, how many hours do you spend working in the NICU?
   (6) Less than 12 hours
   (7) 13-24 hours
   (8) 25-36 hours
   (9) 37-48 hours
   (10) More than 48 hours
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<th>Which work space(s) do you spend most of your time in while working at NICU? (You can choose more than one)</th>
<th>How many hours per week do you spend in these spaces?</th>
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<td>☐ Reading (e.g. Charts, Books, …)&lt;br&gt;☐ Reading Medical Supply Labels&lt;br&gt;☐ Viewing X-rays&lt;br&gt;☐ Writing&lt;br&gt;☐ Using Computers/Monitors&lt;br&gt;☐ Any other activities (please specify):</td>
<td>☐ -3, Not at all&lt;br&gt;☐ -2&lt;br&gt;☐ -1&lt;br&gt;☐ 0&lt;br&gt;☐ 1&lt;br&gt;☐ 2&lt;br&gt;☐ 3, Very much</td>
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<td>☐ Newborn care area&lt;br&gt;☐ Less than 5 hours&lt;br&gt;☐ 5-10 hours&lt;br&gt;☐ 11-25 hours&lt;br&gt;☐ 26-35 hours&lt;br&gt;☐ More than 35 hours</td>
<td>☐ Reading (e.g. Charts, Books, …)&lt;br&gt;☐ Reading Medical Supply Labels&lt;br&gt;☐ Viewing X-rays&lt;br&gt;☐ Writing&lt;br&gt;☐ Using Computers/Monitors&lt;br&gt;☐ Any other activities (please specify):</td>
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<td>☐ Other (Please Specify):</td>
<td>☐ Reading (e.g. Charts, Books, …)&lt;br&gt;☐ Reading Medical Supply Labels&lt;br&gt;☐ Viewing X-rays&lt;br&gt;☐ Writing&lt;br&gt;☐ Using Computers/Monitors&lt;br&gt;☐ Any other activities (please specify):</td>
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<tr>
<td>☐ Nurse Station&lt;br&gt;☐ Less than 5 hours&lt;br&gt;☐ 5-10 hours&lt;br&gt;☐ 11-25 hours&lt;br&gt;☐ 26-35 hours&lt;br&gt;☐ More than 35 hours</td>
<td>☐ Reading (e.g. Charts, Books, …)&lt;br&gt;☐ Reading Medical Supply Labels&lt;br&gt;☐ Viewing X-rays&lt;br&gt;☐ Writing&lt;br&gt;☐ Using Computers/Monitors&lt;br&gt;☐ Any other activities (please specify):</td>
<td>☐ -3, Not at all&lt;br&gt;☐ -2&lt;br&gt;☐ -1&lt;br&gt;☐ 0&lt;br&gt;☐ 1&lt;br&gt;☐ 2&lt;br&gt;☐ 3, Very much</td>
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<td></td>
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<tr>
<td>☐ Transport Team Desk or other (Please Specify):</td>
<td>☐ Reading (e.g. Charts, Books, …)&lt;br&gt;☐ Reading Medical Supply Labels&lt;br&gt;☐ Viewing X-rays&lt;br&gt;☐ Writing&lt;br&gt;☐ Using Computers/Monitors&lt;br&gt;☐ Any other activities (please specify):</td>
<td>☐ -3, Not at all&lt;br&gt;☐ -2&lt;br&gt;☐ -1&lt;br&gt;☐ 0&lt;br&gt;☐ 1&lt;br&gt;☐ 2&lt;br&gt;☐ 3, Very much</td>
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</tbody>
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1. Which of the following do you have the ability to control/adjust in your workspace? (Check all that apply)
   (1) Light Switch
   (2) Under Cabinet Light
   (3) Desk Lamp
   (4) Window Blinders
   (5) Light Dimmers
   (6) None of the above
   (7) Other (Please Specify):

2. How well-informed do you feel about using the features you indicated above? (Choose one):
   Not well informed 1 2 3 4 5 6 7 very well informed

3. How satisfied are you with amount of natural lighting available in your workspace?
   Please indicate the space:_________________________
   Very dissatisfied 1 2 3 4 5 6 7 very satisfied
   Please explain why:

4. How satisfied are you with the existing ambient/general lighting condition in your workspace?
   Please indicate the space:_________________________
   Very dissatisfied 1 2 3 4 5 6 7 very satisfied
   Please explain why:

5. How satisfied are you with the existing task light condition in your workspace?
   Please indicate the space:_________________________
   Very dissatisfied 1 2 3 4 5 6 7 very satisfied
   Please explain why:

5-1. Does your workspace lighting enhance or hinder your ability to do your job efficiently?
   greatly dissatisfied 1 2 3 4 5 6 7 greatly enhanced
   Please indicate why:

6. How satisfied are you with the visual comfort (i.e. glare, shadow, contrast) in your workspace?
   Please indicate the space:_________________________
   Very dissatisfied 1 2 3 4 5 6 7 very satisfied
   Please indicate why:

7. Please describe any issues you may be experiencing with your lighting that may not have been addressed above.

8. Thank you for participating in the recent survey. I would like to conduct a 30 minute interview to learn about your ideas and suggestions related to this matter.
   Please let me know when would be a good date and time (preferably next week, if not the week after).
   Also, please indicate your e-mail address/phone number if you plan to participate in this interview:
APPENDIX G  
SURVEY INSTRUMENT 3 (PARENTS AND FAMILIES)

1. Your gender?
   (1) Male       (2) Female

2. What is your age?
   (1) 18 – 35 years
   (2) 36 – 45 years
   (3) 46 – 55 years
   (4) 56 – 65 years
   (5) Above 65 years

3. What is your relationship to the newborn?
   (1) Parent
   (2) Family/Relative
   (3) Friend

4. What time of the day do you spend in NICU?
   (1) Day (between 7:30AM to 7PM)
   (2) Night (between 7:30PM to 7AM)
   (3) Other (Please Specify):

5. How long has your Newborn been in NICU?
   (1) Less than a week
   (2) 1 week – 2 weeks
   (3) 2 weeks – 3 weeks
   (4) 3 weeks – 4 weeks
   (5) 4 weeks – 5 weeks
   (6) 5 weeks – 6 weeks
   (7) 6 weeks – 7 weeks
   (8) 7 weeks – 8 weeks
   (9) More than 8 weeks

6. What part of NICU is your Newborn at?
   (1) NICU II (Please specify the space#):
   (2) NICU III (Please specify the space#):
   (3) Isolation Room
<table>
<thead>
<tr>
<th>NICU I</th>
<th>NICU II</th>
<th>NICU III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which area(s) of NICU do you spend most of your time in? (You can choose more than one)</td>
<td>Newborn care area</td>
<td>Rooming-In</td>
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<tr>
<td>How many hours per week do you spend in these spaces?</td>
<td>Less than 5 hours</td>
<td>Less than 5 hours</td>
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<td>5-10 hours</td>
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<td>More than 35 hours</td>
<td>More than 35 hours</td>
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<tr>
<td>Which tasks do you participate in while in these spaces?</td>
<td>Feeding/changing the Baby</td>
<td>Reading (e.g. Charts, Books, ...)</td>
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<td>Watching TV</td>
<td>Writing</td>
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<td>Using Computers/Monitors</td>
<td>Any other activities (please specify):</td>
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<td>How well the lighting in these spaces support your visual tasks?</td>
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<td>3, Very much</td>
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<td>What level of control do you have over the lighting adjustment in these spaces?</td>
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<td>2</td>
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<tr>
<td></td>
<td>3, Very much</td>
<td>3, Very much</td>
</tr>
</tbody>
</table>
1. Which of the following do you have the ability to control/adjust in your indicated space? (Check all that apply)

Please indicate the space: ________________________

1) Light Switch
2) Under Cabinet Light
3) Desk Lamp
4) Window Blinders
5) Light Dimmers
6) None of the above
7) Other (Please Specify):

2. How well-informed do you feel about using the features you indicated above? (Choose one):

<table>
<thead>
<tr>
<th>Not well informed</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>very well informed</th>
</tr>
</thead>
</table>

3. How satisfied are you with amount of natural lighting available in your most used space?

Please indicate the space: ________________________

<table>
<thead>
<tr>
<th>Very dissatisfied</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>very satisfied</th>
</tr>
</thead>
</table>

Please explain why:

4. How satisfied are you with the existing ambient/general lighting condition in your most used space?

Please indicate the space: ________________________

<table>
<thead>
<tr>
<th>Very dissatisfied</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>very satisfied</th>
</tr>
</thead>
</table>

Please explain why:

5. How satisfied are you with the existing task lighting condition available in your most used space?

Please indicate the space: ________________________

<table>
<thead>
<tr>
<th>Very dissatisfied</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>very satisfied</th>
</tr>
</thead>
</table>

Please explain why:

5-1. Does your indicated space lighting enhance or hinder your ability to do your tasks efficiently?

<table>
<thead>
<tr>
<th>greatly hindered</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>greatly enhanced</th>
</tr>
</thead>
</table>

Please indicate why:

6. How satisfied are you with the visual comfort (i.e. glare, shadow, contrast) in your workspace?

Please indicate the space: ________________________

<table>
<thead>
<tr>
<th>Very dissatisfied</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>very satisfied</th>
</tr>
</thead>
</table>

If dissatisfied, please indicate why:
7. Please describe any issues you may be experiencing with your lighting that may not have been addressed above.

8. Thank you for participating in the recent survey. I would like to conduct a 30 minute interview to learn about your ideas and suggestions related to this matter.

Please let me know when would be a good date and time (preferably next week, if not the week after).

Also, please indicate your e-mail address/phone number if you plan to participate in this interview:

Thank you once again for your participation and I look forward to our Interview!

Rozita Mozaffarian
University of Florida, Department of Interior Design
Master’s Student
APPENDIX H
INTERVIEW INSTRUMENT 1 (DOCTORS, NURSE PRACTITIONERS & RESIDENTS)

1. What do you prefer/suggest as far as general lighting in your workspace(s)?

2. How satisfied are you with the placement of light switches (especially in newborn care area)?

3. While working with computer/monitors, do you experience glare, shadow or contrast interfering?

4. For the people who work in night shift:
   4.1. How does that affect you? (e.g. productivity, mood, health, welfare)?
   4.2. What is your suggestion on improving lighting (ambient and task) for night shifts?

5. Does the lighting condition meet the needs of newborns at different stages of development?

6. Does increasing the illumination level of procedure lighting effect other newborns?

7. How easy/hard is it for you to work under existing procedure lighting as far as flexibility, glare, and shadow and also preventing effect on other newborns?

8. When doing procedures on babies, how do you avoid direct exposure of newborn’s eyes to procedure lighting?

9. How often do you use the natural lighting in NICU?

10. What is your suggestion about a better use of natural lighting that suits both the NICU newborn area as well as caregivers’ need?

11. How satisfied are you with the lighting in these public areas? (ambient/general, task, natural, accent, emergency lighting)

NICU II:
   (1) Control-Charting Station
   (2) Supply Room
   (3) Storage Room (“The Garage”)

NICU III:
   (4) Staff Lounge
   (5) Hand-Washing Station
   (6) Isolation Room
   (7) X-Ray Viewing Station
   (8) Supply Area in the Hallway
   (9) Multi-Purpose Room (Fran’s Room)
   (10) Conference Room
APPENDIX I
INTERVIEW INSTRUMENT 2 (NURSES, RESPIRATORY THERAPISTS & TRANSPORT TEAM)

1. What do you prefer/suggest as far as general lighting in your workspace(s)?

2. How satisfied are you with the placement of light switches (especially in newborn care area)?

3. While working with computer/monitors, do you experience glare, shadow or contrast interfering?

4. For the people who work in night shift:
   4.1. How does that affect you (e.g. productivity, mood, health, welfare)?
   4.2. What is your suggestion on improving lighting (ambient and task) for night shifts?

5. Does the lighting condition meet the needs of newborns at different stages of development?

6. Does increasing the illumination level of procedure lighting effect other newborns?

7. How easy/hard is it for you to work under existing procedure lighting as far as flexibility, glare, and shadow and also preventing effect on other newborns?

8. When doing procedures on babies, how do you avoid direct exposure of newborn’s eyes to procedure lighting?

9. How often do you use the natural lighting in NICU?

10. What is your suggestion about a better use of natural lighting that suits both the NICU newborn area as well as caregivers’ need?

11. How satisfied are you with the lighting in these public areas? (ambient/general, task, natural, accent, emergency lighting)

NICU II:
   (1) Control-Charting Station
   (2) Supply Room
   (3) Storage Room (“The Garage”)

NICU III:
   (4) Staff Lounge
   (5) Hand-Washing Station
   (6) Isolation Room
   (7) X-Ray Viewing Station
   (8) Multi-Purpose Room (Fran’s Room)
   (9) Pump Room
   (10) Conference Room
APPENDIX J
INTERVIEW INSTRUMENT 3 (PARENTS AND FAMILY)

1. What do you prefer/suggest as far as general lighting in the space you spend most of your time in?

2. How does your indicated space lighting make you feel?

3. For the people who use NICU at night, what is your suggestion on improving lighting (ambient and task)?

4. How easy/hard is it for you to work under existing task lighting in your baby’s area?

5. When feeding or changing your baby, how do you avoid direct exposure of newborn’s eyes to the task lighting?

6. How satisfied are you with the lighting in these public areas? (ambient/general, task, natural, accent, emergency lighting)

   6.1. What is your preference/suggestion for lighting in these areas?
### APPENDIX K
### PARTICIPANTS’ COMMENTS

<table>
<thead>
<tr>
<th>Participants</th>
<th>Comments</th>
</tr>
</thead>
</table>
| D1           | Q.1: Glare from the isolates  
Q.2: Giraffes have two levels  
Q.3: Do not like the Fluorescent  
Q.4: Very rarely. If the baby is grown and has been here for a long time, they might open the window to get sunlight; but that means more glare for us!  
Some of the blinders are closed; that is a nurse preference  
Q.5: The Giraffes are very adequate  
Q.6: Same as day b/c they rely on Artificial light only  
The ones under the heater get hot for us. The heater is always on.  
We sometimes use the emergency light for surgeries or some procedures.  
Q.7: I have noticed my eyesight has changed and I hear a lot of people complain about their eyesight. Now having to use the computers all the time is even worse.  
Q.8: I don’t like the sheets, they hinder what I’m doing- it may fall down and get contaminated  
Q.9: When two beds are too close, it is hard to turn on the light without bothering the baby next-door  
Q.10: X-ray viewing station: sometimes glare and shadow depends on which direction you look at |
| Doctors      | Q.1: Had to use a flashlight to pull the IV  
Q.2: a lot of the switches are behind the beds and hard to reach  
If the lights bulb is burned, you can’t change it; I don’t know where the bulbs are. If there is a baby in that space, they don’t change the bulb!  
Q.3: NICU II is worse than III  
Q.4: In the summer time, I like to open the blinds otherwise we don’t use it.  
Q.5: Not enough-we have to use emergency lights-people don’t turn them off  
Q.6: Productivity: At night we keep it dim here, towards the end of the shift, we get more tired and sleepy. Health and Mood: No effects  
I wish there were certain lights you could turn off, more for the patients. For me, it is more important that the light works properly.  
Q.7: there is a spot in NICU III that we weigh diapers and we check Dipsticks; often we have to walk from there to a lit space to be able to read the labels and the dipsticks  
Q.8&9: It depends on which light you turn on, if it is the halogen |
light, I turn it on for my first assessment to get a clear picture of
the baby, then I turn on the dim light or the spot light (task light),
we flip it up to get an indirect light. I use it as an ambient light and
it doesn't affect other babies. We flip it back down for procedures
light Ivy.

Q.10: Staff Lounge: Control is good here
Hand-Washing Station: They have dimmers
Fran’s room: It has Lamps and overhead lighting- Sometimes the
overhead is too bright and the lamps too dim
Pump Room: Needs more control-too dark
Suggestions: For Billie light, cover the isolates on the side.
If they could have 3-way lighting in Fran’s Room, it would be
better for having more options for controlling it.

Q.1: No; the monitors, I can adjust- The only Glare I get is from
the isolate
Q.2: some switches have dimmers which is helpful
Q.3: Always dim in the unit, no circadian rhythm for babies
Q.4: Blinders on and off, depends on the Nurses’ preference.
Sometimes one baby is very sensitive to light so we can’t put him
next to the window.
Q.5: I don’t use the under cabinet lights b/c they fall far back
Q.6: Nights aren’t as bad, no glare from the windows, NICU III has
been brighter, and they had the overhead lights on. In II, they
actually had the lights on which surprised me. If all the lights are
off, it is hard to assess the baby especially if he has instauration; it
is hard to figure out the color of their skin.
Q.7: If you have a task light, great! But if you only have the above
lights, they are good amount of light but you generally cannot use
them as spot light b/c in order to move them and change the
direction, you have to step on a chair.
HEAT: they put out heat which is good for the baby not good for
us!
Q.8: They have blanket over the bassinets so they may get a little
bit of light change but it is not major.
Q.9: Not Major
Q.10: Staff Lounge: Enough light but not enough control.
Fran’s Room: Nice, you can adjust the light.
Pump Room: Light above each station and above the sink.
Suggestions: If general lights could be on a track that you could
move them and adjust it to where exactly you want the light to
shine.
More adjustable lights in the bedsides.

Q.1: No paper work, all computer charting- No glare from monitors
and no from the isolates, all of them have an exam light and also
the radio warmers have exam lights too! It’s not that bad working in NICU III, the issue is in NICU II: The bed spaces are not designed to just one space, it’s not like NICU III that one space ends and then the next one starts; the lighting system is not that individualized, so when you turn on the light to examine one baby, it could get the other baby blinded by the light.

Q.2: only one switch for all 3 emergency lights
Q.3: Very yellow, bad for diagnosing babies for jaundice
Q.4: Sometimes- I like them open- I don’t use them as task light and I close the blinds if ultrasound people are here so they can see the monitor better!
Q.5: The warmer’s light directly aims babies’ eyes
Q.6: No
Q.7: Refer to Q.5
Q.8: Mostly they are already covered, if they are not, you put a blanket or a cloth on their eyes
Q.9: Not Major
Q.10: 1. Hard, keyboard is hard to see b/c NICUII is too dark
2. They have soft lighting there that is less harsh

Suggestions: We should use the keyboards that have light switch on them, especially in NICU II

Q.1: Not monitors- Computers are OK except where they are located, they are on the counter and it is hard to see them. I experience shadow and glare on isolates.
Q.2: we have to try switches to find the right one and this bothers babies and other staff
Q.3: We have quite a few spots with no general lighting
Q.4: only night shift.
The only reason some babies are put next to the window is because that spot was available.
Q.5: OK
Q.6: 1. 12 years
2. Not really
3. No
Q.7: OK
Q.8: Put a cloth over their eyes or if possible to adjust the light to the spot it is needed to shine- I like the covers on the isolates b/c you can shine the light only to where you want and when you turn the light on it shields it.
Q.9: Not Major
Q.10: 1. Good to have regular light and under cabinet light there 2&3. They are always on.

Suggestions: Bring the computer monitors in a lower countertop so we can get a better eye view of them- I wish the general light was as flexible as Task light.
Q.1: A little bit of glare on the computers but they are not placed properly anyways, b/c they are on the counters and hard to reach and we also need more space. Only on certain bed spots we experience shadow.

Q.2: You don’t know which way the dimmer should be turned.

Q.3: Satisfied with the ambient light b/c the dimmer switches help a lot.

Q.4: None

Q.5: Procedure lighting in NICU II is well lit and if we need to, we flip around the runner lights and we have the dimmer switches to make it brighter, we only have to adjust ourselves to avoid shadow.

Q.6: 1. Only night shift for 26 years.
2. I am used to it,
3. more awake at night than day
4. I have fibromyalgia, that’s an effect of working nights; there are studies that say working in bright light at night causes breast cancer; so a lot of us try to keep it dark at night as much as possible and we just use the general switches.

Q.7: Refer to Q.5.

Q.8: Put a cloth over their eyes; it works

Q.9: Not Major

Q.10: All OK

Suggestions: Have dimmers, make all isolates as giraffes (the new task lights)

Q.1: Sometimes on the monitor- depends on the direction- Hardest thing I try to start an I.V. when don’t have a light that’s right overhead or if the isolate is on the way, creates shadow.

Q.2: If the baby an open crib, you can move it and adjust but if it’s an isolate, you cannot move it and that’s when it gets hard.

SWITCHES: Depends on if the baby is on an assigned bed space or we are cramped b/c when we have more babies than spaces, we have to move around the monitors to make space for babies and sometimes you have to reach behind a monitor to get to a light switch.

I am aware of the task switches but not the ambient ones! The switches don’t seem to be logically placed!

Q.3: Refer to Q.2.

Q.4: No- Just night shift

Q.5: Shadow

Q.6: 1. Most of my life
2. I function better at night

Q.7: Refer to Q.5.

Q.8: Task lighting on top of the new isolates is a spot light that you can move around; the old isolates have the task lights that lit the
whole bed so we have cover the top of the isolate with a blanket to prevent exposure of baby's eyes.

Q.9: Blanket is the most cost-effective; it is reasonable and easily accessible

Q.10: Is dim

Suggestions: Change all the old task lights to an adjustable spot light- add mobile lighting

Q.1: No glare
Q.2: Hard to find light switches- too many switches and lights- you have to try them to find out which is which and this causes discomfort for babies and other nurses
Q.3: NICU III: Ambient Is too dark; I can’t read while I’m walking; I physically have to move to find a lit space.
NICU II: I have to use a flash light to check equipments that are plugged into the wall.
Q.4: Patients by the window- I love it b/c can see there and I don’t need the task light as much as other spaces- but for procedures like putting in a tube, I need the task light on.
Q.5: Glaring
Q.6: I can’t see while working in night shift, I usually have to wait for the sun to come up.
Q.7: Refer to Q.5.
Q.8: Cover their face; in general it’s a good idea b/c ........

Q.1: No paper work, all computer charting- No glare from monitors and no from the isolates, all of them have an exam light and also the radio warmers have exam lights too! It's not that bad working in NICU III, the issue is in NICU II: The bed spaces are not designed to just one space, it's not like NICU III that one space ends and then the next one starts; the lighting system is not that individualized, so when you turn on the light to examine one baby, it could get the other baby blinded by the light.
Q.2: in NICU II I have a problem to know which switch what. I have to flip them all to find out which is the one I want- Not so much in NICU III, you pretty much can tell.
Q.3: Refer to above
Q.4: Sometimes- I like them open- I don’t use them as task light and I close the blinds if ultrasound people are here so they can see the monitor better!
Q.5: The level of the task lighting is good but the heat of the task lighting is too much sometimes specially that your arms are covered and that makes it hotter!
Q.6: No
Q.7: Refer to Q.5
Q.8: Mostly they are already covered, if they are not, you put a
blanket or a cloth on their eyes
Q.9: Not Major
Q.10: 1. Hard, keyboard is hard to see b/c NICU II is too dark
9. They have soft lighting there that is less harsh
Q.10: All OK

Q.1: No; the monitors, I can adjust- The only glare I get is from the isolate
Q.2: some switches have dimmers which is helpful
Q.3: Always dim in the unit, no circadian rhythm for babies
Q.4: Blinders on and off, depends on the Nurses’ preference. Sometimes one baby is very sensitive to light so we can’t put him next to the window.
Q.5: I don’t use the under cabinet lights b/c they fall far back
Q.6: Nights aren’t as bad, no glare from the windows, NICU III has been brighter, and they had the overhead lights on. In II, they actually had the lights on which surprised me. If all the lights are off, it is hard to assess the baby especially if he has instauration; it is hard to figure out the color of their skin.
Q.7: If you have a task light, great! But if you only have the above lights, they are good amount of light but you generally cannot use them as spot light b/c in order to move them and change the direction, you have to step on a chair.
HEAT: they put out heat which is good for the baby not good for us!
Q.8: They have blanket over the bassinets so they may get a little bit of light change but it is not major.
Q.9: Not Major
Q.10: Staff Lounge: Enough light but not enough control.
Fran’s Room: Nice, you can adjust the light.
Pump Room: Light above each station and above the sink.

Q.1: Glare on Monitors. Depends on the direction of the light hits it. The ones facing the window are worst.
Shadows when we have turned the light on.
The contrast between the computer monitors and surrounding hurts the eyes.
We sometimes turn on both task and general light, or just the task.
Q.2: I wish we could turn more lights on and have this area lit.
NICU II is worse.
Q.3: Babies all have blanket over their isolates but still they keep this area very dark which makes it hard for the caregivers to work.
Q.4: Very rarely. If the baby is grown and has been here for a long time, they might open the window to get sunlight; but that means more glare for us!
Some of the blinders are closed; that is a nurse preference
Q.5: In general it is enough. The armed ones are OK.
Q.6: N/A
The ones under the heater get hot for us. The heater is always on. We sometimes use the emergency light for surgeries or some procedures.
Q.7: I have noticed my eyesight has changed and I hear a lot of people complain about their eyesight. Now having to use the computers all the time is even worse.
Q.8: Put a blanket over other babies when they are using the Billie light for one baby
Q.9: Yes, it affects other babies but not their health. If they are too young it may affect their oxidation; otherwise it may just irritate them.
Q.10: X-ray viewing station: sometimes glare and shadow depends on which direction you look at

Q.1: Sometimes-Glare coming from isolates
Q.2: Depends- If you have access to the wall, it is easier. If the lights bulb is burned, you can’t change it; I don’t know where the bulbs are. If there is a baby in that space, they don’t change the bulb!
Q.3: The three halogen lights are too bright and too hot for both the caregivers and the baby.
Q.4: In the summer time, I like to open the blinds otherwise we don’t use it.
Q.5: If the baby is not in a bed space (N-Cap), you don’t have task lighting or the red light so we have to turn on the Amb. Light which doesn’t give enough light to do your task? Only the Billie light can be brought from other beds.
Q.6: Productivity: At night we keep it dim here, towards the end of the shift, we get more tired and sleepy. Health and Mood: No effects
I wish there were certain lights you could turn off, more for the patients. For me, it is more important that the light works properly.
Q.7: there is a spot in NICU III that we weigh diapers and we check Dipsticks; often we have to walk from there to a lit space to be able to read the labels and the dipsticks
Q.8&9: It depends on which light you turn on, if it is the halogen light, I turn it on for my first assessment to get a clear picture of the baby, then I turn on the dim light or the spot light (task light), we flip it up to get an indirect light. I use it as an ambient light and it doesn’t affect other babies. We flip it back down for procedures light Ivy.
Q.10: Staff Lounge: Control is good here
Hand-Washing Station: They have dimmers
Fran’s room: It has Lamps and overhead lighting- Sometimes the
overhead is too bright and the lamps too dim
Pump Room: Needs more control-too dark
Suggestions: For Billie light, cover the isolates on the side.
If they could have 3-way lighting in Fran’s Room, it would be
better for having more options for controlling it.

Q.1: No; the monitors, I can adjust- The only glare I get is from
the isolate
Q.2: NICU III, control is easier because you can control the
bedside and with the windows it is a lot nicer.
NICU II is harder b/c it’s generally very dark, and if I turn on a
light, there is someone that doesn’t like it so turns it back off as
soon as you turn around.
SWITCHES: are not in a place that are easily reachable, or we
don’t know which is for which light.
Q.3: There are some beds in NICU III that the light doesn’t shine
on the bed and is hard to assess the baby.
Q.4: Blinders on and off, depends on the Nurses’ preference.
Sometimes one baby is very sensitive to light so we can’t put him
next to the window.
Q.5: If you are lucky and you have a light on your bedside, you
can adjust these and move around
Q.6: Nights aren’t as bad, no glare from the windows, NICU III has
been brighter, and they had the overhead lights on. In II, they
actually had the lights on which surprised me. If all the lights are
off, it is hard to assess the baby especially if he is not saturation; it
is hard to figure out the color of their skin.
Q.7: If you have a task light, great! But if you only have the above
lights, they are good amount of light but you generally cannot use
them as spot light b/c in order to move them and change the
direction, you have to step on a chair.
HEAT: they put out heat which is good for the baby not good for
us!
Q.8: They have blanket over the bassinets so they may get a little
bit of light change but it is not major.
Q.9: Not Major
Q.10: Staff Lounge: Enough light but not enough control.
Fran’s Room: Nice, you can adjust the light.
Pump Room: Light above each station and above the sink.
Suggestions: If general lights could be on a track that you could
move them and adjust it to where exactly you want the light to
shine.
More adjustable lights in the bedsides.

Q.1: No paper work, all computer charting- No glare from monitors
and no from the isolates, all of them have an exam light and also
the radio warmers have exam lights too! It’s not that bad working in NICU III, the issue is in NICU II: The bed spaces are not designed to just one space, it’s not like NICU III that one space ends and then the next one starts; the lighting system is not that individualized, so when you turn on the light to examine one baby, it could get the other baby blinded by the light.

Q.2: in NICU II I have a problem to know which switch what. I have to flip them all to find out which is the one I want- Not so much in NICU III, you pretty much can tell.

Q.3: Refer to above

Q.4: Sometimes- I like them open- I don’t use them as task light and I close the blinds if ultrasound people are here so they can see the monitor better!

Q.5: The level of the task lighting is good but the heat of the task lighting is too much sometimes specially that your arms are covered and that makes it hotter!

Q.6: No

Q.7: Refer to Q.5

Q.8: Mostly they are already covered, if they are not, you put a blanket or a cloth on their eyes

Q.9: Not Major

Q.10: 1. Hard, keyboard is hard to see b/c NICUII is too dark

Suggestions: We should use the keyboards that have light switch on them, especially in NICU II

Q.1: Not monitors- Computers are OK except where they are located, they are on the counter and it is hard to see them.

Q.2: Task good, General light not good

Q.3: We have quite a few spots with no general lighting

Q.4: only night shift.

The only reason some babies are put next to the window is because that spot was available.

Q.5: OK

Q.6: 1. 12 years

2. Not really

Q.7: OK

Q.8: Put a cloth over their eyes or if possible to adjust the light to the spot it is needed to shine- I like the covers on the isolates b/c you can shine the light only to where you want and when you turn the light on it shields it.

Q.9: Not Major

Q.10: 1. Good to have regular light and under cabinet light there

2&3. They are always on.
Suggestions: Bring the computer monitors in a lower countertop so we can get a better eye view of them- I wish the general light was as flexible as Task light.

Q.1: A little bit of glare on the computers but they are not placed properly anyways, b/c they are on the counters and hard to reach and we also need more space.

Q.2: If the ambient lighting went all the way to the walls, there wouldn’t be any problems with the lighting for the bed spaces that were all the way to the end of the wall; these spots are very dark.

Q.3: Satisfied with the ambient light b/c the dimmer switches help a lot.

Q.4: None

Q.5: Procedure lighting in NICU II is well lit and if we need to, we flip around the runner lights and we have the dimmer switches to make it brighter, we only have to adjust ourselves to avoid shadow.

Q.6: 1. Only night shift for 26 years.

2. I am used to it,

3. more awake at night than day

4. I have fibromyalgia, that’s an effect of working nights; there are studies that say working in bright light at night causes breast cancer; so a lot of us try to keep it dark at night as much as possible and we just use the general switches.

Q.7: Refer to Q.5.

Q.8: Put a cloth over their eyes; it works

Q.9: Not Major

Q.10: All OK

Suggestions: Have dimmers, make all isolates as giraffes (the new task lights)

Q.1: Sometimes on the monitor- depends on the direction-

Hardest thing I try to start an I.V. when don’t have a light that’s right overhead or if the isolate is on the way, creates shadow.

Q.2: If the baby an open crib, you can move it and adjust but if it’s an isolate, you cannot move it and that’s when it gets hard.

SWITCHES: Depends on if the baby is on an assigned bed space or we are cramped b/c when we have more babies than spaces, we have to move around the monitors to make space for babies and sometimes you have to reach behind a monitor to get to a light switch.

I am aware of the task switches but not the ambient ones! The switches don’t seem to be logically placed!

Q.3: Refer to Q.2.
Q.4: No- Just night shift
Q.5: Shadow
Q.6: 1. Most of my life
2. I function better at night
Q.7: Refer to Q.5.
Q.8: Task lighting on top of the new isolates is a spot light that you
can move around; the old isolates have the task lights that lit the
whole bed so we have cover the top of the isolate with a blanket
to prevent exposure of baby’s eyes.
Q.9: Blanket is the most cost-effective; it is reasonable and easily
accessible
Q.10: 1. Is dim
Suggestions: Change all the old task lights to an adjustable spot
light- add mobile lighting

Q.1: No glare
Q.2: Hard to find light switches- too many switches and lights- you
have to try them to find out which is which and this causes
discomfort for babies and other nurses
Q.3: NICU III: Ambient Is too dark; I can’t read while I’m walking; I
physically have to move to find a lit space.
NICU II: I have to use a flash light to check equipments that are
plugged into the wall.
Q.4: Patients by the window- I love it b/c can see there and I don’t
need the task light as much as other spaces- but for procedures
like putting in a tube, I need the task light on.
Q.5: Glaring
Q.6: I can’t see while working in night shift, I usually have to wait
for the sun to come up.
Q.7: Refer to Q.5.
Q.8: Cover their face; in general it’s a good idea b/c ……..

Q.1: No paper work, all computer charting- No glare from monitors
and no from the isolates, all of them have an exam light and also
the radio warmers have exam lights too!- It’s not that bad working
in NICU III, the issue is in NICU II: The bed spaces are not
designed to just one space, it’s not like NICU III that one space
ends and then the next one starts; the lighting system is not that
individualized, so when you turn on the light to examine one baby,
it could get the other baby blinded by the light.
Q.2: in NICU II I have a problem to know which switch what. I
have to flip them all to find out which is the one I want- Not so
much in NICU III, you pretty much can tell.
Q.3: Refer to above
Q.4: Sometimes- I like them open- I don’t use them as task light
and I close the blinds if ultrasound people are here so they can
see the monitor better!
Q.5: The level of the task lighting is good but the heat of the task lighting is too much sometimes specially that your arms are covered and that makes it hotter!
Q.6: No
Q.7: Refer to Q.5
Q.8: Mostly they are already covered, if they are not, you put a blanket or a cloth on their eyes
Q.9: Not Major
Q.10: 1. Hard, keyboard is hard to see b/c NICU II is too dark
9. They have soft lighting there that is less harsh

Q.1: No; the monitors, I can adjust- The only Glare I get is from the isolate
Q.2: some switches have dimmers which is helpful
Q.3: Always dim in the unit, no circadian rhythm for babies
Q.4: Blinders on and off, depends on the Nurses’ preference. Sometimes one baby is very sensitive to light so we can’t put him next to the window.
Q.5: I don’t use the under cabinet lights b/c they fall far back
Q.6: Nights aren’t as bad, no glare from the windows, NICU III has been brighter, and they had the overhead lights on. In II, they actually had the lights on which surprised me. If all the lights are off, it is hard to assess the baby especially if he is saturation; it is hard to figure out the color of their skin.
Q.7: If you have a task light, great! But if you only have the above lights, they are good amount of light but you generally cannot use them as spot light b/c in order to move them and change the direction, you have to step on a chair.
HEAT: they put out heat which is good for the baby not good for us!
Q.8: They have blanket over the bassinets so they may get a little bit of light change but it is not major.
Q.9: Not Major
Q.10: Staff Lounge: Enough light but not enough control. 
Fran’s Room: Nice, you can adjust the light. 
Pump Room: Light above each station and above the sink.

Families

F1

Q.1: 1. Change Diapers, feed, Crochet
2. In III, across from window, the light in the space was OK but we couldn’t see anything ahead of us so we had to turn the light on; in II, they had four lights on above the children so it was too much for the baby to sleep.
3. Well if you could have a little lamp that you could turn on yourself instead of illuminating everything else around you, like at home, would be great!
4. Not enough
Q.2: No
Q.3: Refer to Q.1.2
Q.4: The light shines on him or I could adjust the blanket on top of the isolate to stop the light exposure.
Q.5: 1. The light shines in from the bottom of the door

Suggestions: If you could have a little lamp that you could turn on yourself instead of illuminating everything else around you, like at home, would be great!
Q.1: 1. Breast feeding, bottle feeding
2. When it is on, it bothers the baby
4. No control
Q.2: 1. The bright light on him was on at 4AM!
2. Put in some different lighting options- Some individualized lighting- Bed spaces in the corner are really dark
Q.3: OK
Q.4: Nothing
Q.5: All OK

Suggestions: Put in some different lighting options- Some individualized lighting- Bed spaces in the corner are really dark
Q.1: 1. Changing
2. Too bright for the baby- Not enough for task- Glare
3. More lighting but softer
4. Not a lot of control

Suggestions: More lighting but softer
Q.1: 1. Changing
2. Not during the daytime b/c there is a window right by her; but at night the task/general light is too bright
3. Softer light
4. A little bit of control b/c it’s either on or off, no dimmers!
SWITCHES: No idea which is which!
Q.2: No
Q.3: Refer to Q.1.2
Q.4: Blanket
Q.5: 1. Haven’t used it
   5. Dimmer in there is good
Fran’s Room: Haven used it

Suggestions: Softer light
Q.1: 1. Changing, observe, reading
   2. Very good
   3. N/A
   4. No control but I don’t want to change it
F5
   2. Very good
   3. N/A

Q.2: No
Q.3: Good
Q.4: Nothing
Q.5: 1. Haven’t used it
Q.1: 1. Changing, feeding, giving bath, some physical therapy
   2. Where he is now is good b/c he is by the window but where he was, was too dark; we had to on the light which is too bright for the baby.
   3. Dimmer lights that adjust
F6
   4. Now Yes but the old space No!
Q.2: At night is about the same for the ones that are not next to the window.
Q.3: Refer to Q.1.2
Q.4: Put my hands over the baby
Q.5: All Good

Suggestions: Dimmer lights that adjust
Q.1: 1. Read to the baby
   2. No, it is good
   3. None
   4. It’s OK
F7
   2. It’s too dark at night
Q.4: Nothing
   Q.5: Lobby: could be a little bit brighter

Q.1: 1. Changing, feeding
   2. Sometimes when it gets too bright, it takes away from the intimacy with the baby
F8
   3. Want dimmers- If we could have a curtain around each baby’s space and its individual lighting, it would be great!
   4. Not much
Q.2: NICU II is even brighter at night
Q.3: Refer to Q.1.2
Q.4: Depends on what light is on, if needed we put blanket on the isolate.
Q.5: 3&5: Haven’t used

Suggestions: Want dimmers- If we could have a curtain around each baby’s space and its individual lighting, it would be great!
Q.1: 1. Changing, feeding
2. Good light- We don’t use the task light
3. None
4. I can ask to change the light and they do it
Q.2: I really like the light at night – The general light is good enough and the task when you need it is here and not too bright
Q.3: Refer to Q.1.2
Q.4: Lean over him so shadow covers his face
Q.5: 1: Overhead light is too bright- The light behind the bed wasn’t in the right place and not comfortable and too bright when on
3&6: Haven’t used it
5: One room has the overhead light and the other doesn’t; one is too dim
Q.1: 1. Just looking at the baby
2. It’s fine b/c she is close to the window; but we get some glare from the isolate
3. It’s adequate
4. No control; Just putting a blanket over the isolate
Q.2: At night, its better b/c maybe window causes the glare – It is brighter and sharper at night though
Q.3: Refer to Q.1.2
Q.4: Blanket
Q.5: 1,3,5: Haven’t used it
10: Bright enough and I am able to read
<table>
<thead>
<tr>
<th>Task/Job Performance</th>
<th>Doctors</th>
<th>Nurses</th>
<th>Families</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Spot lighting is often insufficient for procedures”</td>
<td>“Job efficiency: It is difficult to view patients + see subtle findings”</td>
<td>“Job Efficiency: Office It is basic and not adjustable. Harsh”</td>
<td>“It does not really affect my ability to do anything I need to do”</td>
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<td>“Poor lighting around each bed space”</td>
<td>“In the office it is fine. In the Unit the bright procedure lights are not adjustable, so if the bay’s bed is not in the right spot, the lights are not directed at the bed causing shadows”</td>
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<td>“When the baby's bed light is on I can see well but not enough when off.”</td>
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<th>Nurses</th>
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<tr>
<th>General lighting Satisfaction</th>
<th>Doctors</th>
<th>Nurses</th>
<th>Families</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Sometimes shadow make procedures difficult at baby’s beds. Or sometimes other staffs turn on bright emergency lights when other available lighting would be OK. Too bright for the babies, or necessary for task but they forget to turn it off after their task”</td>
<td>“as you get older you need more light for things like visualizing monitors from across the room and things like that”</td>
<td>“Need more light but softer for the baby’s eyes”</td>
<td>“I like the pump room ambient light”</td>
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<td>“Some of the bed spaces in NICU3 have poorly placed pot lights. Not conducive to seeing the care you are providing to the patients or for procedures. NICU2 lighting is much better”</td>
<td>“Need more light but softer for the baby’s eyes”</td>
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<td>“I like the pump room ambient light”</td>
</tr>
<tr>
<td>Natural Lighting Satisfaction</td>
<td>“None in office”</td>
<td>“Office - no natural lighting”</td>
<td>“I think they could use a little more sunlight. It is good for the baby”</td>
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<tr>
<td></td>
<td>“Physicians’ room is dark”</td>
<td>“not enough for things like starting IVs and other small procedures”</td>
<td></td>
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<tr>
<td>Level of Visual Comfort</td>
<td>“If the lights are directed right it is great. When they are not it takes someone standing on a chair and redirecting them from the ceiling. Frequently I just work without the light”</td>
<td>“Shadows are difficult to work with in NICU3”</td>
<td>“Hard to see baby through glare on isolate at times”</td>
</tr>
<tr>
<td></td>
<td>“Bed space. Sometimes there is a glare from the overheads onto the isolates that make it difficult to see the patient clearly”</td>
<td>“Fluor. Light is harsh”</td>
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<tr>
<td>Level of Control</td>
<td>N/C</td>
<td>“No control over lights in the hallways”</td>
<td>“Not knowing how to control the light!”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“No control over light”</td>
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Table K-1 Continued.
### APPENDIX L
FREQUENCY FOR PARTICIPANTS’ LIGHTING SATISFACTION IN INTERVIEW

Table L-1. Frequency for participants’ lighting satisfaction in interview

<table>
<thead>
<tr>
<th>Themes</th>
<th>Doctors (N=10)</th>
<th>Nurses (N=10)</th>
<th>Families (N=10)</th>
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<tr>
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<td>S^A</td>
<td>U^B</td>
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<tr>
<td>Daytime Lighting Condition ^c</td>
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<td>1) General Lighting</td>
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<td>Illumination</td>
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<td>Color Of Light</td>
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<td>Distribution</td>
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<td>Heat</td>
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<td></td>
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<tr>
<td>2) Task Lighting</td>
<td>3</td>
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<td>Illumination</td>
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<tr>
<td>Distribution</td>
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<td>Heat</td>
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<td>3) Natural</td>
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<td>Nighttime Lighting Condition ^d</td>
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<td>1) General Illumination</td>
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<td>2) Task Illumination</td>
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<td>Lighting Factors</td>
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<td>Glare</td>
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<td>Newborn Focused</td>
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<td>Preventing Direct Light Exposure</td>
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<td>Themes</td>
<td>Doctors (N=10)</td>
<td>Workforce (N=10)</td>
<td>Families (N=10)</td>
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<td>S^A</td>
<td>U^B</td>
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<td>Public Areas</td>
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<tr>
<td>X-Ray Viewing</td>
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<td>Hallways</td>
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<td>Call Room</td>
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<tr>
<td>Family Room</td>
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</table>

^a: S=Satisfied, ^b: U=Unsatisfied, ^c: during the day, artificial and natural light are used, ^d: during night, only artificial light is used, ^e: regarding overall general lighting condition and visual comfort of each area
LIST OF REFERENCES


Moller, J. (2008). Environments for aging -A design primer for the aging eye Interior design features to consider when accommodating fading vision.


BIOGRAPHICAL SKETCH

Rozita Mozaffarian was born and raised in Tehran, Iran. From the early ages she showed her talent in the art of painting. She always had the passion for art and design throughout her academic studies. She received her Bachelor of Science in microbiology from Azad University in the year 2000 and moved to the United States. She started working at the McKnight Brain Institute at the University of Florida as a research assistant and then at the school of medicine at University of California, Irvine as a lab manager. She took the post-baccalaureate courses for Biotechnology in these two universities. These job experiences helped her realize she needed to pursue her passion in art and design. She then took a training course in AutoCAD and was able to get an internship at an architecture firm in Gainesville, FL. She then applied for interior design program and got accepted at the University of Florida. She will pursue a career in the field of interior design, in the Washington DC area.