UNDERSTANDING THE COUPLET CARE ENVIRONMENTAL MODEL AND ITS EFFECT ON BONDING BETWEEN MOTHER AND INFANT

A Thesis
Presented to the Faculty of the Graduate School
of Cornell University
In Partial Fulfillment of the Requirements for the Degree of
Master of Science

by
Sabah Mohammed
August 2022

ABSTRACT

Couplet Care is an emerging model of care in neonatology where the strategy is to deliver intensive care to newborns and their postpartum mothers in a shared room. The evaluation of these environments for high-risk newborns through post-occupancy evaluations is essential for evidence-based design. However, there is little evidence available that demonstrates outcomes with couplet care. The Neonatal Experience Evaluation Toolkit used in this study was developed at Yale New Haven Hospital. It is an approach that measures the effect of exposure to couplet care on maternal-infant bonding during hospitalization. In this prospective cohort study, Memorial Hospital in South Bend, Indiana served as the data collection site. Participants (n=19) showed high satisfaction with care during the immediate postpartum period. Built environment characteristics at the room and unit levels emerged as factors impacting behavioral outcomes. Improvements in future iterations of couplet care are highlighted through design, operational policy, and technology recommendations.

Keywords: couplet care, kangaroo care, bonding, neonatal intensive care

BIOGRAPHICAL SKETCH

Sabah Mohammed is originally from Bangalore, India, where she graduated from National Institute of Technology, Calicut with a Bachelor of Architecture in 2017. After graduation, Sabah was based in Dubai, UAE, working as an Architect at Total Alliance Health Partners International (TAHPI) where she worked on prefabricated hospitals in the Middle East and India from conceptual design to design development, and the adaptation of the International Health Facility Guidelines (IHFG) for the Dubai Health Authority. After a brief introduction to evidence-based design, Sabah was interested in exploring healthcare design in a rigorous environment that encouraged divergent thinking. In 2019, Sabah accepted to the Master of Science program at the College of Human Ecology at Cornell University, where she majored in Design + Health and minored in Human Development. Inspired by her mother's resilience during the birth of her preterm twin brothers, Sabah chose to focus her research on evidence-based practices in high acuity environments for preterm infants. She has been awarded three Teaching Assistant positions at Cornell, and various grants, including the prestigious Arthur N. Tuttle Jr. Fellowship by the AIA-AAH, the Degree Marshall for Cornell Graduate School at the 2021 University Commencement and the Patricia J. Harris Scholarship by the International Facility Management Association. She has presented at various conferences including the 34th & 35th Annual Gravens Conference on the Environment of Care for High-Risk Newborns, EDRA53 and has participated in the Reimagining the NICU workshops as a student volunteer and facilitator. She will receive her Master of Science in August 2022.

Between 2021-2022, Sabah was the E. Todd Wheeler Health Fellow at Perkins&Will, Atlanta where she conducted research on healing environments for patients with behavioral health needs. She continues to work at Perkins&Will where she is now a Designer on the Health Planning + Strategies team. Sabah believes in the power of making a difference by design through the tripartite effect of research, advocacy and education.

DEDICATION

Dedicated to *Umma* for bringing us into this world and nurturing us to be compassionate, curious, and creative thinkers.

To *Uppa* for his unconditional love, sacrifices, and unwavering support.

ACKNOWLEDGMENTS

I would like to express my deepest gratitude to all the study participants from Beacon Children's Hospital in South Bend, IN for their generous and whole-hearted contribution to making this research possible. I would like to sincerely thank all involved staff members from Beacon Children's Hospital, particularly Dr. Robert White, Mashelle Monhaut, and Jane Kaiser, who devoted their valuable time and energy to facilitate this research project, aid in recruiting participants, and provided a virtual site tour of the facility. The generous support from Beacon Children's Hospital has made this research project a pleasurable and meaningful memory that I will always be grateful for.

I would like to express my sincere gratitude to my chair, Dr. Mardelle Shepley, for the continuous encouragement, advisement, and dedication throughout my graduate study. She has been a source of counseling, encouragement, and motivation. I appreciate the patience she provided to me for growing and exploring, and the trust she provided to me for shaping my own research interests and approach. I would like to extend my gratitude to my minor chair, Dr. Jane Mendle, for her trust, responsiveness, flexibility, and steadfast support. My deepest gratitude to my external committee members, Dr. Kati Peditto for the early encouragement, and for being a mentor throughout my time at Cornell, and Dr. Robert White, who has been a guiding force during my research, providing me access to his team at Beacon Children's Hospital, resources, opportunities, and insight. My sincere gratitude to Dr. Sarah Taylor from Yale New Haven Hospital (YNHH) for sharing the survey and study protocol developed by her team and the virtual tours of her facility.

I would like to thank my family, especially my mother and my grandfather for being my backbone and a constant source of encouragement during my graduate studies. To my amazing graduate student colleagues: Jina Lee, Heather Bazille, Bethany Welgoss, Michael Darfler, Hannah Bidigare-Curtis, Jeremy Faulk, and Julia Jaffe for the insightful comments, constructive feedback, and constant encouragement. Special

thanks to May Boggess from Cornell Statistical Consulting Unit for her dedicated contribution to the process of data management and for having patience while I learned to conduct data analysis.

This research was supported financially by grants from the Department of Human Centered Design and the Arthur N. Tuttle Jr. Health Fellowship from the American Institute of Architects and the Academy of Architecture for Health. I would like to thank all the parties for their steadfast support.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION & LITERATURE REVIEW

Purpose

The past three decades have seen premature births increase to 12.8% of all live births in the United States (Callahan, 2013; Martin et al., 2017). Premature births are defined as those birth with a gestational age < 37 weeks. As medical advances increase the survival of these preterm infants, the need for neonatal intensive care units (NICUs) increases concomitantly. This growth is occurring within a health-care environment that is increasingly competitive and consumer driven.

Literature Review

Evidence-based design research has demonstrated that the physical environment of the neonatal intensive care units (NICU) has a significant effect on vulnerable infants who spend their first crucial developmental phase in these units. This chapter includes a literature review on the role of the physical environment in the development of high-risk newborns, its effects on maternal stress, hospital stay satisfaction and bonding between the mother and infant dyad.

The American Academy of Pediatrics has NICU levels of care (Barfield et al, 2012) based primarily on availability of specialized equipment and staff, but many NICUs often encompass both intensive and step-down or intermediate care. For the purposes of this study, “newborn intensive care” is defined as care for medically unstable or critically ill newborns requiring constant nursing, complicated surgical procedures, continual respiratory support, or other intensive interventions. NICU design is continuously evolving in response to research that babies will have better health and developmental outcomes if their physical surroundings support new care models, such as couplet care, skin-to-skin care, and family-centered/integrated care. Many studies show the benefits of skin-to-skin in their mother’s arms, or “kangaroo care,” for babies in the NICU, because it is comforting and helps newborns adapt to life outside the

womb. Couplet care is an emerging iteration of the traditional NICU that is further along the spectrum of family integration. Instead of separating the mother and baby, the guiding principle is to keep them together after delivery. Couplet care promotes family bonding by allowing mother and newborn to stay together while in the hospital, and family-centered/integrated care, where parents are included as part of the care team, are driving the need for newly designed space to accommodate families in the NICU. As development-based, family centered care shifts the focus from the preterm infant alone to the parent–child dyad, the design of NICU environments is responding by trending away from multi-patient, open-bay wards (OPEN) to single family room (SFR) floor plans, and now Couplet Care Rooms (CCRs) (Connor, 1999; Floyd, 2005). As anticipated by White (2003), private rooms favor patients and their parents by affording greater privacy, environmental control, and space customization to the infant's individual medical and developmental needs.

The high-intensity NICU can be a very stressful place for babies. Conventional open-ward NICU's have an inappropriate sensory environment for infants, with noise levels from alarms and activities that impair the infant's ability to sleep, develop, and grow. The open environment is also stressful for families: The lack of space, privacy, and control make extended time in the NICU uncomfortable, creating a barrier for parents to spend time in extended intimate contact with their baby.

Human Development in Infants

"All of us, from the cradle to the grave, are happiest when life is organized as a series of excursions, long or short, from a secure base provided by our attachment figure(s)."- John Bowlby (1979, p. 129)

Brofenbrenner's ecological theory of human development provides an interesting point of departure towards understanding the role of the microsystem, mesosystem, exosystem, macrosystem and chronosystem on the development of an individual. Brofenbrenner's ecological model states that human development occurs during a vibrant, complex environment. The 'environment' here is defined by social and

cultural practices and institutions that form the backbone of the experiences that shape an individual's approach to love and intimate relationships (Bronfenbrenner, 1994). Unlike early research on developmental psychology that was conducted in laboratory settings, Bronfenbrenner's approach focused on ecological systems, which included the social and cultural aspects of the human environment; specifically, on the subsystems and how they interact with and influence each other (Härkönen, 2001). The 'microsystem' in Brofenbrenner's theory includes the immediate external environment such as the home, the school, and the workplace among others.

Understanding the first external environment that most individuals are exposed to after birth, *the cradle*, or the neonatal environment will provide an indicator of attachment styles, maternal mental health, and infant well-being. Bonding between the mother and infant is a unique and long-term emotional tie that begins with the first contact between the mother and infant and continues throughout the postpartum period (Johnson, 2013). The interactions between the mother and infant dyad include increased infant holding (kangaroo care), skin-to-skin contact between the infant and both primary and secondary caregivers, increased opportunities for breastfeeding and physical proximity between the infant and the caregiver. There is research that shows that mothers who engaged in immediate skin-to-skin contact within two hours following childbirth were more sensitive to the infant's needs and the child seemed more content at one-year post-partum. Inadequate mother-infant relationships result in long-term consequences for the child with poor interactions moderating the child's cognitive and socio-emotional development, physical health, and personal relationships (Nonnenmacher et al., 2016). Attachment theory proposes that the intimate relationships that individuals form as adults are associated with and are influenced by the nature of the bonds they formed with their primary caregivers during infancy and early childhood (Bowlby, 1969; Bradbury & Karney, 2014).

NICU Associated Stressors.

Although there have been several studies on associated stressors in a traditional NICU and despite the advancements in NICU design, NICU-associated stressors have not been studied in mother-infant dyads who receive co-care. Having a separate room may permit more relaxation and stress reduction for a mother, which are beneficial for breastfeeding and bonding, as higher levels of circulating stress hormones are associated with breastfeeding failure (Jaafar, Ho & Lee, 2016). As couplet care is a novel approach, to our knowledge, no studies exist examining outcomes associated with this NICU design. Therefore, this study aims to evaluate the effect of couplet care on breastfeeding, maternal-infant bonding, and maternal stress. The couplet care model is a novel approach that is seeing an increase in adoption rates in numerous hospitals across the United States. To our knowledge, very few studies exist that examine the outcomes associated with this type of NICU design.

Figure 1: A Timeline of the Evolution of Neonatal Environments

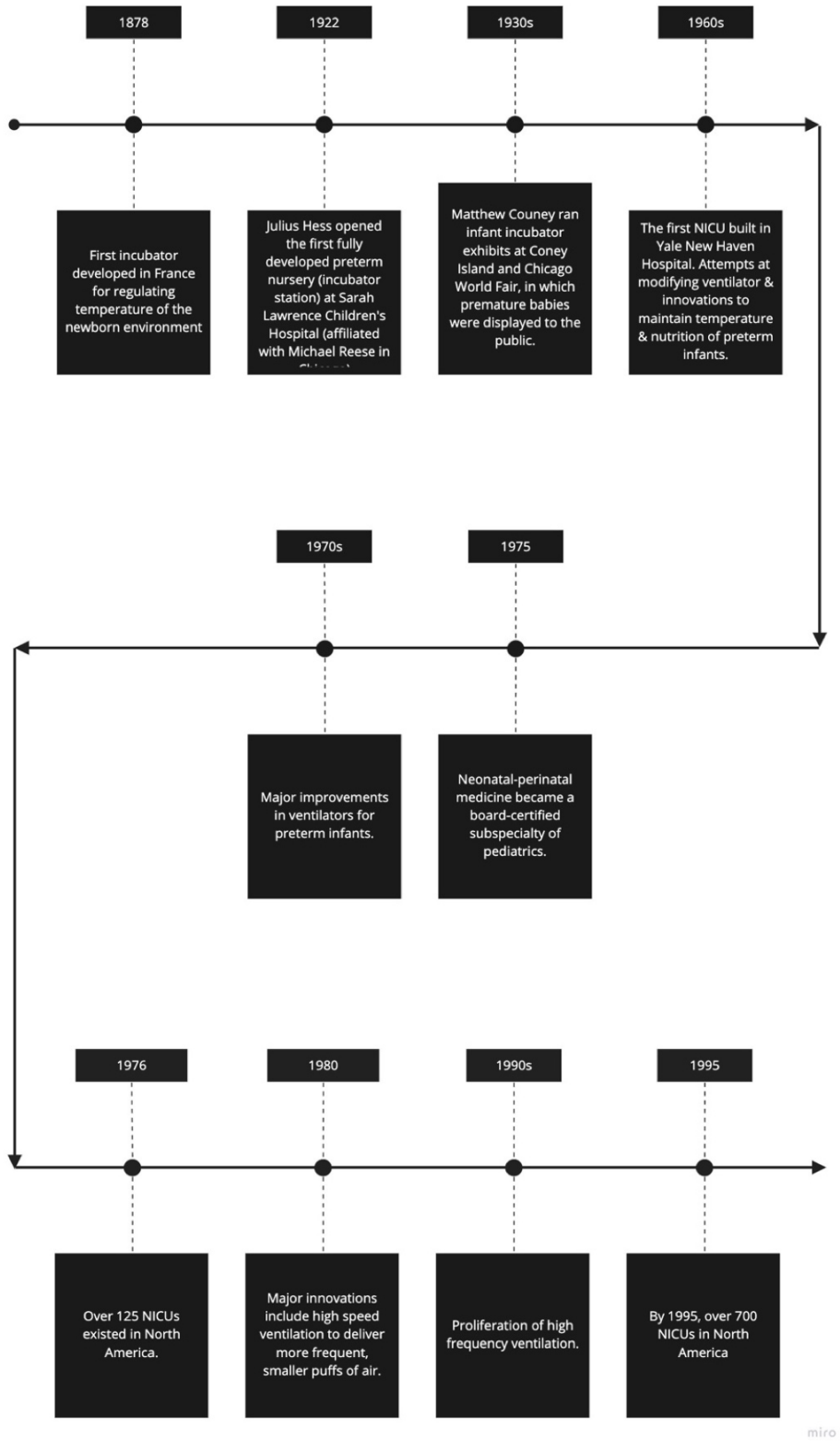


Table 1: Definitions, Capabilities, and Provider Types: Neonatal Levels of Care

Levels of Care	Capabilities	Provider Types[a]
Level I Well newborn nursery	• Provide neonatal resuscitation at every delivery • Evaluate and provide postnatal care to stable term newborn infants • Stabilize and provide care for infants born 35–37 week gestation who remain physiologically stable • Stabilize newborn infants who are ill and those born at <35-week gestation until transfer to a higher level of care	Pediatricians, family physicians, nurse practitioners, and other advanced practice registered nurses
Level II Special care nursery	In addition to Level I capabilities- • Provide care for infants born ≥32 wk gestation and weighing ≥1500 g who have physiologic immaturity or who are moderately ill with problems that are expected to resolve rapidly and are not anticipated to need subspecialty services on an urgent basis • Provide care for infants convalescing after intensive care • Provide mechanical ventilation for brief duration (<24h) or continuous positive airway pressure or both • Stabilize infants born before 32-week gestation and weighing less than 1500 g until transfer to a neonatal intensive care facility	In addition to Level I Providers- Pediatric hospitalists, neonatologist, and neonatal nurse practitioners

Level III NICU	In addition to Level II capabilities- • Provide sustained life support • Provide comprehensive care for infants born < 32-week gestation and weighing <1500 g and infants born at all gestational ages and birth weights with critical illness • Provide prompt and readily available access to a full range of pediatric medical subspecialists, pediatric surgical specialists, pediatric anesthesiologists, and pediatric ophthalmologists • Provide a full range of respiratory support that may include conventional and/or high-frequency ventilation and inhaled nitric oxide • Perform advanced imaging, with interpretation on an urgent basis, including computed tomography, Magnetic resonance imaging (MRI), and echocardiography	In addition to Level II Providers- Pediatric medical subspecialists[b], pediatric anesthesiologists[b], pediatric surgeons, and pediatric opthalmologists[b]
Level IV Regional NICUS	In addition to Level III capabilities- • Located within an institution with the capability to provide surgical repair of complex congenital or acquired conditions • Maintain a full range of pediatric medical subspecialists, pediatric surgical subspecialists, and	In addition to Level III Providers- Pediatric surgical subspecialists

	pediatric anesthesiologists at the site • Facilitate transport and provide outreach education

[a] Includes all providers with relevant experience, training, and demonstrated competence.
[b] At the site or at a closely related institution by prearranged consultative agreement.
Note: Table 1 in Committee on Fetus and Newborn, Barfield, W. D., Papile, L. A., Baley, J. E., Benitz, W., Cummings, J., ... & Watterberg, K. L. (2012). Levels of neonatal care. Pediatrics, 130(3), 587-597.

Level 1: Well care nursery

This level provides post-delivery support to the infant. This includes evaluation, resuscitation, and stabilization for both infants who are physically stable and those in need of higher-level care as they await transport (Barfield et al, 2012).

Level 2: Special care nursery

This level of care provides all the Level 1 needs; here, infants are placed into an incubator and begin receiving care. Level 2 attends to infants older than 32 weeks gestation who need short-term care and may be moderately ill. The special care nursery will provide stabilization for an infant interim to transport to a higher level of care. The level 2 care nursery must provide services such as x-rays, blood gas analysis, intravenous medications, feeding tubes (either nasogastric, through the nose, or orogastric, through the mouth), and respiratory assistance through a nasal cannula or continuous positive airway pressure (CPAP). It shall also provide care for those infants recovering from illness or minor surgeries. Infants within this nursery can be treated for such ailments as infections, low blood oxygen levels, or jaundice. A specialized staff attends to these nurseries, and the team is comprised of specialized nurses, pediatricians, and respiratory therapists and may also include a neonatologist (Barfield et al, 2012).

Level 3: Neonatal intensive care

This level provides all the same care available in Levels 1 and 2. An infant brought into Level 3 care has been evaluated and attended to under either a Level 1 or 2 care first and has been referred to a more intensive level of care. Patients in need of this level care can be of any gestational age, less than or greater than 32 weeks. Infants within these nurseries may anticipate having short- or long-term stays. These patients require consistent, close, specialized physiological monitoring. NICUs provide a range of services compatible with the hospital's capabilities. NICUs can be found in large hospitals as they are equipped with advanced technology and can perform major surgeries, if needed. NICUs are comprised of a range of staff that includes various subspecialties. Neonatal nurses, neonatologists, and respiratory therapist are continuously available. Specialty personnel such as pediatric surgeons; pediatric anesthesiologists; pediatric cardiologist; and pediatric ear, nose and throat (ENT) doctors additionally are available. Services a NICU provides include life support, post-care from operations or serious illnesses, or specialized imaging such as MRI or echocardiography. These nurseries are also equipped to provide advanced respiratory support through continuous positive airway pressure (CPAP), a mechanical ventilator or high-frequency ventilator. Additional services that a NICU can provide include lactation consulting, a nutritionist, and social workers (Barfield et al, 2012).

Level 4: Regional neonatal intensive care

This level provides all the same care as in all the three previous levels. A regional NICU must have the capabilities to attend to a critically ill infant and be able to perform major surgeries for serious conditions such as congenital abnormalities. A Level 4 NICU may not be a dedicated neonatal unit but instead reside within a pediatric intensive care unit (PICU). That unit will have abilities and staff capable to care for all ages of pediatrics including neonates (Barfield et al, 2012).

Neonatal Intensive Care Units

The evolution of neonatal intensive care spaces began with small rooms carved out from newborn nurseries, then evolved into bright, noisy, crowded, and sometimes windowless units. More recently, hospitals are providing single-family rooms (SFR) where the parents can reside with their babies, with evidence that SFRs are associated with increased family-centered care, breastfeeding, and parent visitation (Lester et al., 2014). Inherent to NICU admission is an oftentimes-unexpected interruption in the anticipated course of closeness and bonding between mother and infant (Phillips, 2013). NICU design has significant potential to mitigate the distress associated with this interruption and facilitate a more normal neonatal course.

Single-Room Maternity Care

Recently, NICU design has been shifting from an open bay layout to single family rooms (SFR), with evidence that the latter is associated with increased family-centered care, breastfeeding, and parent visitation (Lester et al., 2014). Research on the SFR model has demonstrated increased privacy and parental participation in care when compared to the previous open bay model (Shepley, 2014). However, the SFR model shows concerns related to peer-to-peer isolation (Shepley et al., 2008; Cone et al., 2010; Bosch et al., 2012). Research of the SFR improve also demonstrate improvements in bonding and developmental outcomes (Lee et al., 2014; Gooding et al., 2011)

Couplet Care

There is an emerging model of care for the mother-baby dyad called ‘couplet care’ that lays even further along the spectrum of family integration. Instead of separating the mother and baby, the guiding principle is to keep the mother and baby together after delivery. It is a novel approach that aims to deliver intensive care to relatively low needs newborns and their postpartum mothers in a shared room (White, 2016).

Couplet care has become the norm for well newborns since WHO/UNICEF published Baby Friendly Hospital guidelines in 1994 recommending 24-hour rooming-in for mother and infant. However, in NICUs, it is practiced in only a handful of hospitals in North America (British Columbia Women's Hospital, Mercy Medical Center, Carroll Hospital Center). There is ongoing research on the outcomes of couplet care in the few healthcare facilities in the United States where it has been implemented. Two such facilities are Yale-New Haven Hospital in Connecticut and Memorial Hospital in South Bend, Indiana, the latter of which will serve as the site for data collection and tool validation in this study.

Providing a mother with postpartum care in the same room where her infant receives NICU care provides physical proximity that increases opportunities for skin-to-skin time, breastfeeding, and bonding, three interrelated activities that enhance short- and long-term physical and emotional well-being for mother and infant. Recent literature suggests that SFR design is associated with more skin-to-skin time as well as longer duration of breastfeeding compared to an open bay layout (Tandberg et al., 2018; Domanico et al., 2011). In addition, skin-to-skin contact is associated with improved maternal-infant attachment (Cho et al., 2016), a greater maternal sense of confidence and competence in caring for her infant (Jaafar, Ho & Lee, 2016), higher levels of breastfeeding after hospital discharge (Kuhnly, 2018) which is associated with decreased rates of postpartum depression in mothers (Eidelman & Schanler, 2012), higher levels of breastfeeding after hospital discharge which is associated with decreased rates of postpartum depression in mothers (Kuhnly, 2018). For breastfeeding specifically, it is known that early, frequent breastfeeding contributes to greater milk production for a longer period (Jaafar, Ho & Lee, 2016); rooming in may provide mothers with more frequent opportunities to breastfeed and consequently enhance their chances for successful breastfeeding.

Increased parental stress in the neonatal ICU has been associated with several undesirable outcomes in infants such as delayed lactogenesis and decreased rates of breastfeeding (Dimitraki et al., 2016; Catala et al., 2018), delayed mother-infant

bonding (Feldman et al., 1999; Bystrova et al., 2009), decreased parental confidence (Ong et al., 2019) and comfort with parenting roles (Al Maghaireh et al., 2016). The two main outcomes that have been extensively studied are rates of breast feeding and parental feeling of bonding with their infant. Several studies have demonstrated that increased maternal stress is associated with delayed lactogenesis (Dimitraki et al., 2016), and decreased rates of breastfeeding (Catala, Peñacoba, Carmona, & Marin, 2018).

Increased levels of maternal stress (Feldman et al., 1999) as well as separation from their infants (Bystrova et al., 2009) have both been shown to delay mother-infant bonding. Higher levels of parental stress have also been associated with decreased parental confidence (Ong et al., 2019). De Bernardo et al. demonstrated that increased parental involvement in infant care and educating parents about the use of support devices, such as feeding tubes, significantly reduced parental stress. Utilization of kangaroo care, in which a parent holds his or her child skin-to-skin, has also been shown to reduce parental stress and improve comfort with parenting roles (Al Maghaireh et al., 2016).

Co-care in the same hospital room eliminates separation of the mother-infant dyad and allows for increased skin-to-skin care time. Continuous maternal presence in the NICU room also allows for greater opportunity for parent education and participation in infant care. In two centers in Sweden, mothers with 24-hour access to their infants, including those who received couplet care in the Neonatal ICU, was not shown to increase skin-to-skin time or breastfeeding rates, but was shown to significantly improve feelings of parental competency at discharge (Flacking, Ewald & Wallin, 2011).

Benefits of CCEs such as increased time for mother-infant skin-to-skin care, improved sleep time, increased hospital stay satisfaction, and improved quality of care must be reinforced by the couplet care unit's culture to achieve utmost benefit for the patient, family, and staff. Other benefits of private rooms include less patient movement and

increased patient safety due to fewer handovers (Hendrich et al., 2004; Brown & Gallant, 2006).

Optimal NICU design requires looking forward at medical and sociological interventions that occur more rapidly than the physical life span of the unit. For this reason, a design must incorporate flexibility at every level, from the bedside headwall to the role of the NICU within the extended community it serves. The rapid uptake of technology will change maternal and infant care dramatically and will have design implications, such as 24/7 magnetic resonance imaging capability within the NICU, continuous monitoring of multiple central nervous system functions, and the use of robotic devices, but these will be the easiest changes to adopt (White, 2016). The evolutions in care culture and the health care system over the next generation will have a profound impact in terms of who, why and where we care for the most vulnerable populations.

Designing for Health

Psychologically supportive healthcare environments focus on architectural choices, features, and attributes of buildings that are linked to wellbeing needs and experiences (Dijkstra et al., 2008; Ryan et al., 2014; Ulrich et al., 2004). The "healing environments" within the healthcare facility suggest that the physical environment can affect the experience within the facility, including how quickly patients recover from illness, how they perceive the quality of care, and their satisfaction and willingness to recommend the facility (Stichler, 2001; Whitehouse et al., 2001).

Healthcare environments that are psychologically supportive are at the center of a socio-ecological approach to health (Maller et al., 2005). This approach recognizes that health is holistic and requires a multidisciplinary approach to manage and promote all-around health successfully (Maller et al., 2005). A recently adopted health-related quality of life (HRQOL) metric, which relates the impacts of physical, mental, emotional, and social functioning, represents the broader view of care that not only focused on physical conditions but also strives to improve satisfaction and overall

quality of life (Sherman et al., 2005; Sullivan, 2003). HRQOL assesses the subjective perceptions of health status and expectations of the individual (Sullivan, 2003).
In recent years, there have been many approaches to designing spaces that reflect the relationship between humans and the natural world. Along with a branch of architecture called Design and Health, the following approaches generate functional efficiency but also improve the health processes within the built environment (Dilani, 2001).

Supportive Design

Ulrich's theory of supportive design was developed on the premise that people in healthcare settings, especially patients, staff, and visitors, are under inordinate amounts of stress (Ulrich, 1991, 1997). However, HCF should be designed to attenuate and even help people cope with the physical, emotional, and mental stress associated with being, living, or working in a HCF by exposing them to physical features and social situations that have stress-reducing attributes. The focus on stress as a dependent variable is practical, as it can be measured through biochemical, physiological, behavioral, and cognitive outcomes intended to either alter the stressful event itself or accommodate its effects (Taylor, 2012). Stress can increase heart rates, blood pressure, and cortisol levels, slow wound healing, disrupt sleep patterns, and indirectly lead to chronic health problems such as heart disease, digestive disorders, and depression (Gouin & Kiecolt-Glaser, 2012). The theory of supportive design proposes three factors that are essential in reducing stress through design (Ulrich, 1991, 1999). These include a sense of control in the physical and social surroundings, access to social support, and access to positive nature distractions, defined as "an environmental feature or element that elicits positive feelings, holds attention and interest without taxing or stressing the individual, and therefore may block or reduce worrisome thoughts" (Ulrich, 1991).

Research Significance

The Impact of Built Environment on Family Engagement

Hospitals and perinatal organizations recognize the importance of family engagement in the neonatal intensive care unit (NICU). The Agency for Healthcare Research and Quality (AHRQ) defines family engagement as "A set of behaviors by patients, family members, and health professionals and a set of organizational policies and procedures that foster both the inclusion of patients and family members as active members of the health care team and collaborative partnerships with providers and provider organizations."

Parents contribute to the development of infants being treated at the NICU, improving infant development, reducing NICU length of stay, and minimizing potential hospital readmissions (Fenwick et al., 2008). Family engagement is critical to maximize family participation in care (Carman et al., 2013), and in the NICU parents experience family engagement while preparing for their role after NICU discharge, through various actions and interactions (Altimier et al., 2005; Örtenstrand et al., 2010). The Single-Family Room (SFR) design model is the current trend in NICUs, showing increased privacy and parental participation in care when compared to the previous model (open bay) (Shepley, 2014). However, the SFR design shows concerns related to peer-to-peer isolation (Shepley et al., 2008; Cone et al., 2010; Bosch et al., 2012), and further research is required on the couplet care model which lies further on the spectrum on family-integrated care.

Family Engagement can be broadly categorized into actions and interactions.

1. **Being present.** The frequency and duration of parents' visits to their infants has been associated to how much they participate in interactions like breastfeeding and medical rounds (Franck & Spencer, 2003; Davidson, 2013).
2. **Receiving care.** Parents' physiological and psychological wellbeing are important conditions for them to interact (Verhaeghe et al., 2005; Garrouste-Orgeas et al., 2010). Previous studies have found that access to information,

social support and daily living activities mitigate parents' stress in the NICU (Cleveland, 2008, Mundy, 2010).

3. **Receiving and providing information.** Interactions between parents and staff are critical to their effective communication as well as for parents' learning in the NICU, which often occurs through medical rounds and infant care training and coaching (Davidson, 2013; Reeves et al., 2015; Cooper et al., 2007).
4. **Providing care.** Participation in infant care is when parents are most active in the engagement process, occurring through hand-on parental contributions to care like infant feeding and cleaning (Griffin, 2006; Skene et al., 2012)

Characteristics of the Built Environment.

1. **Global Characteristics.** The overall layout of spaces in the unit, like infant rooms, staff workstations and corridors, may create different conditions of physical proximity and visibility between people in the unit, thus affecting differently their movement and interactions (Cai & Zimring, 2011; Lu, 2010; Domanico et al., 2010; Shepley et al., 2008).
2. **Relational Characteristics.** Physical proximity and visibility between spaces reinforce communication patterns through movement and interactions in healthcare settings, office settings and educational settings (Cai & Zimring, 2011; Serrato & Wineman, 1999).
3. **Local Characteristics.** Physical characteristics within spaces like their size, shape and boundaries can be barriers to physical proximity and visibility, hindering interactions (Walsh et al., 2006; Hadi & Zimring, 2016). Light, noise, personal space (e.g., bedside furniture), social support-oriented space types and seating layouts, and positive distractions (e.g., access to nature, artwork, views) may also affect perceptions of satisfaction and social support in the NICU (Andrade & Devlin, 2015; Shepley et al., 2008; Heermann et al., 2005; Ulrich, 1991).

Built Environment Characteristics Influencing Receiving Care.

Machry & Joseph (2019) recommend the following based on their research on the built environment as a contextual factor to family engagement in the NICU. Built environment characteristics are categized as influencing receiving care; receiving and providing information; and influencing providing care

1. Visibility between SFR and staff workstations supporting parents' sense of security: Being able to see the workstation from the SFR reassures parents that their infants are receiving proper staff supervision.
2. SFR seating and storage supporting social support interactions: Seating areas free of clutter support interactions in which staff purposefully talks to parents at eye level (e.g., social assessments), suggesting the need for storage cabinets to keep parents' personal items from cluttering seating areas
3. Type of window views in the SFR supporting parents' mental health: Looking at other buildings from the SFR window may intensify feelings of depression on parents prone to depression.
4. Type of artwork in the SFR supporting parents' sense of ownership towards infant: The display of artwork on SFR walls supports milestone celebrations (e.g., infant's first breastfeeding) which contribute to parents' sense of ownership towards their infant

Built Environment Characteristics Influencing Receiving and Providing Information.

1. Room shape and layout supporting parent-staff visibility and communication: Room depth in relation to corridors combined with the location of parents' chairs in the room may influence staff's ability to see if parents are in the room and available for unplanned bedside discussions.
2. Room size and layout supporting teaching: Discharge classes support multiple types of activities, such as interactive lectures, infant care simulations with

dolls, watching infant care videos, and eating, suggesting the need for adequate space for storage and circulation in NICU classrooms.

Built Environment Characteristics Influencing Providing Care.

1. Physical proximity between SFR and amenities supporting parent-infant interactions: The location of coffee and vending machines may reduce the time parents have to spend away from their infants (SFR).
2. Isolette position supporting infant care (parent-infant and parent-staff): The position of the isolette in relation to the headwall affects the interaction between parent and staff during infant care, as well as parents' ability to interact with the infant (e.g., left-handed vs. right-handed parents).

In-unit barriers and facilitators to enhance family engagement are well studied; however, less is known specifically about maternal engagement's influence in the NICU on the health of infants and mothers, particularly within U.S. social and healthcare contexts. Prior research illustrates maternal engagement in the NICU is associated with infant outcomes, maternal health-behavior outcomes, maternal mental health outcomes, maternal-child bonding outcomes, and breastfeeding outcomes (Klawetter et al., 2019). Maternal involvement was measured by number of days per week of kangaroo care, bottle or breast feeding, and maternal care. Skin-to-skin holding is the most studied maternal engagement activity in the U.S. preterm NICU population. Further research is needed to understand what types of engagement are most salient, how they should be measured, and which immediate outcomes are the best predictors of long-term health and well-being.

Infant outcomes.

Many of the reviewed articles reported findings related to the relationship between maternal engagement and infant health outcomes. Maternal-infant bonding and breastfeeding outcomes are included in their own categories. A review of the literature

suggests that maternal engagement activities are safe for infants and may be associated with positive infant health outcomes.

An early study of 15 preterm infants evaluated the safety of skin-to-skin care while transferring ventilated preterm infants from their isolettes to skin-to-skin holding (Neu et al., 2000). Infants were randomly assigned to either nurse-to-parent transfer or parent transfer groups. Skin-to-skin holding was associated with stabilized oxygen saturation levels, stabilized heart rates, and maintained energy levels regardless of transfer methods (Neu, M., 2014). In a randomized control trial of 27 preterm infants, those who were skin-to-skin held in the NICU had clinically acceptable cardiorespiratory and temperature ranges during skin-to-skin holding and had no apnea or bradycardia events. Infants who were skin-to-skin held had increased regular breathing patterns compared to infants who received standard NICU care (Ludington-Hoe et al., 2004). McCain et al. also found in a case study that a preterm infant in the NICU had more a more stable and consistent heart rate when they were skin-to-skin held compared to when lying in their crib (McCain et al., 2005). A more recent study evaluated the safety of the Family Nurture Intervention, an intervention designed to enhance families' bonding and caregiving experiences in the NICU (Welch et al., 2013). This intervention included skin-to-skin holding as one of its caregiving enhancement elements. Findings from a randomized control trial of the Family Nurture Intervention confirmed the intervention was safe and feasible, as evidenced by no increase in medical risk or change in level of acuity for preterm infants (Welch et al., 2013).

Skin-to-skin holding has also been evaluated as an analgesic. Two crossover trials showed that preterm infants who were skin-to-skin held during heel sticks had more stable heart rates and recovered faster as evidenced by lower heart rates compared to infants in incubators (Cong et al., 2012; Cong et al, 2009). When infants (n = 26) were held skin-to-skin, they spent more time in quiet sleep states compared to when they were in incubators (Cong et al, 2009). These findings were consistent when the infants received only fifteen-minute periods of skin-to-skin holding (Cong et al, 2009).

Various maternal engagement activities in the NICU are also linked to positive neurobehavioral outcomes among preterm infants. Maternal visitation is associated with positive infant arousal and motor development outcomes. Specifically, high maternal visitation rates were associated with less arousal, higher quality motor movement, less hypertonia, more hypotonia, and less excitability in a longitudinal cohort study of 81 preterm infants in the NICU. This same study demonstrated that traditional blanket holding (i.e., not skin-to-skin holding) was associated with less infant stress and less infant excitability (Reynolds et al., 2013).

Blanket holding and skin-to-skin holding are also linked to more optimal crying patterns and motor development. In a randomized control trial of 87 preterm infants, parents were assigned to either a group who received encouragement from nurses to hold or skin-to-skin hold or a group who did not receive such encouragement. Evaluations of crying patterns showed that infants whose parents received encouragement to hold, or skin-to-skin hold were able to vigorously cry and then be calmed and consoled more quickly than those whose parents did not receive the encouragement (Neu et al., 2013). In this same study, there was no significant difference in crying patterns between blanket held or skin-to-skin held infants. A study of 81 parent-infant triads tracked parental visitation, blanket holding, and skin-to-skin holding patterns and found that blanket holding and skin-to-skin holding was linked to better infant reflex development at term. In this same study, skin-to-skin holding was also associated with less asymmetry at term (Pineda et al., 2018).

A randomized crossover study comparing preterm infant (n = 28) cortisol levels prior to skin-to-skin holding to those directly after skin-to-skin holding found that preterm infants' cortisol levels decreased from pre-to post-skin-to-skin holding (Vittner et al., 2018). Since cortisol may serve as a signal of stress, this study suggests that skin-to-skin holding decreases stress in preterm infants.

Studies produce mixed findings regarding the effect of maternal engagement on infant length of stay in the NICU. An early randomized control trial of 32 mother-infant dyads found that higher maternal visitation rates in the NICU was related to shorter

infant length of stay (Zeskind, P. S., & Iacino, R., 1984). A later study that evaluated the effects of a music and multimodal stimulation parent training found that preterm infants whose parents received the training had less stress and shorter length of stay compared a control group (Whipple, 2000). However, the Family Nurture Intervention described above did not affect infant length of stay in the NICU (Welch et al., 2013). These results suggest further study evaluating maternal engagement and preterm infant length of stay in the NICU is needed.

Finally, multiple studies have evaluated how maternal engagement activities may impact post-discharge infant outcomes. For the two studies expressly studying the effect of maternal visitation on infant post-discharge outcomes, findings are mixed. Lewis et al. found in their longitudinal study of 164 maternal-infant dyads, which included medical record data extraction, interviews with mothers, and 3-month follow-up clinic data, that maternal visitation was positively related to attendance at 3-month follow-up infant clinic visits (Lewis et al., 1991). However, Greene et al. found more recently in a study of 69 mother-infant dyads that maternal visitation rates were not linked to infant outcomes at discharge or post-discharge follow-up (Greene et al., 2015). Skin-to-skin holding appears to have somewhat complicated infant post-discharge results in the literature, suggesting a need for further study in this area. Skin-to-skin holding was associated with more desirable scores on infant social behaviors and developmental maturity tests up to 12 months corrected age in a randomized control trial conducted with preterm infants and mothers in 4 U.S. hospitals (Holditch-Davis et al., 2014). In a study that evaluated infant post-discharge outcomes among 123 preterm infants who had stayed in a single-family room (SFR) NICU compared to 93 infants who had stayed in an open-bay NICU, infants from both NICU environments with more “highly involved mothers” had higher receptive and expressive communication at 18-month follow up (Lester et al., 2016). Maternal involvement was measured through electronic medical record extraction of documentation of maternal and infant characteristics including participation in skin-to-skin holding, breast and/or bottle feedings, and maternal care in the NICU. Infant post-discharge outcomes were particularly positive among infants from the SFR NICU

environment whose mothers also showed high levels of maternal involvement (Lester et al., 2016). While a retrospective cohort study of parental skin-to-skin holding of extremely preterm infants, defined by the study's authors as GA < 27 weeks, in the NICU showed a positive but nonsignificant relationship between parents who skin-to-skin held and infant communication development (Gonya et al., 2017), the Family Nurture Intervention trial demonstrated improved cognitive and language outcomes at the 18 month follow-up assessment between intervention and control groups (Welch et al., 2015). A longitudinal cohort study followed 81 parent-infant triads over 4–5 years after recording parental visitation, blanket holding, and skin-to-skin holding patterns while preterm infants were hospitalized in the NICU. This study found that skin-to-skin holding was associated with gross motor development, but that other parent engagement activities were not (Pineda et al., 2018).

Maternal Health-Behavior Outcomes.

While most studies explored how maternal engagement-related activities relate to maternal mental health outcomes, infant outcomes, maternal-child bonding outcomes, and/or breastfeeding outcomes, one study exclusively examined maternal health-behavior outcomes. Phillips et al. explored the effect of an intervention designed to support and maintain maternal smoking cessation during and after NICU hospitalization (Phillips et al., 2012). Mothers (n = 49) were randomized into either a control group (n = 28) which included support for breastfeeding and smoking cessation encouragement or an intervention group. The intervention group (n = 21) added a maternal-infant bonding support element through skin-to-skin holding and information about recognizing and interpreting infant behavioral cues. Mothers in the intervention group were more likely maintain their smoke-free status 8 weeks postpartum compared to mothers in the control group, suggesting that certain maternal engagement activities may support positive maternal health-behavior outcomes.

Maternal Mental Health Outcomes.

Several studies addressed different facets of how engagement in the NICU relates to maternal mental health and well-being. An early mixed methods study of 25 sets of parents of intubated preterm infants found that parents had positive perceptions of skin-to-skin holding and believed skin-to-skin holding helped them identify with and experience a sense of knowing their infants (Gale et al., 1993). A qualitative study of 8 mothers of preterm infants in the NICU found that mothers who participate in skin-to-skin holding reported feelings of confidence, a sense of control, and competence (Affonso et al., 1993). These findings are echoed in a qualitative study (n = 18) in which mothers who skin-to-skin held felt confidence, described as feeling "needed" and "being comfortable" despite the health conditions of their infants (Johnson, 2007). More recently, a qualitative study of 10 mothers with preterm infants in the NICU affirm the value of skin-to-skin holding in helping them experience more self-awareness and maternal identity (Roller, 2005).

The literature also reflects how maternal engagement in the NICU relates to symptoms of depression and feelings of worry, stress, and anxiety. In a study comparing NICU visitation rates among 69 mothers, those with lower visitation rates were more likely to have had prior trauma exposure, low anxiety, and to experience symptoms of depression at their infants' 4 months corrected age (Greene et al., 2015). In addition to visitation, skin-to-skin holding and activities that promote other forms of maternal-infant physical contact are linked to positive maternal mental health and well-being. In a randomized control trial comparing three groups (n = 240), one in which mothers were encouraged to provide skin-to-skin care, one in which mothers were encouraged to provide an auditory-tactile-visual-vestibular (ATVV) intervention, and a control group, mothers in the skin-to-skin group experienced a quicker reduction in maternal worry (Holditch-Davis et al., 2014). Mothers in the ATVV group who provided infant massage experienced a significant decrease in maternal depression symptoms. Mothers in both the skin-to-skin and ATVV groups experienced less parenting stress compared to the control group.

In a crossover study of 28 parent-infant sets, associations among skin-to-skin holding, parental stress and anxiety, and oxytocin levels, oxytocin appears to have modulated stress and anxiety for both mothers and fathers (Cong et al., 2015). Mothers and fathers were assigned skin-to-skin holding patterns in the NICU over a 2-day period. Parents' saliva was collected, and anxiety was assessed using a validated scale before, during, and after skin-to-skin holding. Parents who participated in skin-to-skin holding experienced increased levels of oxytocin during the activity, and skin-to-skin holding was related to decreased stress and anxiety for both mothers and fathers. Interestingly, mothers and fathers also appeared to have synchronized levels of stress and anxiety in the NICU, which suggests that more research is needed on *all* caregivers' experiences in the NICU. Vittner et al.'s work supports these findings in their randomized cross-over study of 28 parent-infant sets, showing that parents who participate in skin-to-skin holding experience a rise in oxytocin levels and lower anxiety levels when measured across 3 days during a 60-minute holding session and again 45 minutes post-holding (Vittner et al., 2018).

However, the relationship between skin-to-skin holding and maternal stress may need more contextual exploration. In a randomized control trial of 40 mother-infant dyads, mothers were given information about the NICU visitation policy and encouraged to skin-to-skin hold their infants. Mothers in the control group were also encouraged to blanket hold their infants at least 3 times a week for 50 minutes, while mothers in the intervention group were encouraged to skin-to-skin hold at least 3 times a week for 50 minutes. Maternal stress was measured using a validated scale once within 24 hours of NICU admission and then again within the 24 hours prior to NICU discharge. Results showed that hours of skin-to-skin holding were associated with increased maternal stress so that mothers who participated in more hours of skin-to-skin holding had higher stress levels (Samra et al., 2015). When comparing the two groups, maternal stress was not significantly different between groups. Notably, this study was under-powered. A more recent randomized control trial examined 49 mothers of preterm infants in the NICU who had quit smoking during pregnancy. Participants were randomly assigned into either a control group or intervention group. Both groups were

encouraged to remain smoke free and breastfeed, but the intervention group was supported in recognizing infant behavioral cues and skin-to-skin holding (Phillips et al., 2012). While results found participation in the control group was associated with smoking cessation and increased breastfeeding, there were no significant differences in maternal depression and stress scores between the two groups. These findings call for additional research in this area.

Another noteworthy finding is that maternal skin-to-skin holding has also been linked to substance use outcomes among mothers. In addition to the above finding that skin-to-skin holding may be associated with smoking cessation, mothers who identified as substance using in the mixed methods study described above in depth reported that participating in skin-to-skin holding motivated them to follow custody requirements and visit their infant more in the NICU (Gale et al., 1993).

Maternal-Infant Bonding Outcomes.

Multiple studies examined how various maternal engagement activities may or may not relate to maternal-child bonding outcomes. Maternal visitation was found to be associated with mothers' perceptions of their infants' behavior and their infants' prognoses in a randomized control trial of 32 mother-infant dyads (Zeskind, P. S., & Iacino, R., 1984). Mothers with higher visitation rates were less likely to have positive perceptions of their infants as measured by the “Your Baby” subscale on the Neonatal Perception Inventory. This finding may result from mothers having more realistic perceptions of behavior the more familiar they are with their infant. Mothers with higher visitation rates were more likely to have positive perceptions of their infant's prognoses, showing higher scores on measures of future intellectual and medical development.

Maternal skin-to-skin holding also showed positive maternal-child bonding outcomes. In a qualitative study, 10 mothers reported that skin-to-skin holding their preterm infant in the NICU facilitated their sense of familiarity with their infants' breathing patterns and preferred sleeping positions (Roller, 2005). Skin-to-skin holding may also be linked to respiratory co-regulation between mothers and infants, as shown by a

study of 11 parent-infant dyads. This study examined respiratory markers (e.g., skin temperature, heart rate) of parents and infants during a control period of the infant resting in an incubator and then during skin-to-skin holding. Results show that parents' heart rhythm influences infants' respiration pattern (Bloch-Salisbury et al., 2014). Studies of oxytocin and cortisol levels among parents and their preterm infants in the NICU point to their potential relationship to the skin-to-skin holding experience. For instance, a study hypothalamic-pituitary-adrenocortical (HPA) system activity among of 20 maternal-infant dyads found that skin-to-skin holding may facilitate the co-regulation of cortisol levels between mothers and infants (Neu et al., 2009). A subsequent randomized control trial of mother-infant dyads (n = 79) who were encouraged to skin-to-skin or traditional blanket hold found that significant co-regulation of cortisol levels did not exist after 60 minutes of holding between the two groups. However, those groups compared to a control did show lower cortisol levels compared to the control group not encouraged to skin-to-skin hold or blanket hold (Neu et al., 2014). Amounts of skin-to-skin holding have been found to positively relate to salivary oxytocin levels for parents and their preterm infants (Vittner et al., 2018). These findings are consistent with a more recent randomized crossover study that found that skin-to-skin care results in raised oxytocin levels for both parents and infants (n = 150), as well as decreased cortisol levels for both parents and infants. The same study demonstrated that parents who initiated skin-to-skin holding within the first two weeks had higher levels of parent engagement at NICU discharge, as measured by the PREEMI parent survey (Vittner et al., 2018). Additionally, parents with high oxytocin levels during skin-to-holding periods displayed more responsiveness and synchronicity with their infants in the NICU as measured by videotaped parent-infant interactions independently scored by two reviewers using the Dyadic Mutuality Code (Vittner et al., 2018).

Interventions that support multiple maternal engagement activities also suggest an advantageous link between maternal engagement and maternal-infant bonding outcomes. The Family Nurture Intervention, designed to encourage skin-to-skin holding, blanket holding, exchange of scent clothes, eye contact between mother and

infant, and mother touching the infant while talking to them, resulted in mothers who demonstrated more responsive caregiving behaviors compared to those who did not receive the intervention in a randomized control trial (n = 65) (Hane et al., 2015). A similar study compared the ATVV intervention to skin-to-skin holding in a randomized control trial conducted in 4 NICUs. This study found that infants (n = 26) who received the multi-sensory intervention had more positive engagement and disengagement behaviors when interacting with their parents than those in the skin-to-skin holding group. The authors point out that interventions that promote infant engagement and disengagement behaviors are important because parents then have more opportunities to adjust their responses in ways that facilitate bonding and attachment (White-Traut et al., 2012). In a separate study, parents who were trained to provide music and multimodal stimulation visited their infants more than parents who did not receive the training (Whipple, 2000). They also demonstrated more appropriate responses to their preterm infants in the NICU compared to parents not trained in the intervention, however these findings were not maintained at one-month post-discharge follow-up (Whipple, 2000).

Breastfeeding outcomes.

Breastfeeding may also be related to maternal engagement activities, in terms of both milk volume mothers are able to produce and duration of breastfeeding practices. Skin-to skin holding has been positively related to milk volume (Hurst et al., 1997; Lau et al., 2007). One study used repeated-measures analysis of variance to compare breastmilk volume between a group of mothers who skin-to-skin held and a group that did not over a 2-week period. Mothers who skin-to-skin held had linear increase in volume over the 2-week period compared to no significant change in the control group. A study conducted 10 years later affirmed these findings, showing that among 124 participants, milk volume was positively correlated with skin-to-skin holding. This study also demonstrated that skin-to-skin holding time may increase mothers' motivation to express milk (Lau et al., 2007). In a randomized cross over study of mothers (n = 28) who quit smoking during pregnancy, mothers who were supported in

skin-to-skin holding and recognizing infant behavioral cues were more likely to be breastfeeding at 8 weeks postpartum compared to mothers who did not receive the skin-to-skin and behavioral cue support (Phillips et al., 2012). This finding is supported by a more recent secondary analysis of a multi-site, randomized trial of breastfeeding practices at NICU discharge and post-discharge (n = 231). Mothers who skin-to-skin held their preterm infant in the NICU were more likely to breastfeed at discharge and post-discharge follow-up compared to mothers randomly assigned to either an auditory-tactile-visual-vestibular intervention group or a group who received information about preterm infant care (Tully et al., 2016).

The evaluation of environments of care for high-risk newborns through post-occupancy evaluations (POE) is essential for research and evidence-based design. However, there is little evidence available that demonstrates outcomes with couplet care.

CHAPTER 2

METHODOLOGY

Introduction

This chapter describes the instruments that were used to address the research questions, along with the overall methods used for each of the tools.

Study Goals

The primary goal of this research was to evaluate the couplet care environmental (CCE) model at a pediatric hospital, and to validate an existing survey developed at Yale New Haven Hospital (YNHH). It is an approach that measures the effect of exposure to the CCE on maternal-infant bonding during hospitalization. The primary aim of this study is to validate the tool that measures the effect of exposure to CCE on maternal- infant bonding during hospitalization. Secondary aims are to determine associations between elements of the CCE and parental stress, and hospital stay satisfaction. A follow-up interview was used to gather both qualitative data, and to triangulate and verify results.

Primary outcomes of interest include scores on a neonatal experience evaluation toolkit (see Appendix C) and a qualitative interview (see Appendix D). Surveys were administered post-hospital discharge. Interested participants were invited to participate in a follow-up interview where they were asked to describe their experience with the CCE model in detail.

Impact

Although there have been several studies on associated stressors in a traditional NICU, it has not been studied in mother-infant dyads who receive co-care. NICU couplet care is a novel approach that is seeing an increase in adoption rates in numerous hospitals across the United States. To our knowledge, there are very few studies that examine the outcomes associated with this iteration of NICU design. The results from this

study provide an evidence-base case upon which further studies and clinical practice improvements can be performed.

Site Description and Context

The case study is a level III NICU located at a Children's Hospital in the Midwestern US. It applies a family centered care model that includes 24h family access with overnight stay and an active family engagement program, which involves various types of family engagement actions and interactions. As depicted in Figure 1, the unit offers two types of SFRs (SFR and Couplet-care SFR), all with adjacent private bathrooms and multiple family support spaces (family-dedicated waiting areas, meeting room, lounge, garden, and atrium).

Study Participants

Potential participants were identified by the medical team and/or the research team based on the eligibility of an infant admitted to the neonatal intensive care unit. Inclusion criteria included mothers who are at least 18 years of age, who understand spoken and written English, and who are eligible for CCE at any point during their infants' birth hospitalization at Memorial Hospital, South Bend. Infants who qualify for CCE are born at a gestational age greater than or equal to 32 weeks with diagnosis of mild respiratory distress (requiring 1 or less liter per minute nasal cannula flow), evaluation for sepsis, and hypoglycemia). Exclusion criteria include factors that exclude mothers from CCE. These factors include risk for hemorrhage (mother received uterotonics other than oxytocin for active bleeding or mother received or is ordered to receive a transfusion), mother requires Maternal Special Care Unit-level care, acute psychiatric issues (requiring daily psychiatric consult liaison or 'sitter'), or active custody or flight risk issues. If eligible, the medical care team asked the mother if she was interested in being approached regarding a research study. The request was performed by a representative of the care team since the investigator was unable to visit the facility due to COVID-19 related travel restrictions. If they expressed interest in participation, they were given more information about the study and their eligibility

based on maternal factors was assessed. Interested participants were presented the study poster (see Appendix E) by nursing staff as a means of recruitment. Those who were eligible were informed about the study and could choose to consent for study participation. The clinical care of the mother-infant dyad, i.e., the availability of a couplet care room, did not impact the mother's decision to participate in the study. The study included mothers in couplet care. The clinical decision of whether a mother-infant dyad participated in couplet care was separate from study procedures. Once enrolled, participants were asked to complete a series of surveys (see Appendix C). Surveys were administered before discharge. The research data was collected by Qualtrics survey (sent to the participants personnel email if they provided permission).

In this prospective, cohort study, participants were divided into two cohorts depending on their length of stay and exposure to the couplet care environmental model based on prior retrospective cohort study that investigated the association of skin-to-skin patterns with length of stay in extreme preterm infants in the NICU (Gonya et al., 2017; Hunt et al., 2015). The short stay cohort had a length of stay in the CCE corresponding to less than 5 days, whereas the long stay cohort had a length of stay in the CCE corresponding to greater than or equal to 5 days. Targeted enrollment is 30 participants for the survey and 10 participants for the follow-up interview.

Primary outcomes of interest include scores on a self-report survey as well as parent satisfaction with their hospital experience, and the amount of education received from nursing.

Tools

Neonatal Experience Evaluation Toolkit

The survey used in this study was developed by Dr. Sarah Taylor and her research team at Yale New Haven Hospital (YNHH) and is an approach that measures the effect of exposure to the CCE on maternal-infant bonding during hospitalization. It is comprised of four surveys, or "tools," designed to evaluate the couplet care

environment quantitatively and qualitatively. The four instruments in the toolkit are the (1) Bonding Scale; (2) Satisfaction Scale; (3) Parental Stress Scale and (4) Breastfeeding support. The author worked in collaboration with Dr. Sarah Taylor to discuss the toolkit, its original intent, and the addition of a follow-up qualitative interview. Therefore, the following instruments have been slightly modified for this study to accommodate data collection. The resulting toolkit has been designated Neonatal Experience Evaluation Toolkit (see Appendix C). The survey and interview questions are described in detail in subsequent sections of this chapter.

Demographic Results

This section covered questions on age and race. The demographic questions were placed at the end of the survey to avoid feelings of intrusiveness and premature termination of the survey. To encourage participants to answer the demographic questions, this section began with the statement, "*A person's background can sometimes influence how they experience the surrounding environment. You are* ***NOT*** *required to answer these demographic questions, but your answers will help us understand any potential relationships that we find. Thank you*!"

For demographic information and results relating to the questions of age, race, and discharge dates, see Appendix C.

Validity and Reliability

Validity in a research tool is described as an instrument that successfully measures what it is supposed to measure (Loewenthal, 2001). Nunnally (1978) states that one, "validates the use to which a measuring instrument is put rather than the instrument itself" (p. 84) and is an established property of a tool. It is easier to establish validity with an objective measure rather than subjective measures like preference and aesthetic qualities. Support for an instrument's validity can be shown through many different aspects of the instrument itself. Three robust types of validity are content validity, face validity, and convergent validity. Content validity represents the extent

to which a research instrument accurately measures all facets of its intended construct and can be derived from similar instruments, expert opinions, and results of instrument testing (Anastasi, 1982; Leedy & Ormrod, 2013). Face validity represents how well an instrument appears to measure a given construct "at face value" (Anastasi, 1982; DeVellis, 2003). Face validity is inherently subjective and thus difficult to measure. Convergent validity is based on the idea of a researcher's variables correlating the way they were intended. It has been described as, "the extent to which an instrument measures a characteristic that cannot be directly observed but is assumed to exist based on patterns of people's behaviors (Leedy & Ormrod, 2013, p 90).

Content, face, and convergent validity were examined during the original development and testing of the survey. Face validity, which was examined as part of the content validation process, is how well an instrument, at face value, measure what it is intended to measure. This was evaluated mostly through the *look* of the survey – professional, legitimate, and appears to make sense. The content validity was established through a literature review; review of similar instruments and the use of them as models; opinions and feedback from a range of experts and lay people; and the original survey testing. Convergent validity was examined through correlating two types of scoring methods.

Neonatal Experience Evaluation Toolkit Protocol.

The QR code was embedded in the recruitment poster. This linked to an online version of the survey on Qualtrics, where written consent was requested, and answers recorded. The survey was active between August 2021 to February 2022.

Qualitative Interviews.

Structured qualitative interviews are used as a tool to triangulate and corroborate other research instruments and data collected, while generating qualitative information regarding common issues and themes with the CCE model. Structured interviews, also known as focused interviews, are dictated by a pre-defined script (questions) to target

the study's hypotheses or research questions and are also less time-consuming for both data collection and analysis than other forms of interviews (semi-structured, unstructured) (Shepley, 2011; Zeisel, 2006).

Qualitative Interview Protocol.

The participants who consented to participate in the follow-up qualitative interview were contacted through the personal email provided by them in the corresponding Qualtrics survey field. For the site visits, the researcher's primary liaison at Beacon Children's Hospital and Yale New Haven Hospital introduced the researcher to the staff, administrators, and facility manager via email. Following this initial contact and agreement, the interviewees were sent the IRB- approved Recruitment Letter (see Appendix E) to explain the study, before the Zoom interviews or at the beginning of the in-person interviews. To keep the interview data collection as standardized as possible, the same base script and data collection protocol were used for each specific interviewee (see Appendix D).

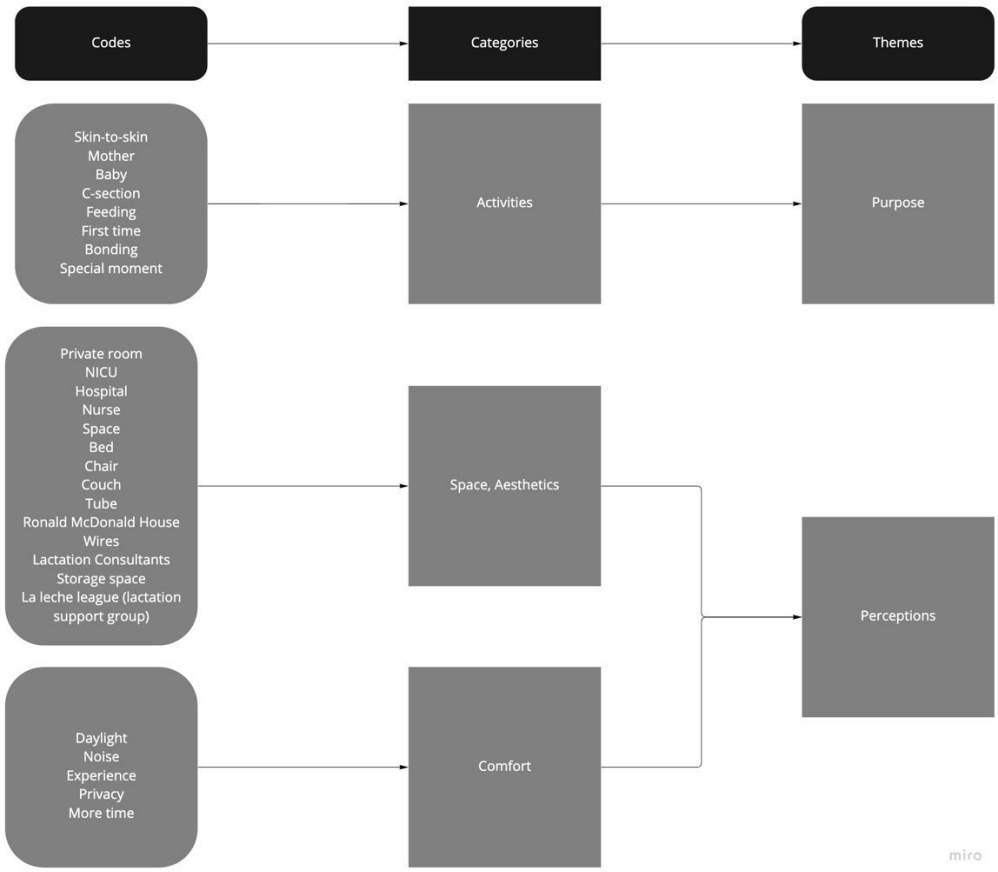
The following questions were asked of all interviewees:

1- *In your own words, what is your connection to couplet care?*
2- *In your experience, what is missing for new mothers? This could include specific resources, spaces and physical environmental features within a hospital, or something broader.*
3- *Where do you think mothers' bond with their newborn infants?*
4- *How do you think being able to be in the same room with your infant post-partum has changed the patient experience?*
5- *What would you change if you were trying to improve feelings of early bonding between mothers and their infants with respect to the physical environment or technology?*
6- *Would you prefer to have a room that would allow a family member to stay the night?*
7- *How do you think having a separate neonatal intensive care unit for your infant would impact your neonatal experience?*

8- *What were some of your fears regarding breastfeeding and skin-to-skin care post-delivery?*

Interviews took approximately 60-minutes, and were conducted either over the phone, or Zoom (video calling). All interviews were recorded using Otter.ai: a voice recording, dictation, and transcription application. The researcher also took pen and paper notes during each interview. The interviews were transcribed and analyzed and coded in Otter.ai. Analysis of these interviews identified facts, themes, commonalities, and outliers across the interviews, as well as aided in the triangulation of results. After applying the thematic analysis, categories and sub- themes were identified and refined, and a thematic map was created (see Figure x). Thematic analysis is a method of qualitative data analysis for identifying and reporting patterns or "themes" within and across the data (Braun & Clarke, 2006).

Figure 2: Code to Theme map for Survey Open Ended Questions



Institutional Review Board (IRB)

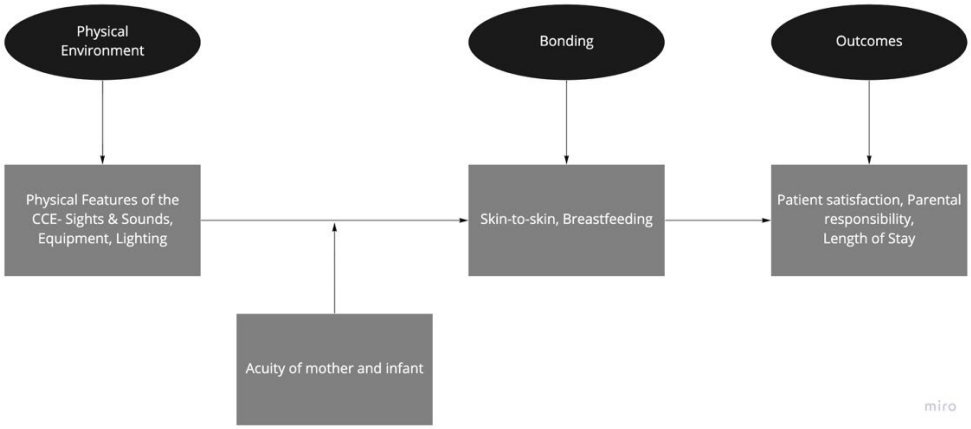
This project involved collecting survey and interview data from human participants, and thus required approval from the Cornell Institutional Review Board for Human Participants as well as approval from Beacon Children's Institutional Review Board for Human Participants. Evaluations that gather staff responses, as opposed to patient or patient-proxy responses, are more likely to receive an exempt status as staff are not considered a vulnerable population. Other evaluations that keep the identities of subjects confidential or anonymous are also more likely to be given an exempt status. Because the protocol involved human subjects in surveys and interviews and were conducted with patients, the "information obtained is recorded in such a manner that human subjects cannot be identified, directly or through identifiers linked to the subjects", the project was granted exemption from IRB review according to Cornell IRB policy (*Department of Health and Human Services Code of Federal Regulations, 45CFR 46.104(d))* (Protocol ID # 2010009902). This exemption was granted on May 07, 2021, prior to data collection. (see Appendix A). The project was granted exemption from IRB review according to Category 2 of Beacon Children's IRB policy. This exemption was granted on April 02, 2021, prior to data collection. (see Appendix B). Once the survey was deployed in the study site, an amendment was made to the recruitment materials to improve recruitment numbers. As the recruitment materials were revised, amendments were submitted to the original IRB application. Final approval for this project was granted on November 17, 2021 (see Appendix B). The author also obtained a letter of support from the Director of Regional Newborn Program stating that they had been informed of the intention and methodology involved in this study and had approved the study (see Appendix H).

Hypotheses are as follows:

i. The primary hypothesis is that CCE exposure will be positively correlated with maternal-infant bonding, hospital stay satisfaction, and lower maternal stress.

ii. The secondary hypothesis is that certain elements of the couplet care experience such as noise, proximity will have stronger associations with maternal infant-bonding, hospital stay satisfaction, and a negative association with maternal stress.

Figure 3: Relationship between constructs and variables



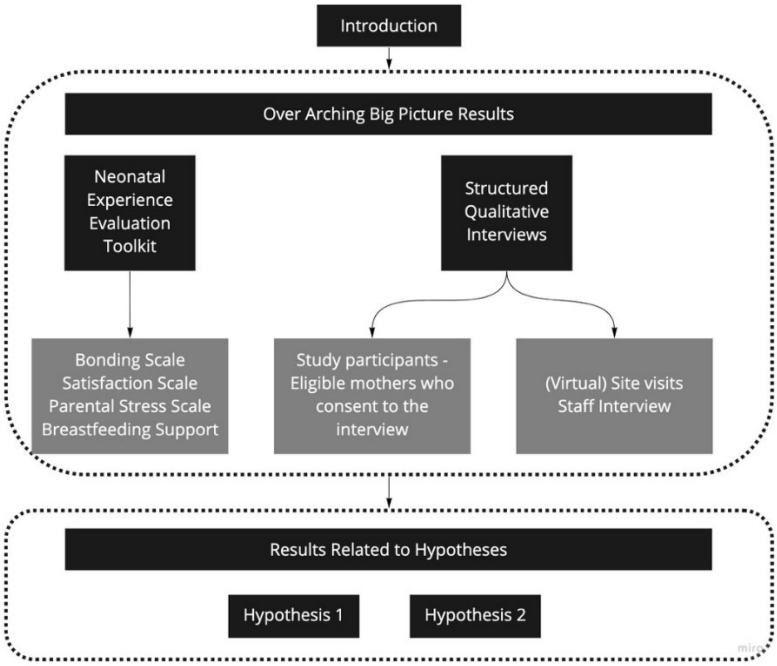
Chapter 3

RESULTS

Introduction

The Neonatal Experience Evaluation Toolkit used in this study was developed at Yale New Haven Hospital (YNHH) and is an approach that measures the effect of exposure to the CCE on maternal-infant bonding during hospitalization. The primary aim of this study is to validate the tool that measures the effect of exposure to CCE on maternal-infant bonding during hospitalization. Secondary aims are to determine associations between elements of the CCE and maternal stress, and hospital stay satisfaction. A follow-up interview was used to gather both qualitative data, and to triangulate and verify results. The data analysis methods used were as follows: most quantitative data analysis was completed in R (version 1.2.1335), including descriptive and inferential statistical analysis. Qualtrics data analysis tools were also used to generate preliminary findings for the survey, which was hosted on the Qualtrics platform. Qualitative interviews were performed over Zoom (version 5.5.0) with the interviews transcribed by the integrated transcription feature. Qualitative data analysis was completed in Otter.ai.

Figure 4: Flowchart illustrating data collection methodology and analysis



General Results

The survey was active between August 2021 to February 2022. Enrollment for the survey was 19 subjects with 16 subjects completing 85% or more of the survey (DeMauro et al., 2019; Bentley et al., 2020). The number of observations available for quantitative analysis was n=16. Follow-up interviews were conducted with 10 subjects, all of whom completed the quantitative survey, where each theme was explored in depth. The number of observations available for qualitative interview was n=10. In this prospective, cohort study, participants were divided into two cohorts depending on their length of stay and exposure to the couplet care environmental model based on prior retrospective cohort study that investigated the association of skin-to-skin patterns with length of stay in extreme preterm infants in the NICU (Gonya et al., 2017; Hunt et al., 2015). The short stay (N=7) cohort had a length of stay in the CCE corresponding to less than 5 days, whereas the long stay cohort (N=9) had a length of stay in the CCE corresponding to greater than or equal to 5 days.

Demographics

Demographic information was available for 13 of the 16 study participants. The proportions of these in each racial category was (69.2%) White Caucasian, (12.5%) Black (12.5%) Hispanic Latino, (0%) Asian. The median household income was not collected as per the instructions by the neonatal care team. The average length of stay in the short stay cohort was 2.57 days with a standard deviation (SD) of 1.1 days whereas the average length of stay in the long stay cohort was 15.60 days with an SD of 7.5 days (see Table 1). The average infant weight at birth in the short stay cohort was 2.60 kg with an SD of 1.2 kg whereas the average infant weight at birth in the long stay cohort was 2.66 kg with an SD of 1.1 kg (see Table 1).

Table 2: Demographic Data

Variable	Short stay N=7	Long stay N=9	P value*
	n (%)	n (%)	
Mothers' Race			
Caucasian	3 (42.9%)	6 (66.7%)	
Black	1 (14.3%)	1 (11.1%)	
Hispanic	1 (14.3%)	1 (11.1%)	
Other/Missing	2 (28.6%)	1 (11.1%)	0.868
	Mean (SD)	Mean (SD)	
Infant Weight at birth (kg)	2.60 (1.2)	2.66 (1.1)	0.924
Length of Stay (days)	2.57 (1.1)	15.60 (7.5)	0.017

Notes: SD = Standard Deviation; * chi-squared test for categorical variable, two-sample t-test for continuous variables.

Bonding Scale and Emotion Score

Study participants rated emotion on a Likert scale where 0 corresponded to "not at all" and 3 corresponded to "very much". Emotions such as "Loving", "Protective" and "Joyful" were positively coded whereas emotions such as "Neutral or felt nothing", "Disappointment", "Resentful", "Aggressive" and "Dislike" were negatively coded. The emotions were then arranged in rank order (See Table 2). To compare the score for both cohorts, the mean scores from all participants were calculated, including the

"Emotion score" which is a cumulative item score from each individual emotion. Cumulative item scores were converted to a 100-point scale. After these calculations were completed, the emotion score average in the short stay cohort was 92.14 with an SD of 10.9 whereas the emotion score average in the long stay cohort was 93.92 with an SD of 6.6 (see Table 2). A chi-squared test for categorical variables and a sample t-test for continuous variables was run. For the emotion score, the test was not significant (p=0.713) due to the low n of this study (N=16).

Table 3: Bonding Scale and Emotion Score

Variable	Short stay N=7	Long stay N=9	P value*
	n (%)	n (%)	
Emotion			
Loving	7 (100.0%)	8 (88.9%)	1
Protective	6 (85.7%)	7 (77.8%)	1
Joyful	4 (57.1%)	5 (55.6%)	1
Neutral or felt nothing	1 (16.7%)	1 (11.1%)	1
Disappointment	1 (16.7%)	0 (0.0%)	1
Resentful	0 (0.0%)	1 (11.1%)	1
Aggressive	0 (0.0%)	1 (12.5%)	1
Dislike	2 (28.6%)	1 (12.5%)	0.569
	Mean (SD)	Mean (SD)	
Emotion score	92.14 (10.9)	93.92 (6.6)	0.713

Notes: SD = Standard Deviation; * chi-squared test for categorical variables, two-sample t-test for continuous variable.

Satisfaction Scores

Study participants rated their satisfaction levels on a Likert scale where 1 corresponded to "extremely dissatisfied" and 5 corresponded to "extremely satisfied". The survey included questions that measured satisfaction with care experience, care personnel, doctors, visiting conditions and hospital personnel (See Table 3). In order to compare the score for both cohorts, the mean scores from all participants were calculated across each field and were converted to a 100-point scale. The average satisfaction score associated with the care experience in the short stay cohort was 91.88 with an SD of 11.4 whereas the average satisfaction score associated with the care experience in the long stay cohort was 90.66 with an SD of 8.4 (see Table 3). A sample t-test for continuous variables was not significant (p=0.816), possibly due to

the low n of this study (N=16). The average satisfaction score associated with the care personnel in the short stay cohort was 91.79 with an SD of 12.0 whereas the average satisfaction score associated with the care personnel in the long stay cohort was 90.00 with an SD of 9.6 (see Table 3). A sample t-test for continuous variables was not significant (p=0.753), possibly due to the low n of this study (N=16). The average satisfaction score associated with doctors in the short stay cohort was 85.27 with an SD of 15.6 whereas the average satisfaction score associated with doctors in the long stay cohort was 95.09 with an SD of 9.5 (see Table 3). A sample t-test for continuous variables was not significant (p=0.186), possibly due to the low n of this study (N=16). The average satisfaction score associated with the visiting conditions in the short stay cohort was 85.71 with an SD of 15.2 whereas the average satisfaction score associated with the visiting conditions in the long stay cohort was 96.43 with an SD of 6.1 (see Table 3). A sample t-test for continuous variables was not significant (p=0.122), possibly due to the low n of this study (N=16). The average satisfaction score associated with the hospital personnel in the short stay cohort was 73.21 with an SD of 14.8 whereas the average satisfaction score associated with the hospital personnel in the long stay cohort was 73.44 with an SD of 11.9 (see Table 3). A sample t-test for continuous variables was not significant (p=0.975), possibly due to the low n of this study (N=16).

Parental Stress Scale and Relationship Scores

Study participants rated emotion on a Likert scale where 0 corresponded to “not applicable” and 5 corresponded to “extremely stressful”. The survey included questions that measured stress with parental role, the sights and sounds in the NICU, and the infant’s appearance and appearance (See Table 3). All fields were negatively coded. In order to compare the score for both cohorts, the mean scores from all participants were calculated across each field and were converted to a 100-point scale to reflect the “relationship scores”. The average relationship score associated with the parental role in the short stay cohort was 55.90 with an SD of 30.4 whereas the average relationship score associated with the parental role in the long stay cohort was

71.67 with an SD of 14.3 (see Table 3). A sample t-test for continuous variables was not significant (p=0.294), possibly due to the low n of this study (N=16). The average relationship score associated with the infant environment and appearance in the short stay cohort was 71.28 with an SD of 20.5 whereas the average relationship score associated with the infant environment and appearance in the long stay cohort was 78.76 with an SD of 15.1 (see Table 3). A sample t-test for continuous variables was not significant (p=0.453), possibly due to the low n of this study (N=16). The average relationship score associated with the sights and sounds in the short stay cohort was 76.05 with an SD of 20.5 whereas the average relationship score associated with the sights and sounds in the long stay cohort was 80.95 with an SD of 28.9 (see Table 3). A sample t-test for continuous variables was not significant (p=0.721), possibly due to the low n of this study (N=16).

Table 4: Parental Stress Scale and Relationship Scores

Variable	Short stay N=7	Long stay N=9	P value*
	Mean (SD)	Mean (SD)	
Satisfaction scores			
Care experience	91.88 (11.4)	90.66 (8.4)	0.816
Care personnel	91.79 (12.0)	90.00 (9.6)	0.753
Doctors	85.27 (15.6)	95.09 (9.5)	0.186
Visiting conditions	85.71 (15.2)	96.43 (6.1)	0.122
Hospital personnel	73.21 (14.8)	73.44 (11.9)	0.975
Relationship scores			
Parental role	55.90 (30.4)	71.67 (14.3)	0.294
Infant environment and appearance	71.28 (20.5)	78.76 (15.1)	0.453
Sights and sounds	76.05 (20.5)	80.95 (28.9)	0.721

Notes: SD = Standard Deviation; * two-sample t-test for continuous variables.

Breastfeeding Support

Study participants indicated their level of engagement with breastfeeding information and support as “have used”, “planned to use” and “not applicable”. The survey included questions that measured level of engagement for breastfeeding support with doctors or physician assistants; nurses, midwives, or nurse practitioners; nutritionist or dietitians; lactation consultants; breastfeeding classes; special supplemental nutrition

program for women, infants, and children (WIC food program); friends; family members; breastfeeding support groups; telephone support helplines; newspapers or magazines; website; books or videos; mobile app; and other sources (See Table 4). A chi-squared test for categorical variables was run and the test was not significant (p=0.462, 1, 1, 0.38, 1, 1, 1, 0.79, 1, 0.65, 0.217, 0.559, 1, 0.559) for any of the breastfeeding support and information sources due to the low n of this study (N=16).

Table 5: Breastfeeding Support

Variable	Short stay N=7	Long stay N=9	P value*
	n (%)	n (%)	
Breastfeeding support			
Doctor or Physician Assistant	5 (71.4%)	7 (100.0%)	0.462
Nurse, nurse midwife, or nurse practitioner	6 (85.7%)	7 (100.0%)	1
Nutritionist or dietitian	2 (28.6%)	2 (28.6%)	1
Lactation consultant	6 (85.7%)	7 (100.0%)	1
Breastfeeding classes	2 (28.6%)	5 (71.4%)	0.388
WIC food program	3 (42.9%)	3 (42.9%)	1
Friends	4 (57.1%)	5 (71.4%)	1
Family members	5 (71.4%)	5 (71.4%)	1
Breastfeeding support group	2 (28.6%)	4 (57.1%)	0.79
Telephone support helpline	2 (28.6%)	2 (28.6%)	1
Newspapers or magazines	3 (42.9%)	2 (28.6%)	0.65
Websites	5 (71.4%)	5 (71.4%)	0.217
Books or videos	4 (57.1%)	5 (71.4%)	0.559
Mobile app	3 (42.9%)	3 (42.9%)	1
Other	1 (14.3%)	3 (42.9%)	0.559

Notes: * chi-squared test for categorical variables.

Qualitative Interview

Thematic Analysis

This section will report on the thematic analysis and the open-ended questions in the follow-up qualitative interview (see Appendix D). The interview transcripts and audio files were analyzed in Otter.ai to identify facts, themes, commonalities, and outliers

across the interviews. Word clouds were generated for the questions in Otter.ai based on the most frequently used words and phrases (see Appendix J). Results from this analysis grouped themes that approximately followed the structure of the interview questions.

Twenty-five codes were used for analysis (see Table 5). When responses to *"How do you think having a separate neonatal intensive care unit for your infant would impact your neonatal experience"* were analyzed, the most frequently coded response was "More time" (16) followed by "Private room" (12). This question yielded 78 total responses involving 14/25 codes. When the content of these responses was analyzed, two major themes emerged: 1) Having more time to bond with the baby and 2) having privacy to breastfeed the baby. Although "baby" was a code used throughout the survey, respondents explicitly highlighted their ability to "bond with their baby" in the couplet care room compared to a separate neonatal intensive care unit. One survey participant remarked, "Being separated would have been miserable. I don't know how mothers do it. Being with my twins made the experience feel more normal. Having them in the room with me took away a little bit of what I suppose would have been trauma having a preterm baby that that needed medical care. I don't even want to imagine being separated. I mean, my stress levels would have been through the roof because even if you know you can't sit there and hold your babies all day long, but you know I was able to watch over them. I sort of had a normal life in there even though I was stressed because they came early. I had to wrap up some work projects so like I was doing zoom calls with like all the NICU equipment in the background, but I could get up, walk around and everything I needed to function was within a 10-step radius of me. I could be pumping and look over and see them. I had everything I needed in that room, which is why I never I never left the NICU until the end. If we were in different places, I don't know if I would be able to breastfeed them. I'd be so stressed out that my milk didn't increase that I'd have to use formula. I have no idea what the outcome would have been. I don't really want to think about what the outcome would have been."

Table 6: Code Frequencies to open-ended questions in follow-up interview

Code	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Total
Baby	12	13	10	13	7	4	8	9	76
More time	0	0	3	0	7	12	16	14	52
Private room	0	0	3	6	0	13	12	11	45
NICU	1	2	1	5	6	3	6	15	39
Skin-to-skin	0	0	3	6	8	2	8	11	38
Daylight	0	4	2	13	3	9	7	0	38
Hospital	3	1	5	3	7	10	4	1	34
Nurse	0	3	1	5	3	7	5	6	30
Experience	4	5	3	7	1	2	6	0	28
Space	2	1	4	6	0	2	1	0	16
Mother	1	2	3	2	1	2	1	2	14
Bed	0	1	4	6	1	1	0	0	13
Chair	0	1	3	0	2	4	0	0	10
C-section	6	0	0	2	0	0	1	1	10
Couch	0	1	3	0	0	5	0	0	9
Tube	0	0	0	0	1	0	2	6	9
Feeding	0	0	0	0	0	0	1	7	8
Ronald McDonald House	0	0	0	0	0	6	0	0	6
First time	0	0	0	0	0	2	0	4	6
Wires	0	0	0	0	5	0	0	1	6
Lactation Consultants	0	0	0	0	0	0	0	5	5
Bonding	0	0	4	0	0	0	0	1	5
Special moment	0	0	4	0	0	0	0	0	4
Storage space	0	0	0	0	0	3	0	0	3
La leche league (lactation support group)	0	0	0	0	1	0	0	2	3

Notes: Q1. What is your connection to couplet care?
Q2. In your experience, what is missing for new mothers?
Q3. Where do you think mothers' bond with their newborn infants?
Q4. How do you think being able to be in the same room with your infant post-partum has changed the patient experience?

Q5. What would you change if you were trying to improve feelings of early bonding between mothers and their infants with respect to the physical environment or technology?
Q6. Would you prefer to have a room that would allow a family member to stay the night?
Q7. How do you think having a separate neonatal intensive care unit for your infant would impact your neonatal experience?
Q8. What were some of your fears regarding breastfeeding and skin-to-skin care post-delivery?

When responses to *"Would you prefer to have a room that would allow a family member to stay the night?"* were analyzed, the most frequently coded response was "Private Room" (13) followed by "More Time" (12). This question yielded 87 total responses involving 17/25 codes. When the content of these responses was analyzed, two major themes emerged: 1) Having more time to rest and 2) having privacy to have conversations with a partner or family member. Although "baby" was a code used throughout the survey, respondents explicitly highlighted their ability to "have a partner or family member bond with their baby while they rested". However, family members that were considered were adults, and the participant's other children. One survey participant remarked, "I think the hardest thing was that my two-year-old couldn't be there, but even if it were convenient, I don't think I would have had him there because I think the whole NICU environment is just a little too much for a two-year-old to have but I would I personally prefer more space, especially for my partner."

Many answers to this question included patients' family's inability to stay overnight due to COVID-19 protocol and its associated restrictions. One participant commented that, "This hospital had a Ronald McDonald House, so we have a room there as well. My husband stays there which is fine, but you know he still has to come over and it's a long walk. It would be nice if he could stay here with me. COVID doesn't really allow others in the NICU right now, but it would be nice if others like my daughter come visit, that she would have somewhere to stay too."

For the question, *"What were some of your fears regarding breastfeeding and skin-to-skin care post-delivery?"* the most frequently coded responses was "NICU" (15) followed by "More Time" (14), "Private Room" (11) and "Skin-to-skin" (11). This question yielded 96 total responses involving 16/25 codes. The content of these responses was analyzed, two major themes emerged: 1) Fear of being unable to breastfeed in the NICU and 2) Not having enough skin-to-skin time while breastfeeding. One participant remarked, "I didn't really have any fears for the skin-to-skin, because I did it quite a bit with my first daughter and I really love it, especially having snuggle time with the baby. I know that there's a lot of good benefits for the baby as well breastfeeding. I had a pretty bad experience trying to breastfeed my daughter as she never latched, and it was quite stressful. So, going into this one my husband and I had both decided not to stress if the breastfeeding wasn't going to work like we did with our first child. But he's done so much better latching and feeding than my daughter ever did. I think, for me the breastfeeding was like a little apprehension because I had such a stressful experience in the past. But this one's been a much more successful and an enjoyable experience because he's latching this feeding, you know he still needs to increase the amount he's getting but he's able to do it, so I definitely am more confident this time that we will get to where we need to be."

For the question, *"What would you change if you were trying to improve feelings of early bonding between mothers and their infants with respect to the physical environment or technology?"*, the most frequently coded responses was "Skin-to-skin" (8) followed by "More Time" (7). This question yielded 53 total responses involving 14/25 codes. The content of these responses was analyzed, two major themes emerged: 1) Having appropriate furniture that will allow skin-to-skin and 2) Having more time to bond with the baby. One participant remarked, "I don't like the rocking chair that they have in our room because it is hard to get in and out and put the footstool up when I'm by myself it or if I'm holding my baby. I think maybe a pull-out couch in the hospital is comfortable but because these rooms are designed to be for the mother to like to stay longer term with the NICU baby. My only suggestion is to have a little bit more thought into the furniture even though I know it needs to be able to be

disinfected and cleaned. While picking the furniture, they could pick more comfortable and easier to use pieces, so it doesn't feel like a hospital but more like a nursery, an apartment or wherever you want to stay. That's one of the things I think would make the bonding experience a little bit better."

Many answers to the question "In your experience, what is missing for new mothers?" included patients and families' own ability to be outdoors, especially on the rooftop garden away from the bedside. One respondent commented that, "Every day until me leaving the hospital. I had my partner who would encourage me to go outside. For me, that was where I could breathe. The day that I was about to have a meltdown because everybody was coming in and out of my room when my baby and I were asleep, I knew that no one would bother me out there in the garden. No one ever bothered me out there, I would just like go get a cup of tea and that seemed to be the place where I processed emotions because I felt like I couldn't process my emotions in my room since I wasn't sure who would be coming in. So, I would like to go out on the garden and that's where I would just have a quiet moment. My partner and I would often eat our dinner out there. Even though the garden was attached to the hospital, it was separate enough that it psychologically created some sort of a space. That was also such a special place for me because that's where we would have our private couple conversations out there because we never saw anybody else out there and we felt like we wouldn't be interrupted by the nurse. I will admit that it was where I would go if I needed to cry privately. So yes, we went out there all the time."

A care team member brought up needing space from families or feeling that the rooftop garden was a space for patients and families. In response to why they use the other outdoor spaces, one staff member commented that the other spaces were, "Definitely easier to get to, more social and feels less invasive of patient space. I need to reflect and decompress. It is very helpful for staff to have a place for staff in the rooftop garden as well. As it is increasingly busy and the acuity higher. A private space where we can reflect is important to our mental health." For all survey results, see Appendix J.

Site Visits

Yale New Haven Hospital

The first NICU in the United States was built at Yale New Haven Hospital in 1960 and continuing in a long-standing history of innovation in patient and family-centered care, YNHCH opened a new, 68-bed state-of-the-art NICU in January 2018, the largest NICU in Connecticut (Bizzarro et al., 2005). Spanning the entirety of 2 floors in YNHCH, the NICU is comprised mostly of single patient rooms as well as 8 couplet rooms, making YNHCH the first academic medical center to offer simultaneous care of post-partum women and their newborns requiring intensive care within the same room. This unique model brings to the NICU the same standard of care provided to healthy newborns by fostering skin-to-skin contact and supporting breastfeeding. Applying the latest developments and best practices in neonatology, the NICU at YNHH was designed to support family-centered care, enhance outcomes and advance research in neonatology.

The NICU also contains a 24-hour pharmacy, a procedure room, a milk room which stores and dispenses breast milk and infant formulas to the bedside, a simulation and education room for staff and community providers, and a neonatal MRI. Each NICU room allows the ability care for the most complex of medical and surgical conditions but offers privacy and the ability for families to remain at their newborn's bedside and to be involved in their care throughout the NICU stay. The NICU located on two floors namely Level 10 & 11 of the Children's Hospital, provides inpatient intensive care, consultative support, and neonatal transport services for critically ill newborns in Connecticut and beyond. The NICU is organized into pods, which the staff have reported as confusing to distinguish between during rotations (see Appendix D).

Figure 5: Yale New Haven Hospital (2020). Couplet Care Room [Photograph]. https://www.ynhh.org/childrens-hospital/services/neonatal-care/nicu

Some of the key spatial features; operational policies and technological interventions of the unit are listed below.

Vertical Departmental Planning.

The Pediatric Intensive Care Unit (PICU) is located on Level 3. There is an overlap when infants with cardiovascular conditions are transferred to the NICU and then transferred to the PICU. Cesarean (C-sections) are performed on Level 4 after which mothers are transferred to the post-partum unit on Level 8.

Figure 6: Yale New Haven Hospital (2020). Corridor [Photograph]. https://www.ynhh.org/childrens-hospital/services/neonatal-care/nicu

Figure 7: Yale New Haven Hospital (2020). NICU Pod [Photograph]. https://www.ynhh.org/childrens-hospital/services/neonatal-care/nicu

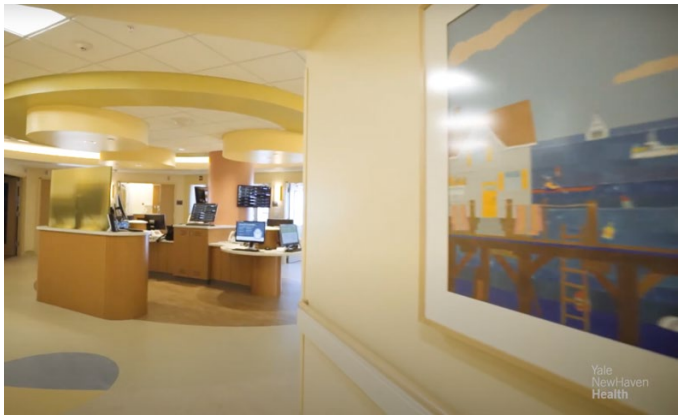


Figure 8: Yale New Haven Hospital (2020). NICU Pod [Photograph]. https://www.ynhh.org/childrens-hospital/services/neonatal-care/nicu

Couplet Care Room

The couplet care room consists of a reclining chair for family, a convertible sofa that converts to table or overnight bed for the overnight guest, closet space, an adult-sized, handicap accessible bathroom, a breast pump, a milk warmer, a TV, and windows with views to Yale School of Medicine, the New Haven harbor and occasionally into the atrium. A NICU Flex Room is located on Level 10 which can accommodate three newborns in each unit on the condition that 1 RN is staffed in the room.

Figure 9: Yale New Haven Hospital (2020). Couplet Care Room [Photograph]. https://www.ynhh.org/childrens-hospital/services/neonatal-care/nicu

Figure 10: Yale New Haven Hospital (2020). Couplet Care Room [Photograph]. https://www.ynhh.org/childrens-hospital/services/neonatal-care/nicu

Figure 11: Yale New Haven Hospital (2020). Isolette in the Couplet Care Room [Photograph]. https://www.ynhh.org/childrens-hospital/services/neonatal-care/nicu

Figure 12: Yale New Haven Hospital (2020). Proximity between the patient bed and the isolette in the Couplet Care Room [Photograph]. https://www.ynhh.org/childrens-hospital/services/neonatal-care/nicu

Figure 13: Yale New Haven Hospital (2020). Patient Headwall [Photograph]. https://www.ynhh.org/childrens-hospital/services/neonatal-care/nicu

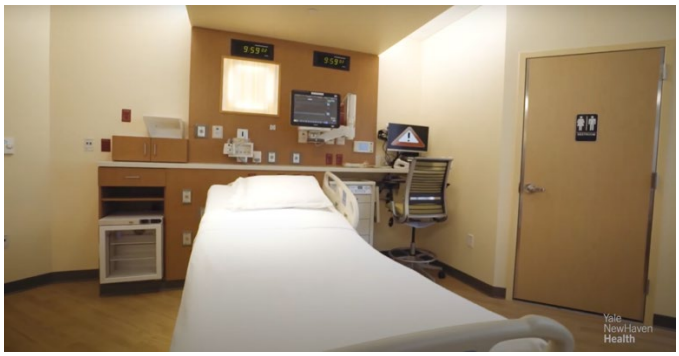


Figure 14: Yale New Haven Hospital (2020). Views from the Couplet Care Room [Photograph]. https://www.ynhh.org/childrens-hospital/services/neonatal-care/nicu

Alicia's Angels Room

Alicia's Angels room is a special room for babies who are taken off medical support (terminal infants). It is designed to feel like a room at home with a couch, a Murphy bed for parents and baby to sleep together and have some moments together. It offers an opportunity for parents to get closure after the departure of their terminal infant. It also offers a dignified death for infants while being surrounded by family.

Family Amenities

All the patient rooms are single occupancy, offering families privacy and a therapeutic environment to promote healing and developmental growth. Family resources include family lounges that offer respite, a laundry facility for overnight guests, and a milk room. During the COVID-19 outbreak, to keep staffing low in high-traffic areas, there was limited access to the Family Lounge Space. Other options for respite include Caroline's Room for family privacy, a waiting room which has chairs that convert into beds and a healing garden located in the adjacent pavilion. Post discharge, families can opt to stay at hotels close by, return home if they live close by or avail short-term or long-term accommodation directly across the street at the Ronald McDonald House.

Figure 15: Yale New Haven Hospital (2020). Caroline's Room for Respite [Photograph]. https://www.ynhh.org/childrens-hospital/services/neonatal-care/nicu

Figure 16: Yale New Haven Hospital (2020). Family Lounge with Amenities [Photograph]. https://www.ynhh.org/childrens-hospital/services/neonatal-care/nicu

Figure 17: Yale New Haven Hospital (2020). Family Lounge with Amenities [Photograph]. https://www.ynhh.org/childrens-hospital/services/neonatal-care/nicu

Procedure Room

The NICU features a procedure room where a full range of care can be provided, from inserting a central line to performing surgeries to initiate extracorporeal membrane oxygenation (ECMO). The availability of the procedure room avoids the need to transport critically ill infants off the unit for these interventions.

Neonatal MRI

The specially designed neonatal MRI machine is one of only two in the nation; and one of only three in the world. Prior to the new neonatal MRI room being operational, the unit used the MRI on the Level 2 and 3 which was associated with longer transfer

time. The new MRI is tailored to serve the smallest newborn patients and is centrally located within the NICU. Consequently, the newborns who require this service do not have to travel far if a scan is needed. It also provides faster and safer imaging to help neonatologists and neurologists better detect and manage brain issues in premature infants. The cutting-edge technology opens new opportunities for caring for critically ill newborns with early interventions and helps advance important clinical research. Currently, the unit shares technical staff with the main MRI unit. The unit head sets up neonatal MRI timings with the technicians around noon on weekdays and has significantly reduced the transfer times for the newborns requiring this service.

Operational Policies

The nursing ratio is two-to-three newborns per one RN. The Obstetric (OB) nurse is present when mom is in the CCU with the nursing ratio of 3 mothers to 1 OB RN. The occupancy rate of the unit in 2020 was 64-68 newborns and was 54 newborns in 2021. The unit staff strive to maintain the census at 50 newborns at any given time to facilitate couplet care. The average length of stay in CCU for mothers is 2-4 days depending on vaginal/C-section, which can extend to 3-4 days depending on the OB/GYN team. Newborns stay on for longer depending on the acuity level. The operational policy is to discharge both the mother and the infant together. The overnight policy for the CCU is that a partner, family member or support personnel can stay overnight. There were significant amendments to the overnight policy during the COVID-19 pandemic, limiting one parent to the unit at a given time. During this period, some mothers chose not to stay in the CCU, since there were limitations to visitation usually if they had another older child (Appendix D). During the seasonal flu season, the only visitation limitation was for children (siblings) who were not vaccinated against the flu.

Ancillary Services and Patient Education

With an onsite pharmacy available round-the-clock, there are pharmacists available to address critical situations and rapidly fill urgent medications. Additionally, clinicians

expressed the need to have proximity to the radiology department; lactation and nutrition services; occupational and speech therapy services; and music therapy services. For lactation support- Levels 4 and 8 rely on perinatal lactation consultants and the NICU relies on post-partum lactation consultants. During patient occupancy surges or staffing shortages, there is an overlap between perinatal and postnatal lactation consultants. Skin-to-skin is the most popular intervention encouraged by nurses and lactation consultants. For parent education during discharge, classes are set up and scheduled through the week. CPR training is the most important component of the patient education series. These are general classes that are not organized according to cohorts depending on patient acuity.

Figure 18: Yale New Haven Hospital (2020). Pharmacy [Photograph]. https://www.ynhh.org/childrens-hospital/services/neonatal-care/nicu

Figure 19: Yale New Haven Hospital (2020). Milk Room, Lactation and Nutrition Services [Photograph]. https://www.ynhh.org/childrens-hospital/services/neonatal-care/nicu

Technological Interventions

A new technology system enables data and alarms captured from bedside equipment and transmits instantaneously to the neonatal team's smartphones, providing the medical team with immediate access to critical information. During the COVID-19 pandemic and the associated restrictions on visitation, a dedicated staff member facilitated Facetime sessions with extended family members, thereby providing the mother-infant dyad access to an extended social support system through technology.

Figure 20: Yale New Haven Hospital (2020). Data capture at bedside [Photograph]. https://www.ynhh.org/childrens-hospital/services/neonatal-care/nicu

Memorial Hospital

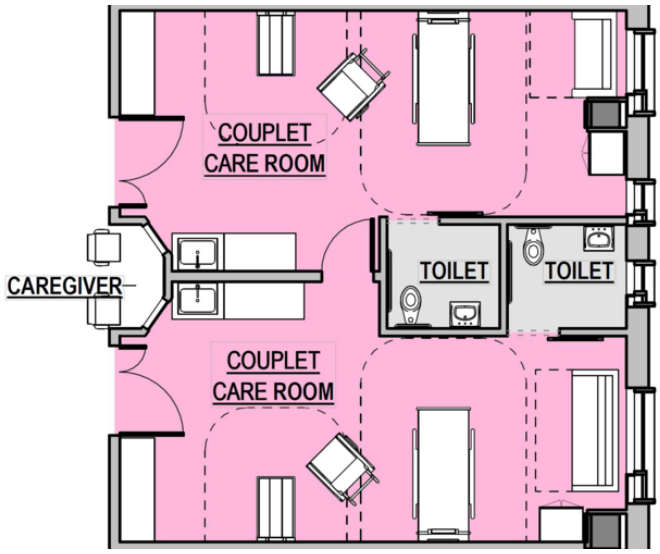
Memorial Hospital is part of Beacon Children's Hospital in South Bend, Indiana. Realized in the third attempt at building the Children's Hospital, the 36-bed unit is the referral center for North Central Indiana and a portion of Southwestern Michigan. Each year, the NICU cares for 400 newborns born at Memorial or transported from other regional hospitals by our NICU's transport team. The NICU is located next to the Memorial Special Care Obstetrics Unit to facilitate rapid response if an emergency arises during childbirth. Operational since May 2017, the NICU is Level III offers an advanced level of care for babies born prematurely as well as babies born with a critical illness. The NICU at Beacon Children's Hospital features enhanced single-family rooms (SFR) and couplet care rooms (CCR), two new room designs that expand clinical functionality and family accommodation in the NICU. The development was spearheaded by a multi-disciplinary team consisting of the Departmental Head, the Nursing Director, the Unit Manager, Nursing team, and

Environmental Services. Previously, some mildly ill or premature babies were taken to the mother's postpartum room, but most babies were not eligible due to the severity of their illness. Both types of rooms in the new NICU are designed to accommodate mothers who are still patients immediately after birth. This facilitates early bonding between mother and child, which historically has been limited during the first few days of a NICU baby's life.

Building on a body of the latest research showing that premature infants benefit from close physical contact with their parents, Dr. Robert White, and his NICU team were strong proponents of developing a NICU that supports couplet care by providing private patient rooms that enable families to stay with infants for weeks or even months. Nine extended family rooms accommodate a variety of scenarios that require more space: couplet care; kangaroo care, a method of neonatal care that involves skin-to-skin contact between mother and child; twins /multiple births; hospice care; and super-critical babies.

Using the Lean Design methodology, hospital staff and ZGF architects gathered evidence and tested clinical simulation scenarios to maximize the efficiency of the space. The Lean methodology considers people, products and processes (3P method). It is a participative approach that generates a collective design by including inputs from a wide range of stakeholders and involves them in decision making relating to potential designs (Hicks et al., 2015). Input from patients and families resulted in a range of design solutions, including customizable LED lighting in rooms, which can be adjusted to white, pink, blue, red, yellow, or green hues; a cave-like haven for teen patients; and a bright color scheme throughout the hospital. Evidence-based design also played a key part in the hospital's creation; daylight and themes of plants and nature, which improve health outcomes for patients and reduce stress for families and staff, are incorporated throughout the space.

Figure 21: Halkin Mason Photography (2020). Couplet Care Room Floor Plan [Photograph]. https://www.tradelineinc.com/reports/2018-10/reimagining-nicu-support-couplet-and-family-care-beacon-childrens-hospital



Implementation

Experience gained during limited couplet care in the old NICU was extremely valuable in obtaining buy-in from obstetricians, postpartum nurses, administration, and nursing staff, all of whom saw first-hand how beneficial couplet care is for families. While the CCR enhances patient outcomes and the patient family experience, the novel design also impacts the training and assignments of nurses, to achieve the model of care supported by this room design.

Some of the key spatial features; operational policies and technological interventions of the unit are listed below.

Vertical Departmental Planning

The overarching theme was to locate all childcare services in one floor. The Emergency Department (ED) is located on Level 2. The Labor and Delivery unit is located on Level 3 with a dedicated elevator to the CCU located on Level 6 in the same building, making patient transfers post-delivery seamless through a vertical corridor. The Pediatrics, Oncology and Hematology departments are located on Level

4. General Pediatrics is located on Level 5 and the NICU is located on Level 6. The NICU is a locked unit only accessible by badge. Standard warmers are located on Level 3 and 6; along with the option for flexible incubators which are also available.

Figure 22: Halkin Mason Photography (2020). Corridor overlooking atrium [Photograph]. https://www.zgf.com/work/603-beacon-health-system-beacon-children-s-hospital-expansion

Figure 23: Halkin Mason Photography (2020). Unit welcome area [Photograph]. https://www.zgf.com/work/603-beacon-health-system-beacon-children-s-hospital-expansion

Single-Family Rooms

The new SFRs at Beacon Children's have elements that promote improved sensory development for the baby and family participation in care, including a family area with a toilet room and shower within each room. The patient begins their journey in

the Labor & Delivery unit where they spend 2-3 hours post-partum. They are then transferred to either the Single-Family Room or the Couplet Care Room where they are reunited with their newborn. A sliding frosted glass door separates the family area from the rest of the room, providing privacy and quiet at night.

Every NICU room has a window to provide a sense of normalcy by connecting to daily cycles of light. Because views of nature can also reduce stress and provide positive distraction for parents who may be distraught or depressed, an innovative feature of the Beacon Children's NICU is an interior courtyard visible from the rooms.

All lighting in the room is dimmable for families to control the light levels. No lights are located directly over the baby's bed, so there is no chance of direct light shining into the baby's eyes. The procedure light is instead mounted on an adjustable arm. Colored LEDs at the footwall wash the wall with color to personalize the room. The color can easily be changed to vary the experience in the room and to suit the mood from day to day. Wall sconces in the family area provide a soft level of light for reading or conversation.

Couplet Care Rooms

Couplet care rooms (CCRs) are modeled after those in Sweden's University Hospital of Karolinska, where the rooms accommodate the entire family unit. The CCR has many of the same features of the SFR but with a second headwall for the mother's bed, including the code-required clearances around the bed. The CCR consists of a family space with a couch that converts into a bed, a refrigerator space, closet space, sibling space and a handicap accessible ensuite bathroom. Beacon Children's Hospital has expanded the functionality of the CCR to accommodate multiple babies, group care, and other care scenarios, giving the NICU increased flexibility. When a CCR is paired with an SFR or another CCR, it can accommodate a mother with twins or higher-order multiples. A door in the sidewall provides easy access between the rooms. Each headwall can serve one critical baby or two intermediate babies. Kangaroo chairs allow both parents to provide skin-to-skin care for their babies together.

While the SFR provides an ideal environment for families, it can become an isolation room for babies whose families rarely visit. In those instances, the larger rooms support group care by providing roommates for babies, which facilitates more frequent interactions with nursing staff.

The additional space in the CCR also accommodates “super-critical” babies who need much more equipment and larger teams to provide specialized care. The CCR’s larger size provides the space needed to perform procedures if an infant requires surgery.

Figure 24: Halkin Mason Photography (2020). Couplet Care Room Interior [Photograph]. https://www.zgf.com/work/603-beacon-health-system-beacon-children-s-hospital-expansion

Figure 25: Halkin Mason Photography (2020). Couplet Care Room Interior [Photograph]. https://www.zgf.com/work/603-beacon-health-system-beacon-children-s-hospital-expansion

Hospice Care

Families need space and privacy to be with their baby during hospice care. When groups of family members come to spend time with the baby, and a pair of connected CCRs provides the additional accommodation needed to support the family.

Family Amenities

The two-story atrium, lit by green “firefly” lights, maximizes daylight to all patient rooms and provides an outdoor-like space sheltered from South Bend’s harsh winters. Other amenities include a rooftop terrace, playrooms, family lounges with coffee machines, staff lounges and napping rooms, and an education/ resource room. The play space, atrium spaces, and rooftop garden are located near the pediatric unit. The atrium space is decorated through sponsors during events and holidays and is used as a pediatric space during the remaining parts of the year. Views into the atrium and externally provides positive distraction to the patients in the unit. The Rooftop terraces separated by a wrought iron divider is used by both patients and staff. It includes a Ribbon tree which memorializes lost babies. Post discharge, families can opt to stay at hotels close by, return home if they stay close by or avail short-term or long-term accommodation at the Ronald McDonald House.

Figure 26: Halkin Mason Photography (2020). Atrium [Photograph]. https://www.zgf.com/work/603-beacon-health-system-beacon-children-s-hospital-expansion

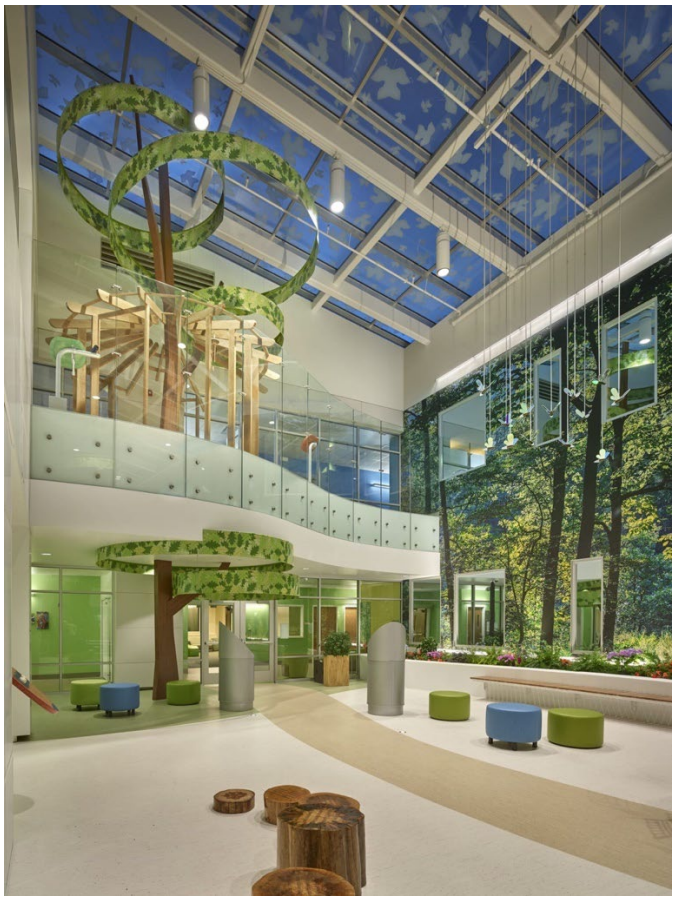


Figure 27: Halkin Mason Photography (2020). Atrium [Photograph]. https://www.zgf.com/work/603-beacon-health-system-beacon-children-s-hospital-expansion

Figure 28: Halkin Mason Photography (2020). Atrium- Sibling Space [Photograph]. https://www.zgf.com/work/603-beacon-health-system-beacon-children-s-hospital-expansion

Figure 29: Halkin Mason Photography (2020). Atrium [Photograph]. https://www.zgf.com/work/603-beacon-health-system-beacon-children-s-hospital-expansion

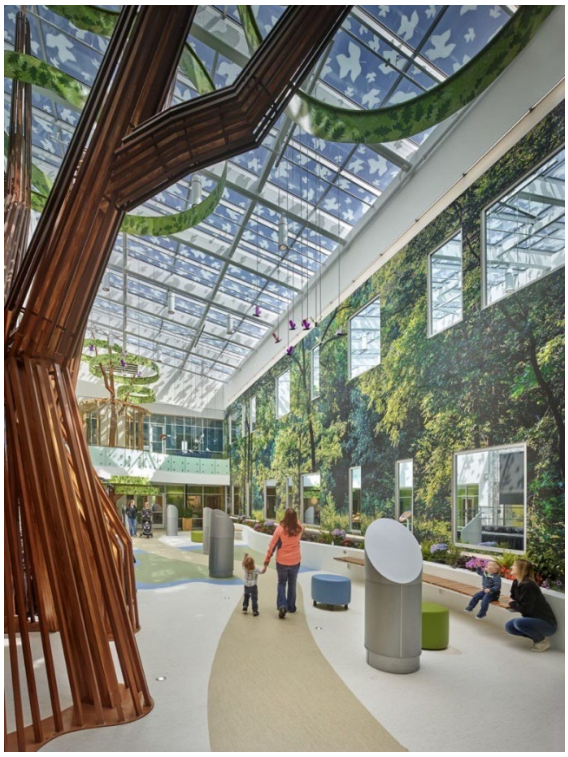


Figure 30: Halkin Mason Photography (2020). Atrium [Photograph]. https://www.zgf.com/work/603-beacon-health-system-beacon-children-s-hospital-expansion

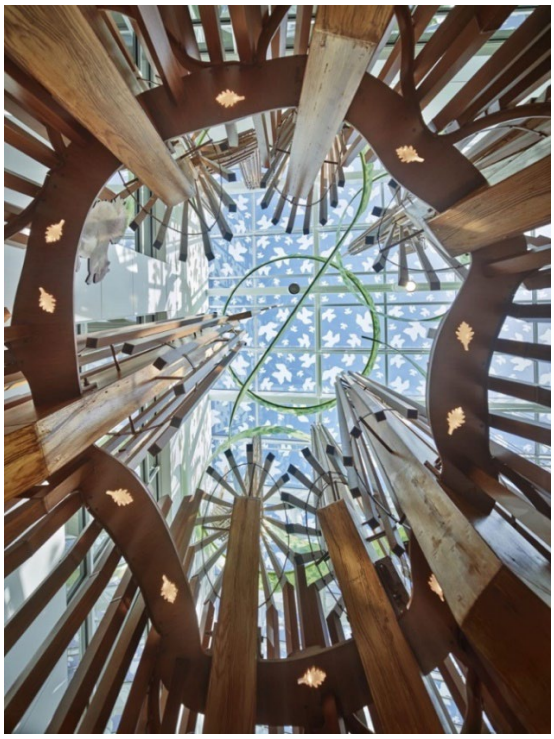
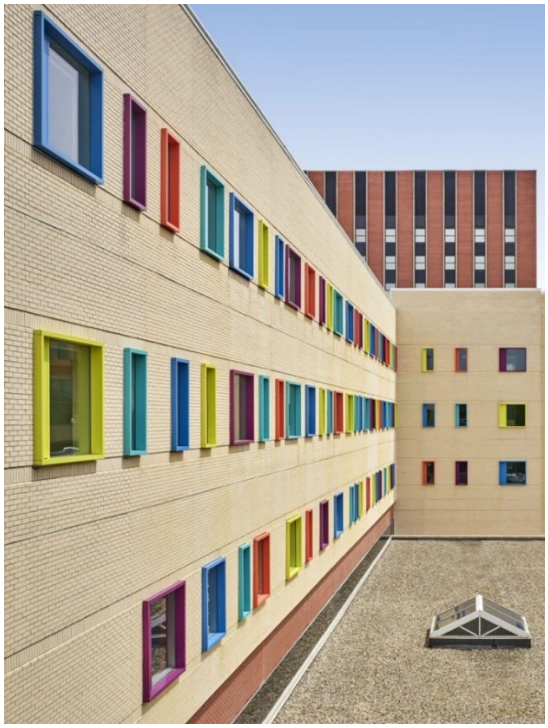


Figure 31: Halkin Mason Photography (2020). External Façade, Beacon Children's Hospital [Photograph]. https://www.zgf.com/work/603-beacon-health-system-beacon-children-s-hospital-expansion



Staff Amenities

The unit includes a staff lounge for all staff with a pump room for nurses and a Zen room with massage chair. The staff indicated that they use the rooftop terrace garden (Appendix D). Most notably, the staff indicated that they take care of certain sections of the rooftop garden and have a dedicated area with memorialized plants for deceased physicians and nurses from the unit.

Stabilization Unit

The current unit is a departure from the old unit, which is connected to the new unit and is still being utilized as a stabilization space. The stabilization room is directly connected to the C-section rooms. The old unit has eight rooms in total with 12 beds in each room with one room being used as a step-down unit. It has been designed to support two caregivers at each bedside. Future renovation plans for include repurposing the old unit to a dedicated pharmacy.

Operational Policies

A core group of nurses in the NICU are trained to provide care for both postpartum mothers and NICU babies up to an intermediate care level. Nurses who provide couplet care in the NICU complete both postpartum and NICU skills validations on an annual basis, which was not required with the more traditional NICU design. A new scope of service was established for postpartum mothers cared for in the CCUs. In an ideal situation, the mother and baby are cared for as a couplet assignment, but they may have separate nurses when the medical needs of the baby are more critical. The nursing ratio is 4 newborns to 1 RN. The occupancy rate of the unit is 25-26 newborns and 2-3 mothers at a time. The unit staff strive to maintain the census at 25 newborns to facilitate couplet care. The average length of stay in CCU for mothers is 2-4 days depending on vaginal/C-section, which can extend to 3-4 days depending on the OB/GYN team. Newborns stay on for longer depending on the acuity level. The

operational policy is to discharge both the mother and the infant together. The overnight policy for the CCU is that a partner, family member or support personnel can stay overnight. There were significant amendments to the overnight policy during the COVID-19 pandemic, limiting one parent to the unit at a given time. During this period, some mothers chose not to stay in the CCU, since there were limitations to visitation usually if they had another older child (Appendix D). During the seasonal flu season, the only visitation limitation was for kids (siblings) who were not vaccinated against the flu. After being in the new space, the staff found that some parents began to treat their room like a hotel and were declining room service for the day. For infection control purposes, Beacon Children's staff inform parents that they need to be awake and have the parent space in the room picked up and ready for housekeeping by 9 a.m. each day. Setting this expectation on admission and explaining that this is to help prevent an infection for their baby, has been very effective. Beacon Children's Hospital has also changed its policy to allow food in all rooms on the unit, while setting the expectation for cleanliness to prevent the risk of infection.

Table 7: NICU Activity Based Staffing Matrix Guidelines

1:1	2:1	3:1	4:1
Unstable High frequency jet ventilation (HFJV) therapy	Ventilated infants	Tracheostomy	Minimal oxygen or flow
Unstabl with chest tubes	Stable HFJV	Stable vent & on full fogs (no IVs)	No IV fluids
Body cooling	Stable chest tube	Stable NCPAP/NIV and high flow	Routine support and teaching
Exchange transfusion	NCPAP/NIV	Colostomy	Rooming in
2-4 hours pre-op	Initial CFM	Ileostomy	
2-4 hours post-op	Monitor 12 hours	Feeding intolerance	
	Impending death	IV fluids	
		Reseal for blood or antibiotics	

Vital signs every 1 hour		Stable CFM Monitor Isolation	
A mom requiring 1:1 nursing care is not an appropriate patient for NCC	A mom requiring 1:1 nursing care is not an appropriate patient for NCC	Fresh post-op C-section, first 12 hours Receiving blood products Blood sugar check/receiving insulin Hypertension- off Mag, with stable blood pressure in 6 hours PCA pump/On Q Initial admission to floor Continued IV antibiotic therapy (beyond one dose time) Drug withdrawal symptoms exhibited	Vaginal delivery/C-section after 1st 12 hours Routine vitals Routine meds IV fluids/Meds Prevena wound vac Routine teaching Discharge
Infant requiring 1:1 nursing care is appropriate patient for couplet care	Baby requiring mechanical ventilation NCPAP/NIV Stable chest tube Stable HFJV	Oxygen/flow PIV NG/po feeds Baby care teaching Central line	Main nursery No IV access Bili baby No oxygen

	NAS baby	Dextrose checks	Q3 hour or greater assessments/feeds
	Baby admission	Isolette	No isolette
			Circumsion

Notes: Provided by staff during virtual site visit and interview

Ancillary Services and Patient Education

Skin-to-skin is the most popular intervention encouraged by nurses and lactation consultants. Families are encouraged to begin skin-to-skin as early as possible. Unit staff spread awareness on the benefits of early skin-to-skin interventions during National Kangaroo Care Day. Lactation consultants visit the unit and encourage mothers to nurse or pump as early as possible.

Figure 32: Halkin Mason Photography (2020). Lactation support [Photograph]. https://www.zgf.com/work/603-beacon-health-system-beacon-children-s-hospital-expansion

Figure 33: Halkin Mason Photography (2020). Music Lessons for the siblings [Photograph]. https://www.zgf.com/work/603-beacon-health-system-beacon-children-s-hospital-expansion

Technological Interventions

During the COVID-19 pandemic and the associated restrictions on visitation, Angel Eye, a dedicated livestream service for extended family members grew in popularity. This provided the mother-infant dyad access to an extended social support system through technology.

Chapter 4

DISCUSSION

Perceptions about the Couplet Care Environment

The period immediately prior to discharge was chosen to assess the perception of the care received. Participants showed high satisfaction with care at the immediate postpartum measurement. It has been suggested that satisfaction at this time is influenced by a "halo effect" where the mother is relieved that both the mother and the baby have come through the experience safely (Hanvey 1988). Research suggests that for most postpartum women, the bulk of the work of processing and integrating the birth experience occurs during the first two weeks postpartum (Harvey et al., 2002).

From the qualitative interviews, built environment characteristics at both room and unit levels emerged as factors impacting family engagement behavioral outcomes. The unit's layout was arranged, so that family support spaces were close to the family entrance and the meeting room, which staff and family perceived as convenient and easily accessible during their flow between activities. Positive feedback came regarding having family classes near infants and having easy access to toys in the family lounge to distract kids accompanying parents during class. The physical proximity between staff offices and the family entrance were perceived as supportive to family-staff face-to-face communication, which occurred through informal family visits to these offices. On the other hand, the family thought that the physical proximity between SFRs and staff workstations facilitated their access to staff.

Participants mentioned the visibility between spaces as supportive to their comfort and reassuring In particular, the window views into the atrium and window views were perceived positively. Additionally, the "kid-friendly" aesthetics (artwork and signage), as well as the "vibrant" and "uplifting" wall colors found in corridors and SFRs, were perceived by both family and staff as supportive to family comfort.

The presence of the CCE was unanimously perceived by the participants as a supporting factor to prolonged presence at the bedside, family privacy and comfort, bonding with the infant and daily living activities, which include childcare and breastfeeding. The private rooms were also perceived as supportive to family staff communication, family education, and caregiving interactions. Participants indicated discomfort with erratic staff and lactation consultant visitation schedules in the first few days of being in the CCE. This stemmed from potential sleep disruptions caused by care team's constant flow in-and-out of the CCE. This, however, may have been affected by other factors related to family and staff individual attitudes and by staff's dual and often conflicting role of being a care provider to both family and infants, at the same time and environment.

The average CCE area of 350 sf was perceived by participants as "sufficient" for their actions and interactions in the room. During the facility tour, staff indicated satisfaction with the layout being conducive to infection control education due to the sink and vertical headwalls that demarcated 'clean' and 'soiled' areas in the room. However, horizontal surfaces were described as insufficient in some CCEs. These surfaces are critical in infection control. An example are the countertops where infant milk is prepared away of patient's potentially contaminated personal items. Additionally, decorations, lighting, and sources of positive distractions in the SFR such as the TV were perceived by family and staff as supporting family comfort that aided in distraction during long periods of isolation due to the COVID-19 visitation policy for extended family and friends. Participants also expressed satisfaction with the adjustable lights that could be manipulated for moments of family-infant bonding.

Perception about the Rooftop Garden

The Rooftop terrace at Beacon Children's Hospital is separated by a wrought iron divider for both patients and staff. It includes a Ribbon tree which memorializes lost infants. A recurring theme in the qualitative interviews with the patients and the staff was the presence of the rooftop garden. Most notably, the staff indicated that they take

care of certain sections of the rooftop garden and have a dedicated area with memorialized plants for deceased physicians and nurses from the unit. The staff also indicated the advantage of having separate gardens for staff and visitors (Appendix D). The patients who were interviewed indicated that they felt that the garden provided space to "have private conversations with their partner" and "get some fresh air during an emotionally exhausting day". Staff indicated that the garden space allowed them to "get away and reflect during a busy day" while still providing them with "some privacy from patients."

The design recommendations that have been given are to be considered for a maternity wardroom. This design may also be appropriate for a children's hospital that has a larger neonatal or pediatric intensive care unit. A combined maternity and neonatal care room is not ideal for every intensive care scenario. It would be ideal for a family that plans to, and can, continually stay with their children.

Design Recommendations

Measures should be taken to keep mothers and infants together within the same hospital room following birth. Utilizing the CCE model, mothers and infants are no longer separated, and this allows mothers to provide most of the care for their newborn infant daily. Research shows that effective design of couplet care units has many benefits to mothers, including reducing stress and anxiety with separation and increasing parental confidence with assuming daily care (Brown, et al., 2016; Spradlin, 2009; White, 2016).

Keeping the mother and baby together after birth reduces a mother's depression, anxiety, PTSD, and PPA surrounding the critical care of the infant. It can increase milk production, decrease pain levels, and improve blood pressure and heart rate (Phillips, 2013). In the case of the babies, being with their mothers promotes bonding and attachment, while minimizing stress, pain, and anxiety levels, as well as encouraging infant neurodevelopment, maximizing nutrition, and weight gain. In

addition, being with their mothers increases stability in respiratory rate, blood pressure, heart rate, reflux development, cognitive development, and promotes natural circadian rhythm development (Brown et al., 2016; Medina et al., 2018; Pineda et al., 2018; Phillips, 2013). It also ensures that both mother and child receive the proper after care they need to ensure no complication gets overlooked (Gulla et al., 2017).

Design Recommendations for Family Engagement in the NICU

While contemporary NICU design guidelines (20, 21) suggest room size and zoning standards (family, patient, and staff zone distinctions inside the SFR), along with the inclusion of specific types of spaces in the NICU (e.g., library and family lounge), empirical data provided by this study support recommendation of NICU design for family engagement that are more evidence-based. First and foremost, our findings support adopting the CCE design model as a resource to support family engagement.

Design Recommendations for the Couplet Care Environment

Integration of private bathrooms adjacent to private couplet care rooms and inpatient mother accommodations in the room is recommended to facilitate the family's prolonged bedside presence and wellbeing. More specific design recommendations relate to interior design features of CC rooms and family support rooms. The room layout should translate to a spatial hierarchy that facilitates different locations of privacy-sensitive family behaviors observed in the room. While family zone doors and curtains contribute to shielding families during activities conducted away from infants (e.g., getting dressed and pumping breast milk), other activities like breastfeeding and skin-to-skin care may need additional elements to protect them visually at the bedside while also securing staff-to-infant supervision. This may be challenging but alleviated by additional shields or by layout or shape changes in the room. The physical arrangement of the room should also afford direct visibility between family and infant, and between family, staff, and information displays, facilitating family-infant supervision, family staff communication, and information access and awareness for

family members. Interviews with staff indicate that visibility and privacy are in conflict, and needs must be balanced. Nurses do not rely on visibility of their patients, with rare exceptions such as the critically ill and very unstable baby, in which case they should be at the bedside. For all other babies, staff rely extensively on the baby's monitors to tell them when the baby needs attention. This is self-evident when they are not within line-of-sight or sufficiently close. Except for babies who require 1:1 supervision, nurses do not keep their babies under direct observation and rely on the monitors to alert them to a problem when they are not directly at the bedside. In the family zone, family presence can be increased by providing more comfortable beds, sources of positive distractions, family storage, and space for artwork and decorations.

Recommendations for the Lounge Spaces

Potential challenges presented by the presence of the CCE to family seclusion may be mitigated with shared and adequately sized family support spaces with activities inside the unit rather than outside, and in proximity and easy accessibility to SFRs, as to support family-to-family and family-staff informal interactions within infant proximity. This room should include a table and chair set for dining or to be used as a desk; a small kitchenette; a television and soft seating. Family members can watch television, make phone calls, have private meetings with staff, complete work, and eat in this lounge space. This room can also be utilized by siblings for daily activities while still being able to interact and be a part of the family bonding post-birth. Patient storage can also remain within this space to minimize objects from coming into the main room. Having this space isolated will also keep sound levels low within the main CCE to not disturb the mother or infant. Seating throughout the room should be multipurpose and flexible. Soft seating used within the lounge should be light and easily moveable. This seating can be transported between the lounge and main room easily to accommodate the needs of visitors and patients. Furniture used for sleeping should also be able to be used for general seating during non-sleeping hours. A detailed table with functional requirements of different user groups is highlighted in Table 8.

Ulrich's Theory of Supportive Design

The following strategies highlights the role of the environment in alleviating stress and promoting healing.

1. **Sense of control with respect to physical-social surroundings (PC)-** Participants indicated discomfort with erratic staff and lactation consultant visitation schedules in the first few days of being in the CCE. This stemmed from potential sleep disruptions caused by care team's constant flow in-and-out of the CCE. Giving the patient control over lighting and room temperature, openable windows, privacy, confidentiality, and reduction of noise. Prior research has found noise reduction to be of benefit to patients and staff in NICUs (Shepley, 2014; Van Enk & Steinberg, 2011).
2. **Access to positive distraction in the physical surroundings (PD)-** Plants, outdoor views, paintings of nature, access to soothing music which can be personalized to the patient. Aiming for balancing family-infant proximity and an increased sense of community in the NICU, findings from this study also recommend sources of distraction in family support rooms, such as TVs and childcare distractions, therefore supporting family respite, socialization, and childcare.
3. **Access to social support (SS)-** This related to dimensions of autonomic, endocrine, and immune function, with family ties appearing to be a key source of support relevant to physiological functioning. Providing spaces for interaction with family and visitors, chairs for visitors, sleeper sofa for visitors. Designing an NICU that is welcoming and supportive to families is likely to lead to increased family presence and participation in the care of their infant and contributes to improved outcomes. Family space near the infant's bedside optimally includes a comfortable chair for skin-to-skin care, a bed, storage and a workspace. Elsewhere in the NICU, there should be a family lounge with nutrition, access to nature and additional amenities, including shower and

laundry facilities. Private bathrooms are required within the FGI (2018) guidelines, but having these facilities gives convenience to the mother with her infants' postpartum needs. The bathroom could also be used by visitors, adding convenience to those providing social support to the mother and infant (White et al., 2013; Williams et al., 2018)

4. **Other features-**
    a. **Access to specialized features-** Providing enough sitting in the CCE is likely to facilitate interactions with staff at eye level when family members are using the kangaroo chair. Due to different levels of privacy needed during social interactions occurring in family support rooms, layout flexibility is also recommended in the design of NICU spaces with a shared kitchen, living room, and play areas. This can be achieved by providing mobile furniture and vertical partitions that can adapt to different group sizes involved in social interactions and to different levels of personal space desired by family members. Spatial hierarchy can be created by furniture or wall positioning to allow for different activities and people to coexist in these shared spaces (e.g., children coexisting with adults, family events coexisting with daily living activities), affording choice for families according to their preferred interaction in the room (e.g., alone time versus socialization). A dedicated area for breast milk storage and milk preparation may reduce the risk of contamination and errors. The small kitchenette can be used for storage of formula, include a breastmilk refrigerator, as well as a personal food refrigerator. A personal size washer and dryer should be considered for laundering the infant's cloth items to promote infection control (White et al., 2013). From an infection control perspective, having the ability to launder items within the room keeps cross contamination at a minimum, since they will not be removed from the room potentially infecting others or any surface outside the space.

b. **Adaptability-** Designing for flexibility depending on acuity level (low acuity to isolation level) to adapt to surge conditions, programming spaces for multipurpose use or designing "flex" spaces. The headwall of the incubator should be designed to be moveable. This allows the incubator to be moved bedside to the mother, then moved away when needed for medical procedures or care of the infant. This innovation will potentially allow mothers to stay in bed and interact with their infant. Mothers could provide skin-to-skin contact during postpartum recovery, once the newborn has been stabilized. Early skin-to-skin contact, and suckling has been proven to have benefits to both the mother and child, in addition to promoting bonding (Pineda et al., 2018). Further research is necessary to design and engineer a movable headwall.
c. **Decentralized staff stations-** In a unit with private CCUs, a central 'nursing station' can be a substantial distance from some patients. Therefore, decentralized staff stations, often referred to as 'satellite stations' outside patient rooms may improve patient safety and nursing satisfaction. A central 'mothership' station is still necessary where nurses can collaborate and socialize when they do not need to be at the bedside.

Technology recommendations

1. **Access to videoconferencing-** A dedicated screen for videoconferencing family or friends in the event of high acuity/isolation level. Incubator video monitors give families, especially extended family members who are unable to physically be present at the hospital the ability to see the infants. Having built-in Bluetooth speakers can allow families to play music, recordings of their voice, or of other family members. This helps calm and relax both the mother and baby, reducing parental stress and anxiety, while having physiological and psychological effects on the infant. Additional technology includes digital staff

display boards. These portray the images and names of attending staff members and change as shifts do. This signage helps to eliminate stress and increase comfortability regarding with care staff (Robson et al., 2016). Electronic medical charting should be available to parents as they are providing most of the infant's care in a CCE model. Parents can chart feeding times and quantities, diaper changes, and can communicate concerns with doctors. This chart can then be accessed by the care team without having to disturb the family.

2. **Access to a centralized patient health record (EHR)** as the single source of information for the care team. This will reduce medical errors and patient discomfort that arises from a misdiagnosis or miscommunication.
3. **A centralized workflow system** which can track medical equipment, nursing staff, custodial staff, doctors, and patients on a single platform leading to improvements in efficiency during patient transfer and shift rotations,
4. **Establishing a continuum of care-** Integrating patient monitoring and behavioral health systems to monitor symptoms and vitals beyond the healthcare facility. This can also be leveraged to ensure compliance with the treatment plan well after discharge from the hospital**.**

Organizational recommendations

1. **Flattening the organizational hierarchy** so as to facilitate more communication channels between nursing staff and doctors. There is extensive data in the occupational health literature establishing the value of ergonomics, access to nature, noise control, and so on for caregivers. There is also an evolving interest in the hazards of shift work (Figueiro & White, 2013). Design features to support staff health might also include respite spaces such as a nap or quiet room and an exercise area.
2. **Infection control-** Sanitization policies to ensure staff compliance in order to achieve infection control targets. As infection is a major determinant of neonatal outcomes, good NICU design requires access to proper sinks and

waterless cleaners, as well as suitable HVAC systems (White et al., 2013). Although there is insufficient evidence that CCU design can reduce caregiver transmission of hospital-acquired pathogens, there are several possible ways in which this might occur. Studies on adult patients have found that increased contact with roommates is a risk factor for infection (Hamel et al., 2010).

3. **Incentivizing departmental performance** across various metrics such as infection control, patient satisfaction, length of stay (LOS) by rewarding the care team appropriately for every milestone achieved.
4. **Staffing ratios**- Shifts to reduce physician and staff fatigue (and medical errors) while positively effecting the organization's bottom line.

Complementary services and alternative medicine (CAM)

1. **Access to educational support-** Providing infant care classes and lactation support prior to discharge has shown to have benefits in parental stress and breastfeeding compliance (Nyqvist et al., 2013).
2. **Integrating diverse, evidence-based CAM approaches** that fall outside conventional allopathic, Western medicine interwoven with the conventional treatment plan.

Lighting Design Recommendations

A variety of lighting options need to be available for all users. Staff must have specific lighting to complete tasks and procedures. Families need to have lighting that fits their everyday routines. Overhead lighting must be provided for daily activities. It should also be dimmable, or adjustable, to coordinate with natural daylight. Task lighting should be provided near all seating areas. A window should be included in every room and have blinds that are completely controllable. This should include sunshades and roller shades to give various levels of light control within the space.

Table 8: People, Process, Place- Functional Scenarios from the Perspectives of Infants, Family, and Caregivers

User Group	Functional Requirements

Infant	• To be protected from direct light, and both direct and indirect light sources should be controllable • A quiet environment • To receive kangaroo care • Exposure to clearly perceived speech from family members • To be protected from sink splashes • To receive care procedures without being moved
Family	• A dedicated space to conduct daily activities, at different degrees of privacy, such as working and sleeping • A comfortable, reclining chair for activities such as kangaroo care while also having visual privacy from outside the patient room • To have access to the baby visually and physically while another family member is in kangaroo care with the baby • Dedicated storage space that they can access without intruding into the provider zone • Access to natural light and views to the outside without exposing the baby to direct light • Enough space near family zone to stand and see babies getting procedures outside 5’ clearance around the isolette
Caregivers	• Visibility to isolette from decentralized nurse’s stations, while using their computer, without compromising family privacy • To be able to enter a room and wash his or her hands at “point of first encounter” while maintaining direct eye contact with families • A work surface with access to the sink for activities like milk preparation • To access patient records, and be able to chart, at the baby’s bedside without breaking visibility to the baby and the family • Easy and quick access to supply storage from the work surface without intruding into family zone • Access to electrical and gas outlets with minimal repetitive movements such as bending and stretching • To go between their points of work quickly to complete tasks around the patient room without excessive walking • Access to all monitors and equipment without intruding into family zone

	• To easily move large medical equipment, such as the maternal bed, in and out of the patient room • To be able to move in and out of the room or around the isolette for evaluating the baby and performing bedside procedures without moving the isolette • To wash their hands and forearms in the patient room, when they first enter, without splashing water from the sink

Note: Functional requirements derived from the survey, interviews, and literature review

Chapter 5

CONCLUSION

By evaluating the design of a NICU intended to promote family engagement, this research was able to show the combined impact of unit layout, aesthetics and family support rooms on family presence, care, information exchanges, and caregiving, from the perspectives of caregivers and staff. We demonstrated how CCE affords privacy as a key environmental quality to facilitate family presence, wellbeing, in-depth family-staff interactions, and intimate family-infant interactions. This study helps guide future NICU projects by providing evidence-based design recommendations. This study adds to the body of knowledge around NICU design by emphasizing and exploring in-depth the perspective of family needs, thereby contributing to existing best practices literature such as the FGI Guidelines and the Journal of Perinatology Recommended Standards for Newborn ICU Design.

Staff indicated the lessons learned from Beacon Children's NICU unit can be applied to any health system considering a NICU redesign. Understanding the research was critical in helping administration, staff, and other stakeholders understand the benefits and potential outcomes. Integrated design events were held during planning phases to provide hands-on participation by staff and families to test the prototype, using iterative, full-scale mock-ups and simulations to ensure that functional and code requirements were met.

Limitations of the Study

Due to complications arising from the COVID-19 pandemic and the associated travel restrictions, data collection was conducted remotely in coordination with the care team on-site at Memorial Hospital, South Bend. The participant recruitment was difficult and only 19 participants consented to participate in the study. Due to the length of the survey, only 16 participants completed more than 85% of the survey fields. Further

research is required to understand the length of surveys and its effect on survey completion and attrition. The pandemic policies, in addition to the low number or participants , lowered the generalizability of the study. Although the recruitment poster was shared with all eligible mothers in the NICU, only those who were able to complete 85% or more of the survey were considered. This could have introduced selection bias into the study. Another limitation with the survey was that detailed demographic information was not collected.

Implications for Practice and Future Research

By analyzing the user processes, both intended and unintended, we can measure the effectiveness and appropriateness of the design – identifying successes and issues to be addressed in either this or future CCE projects. It is important to evaluate these spaces to better understand the impact of CCE exposure on patients in a wide range of levels of acuity, and possibly uncover mechanisms to enhance the therapeutic effects of the space.

Future studies can deploy the YNHH survey at multiple sites to measure the outcomes from a couplet care unit compared to a traditional NICU. Future research may include data collected at multiple cross-sections of time reflecting the decrease of the halo effect as the mother reviews and processes the birth experience. A particular area that can be explored is the correlation between the rooftop garden in the NICU and patient and staff satisfaction. By examining healing gardens, we can create evidence-based recommendations for rooftop gardens to support the well-being of staff, patients, and families, and justify for the cost of creating the rooftop garden. The research findings of this future study might support design guidelines suggested by previous researchers with the goal of helping to develop a more holistic approach to healthcare.

Future research could include behavioral observations to understand the needs of the NICU staff within their workspace and the movement of patients and staff in the couplet care portion of the NICU. This can include special requirements for equipment

and accessibility codes and can be supplemented with interviews with the care team including anyone who might interact with the space, such as nurses, doctors, and housekeeping staff. The addition of these methodologies will aid in understanding the spatial requirements for optimal clinical and patient experience.

Future researchers might also look at ways to measure benefits more quantitatively, such as examining biomarkers or stress or developing measures to operationalize concepts such as stress and satisfaction. The operationalization of these concepts may help answer the question regarding whether CCE exposure can assist in both preventing illnesses stemming from psychological processes (stress) and alleviating stress-related symptoms (postpartum depression).

Considering upcoming couplet care projects in healthcare facilities, future research could incorporate pre-occupancy evaluations to collect data to measure against in the post-occupancy phase. This type of research could help identify specific features of the CCE model that may have impacts on cognitive development, functioning, bonding, and satisfaction, and identify the causal pathways for these effects.

Other future research specifically related to this CCE might include increased communication between potential patients and staff. Additionally, researchers could support training staff about the available CCE model for patients and information about associated outcomes by disseminating study findings. Following this, they could complete a post-survey to understand whether identifying this in the context of the healthcare facilities larger marketing plan and increased communication changes perceptions and whether future patients appreciate the communication and transparency.

Closing Thoughts

Infants enter the world helpless, depending on their caregivers to meet their most basic needs for food, shelter, safety, stimulation, and affection. Because of the infant's

profound dependence and vulnerability, it is easy to see how the developing child might be affected by the intimate relationships of his or her caregivers (Bradbury & Karney, 2014). Understanding the importance of early interactions between the caregivers and infant on attachment styles will help designers design spaces and systems that facilitate these interactions.

In addition to understanding the benefits of these early interactions and its impact on emotional and cognitive development, designers must familiarize themselves with the business-case of evidence-based design to champion these design recommendations to stakeholders across various levels of the healthcare system. Designers, researchers, and healthcare professionals must continue to learn and work together to realize the potential impacts of healthcare environments to support human development and holistic care. This research represents a call to action across disciplines to focus on our most vulnerable, premature populations and contributes to giving those groups an opportunity to improve the quality of life and the quality of the experience for everyone involved. Ultimately, a patient's high satisfaction level with the care experience can potentially generate repeat business in the pediatric service lines because of the "halo effect" generated when hospital becomes the "hospital of choice" for mothers and their growing family.

REFERENCES

Affonso, D., Bosque, E., Wahlberg, V., & Brady, J. P. (1993). Reconciliation and healing for mothers through skin-to-skin contact provided in an American tertiary level intensive care nursery. *Neonatal network: NN*, *12*(3), 25-32.

Al Maghaireh, D. A. F., Abdullah, K. L., Chan, C. M., Piaw, C. Y., & Al Kawafha, M. M. (2016). Systematic review of qualitative studies exploring parental experiences in the Neonatal Intensive Care Unit. *Journal of clinical nursing*, *25*(19-20), 2745-2756.

Al Maghaireh, D. A. F., Abdullah, K. L., Chan, C. M., Piaw, C. Y., & Al Kawafha, M. M. (2016). Systematic review of qualitative studies exploring parental experiences in the Neonatal Intensive Care Unit. *Journal of clinical nursing*, *25*(19-20), 2745-2756.

Altimier, L. B., Eichel, M., Warner, B., Tedeschi, L., & Brown, B. (2005). Developmental care: changing the NICU physically and behaviorally to promote patient outcomes and contain costs. *Neonatal Intensive Care*, *18*(4), 12-16.

Altimier, L. B., Eichel, M., Warner, B., Tedeschi, L., & Brown, B. (2005). Developmental care: Changing the NICU physically and behaviorally to promote patient outcomes and contain costs. Neonatal Intensive Care, 18(4), 12-16.

Anastasi, A. (1985). Psychological testing: Basic concepts and common misconceptions. In *Annual Meeting of the American Psychological Association, 1984, Toronto, ON, Canada; This lecture was presented at the aforementioned meeting.*. American Psychological Association.

Andrade, C. C., & Devlin, A. S. (2015). Stress reduction in the hospital room: Applying Ulrich's theory of supportive design. Journal of Environmental Psychology, 41, 125-134.

Bentley, F., O'Neill, K., Quehl, K., & Lottridge, D. (2020, April). Exploring the quality, efficiency, and representative nature of responses across multiple

survey panels. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems* (pp. 1-12).

Berry, L. L., Parker, D., Coile, R. C., Hamilton, D. K., O Neill, D. D., & Sadler, B. L. (2004). The business case for better buildings. *Frontiers of health services management*, *21*, 3-24.

Bizzarro, M. J., Raskind, C., Baltimore, R. S., & Gallagher, P. G. (2005). Seventy-five years of neonatal sepsis at Yale: 1928–2003. *Pediatrics*, *116*(3), 595-602.

Bloch-Salisbury, E., Zuzarte, I., Indic, P., Bednarek, F., & Paydarfar, D. (2014). Kangaroo care: cardio-respiratory relationships between the infant and caregiver. *Early human development*, *90*(12), 843-850.

Bosch, S., Bledsoe, T., & Jenzarli, A. (2012). Staff perceptions before and after adding single-family rooms in the NICU. HERD: Health Environments Research & Design Journal, 5(4), 64-75. Cai, H., Zimring, C. (2011). The impact of nurse station typology on nurses' informal communication and learning. World Health, 61.

Bradbury, T. N., & Karney, B. R. (2014). *Intimate relationships*. WW Norton.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, *3*(2), 77-101.

Bronfenbrenner, U. (1994). Ecological models of human development. *Readings on the development of children*, *2*(1), 37-43.

Brown, K. K., & Gallant, D. (2006). Impacting patient outcomes through design: acuity adaptable care/universal room design. *Critical care nursing quarterly*, *29*(4), 326-341.

Browne, J. V., Martinez, D., & Talmi, A. (2016). Infant mental health (IMH) in the intensive care unit: considerations for the infant, the family and the staff. *Newborn and Infant Nursing Reviews*, *16*(4), 274-280.

Bystrova, K., Ivanova, V., Edhborg, M., Matthiesen, A. S., Ransjö-Arvidson, A. B., Mukhamedrakhimov, R., ... & Widström, A. M. (2009). Early contact versus separation: effects on mother–infant interaction one year later. *Birth*, *36*(2), 97-109.

Bystrova, K., Ivanova, V., Edhborg, M., Matthiesen, A. S., Ransjö-Arvidson, A. B., Mukhamedrakhimov, R., ... & Widström, A. M. (2009). Early contact versus separation: effects on mother–infant interaction one year later. *Birth*, *36*(2), 97-109.

Callahan, W. (2013). Chief, Maternal and Infant Health Branch. *National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention. E-mail interview*.

Carman, K. L., Dardess, P., Maurer, M., Sofaer, S., Adams, K., Bechtel, C., et al. (2013). Patient and family engagement: A framework for understanding the elements and developing interventions and policies. Health Affairs (Project Hope), 32(2), 223-231. doi:10.1377/hlthaff.2012.1133 [doi]

Catala, P., Peñacoba, C., Carmona, J., & Marin, D. (2018). Maternal Personality and Psychosocial Variables Associated with Initiation Compared to Maintenance of Breastfeeding: A Study in Low Obstetric Risk Women. *Breastfeeding Medicine*, *13*(10), 680-686.

Catala, P., Peñacoba, C., Carmona, J., & Marin, D. (2018). Maternal Personality and Psychosocial Variables Associated with Initiation Compared to Maintenance of Breastfeeding: A Study in Low Obstetric Risk Women. *Breastfeeding Medicine*, *13*(10), 680-686.

Cho, E. S., Kim, S. J., Kwon, M. S., Cho, H., Kim, E. H., Jun, E. M., & Lee, S. (2016). The effects of kangaroo care in the neonatal intensive care unit on the physiological functions of preterm infants, maternal–infant attachment, and maternal stress. *Journal of pediatric nursing*, *31*(4), 430-438.

Cho, E. S., Kim, S. J., Kwon, M. S., Cho, H., Kim, E. H., Jun, E. M., & Lee, S. (2016). The effects of kangaroo care in the neonatal intensive care unit on the physiological functions of preterm infants, maternal–infant attachment, and maternal stress. *Journal of pediatric nursing*, *31*(4), 430-438.

Cleveland, L. M. (2008). Parenting in the neonatal intensive care unit. Journal of Obstetric, Gynecologic, & Neonatal Nursing, 37(6), 666-691.

Committee on Fetus and Newborn, Barfield, W. D., Papile, L. A., Baley, J. E., Benitz, W., Cummings, J., ... & Watterberg, K. L. (2012). Levels of neonatal care. *Pediatrics*, *130*(3), 587-597.

Cone, S. K., Short, S., & Gutcher, G. (2010). From “baby barn” to the “single family room designed NICU”: A report of staff perceptions one year post occupancy. Newborn and Infant Nursing Reviews, 10(2), 97-103.

Cong, X., Cusson, R. M., Walsh, S., Hussain, N., Ludington-Hoe, S. M., & Zhang, D. (2012). Effects of skin-to-skin contact on autonomic pain responses in preterm infants. *The Journal of Pain*, *13*(7), 636-645.

Cong, X., Ludington-Hoe, S. M., Hussain, N., Cusson, R. M., Walsh, S., Vazquez, V., ... & Vittner, D. (2015). Parental oxytocin responses during skin-to-skin contact in pre-term infants. *Early Human Development*, *91*(7), 401-406.

Cong, X., Ludington-Hoe, S. M., McCain, G., & Fu, P. (2009). Kangaroo Care modifies preterm infant heart rate variability in response to heel stick pain: pilot study. *Early human development*, *85*(9), 561-567.

Conner, J. M., & Nelson, E. C. (1999). Neonatal intensive care: satisfaction measured from a parent's perspective. *Pediatrics*, *103*(Supplement E1), 336-349.

Cooper L, Gooding J, Gallagher J, et al: Impact of a family-centered care initiative on NICU care, staff and families. Journal of Perinatology, 27:S32-S37, 2007

Davidson, J. E. (2013). Family presence on rounds in neonatal, pediatric, and adult intensive care units. Annals of the American Thoracic Society, 10(2), 152-156.

Davis, B. E. (2011). Rooftop hospital gardens for physical therapy: A post-occupancy evaluation. *HERD: Health Environments Research & Design Journal*, *4*(3), 14-43.

DeMauro, S. B., Bellamy, S. L., Fernando, M., Hoffmann, J., Gratton, T., Schmidt, B., & PROP Investigators. (2019). Patient, family, and center-based factors associated with attrition in neonatal clinical research: a prospective study. *Neonatology*, *115*(4), 328-334.

DeVellis, R. F., & Thorpe, C. T. (2021). *Scale development: Theory and applications*. Sage publications.

Dimitraki, M., Tsikouras, P., Manav, B., Gioka, T., Koutlaki, N., Zervoudis, S., & Galazios, G. (2016). Evaluation of the effect of natural and emotional stress of labor on lactation and breast-feeding. *Archives of gynecology and obstetrics*, *293*(2), 317-328.

Dimitraki, M., Tsikouras, P., Manav, B., Gioka, T., Koutlaki, N., Zervoudis, S., & Galazios, G. (2016). Evaluation of the effect of natural and emotional stress of labor on lactation and breast-feeding. *Archives of gynecology and obstetrics*, *293*(2), 317-328.

Domanico, R., Davis, D. K., Coleman, F., & Davis, B. O. (2011). Documenting the NICU design dilemma: comparative patient progress in open-ward and single family room units. *Journal of Perinatology*, *31*(4), 281-288.

Domanico, R., Davis, D. K., Coleman, F., & Davis, B. O. (2011). Documenting the NICU design dilemma: comparative patient progress in open-ward and single family room units. *Journal of Perinatology*, *31*(4), 281-288.

Domanico, Renee, Diana K. Davis, F. Coleman, and Bowman O. Davis (2011). Documenting the NICU design dilemma: comparative patient progress in open-ward and single-family room units. Journal of Perinatology 31, no. 4:281-288.

Eidelman, A. I., & Schanler, R. J. (2012). Breastfeeding and the use of human milk. *Pediatrics*.

England, P., & Folbre, N. (1999). The cost of caring. *The Annals of the American Academy of Political and Social Science*, *561*(1), 39-51.

Feldman, R., Weller, A., Leckman, J. F., Kuint, J., & Eidelman, A. I. (1999). The nature of the mother's tie to her infant: Maternal bonding under conditions of proximity, separation, and potential loss. *The Journal of Child Psychology and Psychiatry and Allied Disciplines*, *40*(6), 929-939.

Feldman, R., Weller, A., Leckman, J. F., Kuint, J., & Eidelman, A. I. (1999). The nature of the mother's tie to her infant: Maternal bonding under conditions of proximity, separation, and potential loss. *The Journal of Child Psychology and Psychiatry and Allied Disciplines*, *40*(6), 929-939.

Fenwick, J., Barclay, L., & Schmied, V. (2008). Craving closeness: a grounded theory analysis of women's experiences of mothering in the Special Care Nursery. Women and birth, 21(2), 71-85.

Figueiro, M. G., & White, R. D. (2013). Health consequences of shift work and implications for structural design. *Journal of Perinatology*, *33*(1), S17-S23.

Flacking, R., Ewald, U., & Wallin, L. (2011). Positive effect of kangaroo mother care on long-term breastfeeding in very preterm infants. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, *40*(2), 190-197.

Floyd, A. M. D. (2005). Challenging designs of neonatal intensive care units. *Critical Care Nurse*, *25*(5), 59-66.

Franck, L. S., & Spencer, C. (2003). Parent visiting and participation in infant caregiving activities in a neonatal unit. Birth, 30(1), 31-35.

Gale, G., Franck, L., & Lund, C. (1993). Skin-to-skin (kangaroo) holding of the intubated premature infant. *Neonatal network: NN*, *12*(6), 49-57.

Garrouste-Orgeas, M., Willems, V., Timsit, J. F., Diaw, F., Brochon, S., Vesin, A., ... & Moulard, M. L. (2010). Opinions of families, staff, and patients about family participation in care in intensive care units. Journal of critical care, 25(4), 634-640. Griffin, T. (2006). Family-centered care in the NICU. The Journal of perinatal & neonatal nursing, 20(1), 98-102.

Gonya, J., Ray, W. C., Rumpf, R. W., & Brock, G. (2017). Investigating skin-to-skin care patterns with extremely preterm infants in the NICU and their effect on early cognitive and communication performance: a retrospective cohort study. *BMJ open*, *7*(3), e012985.

Gonya, J., Ray, W. C., Rumpf, R. W., & Brock, G. (2017). Investigating skin-to-skin care patterns with extremely preterm infants in the NICU and their effect on early cognitive and communication performance: a retrospective cohort study. *BMJ open*, *7*(3), e012985.

Greene, M. M., Rossman, B., Patra, K., Kratovil, A., Khan, S., & Meier, P. P. (2015). Maternal psychological distress and visitation to the neonatal intensive care unit. *Acta Paediatrica*, *104*(7), e306-e313.

Gulla, K., Dahlø, R., & Eilertsen, M. E. B. (2017). From the delivery room to the neonatal intensive care unit—Mothers' experiences with follow-up of skin-to-skin contact after premature birth. *Journal of Neonatal Nursing*, *23*(6), 253-257.

Hadi, K., & Zimring, C. (2016). Design to Improve Visibility Impact of Corridor Width and Unit Shape. HERD: Health Environments Research & Design Journal, 1937586715621643.

Hamel, M., Zoutman, D., & O'Callaghan, C. (2010). Exposure to hospital roommates as a risk factor for health care–associated infection. *American journal of infection control*, *38*(3), 173-181.

Hane, A. A., Myers, M. M., Hofer, M. A., Ludwig, R. J., Halperin, M. S., Austin, J., ... & Welch, M. G. (2015). Family nurture intervention improves the quality of maternal caregiving in the neonatal intensive care unit: evidence from a randomized controlled trial. *Journal of Developmental & Behavioral Pediatrics*, *36*(3), 188-196.

Hanvey, L. (1988). Obstetrics' 87, the CMA report on obstetric care in Canada: what have we really learned? *CMAJ: Canadian Medical Association Journal*, *139*(6), 481.

Härkönen, U. (2001). The Bronfenbrenner ecological systems theory of human development.

Harvey, S., Rach, D., Stainton, M. C., Jarrell, J., & Brant, R. (2002). Evaluation of satisfaction with midwifery care. *Midwifery*, *18*(4), 260-267.

Hazan, C., & Shaver, P. R. (1990). Love and work: An attachment-theoretical perspective. *Journal of Personality and social Psychology*, *59*(2), 270.

Heermann, J. A., Wilson, M. E., & Wilhelm, P. A. (2005). Mothers in the NICU: Outsider to partner. Pediatric Nursing, 31(3), 176-181. Mundy, C. A. (2010). Assessment of family needs in neonatal intensive care units. American Journal of Critical Care, 19(2), 156-163.

Hendrich, A. L., Fay, J., & Sorrells, A. K. (2004). Effects of acuity-adaptable rooms on flow of patients and delivery of care. *American Journal of Critical Care*, *13*(1), 35-45.

Hicks, C., McGovern, T., Prior, G., & Smith, I. (2015). Applying lean principles to the design of healthcare facilities. *International Journal of Production Economics*, *170*, 677-686.

Holditch-Davis, D., White-Traut, R. C., Levy, J. A., O'Shea, T. M., Geraldo, V., & David, R. J. (2014). Maternally administered interventions for preterm infants in the NICU: Effects on maternal psychological distress and mother–infant relationship. *Infant Behavior and Development*, *37*(4), 695-710.

Hunt, L., Hallford, G., Robledo, C., Szyld, E., & Song, C. (2015). Impact of specialized nursery care for late preterm infants on NICU admission rate and length of stay. *American Journal of Perinatology*, *32*(13), 1198-1204.

Hurst, N. M., Valentine, C. J., Renfro, L., Burns, P., & Ferlic, L. (1997). Skin-to-skin holding in the neonatal intensive care unit influences maternal milk volume. *Journal of Perinatology*, *17*(3), 213-217.

Jaafar, S. H., Ho, J. J., & Lee, K. S. (2016). Rooming-in for new mother and infant versus separate care for increasing the duration of breastfeeding. *Cochrane Database of Systematic Reviews*, (8).

Jaafar, S. H., Ho, J. J., & Lee, K. S. (2016). Rooming-in for new mother and infant versus separate care for increasing the duration of breastfeeding. *Cochrane Database of Systematic Reviews*, (8).

Johnson, A. N. (2007). The maternal experience of kangaroo holding. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, *36*(6), 568-573.

Johnson, K. (2013). Maternal-Infant Bonding: A Review of Literature. *International Journal of Childbirth Education*, *28*(3).

Klawetter, S., Greenfield, J. C., Speer, S. R., Brown, K., & Hwang, S. S. (2019). An integrative review: maternal engagement in the neonatal intensive care unit and health outcomes for US-born preterm infants and their parents. *AIMS public health*, *6*(2), 160.

Krol, M. W., de Boer, D., Delnoij, D. M., & Rademakers, J. J. (2015). The Net Promoter Score–an asset to patient experience surveys?. *Health Expectations*, *18*(6), 3099-3109.

Kuhnly, J. E. (2018). Sustained breastfeeding and related factors for late preterm and early term infants. *The Journal of Perinatal & Neonatal Nursing*, *32*(2), 175-188.

Kuhnly, J. E. (2018). Sustained breastfeeding and related factors for late preterm and early term infants. *The Journal of Perinatal & Neonatal Nursing*, *32*(2), 175-188.

Lau, C., Hurst, N. M., Smith, E. O., & Schanler, R. J. (2007). Ethnic/racial diversity, maternal stress, lactation and very low birthweight infants. *Journal of Perinatology*, *27*(7), 399-408.

Leedy, P.D., & Ormrod, J.E. (2013). *Practical research planning and design*. Pearson Education, Inc.

Lester, B. M., Hawes, K., Abar, B., Sullivan, M., Miller, R., Bigsby, R., ... & Padbury, J. F. (2014). Single-family room care and neurobehavioral and medical outcomes in preterm infants. *Pediatrics*, *134*(4), 754-760.

Lester, B. M., Hawes, K., Abar, B., Sullivan, M., Miller, R., Bigsby, R., ... & Padbury, J. F. (2014). Single-family room care and neurobehavioral and medical outcomes in preterm infants. *Pediatrics*, *134*(4), 754-760.

Lester, B. M., Salisbury, A. L., Hawes, K., Dansereau, L. M., Bigsby, R., Laptook, A., ... & Padbury, J. F. (2016). 18-month follow-up of infants cared for in a single-family room neonatal intensive care unit. *The Journal of pediatrics*, *177*, 84-89.

Lewis, M., Bendersky, M., Koons, A., Hegyi, T., Hiatt, I. M., Ostfeld, B., & Rosenfeld, D. (1991). Visitation to a neonatal intensive care unit. *Pediatrics*, *88*(4), 795-800.

Loewenthal, K., & Lewis, C. A. (2018). *An introduction to psychological tests and scales*. Psychology press.

Ludington-Hoe, S., Anderson, G. C., Swinth, J., Thompson, C., & Hadeed, A. (2004). Randomized controlled trial of kangaroo care: cardiorespiratory and thermal effects on healthy preterm infants. *Neonatal Network*, *23*(3), 39-48.

Machry, H., & Joseph, A. (2019). Examining the Built Environment as a Contextual Factor to Family Engagement in the NICU.

Marcus, C. C., & Barnes, M. (1995). *Gardens in healthcare facilities: Uses, therapeutic benefits, and design recommendations*. Concord, CA: Center for Health Design.

Marcus, C. C., & Sachs, N. A. (2013). *Therapeutic landscapes: An evidence-based approach to designing healing gardens and restorative outdoor spaces*. John Wiley & Sons.

Martin, J. A., Hamilton, B. E., Osterman, M. J., Driscoll, A. K., & Mathews, T. J. (2017). Births: final data for 2015.

McCain, G. C., Ludington-Hoe, S. M., Swinth, J. Y., & Hadeed, A. J. (2005). Heart rate variability responses of a preterm infant to kangaroo care. *Journal of Obstetric, Gynecologic, & Neonatal Nursing*, *34*(6), 689-694.

Medina, I. M. F., Granero-Molina, J., Fernández-Sola, C., Hernández-Padilla, J. M., Ávila, M. C., & Rodríguez, M. D. M. L. (2018). Bonding in neonatal intensive care units: Experiences of extremely preterm infants' mothers. *Women and Birth*, *31*(4), 325-330.

Naderi, J. R., & Shin, W. H. (2008). Humane design for hospital landscapes: A case study in landscape architecture of a healing garden for nurses. *HERD: Health Environments Research & Design Journal*, *2*(1), 82-119.

Neu, M. (2014). An innovative investigation into the etiology of feeding intolerance in preterm infants. *Journal of pediatric gastroenterology and nutrition*, *58*(1), 4-5.

Neu, M., Browne, J. V., & Vojir, C. (2000). The impact of two transfer techniques used during skin-to-skin care on the physiologic and behavioral responses of preterm infants. *Nursing Research*, *49*(4), 215-223.

Neu, M., Hazel, N. A., Robinson, J., Schmiege, S. J., & Laudenslager, M. (2014). Effect of holding on co-regulation in preterm infants: a randomized controlled trial. *Early human development*, *90*(3), 141-147.

Neu, M., Laudenslager, M. L., & Robinson, J. (2009). Coregulation in salivary cortisol during maternal holding of premature infants. *Biological research for nursing*, *10*(3), 226-240.

Neu, M., Robinson, J., & Schmiege, S. J. (2013). Influence of holding practice on preterm infant development. *MCN. The American journal of maternal child nursing*, *38*(3), 136.

Nonnenmacher, N., Noe, D., Ehrenthal, J. C., & Reck, C. (2016). Postpartum bonding: the impact of maternal depression and adult attachment style. *Archives of women's mental health*, *19*(5), 927-935.

Nordahl, D., Rognmo, K., Bohne, A., Landsem, I. P., Moe, V., Wang, C. E. A., & Høifødt, R. S. (2020). Adult attachment style and maternal-infant bonding: the indirect path of parenting stress. *BMC Psychology*, *8*(1), 1-11.

Nunnally, J. C. (1978). An overview of psychological measurement. *Clinical diagnosis of mental disorders*, 97-146.

Nyqvist, K. H., Häggkvist, A. P., Hansen, M. N., Kylberg, E., Frandsen, A. L., Maastrup, R., ... & Haiek, L. N. (2013). Expansion of the baby-friendly hospital initiative ten steps to successful breastfeeding into neonatal intensive care: expert group recommendations. *Journal of Human Lactation*, *29*(3), 300-309.

Ong, S. L., Abdullah, K. L., Danaee, M., Soh, K. L., Soh, K. G., Lee, D. S. K., & Hussin, E. O. D. (2019). The effectiveness of a structured nursing intervention program on maternal stress and ability among mothers of premature infants in a neonatal intensive care unit. *Journal of clinical nursing*, *28*(3-4), 641-649.

Ong, S. L., Abdullah, K. L., Danaee, M., Soh, K. L., Soh, K. G., Lee, D. S. K., & Hussin, E. O. D. (2019). The effectiveness of a structured nursing intervention program on maternal stress and ability among mothers of premature infants in a neonatal intensive care unit. *Journal of clinical nursing*, *28*(3-4), 641-649.

Örtenstrand, A., Westrup, B., Broström, E. B., Sarman, I., Åkerström, S., Brune, T., ... & Waldenström, U. (2010). The Stockholm Neonatal Family Centered Care Study: effects on length of stay and infant morbidity. *Pediatrics*, *125*(2), e278-e285.

Örtenstrand, A., Westrup, B., Broström, E. B., Sarman, I., Åkerström, S., Brune, T., ... & Waldenström, U. (2010). The Stockholm Neonatal Family Centered Care Study: effects on length of stay and infant morbidity. Pediatrics, peds-2009.

Pasha, S. (2012). *Usability of Outdoor Spaces in Children's Hospitals* (Doctoral dissertation, Texas A & M University).

Phillips, R. (2013). The sacred hour: Uninterrupted skin-to-skin contact immediately after birth. *Newborn and Infant Nursing Reviews*, *13*(2), 67-72.

Phillips, R. M., Merritt, T. A., Goldstein, M. R., Deming, D. D., Slater, L. E., & Angeles, D. M. (2012). Prevention of postpartum smoking relapse in mothers of infants in the neonatal intensive care unit. *Journal of Perinatology*, *32*(5), 374-380.

Pineda, R., Bender, J., Hall, B., Shabosky, L., Annecca, A., & Smith, J. (2018). Parent participation in the neonatal intensive care unit: Predictors and relationships to neurobehavior and developmental outcomes. *Early human development*, *117*, 32-38.

Pineda, R., Bender, J., Hall, B., Shabosky, L., Annecca, A., & Smith, J. (2018). Parent participation in the neonatal intensive care unit: Predictors and relationships to neurobehavior and developmental outcomes. *Early human development*, *117*, 32-38

Reeves, S., McMillan, S. E., Kachan, N., Paradis, E., Leslie, M., & Kitto, S. (2015). Interprofessional collaboration and family member involvement in intensive care units: emerging themes from a multi-sited ethnography. Journal of interprofessional care, 29(3), 230-237.

Reynolds, L. C., Duncan, M. M., Smith, G. C., Mathur, A., Neil, J., Inder, T., & Pineda, R. G. (2013). Parental presence and holding in the neonatal intensive

care unit and associations with early neurobehavior. *Journal of Perinatology*, *33*(8), 636-641.

Robson, K., MacMillan-York, E., & Dunn, M. S. (2016). Celebration in the face of trauma: supporting NICU families through compassionate facility design. *Newborn and Infant Nursing Reviews*, *16*(4), 225-229.

Roller, C. G. (2005). Getting to know you: mothers' experiences of kangaroo care. *Journal of Obstetric, Gynecologic, & Neonatal Nursing*, *34*(2), 210-217.

Sadler, B. L., Berry, L. L., Guenther, R., Hamilton, D. K., Hessler, F. A., Merritt, C., & Parker, D. (2011). Fable hospital 2.0: the business case for building better health care facilities. *Hastings Center Report*, *41*(1), 13-23.

Samra, H. A., Dutcher, J., McGrath, J. M., Foster, M., Klein, L., Djira, G., ... & Dowling, D. (2015). Effect of skin-to-skin holding on stress in mothers of late-preterm infants. *Advances in neonatal care*, *15*(5), 354-364.

Serrato, M., & Wîneman, J. (1999, March). Spatial and communication patterns in research & development facilities. In Second International Space Syntax Symposium (Vol. 1, pp. 11-1).

Shaver, E. F., & Braun, C. C. (2008). The Return on Investment (ROI) for Human Factors & Ergonomics Initiatives. *Benchmark Research & Safety Inc., Moscow*.

Shepley, M. M. (2011). Research methods for design practitioners to evaluate facilities. *HERD: Health Environments Research & Design Journal*, *4*(3), 7-13.

Shepley, M. M. (2014). Design for pediatric and neonatal critical care. Routledge.

Shepley, M. M., Harris, D. D., & White, R. (2008). Open-bay and single-family room neonatal intensive care units caregiver satisfaction and stress. Environment and Behavior, 40(2), 249-268.

Shepley, M. M., Smith, J. A., Sadler, B. L., & White, R. D. (2014). The business case for building better neonatal intensive care units. *Journal of Perinatology*, *34*(11), 811-815.

Sherman, S. A., Varni, J. W., Ulrich, R. S., & Malcarne, V. L. (2005). Post-occupancy evaluation of healing gardens in a pediatric cancer center. *Landscape and Urban Planning*, *73*(2-3), 167-183.

Skene, C., Franck, L., Curtis, P., & Gerrish, K. (2012). Parental involvement in neonatal comfort care. Journal of Obstetric, Gynecologic & Neonatal Nursing, 41(6), 786-797.

Spradlin, L. R. (2009). Implementation of a couplet care program for families after a cesarean birth. *AORN journal*, *89*(3), 553-562.

Stevens, D. C., Helseth, C. C., Thompson, P. A., Pottala, J. V., Khan, M. A., & Munson, D. P. (2012). A comprehensive comparison of open-bay and single-family-room neonatal intensive care units at Sanford Children's Hospital. *HERD: Health Environments Research & Design Journal*, *5*(4), 23-39.

Stokols, D., & Altman, I. (Eds.). (1987). *Handbook of environmental psychology* (Vol. 2). Wiley.

Tandberg, B. S., Frøslie, K. F., Flacking, R., Grundt, H., Lehtonen, L., & Moen, A. (2018). Parent-infant closeness, parents' participation, and nursing support in single-family room and open bay NICUs. *The Journal of Perinatal & Neonatal Nursing*, *32*(4), E22-E32.

Tandberg, B. S., Frøslie, K. F., Flacking, R., Grundt, H., Lehtonen, L., & Moen, A. (2018). Parent-infant closeness, parents' participation, and nursing support in single-family room and open bay NICUs. *The Journal of Perinatal & Neonatal Nursing*, *32*(4), E22-E32.

Tully, K. P., Holditch-Davis, D., White-Traut, R. C., David, R., O'Shea, T. M., & Geraldo, V. (2016). A test of kangaroo care on preterm infant breastfeeding. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, *45*(1), 45-61.

Ulrich, R. S. (1991). Effects of interior design on wellness: Theory and recent scientific research. Journal of Health Care Interior Design, 3(1), 97- 109.

Ulrich, R. S. (1997, January). A theory of supportive design for healthcare facilities. In *Journal of healthcare design: proceedings from the... Symposium on Healthcare Design. Symposium on Healthcare Design* (Vol. 9, pp. 3-7).

Ulrich, R. S., Zimring, C., Zhu, X., DuBose, J., Seo, H. B., Choi, Y. S., ... & Joseph, A. (2008). A review of the research literature on evidence-based healthcare design. *HERD: Health Environments Research & Design Journal*, *1*(3), 61-125.

Van Enk, R. A., & Steinberg, F. (2011). Comparison of private room with multiple-bed ward neonatal intensive care unit environments. *HERD: Health Environments Research & Design Journal*, *5*(1), 52-63.

Verhaeghe, S., Defloor, T., Van Zuuren, F., Duijnstee, M., & Grypdonck, M. (2005). The needs and experiences of family members of adult patients in an intensive care unit: a review of the literature. Journal of clinical nursing, 14(4), 501-509.

Vittner, D., McGrath, J., Robinson, J., Lawhon, G., Cusson, R., Eisenfeld, L., ... & Cong, X. (2018). Increase in oxytocin from skin-to-skin contact enhances development of parent–infant relationship. *Biological research for nursing*, *20*(1), 54-62.

Walsh, W. F., McCullough, K. L., & White, R. D. (2006). Room for improvement: Nurses' perceptions of providing care in a single room newborn intensive care setting. Advances in Neonatal Care : Official Journal of the National Association of Neonatal Nurses, 6(5), 261-270. doi:S1536-0903(06)00234-7 [pii]

Welch, M. G., Firestein, M. R., Austin, J., Hane, A. A., Stark, R. I., Hofer, M. A., ... & Myers, M. M. (2015). Family Nurture Intervention in the Neonatal Intensive Care Unit improves social-relatedness, attention, and neurodevelopment of preterm infants at 18 months in a randomized controlled trial. *Journal of Child Psychology and Psychiatry*, *56*(11), 1202-1211.

Welch, M. G., Hofer, M. A., Stark, R. I., Andrews, H. F., Austin, J., Glickstein, S. B., ... & Myers, M. M. (2013). Randomized controlled trial of Family Nurture

Intervention in the NICU: assessments of length of stay, feasibility and safety. *BMC pediatrics*, *13*(1), 1-10.

Whipple, J. (2000). The effect of parent training in music and multimodal stimulation on parent-neonate interactions in the neonatal intensive care unit. *Journal of Music Therapy*, *37*(4), 250-268.

White-Traut, R., Wink, T., Minehart, T., & Holditch-Davis, D. (2012). Frequency of premature infant engagement and disengagement behaviors during two maternally administered interventions. *Newborn and Infant Nursing Reviews*, *12*(3), 124-131.

White, R. (2012). Small comforts: Evidence-based design comes to the NICU.

White, R. D. (2003). Individual rooms in the NICU—an evolving concept. *Journal of Perinatology*, *23*(1), S22-S24.

White, R. D. (2016). The next big ideas in NICU design. *Journal of Perinatology*, *36*(4), 259-262.

White, R. D. (2016). The next big ideas in NICU design. *Journal of Perinatology*, *36*(4), 259-262.

White, R. D., Smith, J. A., & Shepley, M. M. (2013). Recommended standards for newborn ICU design. *Journal of Perinatology*, *33*(1), S2-S16.

Whitehouse, S., Varni, J. W., Seid, M., Cooper-Marcus, C., Ensberg, M. J., Jacobs, J. R., & Mehlenbeck, R. S. (2001). Evaluating a children's hospital garden environment: Utilization and consumer satisfaction. *Journal of environmental psychology*, *21*(3), 301-314.

Williams, K. G., Patel, K. T., Stausmire, J. M., Bridges, C., Mathis, M. W., & Barkin, J. L. (2018). The neonatal intensive care unit: environmental stressors and supports. *International journal of environmental research and public health*, *15*(1), 60.

Zeisel, J. (2006). Inquiry by design. *Environment/behavior/neuroscience in architecture, interiors, landscape, and planning*.

Zeskind, P. S., & Iacino, R. (1984). Effects of maternal visitation to preterm infants in the neonatal intensive care unit. *Child Development*, 1887-1893.

APPENDIX A

CORNELL IRB APPROVAL LETTER

Cornell University
Office of
Research Integrity and Assurance

East Hill Office Building, Suite 320
395 Pine Tree Road
Ithaca, NY 14850
p. 607-254-5162
f. 607-255-0758
www.irb.cornell.edu

Institutional Review Board for Human Participants

Notice of Exemption

To:	Sabah Nafeesa Mohammed
From:	Andrew Willford, IRB Chairperson
Protocol ID#:	2010009902
Protocol Title:	Understanding the Couplet Care environmental model and its effect on bonding between mother and infant.
Approval Date:	May 07, 2021
Expiration Date:	None

Your protocol has been granted exemption from IRB review according to Cornell IRB policy and under paragraph(s) 2 of the Department of Health and Human Services Code of Federal Regulations 45CFR 46.104(d).

• Paragraph 2 allows to be exempted from IRB review research activities in which the only involvement of human subjects will be in the following category: Surveys/Interviews/Standardized Educational Tests/Observation of Public BehaviorResearch involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior if:i) information obtained is recorded in such a manner that human subjects cannot be identified, directly or through identifiers linked to the subjects; orii) any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability or reputation.

Please note the following:

- Investigators are responsible for ensuring that the welfare of research subjects is protected and that methods used and information provided to gain participant consent are appropriate to the activity. Please familiarize yourself with and conduct the research in accordance with the ethical standards of the Belmont Report (https://www.hhs.gov/ohrp/regulations-and-policy/belmont-report/index.html) .
- Investigators are responsible for notifying the IRB office of change or amendments to the protocol and acquiring approval or concurrence **BEFORE** their implementation.
- Progress reports, requests for personnel or other administrative changes, or requests for continuation of approval are not required for the study. However, upon conclusion of the study, please submit a Project Closure form: http://www.irb.cornell.edu/forms.

APPENDIX B

BEACONS IRB APPROVAL LETTER

BEACON HEALTH SYSTEM

600 East Boulevard Elkhart, Indiana 46514
FWA 00029724 IORG 0003215 IRB 00003842

Date 4/2/2021

Sabah Mohammed
111 S. Cayuga Street
Ithaca, NY 14850
Sm2773@cornell.edu

RE: Understanding the Couplet Care Environment model and its effect on bonding between mother and infant

Dear Sabah,

The following documents were received:

- Application for exempt research review
- Neonatal Study Poster
- Interview Script
- Neonatal experience survey tool
- Participant consent form
- Dr. White consent letter
- Human Research Protections Training – Kathryn Peditto
- Human Research Protections Training – Mardelle Shepley
- Human Research Protections Training – Jane Mendle
- Human Research Protections Training – Sabah Mohammed
- Human Research Protections Training – Robert White

Your protocol involves validating a tool to measure the effect of the Couplet Care Experience and to find associations between elements of the Couplet Care Experience and maternal stress and hospital stay satisfaction. Per your exempt review application, eligible mothers will be identified by the healthcare team. They will be given your study participation poster. If the mother wishes to participate, she will voluntarily scan the URL code off of the poster which will provide her with written information about the study and allow her to give consent for participation if she so desires. If consent is given the participant will provide you with contact information for future follow up with a survey.

This protocol presents no more than minimal risk to the research participants. The data collected will be kept in a secure location with adequate protections for privacy and confidentiality.

This research qualifies for exemption from IRB review.
Category 2
Research that only includes interactions involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior (including visual or auditory recording) if any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability; or be damaging to the subjects' financial standing, employability, or reputation. NOTE: For research that

BEACON HEALTH SYSTEM

600 East Boulevard· Elkhart, Indiana 46514
FWA 00029724 IORG 0003215 IRB 00003842

November 17, 2021

Sabah Mohammed
111 S. Cayuga Street
Ithaca, NY 14850
Sm2773@cornell.edu

RE: Understanding the Couplet Care Environment model and its effect on bonding between mother and infant

Dear Sabah,

The following documents were received:

- Patient item – poster for recruitment
- Informed Consent – English from 11/10/21 received in email.

IRB Internal # 2151

The amended patient recruitment poster and informed consent are approved for use and do not change the *exempt from review* status of your study.

The Beacon Institutional Review Board complies with the FDA and OHRP requirements for IRBs.

If you have any questions please call me at 574-523-3437 or Betty McKinney at 574-296-6505.

Respectfully yours,

Darra Savick, Pharm.D., R.Ph.
Chairperson
Institutional Review Board

/bm

APPENDIX C

SURVEY INTRODUCTION

Dear Parent, Greetings from the NICU team at Beacon Children's Hospital!
We are collaborating with a research team from Cornell University's College of Human Ecology. We are interested in **understanding the Couplet Care Environment model and its effect on bonding between mother and infant**.

What the study is about

The purpose of this research is to identify the outcomes associated with the Couplet Care Experience (CCE). Couplet Care refers to the practice of delivering NICU care to the infant and postpartum care to the mother in a **same NICU room** – this is available in only a few NICUs throughout the world, so we are curious to learn how to do it better, and much of that knowledge will come from you, based on your own experience.

The Research Team

This study is being led by Sabah Mohammed from the Department of Design + Environmental Analysis at Cornell University. The Faculty Advisor for this study is Dr. Mardelle McCuskey Shepley and the study team at Beacon Children's includes Dr. Robert White M.D., Director, Regional Newborn Program, Memorial Hospital of South Bend and Mashelle Monhaut MSN, NNP-BC, NICU Research Coordinator.

What we will ask you to do

If you consent, you will be asked to complete this survey upon discharge. It consists of 9 sections and should take **15 minutes to complete**.

Risks and discomforts

A risk to participant privacy exists through a potential breach of confidentiality. Only study staff will have access to the password-protected master list that will link the

patient information with the study identifier. Apart from a potential loss of confidentiality, we do not anticipate any other risks from participating in this research.

Taking part is voluntary

Your participation and involvement in this study is voluntary. As a study participant, you may refuse to participate before the study begins, discontinue at any time, or skip any questions or procedures that may make you feel uncomfortable, with no penalty to you or your relationship with any of the organizations or services that are involved with the research. You can choose not to participate in this study if you are uncomfortable with these conditions.

Compensation for participation

- In appreciation for your time, you will receive a **$15 Amazon gift card**, which is conditional on survey completion.
- If you consent to participate in a follow-up interview, you will receive a **$25 Amazon gift card**.
- Participants also stand a chance to win 1 of 2 **$50 Amazon gift cards**. At the end of the survey, you will be prompted to provide an email address where you would like to receive your gift card(s).

Follow up studies

We may contact you again to request your participation in a follow up study which involves a virtual interview. In appreciation for your time, you will receive a $25 Amazon gift card. As always, your participation will be voluntary, and we will ask for your explicit consent to participate in any of the follow up studies.

May we contact you again to request your participation in a follow up study?

Yes

No

If you have questions

The main researcher conducting this study is Sabah Mohammed, a graduate student at Cornell University. If you have any questions regarding this study, you may contact Sabah Mohammed at sm2773@cornell.edu or at +1(209)4078942. If you have any questions or concerns regarding your rights as a subject in this study, you may contact the Institutional Review Board (IRB) for Human Participants at 607-255-5138 or access their website at http://www.irb.cornell.edu. You may also report your concerns or complaints anonymously through Ethicspoint online at www.hotline.cornell.edu or by calling toll free at 1-866-293-3077. Ethicspoint is an independent organization that serves as a liaison between the University and the person bringing the complaint so that anonymity can be ensured.

If you consent to participate in this study, you will be sent a copy of this consent form to your email address.

Statement of Consent

I have read the above information and have received answers to any questions I asked. I consent to take part in the study.

Yes

Your name: (First name, Last name) _____

Your email address: _____

Today's Date (MM/DD/YYYY): _____

Printed name of person obtaining consent: SABAH MOHAMMED

This consent form will be kept by the researcher for five years beyond the end of the study.

NEONATAL EXPERIENCE SURVEY

Block 1- MOTHER TO INFANT BONDING SCALE

These questions are about your feeling for your child recently. Some adjectives are listed below which describe some of the emotions mothers have toward their baby in the first weeks after they were born. Please check the box for each word which best describes how you feel in these first weeks with your baby.

	VERY MUCH	A LOT	A LITTLE	NOT AT ALL
Loving				
Resentful				
Neutral or felt nothing				
Joyful				

Dislike				
Protective				
Disappointment				
Aggressive				

Block 2- NEONATAL SATISFACTION SURVEY

	Very Dissatisfied	Quite Dissatisfied	Neither Satisfied or Dissatisfied	Quite Satisfied	Very Satisfied
All in all, how satisfied or dissatisfied are you with the treatment the child received at the hospital?					
All in all, how satisfied or dissatisfied are you with how you as the mother were treated?					
To what extent did you experience that a permanent group of care givers/nurses were looking after you and your child?					
To what extent did you experience that the employees co-operated on the treatment and care the child received?					

Did you experience that the treatment and care the child received at the hospital followed a thought-out plan?					
To what extent did you experience that you were taken care of upon arrival at the unit?					
To what extent did you experience that the child were taken care of upon arrival at the unit?					
To what extent did you experience that you were taken care of later in the process?					
To what extent did you experience that the child were taken care of later in the process?					
To what extent did you experience that you received guidance / training in meeting your child's needs?					

I experienced that both mother and father were treated equally by the unit.					

To what extent did you experience that the care personnel:	**Not at all**	**In small extent**	**In some extent**	**Largely**	**Very large extent**
Took your family situation into consideration?					
Provided relief or assistance to the admitted child during the stay?					
Informed you about your responsibilities as the mother to the child at the hospital?					
Had consideration and care for the child?					
Had consideration and care for you?					
Were interested in hearing your opinions as mother?					
Gave you explanations in a way you understood?					
Were available/stayed in reasonable proximity to the child?					

Signaled that they had time for you?					
Appeared professionally competent?					

	Not at all	**In small extent**	**In some extent**	**Largely**	**Very large extent**
Were you angry, upset or disappointed in the hospital personnel during the stay?					
I experienced that the personnel showed understanding and respect for our situation.					
While the child was admitted, did you experience that the personnel kept agreements regarding ringing you (when you were not at the unit) in the event of changes in the child's condition or treatment?					
To what extent did you experience that one doctor had the principal responsibility for the child?					

To what degree do you think the doctors…	**Not at all**	**In small extent**	**In some extent**	**Largely**	**Very large extent**

Showed care and consideration for the child?					
Showed care and consideration for you?					
Were interested in hearing your opinions as mother?					
Gave you explanations in a way you understood?					
Gave you and your child sufficient information regarding the prognosis/outcome?					
Appeared professionally competent?					
Took your family situation into consideration?					
Signaled that they had time for you?					

	Not at all	**In small extent**	**In some extent**	**Largely**	**Very large extent**
All in all, how satisfied were you with the conditions for visiting at the unit?					
All in all, how satisfied were you with the routines for visiting in the unit?					

All in all, how satisfied were you with the conditions for visiting your child?					
All in all, how satisfied were you with other children's families visiting?					

Block 3- PARENTAL STRESS SCALE

We are interested in knowing more about the stresses experienced by parents when a premature is sick and hospitalized in a neonatal intensive care unit (NICU). We would like to know about your experience as a parent whose child is presently in the NICU.

This questionnaire lists various experiences other parents have reported as stressful when their baby was in the NICU. We would like you to indicate how stressful each item listed below has been for you. **By stressful, we mean that the experience has caused you to feel anxious, upset, or tense.** On the questionnaire, circle the single number that best expresses how stressful each experience has been for you. The numbers indicate the following levels of stress:

1 = Not at all stressful the experience did not cause you to feel upset, tense, or anxious

2 = A little stressful

3 = Moderately stressful

4 = Very stressful

5 = Extremely stressful

If you have not experienced an item, please circle NA "not applicable"

Now let's take an item for an example: **The bright lights in the NICU**.

If for example you feel that the bright lights in the neonatal intensive care unit were extremely stressful to you, you would circle the number 5 below:

NA 1 2 3 4 **5**

If you feel that the lights were not stressful at all, you would circle the number 1 below:

NA **1** 2 3 4 5

Below is a list of the various **SIGHTS AND SOUNDS** commonly experienced in an NICU. We are interested in knowing about your view of how stressful these **SIGHTS AND SOUNDS** are for you. Circle the number that best represents your level of stress. If you did not see or hear the item, circle the NA meaning "Not applicable."

1.	The presence of monitors and equipment	NA 1 2 3 4 5
2.	The constant noises of monitors and equipment	NA 1 2 3 4 5
3.	The sudden noises of monitor alarms	NA 1 2 3 4 5
4.	The other sick babies in the room	NA 1 2 3 4 5
5.	The large number of people working in the unit	NA 1 2 3 4 5

Below is a list of items that might describe the way your **BABY LOOKS AND BEHAVES** while you are visiting in the NICU as well as some of the **TREATMENTS** that you have seen done to the baby. Not all babies have these experiences or look this way, so circle the NA, if you have not experienced or seen the listed item. If the item reflects something that you have experienced, then indicate how much the experience was stressful or upsetting to you by circling the appropriate number.

6.	Tubes and equipment on or near my baby	NA 1 2 3 4 5
7.	Bruises, cuts, or incisions on my baby	NA 1 2 3 4 5
8.	The unusual color of my baby (for example looking pale or yellow jaundiced)	NA 1 2 3 4 5
9.	My baby's unusual or abnormal breathing patterns	NA 1 2 3 4 5

10.	The small size of my baby	NA 1 2 3 4 5
11.	The wrinkled appearance of my baby	NA 1 2 3 4 5
12.	Having a machine (respirator) breathe for my baby	NA 1 2 3 4 5
13.	Seeing needles and tubes put in my baby	NA 1 2 3 4 5
14.	My baby being fed by an intravenous line or tube	NA 1 2 3 4 5
15.	When my baby seemed to be in pain	NA 1 2 3 4 5
16.	When my baby looked sad	NA 1 2 3 4 5
17.	The limp and weak appearance of my baby	NA 1 2 3 4 5
18.	Jerky or restless movements of my baby	NA 1 2 3 4 5
19.	My baby not being able to cry like other babies	NA 1 2 3 4 5

The last area we want to ask you about is how you feel about your own **RELATIONSHIP** with the baby and your **PARENTAL ROLE**. If you have experienced the following situations or feelings, indicate how stressful you have been by them by circling the appropriate number. Again, circle NA if you did not experience the item.

20.	Being separated from my baby	NA 1 2 3 4 5
21.	Not feeding my baby myself	NA 1 2 3 4 5
22.	Not being able to care for my baby myself (for example, diapering, bathing)	NA 1 2 3 4 5
23.	Not being able to hold my baby when I want	NA 1 2 3 4 5
24.	Feeling helpless and unable to protect my baby from pain and painful procedures	NA 1 2 3 4 5

25.	Feeling helpless about how to help my baby during this time	NA 1 2 3 4 5
26.	Not having time alone with my baby	NA 1 2 3 4 5

Block 4- BREASTFEEDING SUPPORT SCALE

Which of the following sources of breastfeeding information or support have you used, or do you plan to use in the future to help you with breastfeeding your baby? Check all that apply.

Source of information or support	Have used	Plan to use
Doctor or physician assistant		
Nurse, nurse midwife, or nurse practitioner		
Nutritionist or dietitian		
Lactation consultant		
Breastfeeding classes		
WIC food program		
Friends		
Family members		
Breastfeeding support group		
Telephone support helpline		
Newspapers or magazines		
Websites		
Books or videos		
Mobile app		
Other (please specify):		
None of the above		

Block 5- DISCHARGE DATA

Infant Date of Birth (MM/DD/YYYY)	
Mother's Date of Birth (MM/DD/YYYY)	
Admission Date (MM/DD/YYYY)	
Discharge Date (MM/DD/YYYY)	
Infant Weight (please specify if it is in ounces or grams)	

APPENDIX D

INTERVIEW SCRIPT

Understanding The Couplet Care Environmental Model and Its Effect On Bonding Between The Mother And Infant Dyad

Principal Investigator: *Sabah Mohammed– Cornell University*

INTRODUCTION

Thank you for agreeing to participate in this interview. I am conducting this research as part of my master's thesis, which aims to improve the quality of care for mothers and newborn infants. The evolution of neonatology began with small rooms carved out from newborn nurseries, then evolved into bright, noisy, crowded, and sometimes windowless units. More recently, hospitals are providing single-family rooms where the parents can reside with their babies. There is an emerging model of care for the mother-baby dyad when either or both members of the dyad require hospital care. Instead of separating the mother and baby, there is a NICU/maternity iteration called *couplet care* whose guiding principle is to keep the mother and baby together after delivery. This model facilitates essential skin-to-skin contact and promotes a family-centered care approach. I am interested in knowing if these environments are encouraging bonding between the mother and infant, and consequently whether that increases the satisfaction with the neonatal experience. By conducting interviews with patients who have experienced this model of care, I am hoping to better understand which physical environmental features and supporting

technologies are beneficial to patients. In our conversation today, we'll talk very generally about your experience with the couplet care model.

CONSENT

Before we begin, I'd like to briefly go over the consent form that was provided earlier via email. In particular, this interview will be recorded. Neither your name nor any other identifying information will be associated with the audio recording or the transcript. Only the research team will be able to listen to the recordings. The tapes will be transcribed by the researcher and erased once the transcriptions are checked for accuracy. Transcripts of your interview may be reproduced in whole or in part for use in presentations or written products that result from this study, but neither your name nor any other identifying information (such as your voice or picture) will be used in presentations or in written products.

INTERVIEW

1. In your own words, what is your connection to couplet care?
2. In your experience, what is missing for new mothers? This could include specific resources, spaces and physical environmental features within a hospital, or something broader.
3. Where do you think mothers' bond with their newborn infants?
4. How do you think being able to be in the same room with your infant post-partum has changed the patient experience?

5. What would you change if you were trying to improve feelings of early bonding between mothers and their infants with respect to the physical environment or technology?
6. Would you prefer to have a room that would allow a family member to stay the night?
7. How do you think having a separate neonatal intensive care unit for your infant would impact your neonatal experience?
8. What were some of your fears regarding breastfeeding and skin-to-skin care post-delivery?

APPENDIX E

PARTICIPANT RECRUITMENT MATERIAL

Help us understand your Couplet Care Experience

Couplet Care offered here at the Beacon Children's NICU, is a new practice of delivering care to the infant and mother in a same NICU room during the crucial first days after birth.

Please join our study to learn more about the optimal ways we can deliver care.

Please follow this link-
https://cornell.ca1.qualtrics.com/jfe/form/SV_cLQNCkolneHLKHI

Eligibility

Mothers who are 18+ years of age whose infants were born at a gestational age of 32 weeks or greater.

Compensation

$15 in Amazon gift cards and an entry to win a $50 gift card.

Time

15 minutes

For any questions, please contact: Sabah Mohammed sm2773@cornell.edu

APPENDIX F

BEACON CHILDREN'S HOSPITAL FACILITY TOUR

1. Who maintains an inventory of spaces, devices?
2. Renovation year? May 2017
3. Standard warmer-
    a. L&D – 3rd Floor
    b. CCU – 6th Floor
    c. Flexible incubators are also available
4. Family space- Overnight stay (24*7), closet space, Couch➡bed, refrigerator space, Ronald McDonald space – post discharge
5. NICU is a locked unit only accessible by badge
6. View- Positive Distraction- Play space, atrium spaces, rooftop garden, close proximity to pediatric space.
7. Atrium space- sponsorship during events, holidays, used as pediatric space
8. Rooftop garden space-
    a. For patients, staff (separate spaces with wrought iron divider)
    b. Ribbon tree memorializing lost babies
9. Family Lounge space- coffee machine
10. Staff Lounge (for all staff)
    a. Pump room for nurses
    b. Zen room with massage chair
    c. Staff use rooftop garden space
        i. Staff take care of certain section of the rooftop garden
        ii. Memorialized plants for physicians & nurses who've passed away
11. Angel Eye- became popular during Covid for extended family to see the newborn infant (livestream for extended family)
12. Multipurpose room for twins, triplets. Connected rooms for triplets, quadruplets.
13. Sibling space
14. Full ensuite bathroom
15. Team- Dr. White, Nursing Director, Manager of the unit, Nursing team, Environmental Services
16. Childcare services all in one floor
    (1986)
    a. 2nd Floor ED
    b. 3rd Floor L&D (Dedicated elevator to 6th Floor)
    c. 4th Floor Pediatrics, Oncology, Hematology (smaller floor)
    d. 5th Floor General Pediatrics
    e. 6th Floor NICU
17. 3rd attempt at building Children's hospital
18. Nursing support
    a. Encourage families to begin skin-to-skin as early as possible

    b. National Kangaroo Care Day
19. Patient journey
    a. Stay 2-3 hours at L&D
    b. Brought to CCU (post-partum)
    c. Lactation Consultants visit (encourage to Nurse or Pump)
    d. Skin-to-skin within 1-2 days of delivery
20. Average stay 2 – 4 days depending on vaginal/C-section, time of day
21. Occupancy Rate-
    a. 25-26 babies at a time
    b. 2-3 moms
22. Old NICU
    a. Connected to old units
    b. Currently used as a stabilization space
    c. Stabilization room- direct connection to C-section rooms
    d. 12 beds in each room (8 rooms in total)
    e. Max 2 caregivers at each bedside
    f. Step down unit present- 1 room with 12 beds
    g. Old NICU will be repurposed to the pharmacy very soon

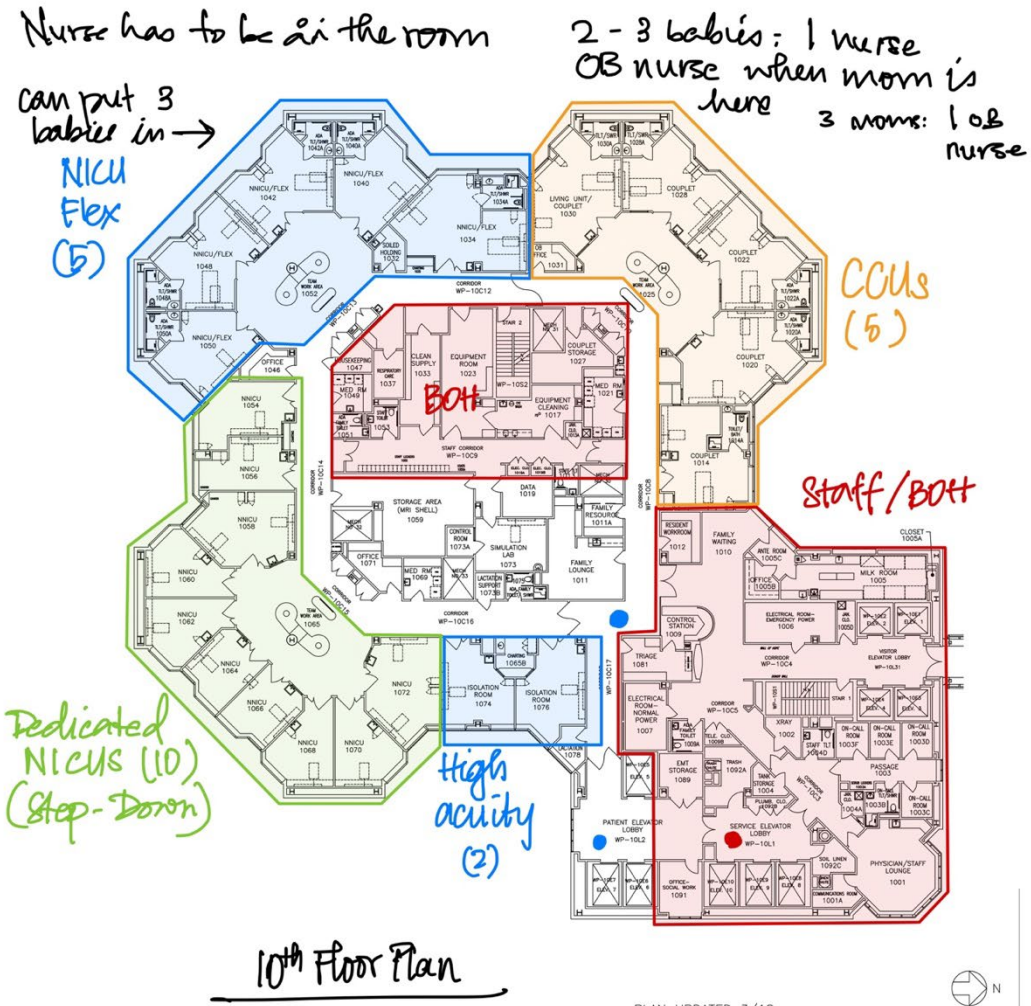
APPENDIX G

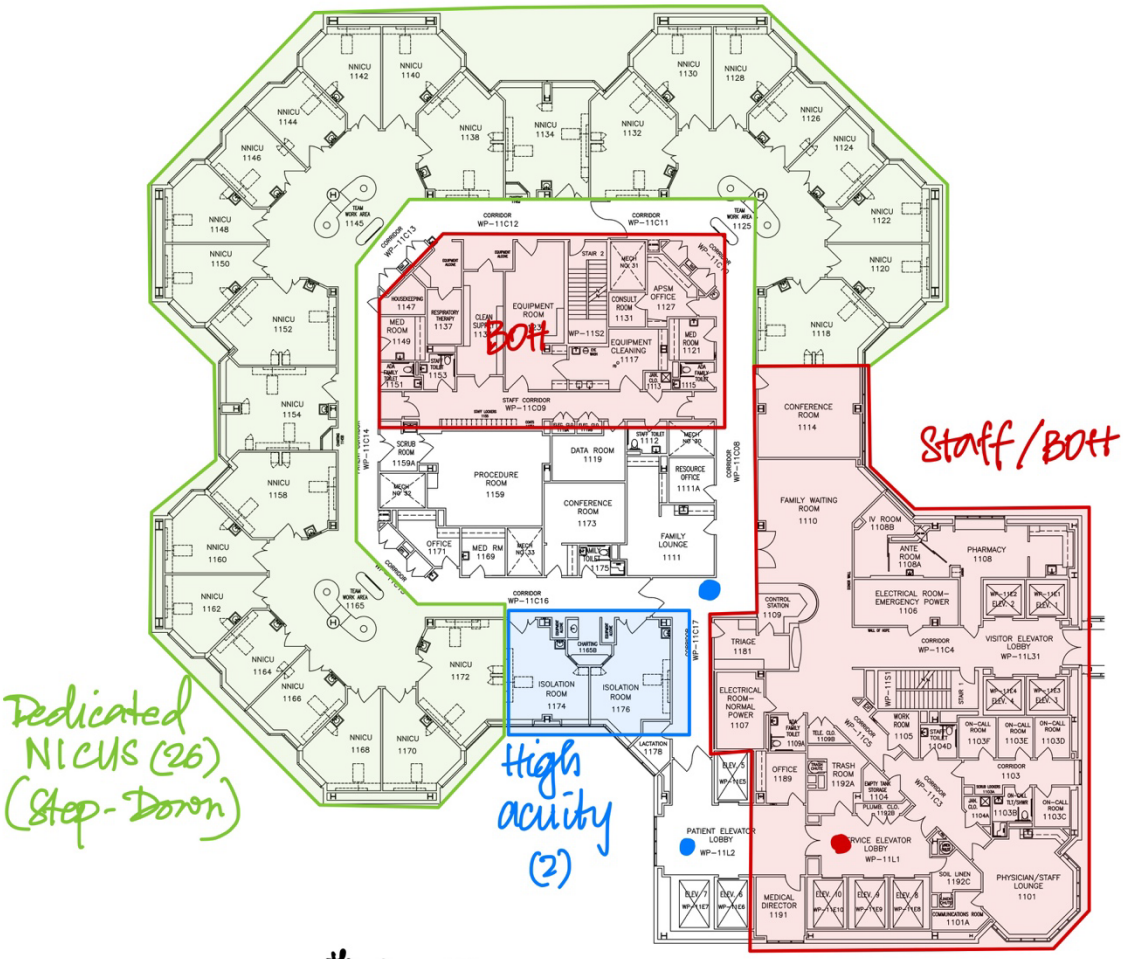
YALE NEW HAVEN HOSPITAL FACILITY TOUR

1. Unit completed in January 2018
2. NICUs organized into pods- but it can be confusing for staff to distinguish pods during rotations
3. Serves the shoreline of CT
4. Strong maternal and fetal program so a lot of mothers are referred here
5. Couplet Care Room-
    a. Reclining chair for family x 2
    b. Convertible sofa (to table or overnight bed) x 2
        i. Support person/overnight guest sleeps on moms' side
    c. Closet space
    d. Adult sized bathroom, handicap accessible
    e. Pump
    f. Milk warmer
    g. TV
    h. Windows with views to Yale School of Medicine, the NH harbor and occasionally into the atrium
6. Nursing ratios-
    a. 2-3 (babies):1 (nurse)
    b. OB nurse is present when mom is in the CCU
    c. 3 (moms):1 (nurse)
7. Occupancy rate-
    a. 64-68 babies in 2020 (could not do couplet care because of the high baby occupancy rate)
    b. 54 babies in 2021 (try to maintain it at 50 babies at a given time)
8. Avg length of stay in CCU-
    a. Moms- 2-4 days depending on vaginal/C-section, can stretch to 3-4 days depending on OB/GYN team
    b. Babies stay on for longer (depending on acuity)
    c. Try to discharge both together
9. Alicia's Angels room-
    a. Special Room for babies who are taken off medical support (terminal infants)
    b. Designed to feel like a room at home – couch, a Murphy bed for parents and baby to sleep together and have some moments together
    c. Closure for parents
    d. Dignified death for infants, surrounded by family
10. NICU Flex unit (5)-
    a. Can put 3 babies in each unit
    b. Nurse must be in the room
11. Family Lounge space-

a. Limited access during Covid- to keep staff low in high traffic areas
b. Washer/dryer for families staying overnight

12. Neonatal MRI-
    a. Earlier – used the MRI on 2nd/3rd floor, took a lot of time to transfer babies
    b. Now – set up timings with Technicians at the MRI downstairs (mostly around noon, M-F)- easy to transfer
13. Places for respite-
    a. Waiting Room – have chairs that convert to beds
    b. Healing Garden in the next pavilion
14. Floor-wise planning
    a. 3rd floor – Pediatric unit (PICU)- overlap when cardio babies first come to the NICU and then transferred to PICU
    b. 4th floor – C-section
    c. 8th floor – port partum unit
    d. 10th floor – Close to Pharmacy
15. Overnight policy-
    a. Dad/Partner/Support person can stay overnight in CCU
    b. Covid policies only allowed 1 parent in the unit at the time
    c. During COVID, some moms choose not to stay in the CCU, since there are limitations to visitation (usually if they have another older child)
    d. Pre-COVID- the only visitation limitation was for kids (siblings) not vaccinated esp. during flu season
16. Facetime with extended families- a dedicated staff member to facilitate this
17. Lactation support- 4th Floor & 8th Floor rely on perinatal lactation consultants and NICU relies on post-partum consultants. Sometimes there is a flex/overlap depending on occupancy surges/staffing
18. Post-discharge families stay at-
    a. Hotels close by
    b. Go home (if they stay close by)
    c. Ronald McDonald House (RMH)-
        i. How often do families use it?
        ii. Its' use is limited to families within a certain radius on RMH
19. Services needed in close proximity-
    a. Radiology
    b. Pharmacy
    c. Lactation/Nutrition
    d. Occupational/Speech Therapy
    e. Music Therapy
20. Skin-to-skin – encouraged by nurses and lactation consultants the most
21. Parent education-
    a. Classes set up and scattered through the week
    b. CPR training is the most important component
    c. Not-acuity specific
    d. No cohorts, just general classes


Nurse has to be in the room
2 - 3 babies : 1 nurse
OB nurse when mom is here
3 moms: 1 OB nurse
can put 3 babies in →
NICU Flex (5)
CCUs (5)
BOTH
Staff/BOTH
Dedicated NICUs (10) (Step-Down)
High acuity (2)
10th Floor Plan
PLAN UPDATED 3/18
MASTER PLAN
EPSPWP-10
1/16"=1'-0"
LEVEL
10


Dedicated NICUS (26) (Step-Down)
BOTH
Staff/BOTH
High acuity (2)
11th Floor Plan
PLAN UPDATED 2/18
MASTER PLAN
EPSPWP-11
DRAWING TITLE
1/16"=1'-0"
SCALE
LEVEL
11
UPDATED
DWN.
CKD.
DRAWING NUMBER

APPENDIX H

FACILITY LETTER OF APPROVAL

MEMORIAL
CHILDREN'S HOSPITAL

Oct. 19, 2020

To Whom it May Concern,

I, Dr. Robert Dennis White M.D., Director, Regional Newborn Program, Memorial Hospital of South Bend, acknowledge that Sabah Mohammed, a Master of Science degree candidate at Cornell University will be recruiting participants and collecting data from the NICU ward at Memorial Hospital for her thesis titled 'Understanding the Couplet Care experience model and its effect on bonding between mother and infant'.

Sincerely,

Robert D. White

Dr. Robert D. White
Date: 10/19/20

615 N. Michigan St. | South Bend, IN 46601 | MemorialChildrensHospital.org

APPENDIX I

SURVEY RESULTS

Figure x

Care Personnel Score v. Sights and Sounds Score

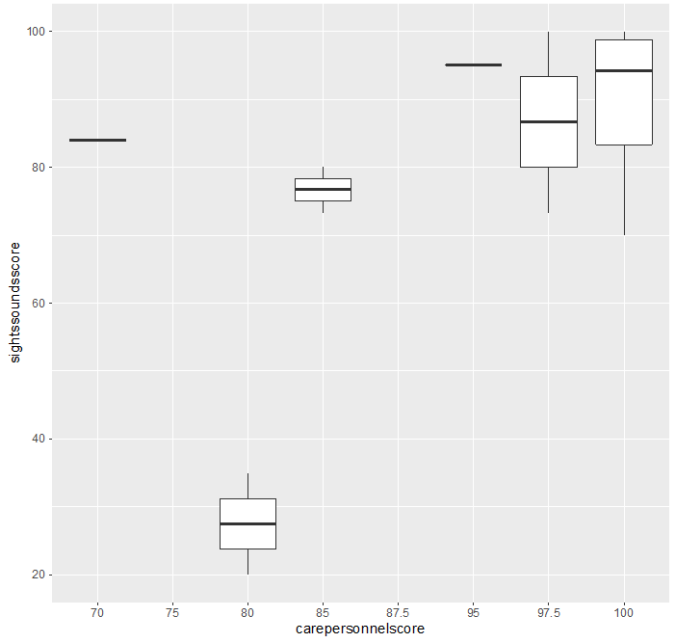


Figure 2

Care Personnel Score v. Baby Environment and Appearance Score

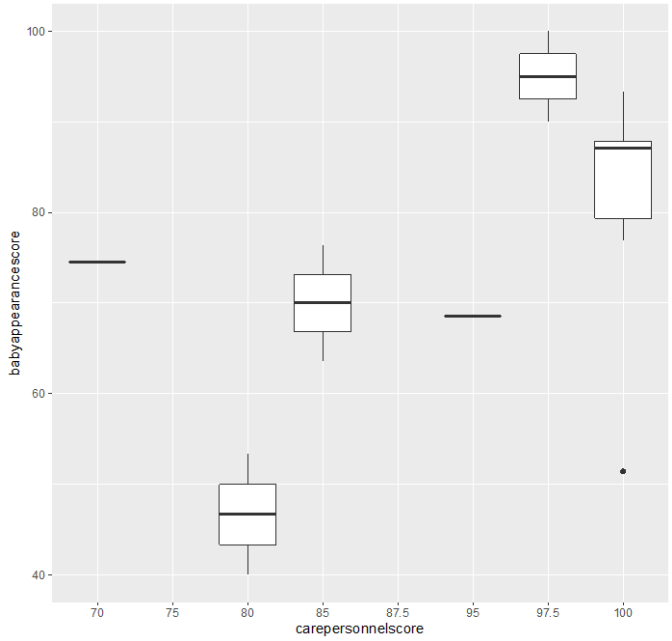


Figure 3

Breastfeeding support module- Doctor or Physician Assistant v. Emotion Score

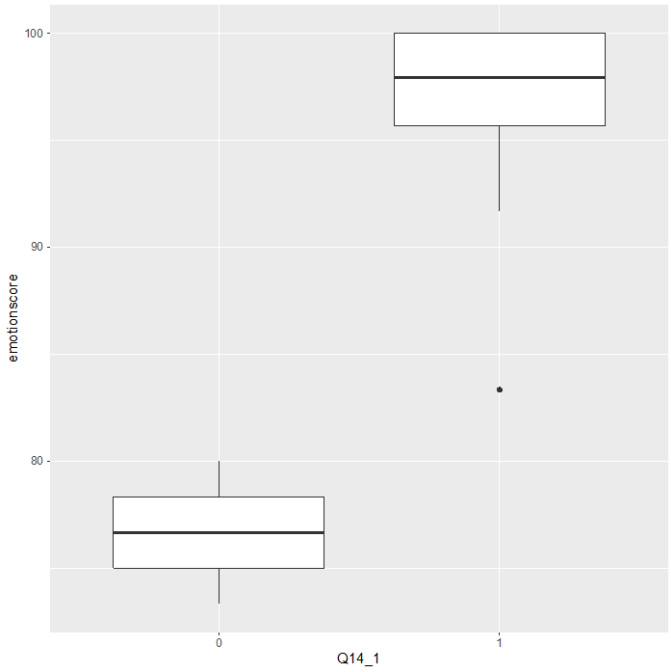


Figure 4

Breastfeeding support module- Breastfeeding Classes v. Emotion Score

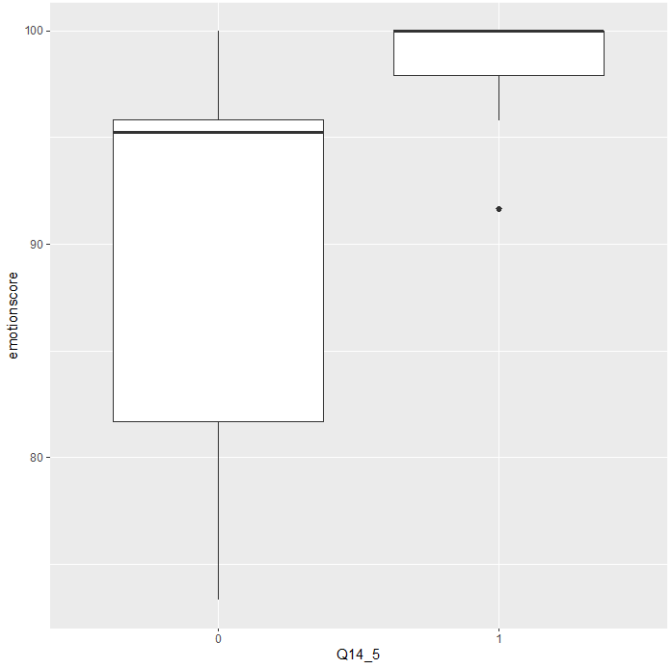


Figure 5

Breastfeeding support module- Webistes v. Emotion Score

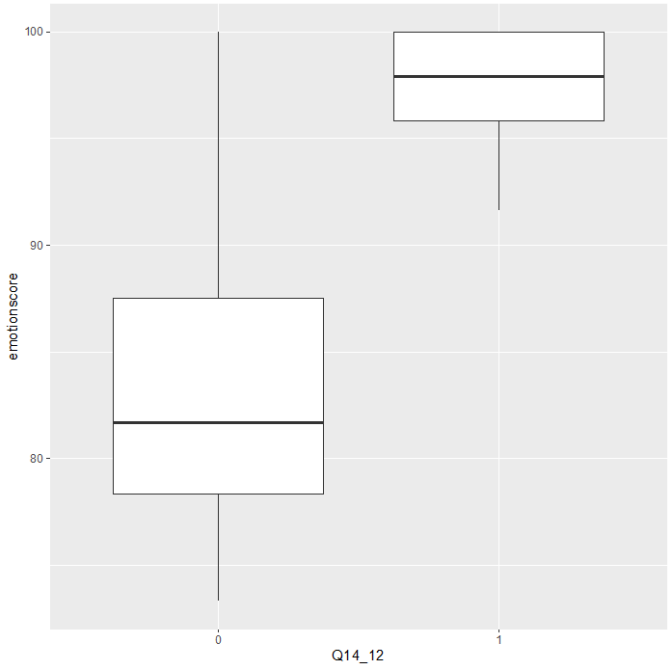
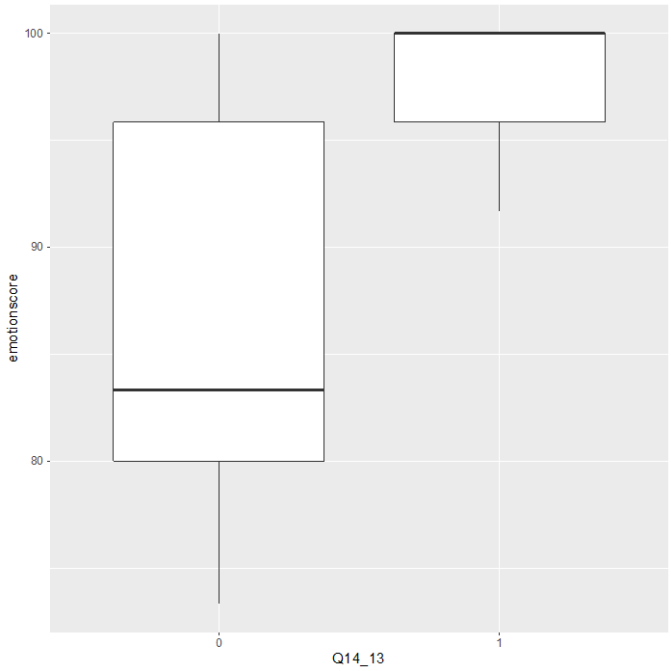


Figure 6

Breastfeeding support module- Books or Videos v. Emotion Score

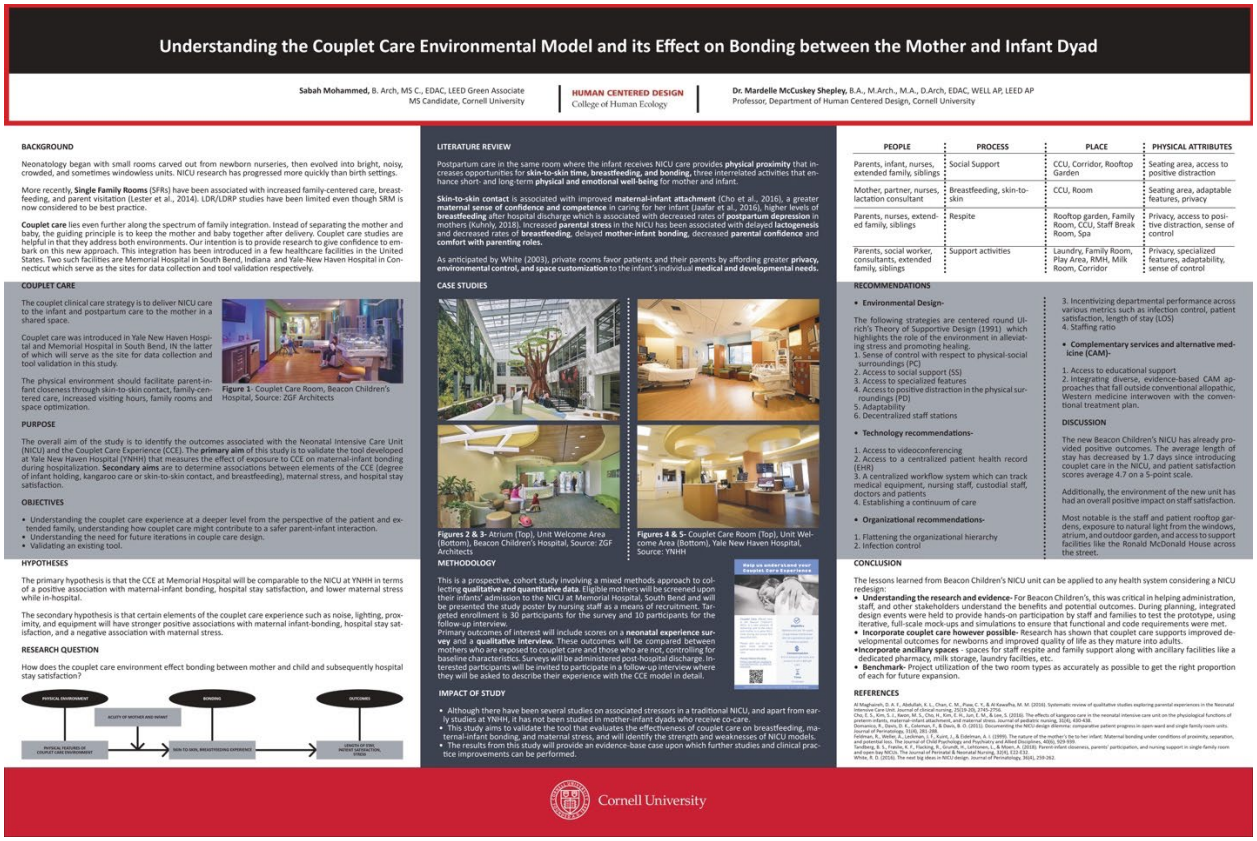


APPENDIX J

QUALITATIVE INTERVIEW RESULTS

APPENDIX K

GRAVENS CONFERENCE POSTER



Understanding the Couplet Care Environmental Model and its Effect on Bonding between the Mother and Infant Dyad

Sabah Mohammed, B. Arch, MS C., EDAC, LEED Green Associate
MS Candidate, Cornell University

HUMAN CENTERED DESIGN
College of Human Ecology

Dr. Mardelle McCuskey Shepley, B.A., M.Arch., M.A., D.Arch, EDAC, WELL AP, LEED AP
Professor, Department of Human Centered Design, Cornell University

BACKGROUND

Neonatology began with small rooms carved out from newborn nurseries, then evolved into bright, noisy, crowded, and sometimes windowless units. NICU research has progressed more quickly than birth settings.

More recently, **Single Family Rooms** (SFRs) have been associated with increased family-centered care, breastfeeding, and parent visitation (Lester et al., 2014). LDR/LDRP studies have been limited even though SRM is now considered to be best practice.

Couplet care lies even further along the spectrum of family integration. Instead of separating the mother and baby, the guiding principle is to keep the mother and baby together after delivery. Couplet care studies are helpful in that they address both environments. Our intention is to provide research to give confidence to embark on this new approach. This integration has been introduced in a few healthcare facilities in the United States. Two such facilities are Memorial Hospital in South Bend, Indiana and Yale-New Haven Hospital in Connecticut which serve as the sites for data collection and tool validation respectively.

COUPLET CARE

The couplet clinical care strategy is to deliver NICU care to the infant and postpartum care to the mother in a shared space.

Couplet care was introduced in Yale New Haven Hospital and Memorial Hospital in South Bend, IN the latter of which will serve as the site for data collection and tool validation in this study.

The physical environment should facilitate parent-infant closeness through skin-to-skin contact, family-centered care, increased visiting hours, family rooms and space optimization.

Figure 1- Couplet Care Room, Beacon Children's Hospital, Source: ZGF Architects

PURPOSE

The overall aim of the study is to identify the outcomes associated with the Neonatal Intensive Care Unit (NICU) and the Couplet Care Experience (CCE). The **primary aim** of this study is to validate the tool developed at Yale New Haven Hospital (YNHH) that measures the effect of exposure to CCE on maternal-infant bonding during hospitalization. **Secondary aims** are to determine associations between elements of the CCE (degree of infant holding, kangaroo care or skin-to-skin contact, and breastfeeding), maternal stress, and hospital stay satisfaction.

OBJECTIVES

- Understanding the couplet care experience at a deeper level from the perspective of the patient and extended family, understanding how couplet care might contribute to a safer parent-infant interaction.
- Understanding the need for future iterations in couple care design.
- Validating an existing tool.

HYPOTHESES

The primary hypothesis is that the CCE at Memorial Hospital will be comparable to the NICU at YNHH in terms of a positive association with maternal-infant bonding, hospital stay satisfaction, and lower maternal stress while in-hospital.

The secondary hypothesis is that certain elements of the couplet care experience such as noise, lighting, proximity, and equipment will have stronger positive associations with maternal infant-bonding, hospital stay satisfaction, and a negative association with maternal stress.

RESEARCH QUESTION

How does the couplet care environment effect bonding between mother and child and subsequently hospital stay satisfaction?

LITERATURE REVIEW

Postpartum care in the same room where the infant receives NICU care provides **physical proximity** that increases opportunities for **skin-to-skin time, breastfeeding, and bonding**, three interrelated activities that enhance short- and long-term **physical and emotional well-being** for mother and infant.

Skin-to-skin contact is associated with improved **maternal-infant attachment** (Cho et al., 2016), a greater **maternal sense of confidence and competence** in caring for her infant (Jaafar et al., 2016), higher levels of **breastfeeding** after hospital discharge which is associated with decreased rates of **postpartum depression** in mothers (Kuhnly, 2018). Increased **parental stress** in the NICU has been associated with delayed **lactogenesis** and decreased rates of **breastfeeding**, delayed **mother-infant bonding**, decreased **parental confidence** and **comfort with parenting roles.**

As anticipated by White (2003), private rooms favor patients and their parents by affording greater **privacy, environmental control, and space customization** to the infant's individual **medical and developmental needs.**

CASE STUDIES

Figures 2 & 3- Atrium (Top), Unit Welcome Area (Bottom), Beacon Children's Hospital, Source: ZGF Architects

Figures 4 & 5- Couplet Care Room (Top), Unit Welcome Area (Bottom), Yale New Haven Hospital, Source: YNHH

METHODOLOGY

This is a prospective, cohort study involving a mixed methods approach to collecting **qualitative and quantitative data**. Eligible mothers will be screened upon their infants' admission to the NICU at Memorial Hospital, South Bend and will be presented the study poster by nursing staff as a means of recruitment. Targeted enrollment is 30 participants for the survey and 10 participants for the follow-up interview.
Primary outcomes of interest will include scores on a **neonatal experience survey** and a **qualitative interview.** These outcomes will be compared between mothers who are exposed to couplet care and those who are not, controlling for baseline characteristics. Surveys will be administered post-hospital discharge. Interested participants will be invited to participate in a follow-up interview where they will be asked to describe their experience with the CCE model in detail.

IMPACT OF STUDY

- Although there have been several studies on associated stressors in a traditional NICU, and apart from early studies at YNHH, it has not been studied in mother-infant dyads who receive co-care.
- This study aims to validate the tool that evaluates the effectiveness of couplet care on breastfeeding, maternal-infant bonding, and maternal stress, and will identify the strength and weaknesses of NICU models.
- The results from this study will provide an evidence-base case upon which further studies and clinical practice improvements can be performed.

PEOPLE	PROCESS	PLACE	PHYSICAL ATTRIBUTES
Parents, infant, nurses, extended family, siblings	Social Support	CCU, Corridor, Rooftop Garden	Seating area, access to positive distraction
Mother, partner, nurses, lactation consultant	Breastfeeding, skin-to-skin	CCU, Room	Seating area, adaptable features, privacy
Parents, nurses, extended family, siblings	Respite	Rooftop garden, Family Room, CCU, Staff Break Room, Spa	Privacy, access to positive distraction, sense of control
Parents, social worker, consultants, extended family, siblings	Support activities	Laundry, Family Room, Play Area, RMH, Milk Room, Corridor	Privacy, specialized features, adaptability, sense of control

RECOMMENDATIONS

- **Environmental Design-**

The following strategies are centered round Ulrich's Theory of Supportive Design (1991) which highlights the role of the environment in alleviating stress and promoting healing.
1. Sense of control with respect to physical-social surroundings (PC)
2. Access to social support (SS)
3. Access to specialized features
4. Access to positive distraction in the physical surroundings (PD)
5. Adaptability
6. Decentralized staff stations

- **Technology recommendations-**

1. Access to videoconferencing
2. Access to a centralized patient health record (EHR)
3. A centralized workflow system which can track medical equipment, nursing staff, custodial staff, doctors and patients
4. Establishing a continuum of care

- **Organizational recommendations-**

1. Flattening the organizational hierarchy
2. Infection control
3. Incentivizing departmental performance across various metrics such as infection control, patient satisfaction, length of stay (LOS)
4. Staffing ratio

- **Complementary services and alternative medicine (CAM)-**

1. Access to educational support
2. Integrating diverse, evidence-based CAM approaches that fall outside conventional allopathic, Western medicine interwoven with the conventional treatment plan.

DISCUSSION

The new Beacon Children's NICU has already provided positive outcomes. The average length of stay has decreased by 1.7 days since introducing couplet care in the NICU, and patient satisfaction scores average 4.7 on a 5-point scale.

Additionally, the environment of the new unit has had an overall positive impact on staff satisfaction.

Most notable is the staff and patient rooftop gardens, exposure to natural light from the windows, atrium, and outdoor garden, and access to support facilities like the Ronald McDonald House across the street.

CONCLUSION

The lessons learned from Beacon Children's NICU unit can be applied to any health system considering a NICU redesign:

- **Understanding the research and evidence-** For Beacon Children's, this was critical in helping administration, staff, and other stakeholders understand the benefits and potential outcomes. During planning, integrated design events were held to provide hands-on participation by staff and families to test the prototype, using iterative, full-scale mock-ups and simulations to ensure that functional and code requirements were met.
- **Incorporate couplet care however possible-** Research has shown that couplet care supports improved developmental outcomes for newborns and improved quality of life as they mature into adults.
- **Incorporate ancillary spaces** - spaces for staff respite and family support along with ancillary facilities like a dedicated pharmacy, milk storage, laundry facilities, etc.
- **Benchmark-** Project utilization of the two room types as accurately as possible to get the right proportion of each for future expansion.

REFERENCES

Al Maghaireh, D. A. F., Abdullah, K. L., Chan, C. M., Piaw, C. Y., & Al Kawafha, M. M. (2016). Systematic review of qualitative studies exploring parental experiences in the Neonatal Intensive Care Unit. Journal of clinical nursing, 25(19-20), 2781-2792.
Cho, E. S., Kim, S. J., Kwon, M. S., Cho, H., Kim, E. H., Jun, E. M., & Lee, S. (2016). The effects of kangaroo care in the neonatal intensive care unit on the physiological functions of preterm infants, maternal-infant attachment, and maternal stress. Journal of pediatric nursing, 31(4), 420-428.
Domanico, R., Davis, D. K., Coleman, T., & Davis, R. D. (2011). Documenting the NICU design dilemma: comparative patient progress in open ward and single family room units. Journal of perinatology, 31(7), 520-528.
Feldman, R., Weller, A., Leckman, J. F., Kuint, J., & Eidelman, A. I. (1999). The nature of the mother's tie to her infant: Maternal bonding under conditions of proximity, separation, and potential loss. The Journal of Child Psychology and Psychiatry and Allied Disciplines, 40(6), 929-939.
Sandberg, B. S., Franke, K. F., Flacking, R., Grundl, H., Lehtonen, L., & Moen, A. (2018). Parent-infant closeness, parents' participation, and nursing support in single-family room and open bay NICUs. The Journal of Perinatal & Neonatal Nursing, 32(4), E22-E32.
White, R. D. (2016). The next big ideas in NICU design. Journal of Perinatology, 35(4), 259-262.

Cornell University