# NEONATOLOGY TODAY

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Therapeutic Design in the Neonatal Intensive Care Unit Issue



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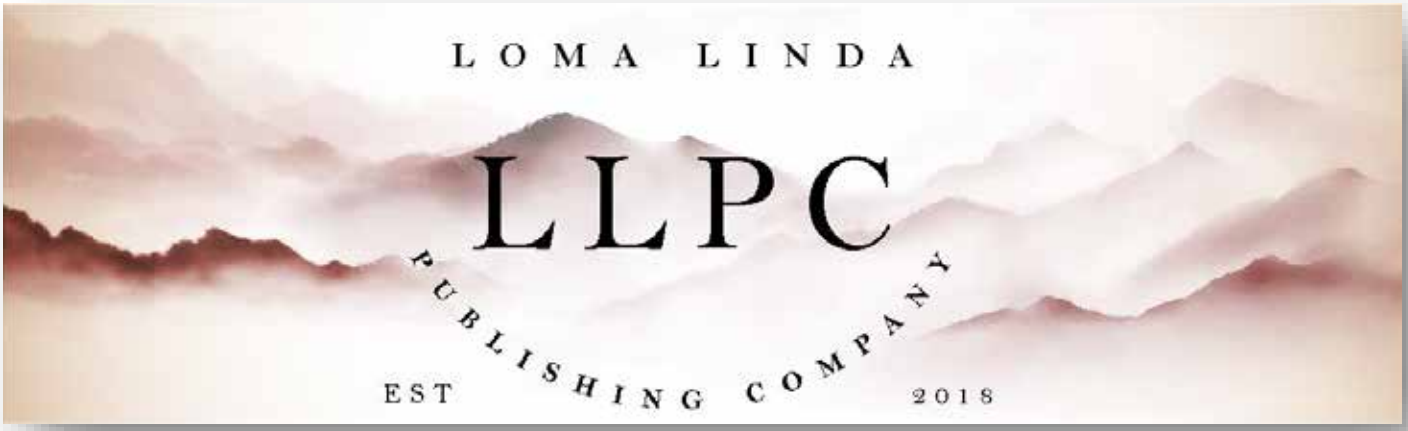



Pictured: Baby Kole with his Dad

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# Preface: Therapeutic Design

*Robert D. White, MD*

*"When they enter the Newborn Intensive Care unit (NICU), both babies and families are at the beginning of a lifetime journey that will in large part be influenced by the care and conditions they experience there."*

When they enter the Newborn Intensive Care unit (NICU), both babies and families are at the beginning of a lifetime journey that will in large part be influenced by the care and conditions they experience there. Since their beginning, NICUs have changed dramatically both in respect to their physical design as well as the practices within them to incorporate families and broaden the focus of care to include developmental support for babies; it is this interplay that makes NICUs unique.

This supplement is not meant to focus on either the physical design of the NICU or the principles of infant and Family-Centered care, though; both of those topics are addressed in published standards (1,2) and must be the foundation on which the concepts discussed here will be built, but those are not complete – a well-designed NICU can still be less welcoming and nurturing than it might be. Most NICUs with excellent infant and Family-Centered care will still benefit from consideration of the physical elements identified in the articles that follow. This special Edition of Neonatology Today will highlight areas where these perspectives overlap and reinforce one another in ways that promote optimal outcomes for babies, their families, and their caregivers. Our hope is that every NICU will find insights to improve their environment of care by nurturing all those who spend time in a NICU.

*"This special Edition of Neonatology Today will highlight areas where these perspectives overlap and reinforce one another in ways that promote optimal outcomes for babies, their families, and their caregivers. Our hope is that every NICU will find insights to improve their environment of care by nurturing all those who spend time in a NICU."*

The first article in this supplement entitled "Therapeutic Environments for Neonatal Intensive Care Units" gives further background on the importance of this topic and provides guidance on therapeutic design considerations for many of the Recommended Standards for Newborn ICU Design. In the body of the supplement are a number of papers on specific topics, each of which we hope readers will find useful regardless of the age or design of their NICU. The final article incorporates these recommendations into a checklist that will be useful for those planning either new construction of a NICU or wanting to upgrade their existing NICU.

*"To this end, please visit https://nicudesign.nd.edu/, where we will post additional resources for those interested in enhancing the environment of care in their NICU."*

Publications like this serve an important purpose to collect current knowledge in a single location but they have limitations – they become outdated over time and some aspects are best demonstrated visually. To this end, please visit https://nicudesign.nd.edu/, where we will post additional resources for those interested in enhancing the environment of care in their NICU.

**References:**

1. Altimier L, Barton SA, Bender J, et al. Recommended Standards for Newborn ICU Design, 10th Edition. https://nicudesign.nd.edu/nicu-standards/

2. Arvedson JC, Bigsby R, Browne JV, et al. Developmental Care Standards for Infants in Intensive Care. https://nicudesign.nd.edu/nicu-care-standards/

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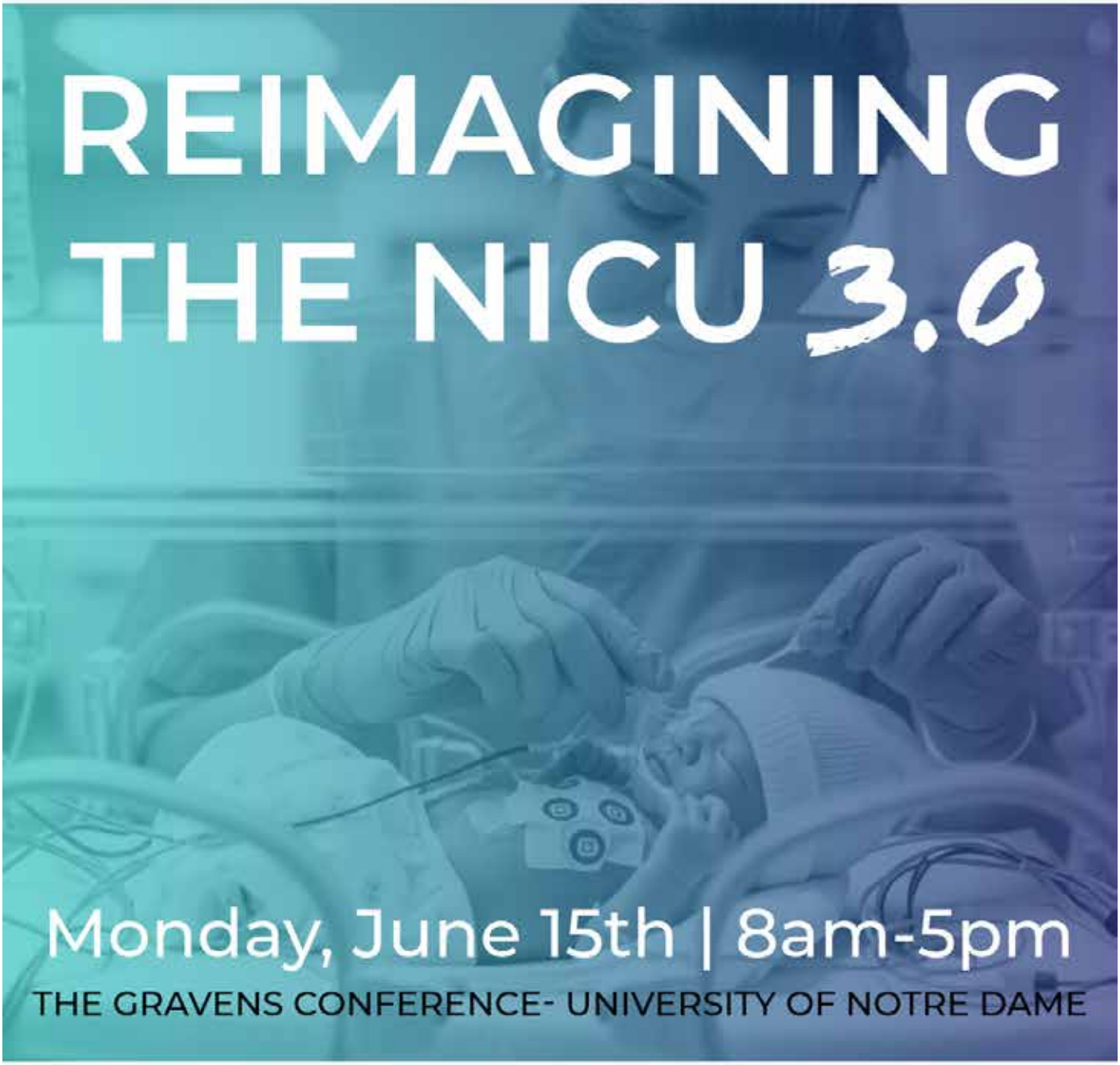
*Corresponding Author*

*Robert D. White, MD*
*Director, Regional Newborn Program*
*Beacon Children's Hospital*
*615 N. Michigan St.*
*South Bend, IN 46601*
*Phone: 574-647-7141*
*Fax: 574-647-3672*
*Email:* Robert_White@pediatrix.com

REIMAGINING WORKSHOP

# REIMAGINING THE NICU 3.0



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# Therapeutic Environments for Neonatal Intensive Care Units

*Mardelle McCuskey Shepley, B.A., M.Arch., M.A. (Psych), D.Arch., Nastaran Radmanesh, B.Arch, M.Arch, M.A., EDAC, Sabah Mohammed, B. Arch, M.S., EDAC, LEED GA, WELL AP, Robert D. White, MD*

*"The promotion of therapeutic environments in neonatal intensive care units has been pursued since the first dedicated facility in the 1960s, although it has not always been recognized as such. Medical practitioners have sought to provide spaces that support infants and families, but with little guidance on how to do so. The broader picture of psychosocial need is difficult to see when focusing on code restrictions and historical protocols."*

The promotion of therapeutic environments in neonatal intensive care units has been pursued since the first dedicated facility in the 1960s, although it has not always been recognized as such. Medical practitioners have sought to provide spaces that support infants and families, but with little guidance on how to do so. The broader picture of psychosocial need is difficult to see when focusing on code restrictions and historical protocols. However, the adoption of human-centered, evidence-based design (EBD) processes has led to the implementation of clear therapeutic design interventions.

**Theories of Therapeutic Design in Healthcare Facilities:**

Therapeutic design features can be defined as physical environmental interventions such as spatial configurations, finishes, and furniture, and sensory components (temperature, lighting, and sound) that support NICU activities while contributing to stress reduction, comfort, and orientation. The foundation of therapeutic design is rooted in the basic tenets of environmental psychology (EP), which focus on the relationship between people and their physical environment. EP research incorporates perceptual and cognitive psychology and examines social behaviors such as privacy and territoriality. Core concepts are the importance of choice and control, awareness of territorial behaviors, the need for personal space, the benefits of positive distraction, and the provision of privacy.

A variety of theories have emerged from this field that can be applied to analyze behavior in NICUs. These theories include:

- Environmental Competence/Press Theory (1). Environmental competence/press theory suggests that there is an ideal balance between an individual's competence and the challenges of the environment in which they find themselves. In NICUs, the environment should be able to transition from a simple, supportive environment to one with greater visual interest and engagement.
- Prospect and Refuge Theory (PRT) (2). According to prospect and refuge theory, when experiencing a visual field, the viewer is most supported when they have access to information and are simultaneously located in a safe space. Family spaces in NICUs can accomplish this by providing seating in single-family rooms, either against a wall or in an alcove, that allows views of the room entrance.
- Attention Restoration Theory (ART) (3). The notion that visual or physical interaction with nature can restore our ability to process information underpins Attention Restoration Theory. An NICU that provides nature artwork, views, or garden access may help staff and families better manage the complexity of decisions regarding infants' care.
- Theory of Supportive Design for Healthcare Facilities (4). The Theory of Supportive Design proposes that certain environmental features can reduce stress, thereby enhancing healing and wellness. The NICU experience can be more supportive when opportunities for positive distraction are available, such as art, nature views, and social interaction.

*"While the Recommended Standards for Newborn ICU Design (5) have identified design elements for NICU spaces and practical features, such as the minimum number of outlets on the headwalls, additional effort is needed to identify environmental interventions that make the space as supportive and uplifting as possible for babies, families, and staff."*

**Applications to the Recommended Standards for Newborn ICU Design**

While the *Recommended Standards for Newborn ICU Design* (5) have identified design elements for NICU spaces and practical features, such as the minimum number of outlets on the headwalls, additional effort is needed to identify environmental interventions that make the space as supportive and uplifting as possible for babies, families, and staff. A NICU might meet the standards for background noise or lighting levels, but still have unpleasant monitor alarm systems and lighting fixtures more suitable for an

office or surgical space. Nuanced recommendations should be available to planners so they can design an optimal environment, rather than just an adequate one. The hospitality industry may be more attuned to therapeutic design features than most hospitals and can inspire a broader perspective regarding a quality spatial experience.

Beyond environmental conditions that support infant development and healing, the goal of a therapeutic NICU is to enhance interactions between parents and their babies by reducing stressors and facilitating their ongoing presence. Another goal is to support staff caregiving strategies and wellness. Some of these goals are immutable (i.e., must be present in the original construction), whereas others are mutable (can be introduced into an existing NICU without major reconstruction). Both are discussed in this paper. Addressing the entire topic of therapeutic NICU environments is a complex endeavor and requires organizational parameters. The *Recommended Standards for Newborn ICU Design* provides a framework for examining opportunities in NICU environmental design. This paper addresses the application of therapeutic design principles to 21 of the 29 standards.

***"The Recommended Standards for Newborn ICU Design provides a framework for examining opportunities in NICU environmental design. This paper addresses the application of therapeutic design principles to 21 of the 29 standards."***

An interpretation accompanies each of the Recommended Standards. Expanding on these interpretations, we discuss how the standard might be associated with therapeutic design. A checklist of recommendations is provided in the closing paper in this special issue.

**General Space Elements:**

Unit Configuration (Standard 1). The design of a NICU requires the participation of clinicians, staff, families, administrators, and designers. By engaging all stakeholders, therapeutic interventions can be identified early in the design process. The decision regarding single-family rooms, open bay, or couplet care will impact well-being (6). Effective monitoring is critical to both infant care quality and families' perception of care quality. When clustering spaces in NICUs, the arrangement should support social interaction, a goal of the Theory of Supportive Design that has been shown to reduce stress (7). Families need access to rest spaces, nutrition, psychosocial support and information, social networks, and a way to address everyday needs such as internet connection and laundry facilities. A deinstitutionalized environment provides a more normalized experience, offering greater opportunities for choice and control.

Family Entry and Reception (Standard 3). The design of this area should create a positive first impression for families and convey that they are important members of their infant's health care team, not just visitors. First impressions of a space significantly influence the expectations of those who enter it (8, 9), and the ability to see into a space before entering it affects feelings of being valued and welcomed (10). A cluttered space may negatively influence perceived care quality, while the presence of lockable storage for families (unless provided elsewhere) can reduce the stress of losing personal property and enhance a sense of belonging.

***"At the unit scale, sufficiently wide and unobstructed circulation paths reduce stress by supporting the smooth movement of staff, families, and equipment throughout the NICU. In the area immediately around each infant, adequate space allows parents to remain seated, reclined, or fully recumbent, supporting prolonged presence and participation in care."***

Minimum Space, Clearance, and Privacy (Standard 6). At the unit scale, sufficiently wide and unobstructed circulation paths reduce stress by supporting the smooth movement of staff, families, and equipment throughout the NICU. In the area immediately around each infant, adequate space allows parents to remain seated, reclined, or fully recumbent, supporting prolonged presence and participation in care. SFRs have a greater capacity to support individualized, private environments for each infant and family compared to multi-patient rooms, while also enhancing control over noise and other environmental stressors (11). In shared or open-bay layouts, where privacy and overnight bedside stays may be more limited, additional strategies are needed to support families. Visual and acoustic privacy can be enhanced by minimizing major circulation routes adjacent to infant beds and incorporating sound-absorbing ceiling and wall materials. In these contexts, designated parent sleep spaces elsewhere on the unit are particularly important during a child's health crisis, as they reduce barriers to family involvement while supporting caregiver well-being (11).

When feasible, rooms should include access to windows. Exposure to daylight supports awareness of diurnal variation and helps regulate circadian rhythms for infants, families, and staff.

**Signage and Positive Distraction:**

Signage and Art (Standard 4). First impressions of hospital spaces can affect subsequent perceptions of the healthcare experience (9). NICU signage and art can communicate the importance of family involvement in the care of their infants. Signage plays a critical role in the family experience in pediatric healthcare environments (12). Art and messaging should promote hope and facilitate community by acknowledging the diversity of families. Both permanent and temporary signage should reflect shared power.

Access to Nature and Other Positive Distractions (Standard 27).

Culturally appropriate positive distractions provide important psychological benefits to staff and families in the NICU. Access to window views, supportive art and gardens, social interaction, fitness facilities, and music may reduce stress for all NICU users and increase staff productivity (13).

*"Culturally appropriate positive distractions provide important psychological benefits to staff and families in the NICU. Access to window views, supportive art and gardens, social interaction, fitness facilities, and music may reduce stress for all NICU users and increase staff productivity (13)."*

**Finishes and Furnishings:**

Ceiling Finishes (Standard 19). Noise in the NICU, mainly from equipment and staff activity, disrupts infant sleep, affects vital signs, increases the risk of hearing damage, and creates stress for babies, family members, and staff (14). Since ceilings have the largest surface area for absorbing sound in the NICU, they are most effective at reducing noise (15).

Furthermore, the materials used in paints and ceiling tiles should comply with indoor environmental quality (IEQ) standards (16). Poor IEQ quality is associated with lower patient and visitor satisfaction in hospitals (17) and is likely to affect families and staff in NICUs similarly.

Wall Surfaces (Standard 20). Surface materials affect acoustics, infection control, and outcomes tied to environmental and human health, including fatigue, stress, and anxiety. Rather than being treated as separate elements, walls should be integrated with ceilings, floors, and other ambient features in a holistic design. Clean, well-maintained surfaces also enhance patient psychological satisfaction (19). Rounded walls and corners may elevate mood and reduce stress (20). Walls play a significant role in controlling noise, which has been found to be harmful for infants and a source of stress for staff and families (21).

Thoughtful use of color in wall design is essential across NICU areas, as wall colors shape perception and emotional response and often carry cultural meanings (22). Restful colors can reassure families (23).

Floor Surfaces (Standard 21). For achieving a therapeutic environment in NICUs, the choice of flooring materials should address noise reduction, cleaning, maintenance, safety, health, and aesthetics. Flooring that reduces ambient noise communicates a calmer environment, enhances patient comfort and satisfaction, and benefits staff by reducing stress, improving task performance, and lowering fatigue, which decreases the likelihood of medication errors (24–26). Materials that are easy to clean, compliant with recommended protocols, and simple to maintain reassure parents about the quality of care and improve safety and indoor air quality by limiting exposure to harmful chemicals (25). Flooring design should also minimize glare and provide slip resistance, as most accidents during the transport of equipment and patients are linked to slippery surfaces (27).

Furnishing (Standard 22). Furniture design and configuration are critical elements that contribute to therapeutic effects for both staff and families. High-quality furnishings provide comfort for visiting families (28) and signal that the institution values and cares for its patients (29). Research highlights the importance of varied furniture configurations, comfortable seating, home-like aesthetics, and an adequate number of seats. The physical distance between furniture in these rooms may reflect cultural norms, as expectations vary across populations (30). Within single-family rooms, furniture choices can foster family engagement in care and support home-like behaviors. Features such as partitions, storage, comfortable couches, positive distractions, and information boards encourage family involvement (31). Storage minimizes clutter, partitions provide privacy, and couches allow rest, depending on size. Positive distractions, including televisions and window views, offer emotional relief, while bedside chairs with curtains provide visual privacy for breastfeeding, pumping, and grieving without limiting interaction with staff (31).

*"Research indicates that while traditional single-family rooms offer benefits, they can also lead to isolation for infants, families, and staff (28), compounding the disruption in mother–infant bonding that often accompanies NICU admission (32). NICU studies show that couplet-care units, which support postpartum mothers through home-like features, are preferred over single-family rooms without inpatient maternal presence (31)."*

**Family:**

Couplet Care Rooms (Standard 7). Research indicates that while traditional single-family rooms offer benefits, they can also lead to isolation for infants, families, and staff (28), compounding the disruption in mother–infant bonding that often accompanies NICU admission (32). NICU studies show that couplet-care units, which support postpartum mothers through home-like features, are preferred over single-family rooms without inpatient maternal presence (31). Supporting home-like behaviors in these rooms is critical to both care quality and satisfaction. Features such as personal storage, positive distractions, educational boards, comfortable furniture, and convenient access to bathrooms or showers have been shown to promote families' home-like, collaborative, educational, and infant-caregiving behaviors (31). Although couplet care has traditionally emphasized mothers'

presence, couplet rooms should also be designed to accommodate fathers, supporting family cohesion during hospitalization (33, 34).

Support Space for Ancillary Services (Standard 15). Services such as respiratory therapy, laboratory testing, pharmacy, radiology, developmental therapy, and specialized feeding preparation are integral to comprehensive NICU care. Creating a therapeutic environment in NICUs requires an emphasis on proximity, appropriate size, and ease of access to ensure timely care while minimizing disruptions for infants and families.

***"Beyond technical efficiency, design interventions can support integrated care, whereby parents are empowered to participate in daily caregiving such as feeding, bathing, monitoring, and charting, while nurses manage technical tasks; this may reduce parental stress and improve infant outcomes, including better weight gain and higher breastfeeding rates (35)."***

Beyond technical efficiency, design interventions can support integrated care, whereby parents are empowered to participate in daily caregiving such as feeding, bathing, monitoring, and charting, while nurses manage technical tasks; this may reduce parental stress and improve infant outcomes, including better weight gain and higher breastfeeding rates (35). Ethnographic research further highlights that NICU design can shape parenting practices; warm, supportive environments encourage bonding and breastfeeding, while overly clinical settings risk detachment (36, 37). Embedding ancillary services within the unit, when designed to be both accessible and family-centered, enhances workflow and safety and fosters parental confidence, engagement, and emotional connection.

Family Support Space (Standard 17). Family support areas are essential components of therapeutic NICU design, as they provide spaces where relatives can rest, connect, and cope with the stress of hospitalization. Another important consideration is the inclusion of supervised areas for children and siblings (28), allowing them to play safely while parents are with the baby. Such spaces not only reduce feelings of isolation by fostering connections with others but can also incorporate educational resources to help children understand what is happening (38).

Hospitality contributes to a supportive stay. Adequate and well-designed provisions for family members and visitors help them feel safe and at "home" (39). Research also demonstrates that patients benefit from interaction and family support during hospital stays (40). Creating comfortable surroundings for families and visitors can positively affect parents' physical, emotional, and spiritual well-being (41). A quiet room can also provide privacy for distressed parents or family members (42).

Family Transition Room(s) (Standard 18). The transition from NICU to home is often abrupt, leading to anxiety about discharge preparation and the loss of nursing support. To better support families, staff should provide guidance on family-centered care during both hospitalization and transition (43). Suggested strategies for a seamless transition include establishing interim communal homes with private rooms and shared spaces, and ensuring easy transportation between hospital and home (32).

***"Within the NICU, dedicated 'Family Transition' rooms are recommended to give families and infants time to prepare for discharge. These rooms should include sleeping accommodations for both parents and access to bathroom facilities (5)."***

Within the NICU, dedicated 'Family Transition' rooms are recommended to give families and infants time to prepare for discharge. These rooms should include sleeping accommodations for both parents and access to bathroom facilities (5). While mothers' needs have historically been the primary focus in NICU spaces, a growing body of evidence highlights the distinct needs of fathers during hospitalization and in preparation for the transition home, including opportunities for involvement, instruction, and physical comfort (44). By providing a private setting for bonding and learning feeding cues, while remaining within the hospital, these rooms support both parents' engagement while maintaining access to staff support (45).

Staff Support Space (Standard 14). The NICU should include dedicated spaces for staff's professional, personal, and administrative needs. Recommended support areas include clinical spaces located as close as possible to patient care areas (46) and staff support spaces, which may occupy up to one-third of the unit's total floor area (47). Key design features include lockers, lounges, and private toilet facilities (48).

Staff performance and well-being are closely tied to good visibility and communication. Limited visibility in NICUs can hinder infant surveillance, delay assistance from teammates, and reduce awareness of the unit environment. These challenges increase concerns over patient safety, reduce teamwork and communication, foster isolation, and contribute to higher perceived workloads, while also weakening the staff support (49).

Finally, fostering a therapeutic environment requires a design approach that prioritizes reducing stress and supporting staff resilience. While NICU work can be rewarding, stressors often outweigh satisfaction, contributing to job dissatisfaction and turnover. Design interventions, such as team-building spaces, can foster mutual respect and strengthen interdisciplinary collaboration (50). In addition, well-designed respite areas with access to daylight and windows are recommended to reduce stress and help prevent burnout.

Administrative Space (Standard 16). The NICU accommodates a

wide range of personnel, many of whom need designated offices or administrative areas. Design strategies should minimize staff walking distances while preserving parental privacy and intimacy and should provide opportunities for families in single rooms to receive social support, including connections with other families. Enhancing staff-to-staff communication is equally important through centralized workspaces, interactive media, or reductions in the size of functional units (21). Separating office areas for different staff groups can provide appropriate workspace while helping maintain a calm, quiet atmosphere at the bedside (51).

*"The Environmental Systems standard emphasizes the creation of a stable and health-supportive atmosphere and promotes a healing environment through multisensory support and physiological stability. Consistent ambient temperature and humidity help minimize unnecessary physiological stress, enabling infants to allocate energy to growth and development."*

**Environmental Systems:**

Ambient Temperature and Ventilation (Standard 11). The Environmental Systems standard emphasizes the creation of a stable and health-supportive atmosphere and promotes a healing environment through multisensory support and physiological stability. Consistent ambient temperature and humidity help minimize unnecessary physiological stress, enabling infants to allocate energy to growth and development. Thoughtfully engineered ventilation reduces noise, prevents airborne contaminants, and provides gentle airflows that reduce sensory disruption, all factors crucial for promoting neurodevelopment and reducing stress. Configuring filtration systems outside clinical sightlines supports a more calming visual environment, while ventilation patterns that avoid drafts enhance comfort. Together, these design strategies create medically safe yet psychologically supportive environments for infants, families, and staff.

**Lighting & Acoustics:**

Ambient Lighting in Infant Care Areas (Standard 23). Standard 23 accommodates the evolving physiological and visual needs of vulnerable infants as well as the operational demands of staff and clinicians. A wide lux range allows for a transition from subdued lighting that supports infants' rest and circadian entrainment to the brighter illumination necessary for clinical tasks. This flexibility encourages energy conservation in infants and improves sleep-wake regulation, both of which support development. Evidence shows that cycled lighting with daytime levels of 100-200 lux and nighttime levels below 50 lux enhances weight gain, accelerates hospital discharge, and stabilizes melatonin levels in preterm infants (52).

High-quality color rendering supports clinical precision, especially in assessing skin tone and coloration, while low flicker levels protect both infants and staff from visual fatigue or discomfort. The mandate to avoid direct light in infants' field of vision fosters a visually comfortable, non-intrusive environment, which can reduce sensory stress. From a therapeutic design perspective, this lighting system promotes a healing environment by minimizing physiological stressors, providing sensory-friendly conditions, and improving staff and clinician efficiency (5, 53, 54). Adaptive lighting conveys psychological reassurance to families, subtly signaling attentiveness and care in the setting.

Procedure Lighting in Infant Care Areas (Standard 24). Standard 24 acknowledges both the fragile sensory systems of neonates and the clinical demands of caregivers. Adjustable intensity and precisely framed lighting reduce exposure to intense light, which may cause discomfort or stress in very preterm infants with immature retinas and limited eyelid closure. Ensuring minimal light spill enhances the restfulness of adjacent infants and supports energy conservation and developmental stability. High-intensity (2,000 lux) lighting facilitates vital visual tasks, such as assessing skin color and capillary refill, and performing delicate interventions, without elevating ambient light levels throughout the space. Targeted control improves accuracy and efficiency while maintaining a calm environment (5).

*"By recommending mounted lights rather than floor stands, the standard helps preserve critical working space, reduces fall hazards, and maintains visual cleanliness, all of which contribute to safety and the perception of order and care."*

By recommending mounted lights rather than floor stands, the standard helps preserve critical working space, reduces fall hazards, and maintains visual cleanliness, all of which contribute to safety and the perception of order and care. Adaptable, precise lighting systems empower staff and clinicians to deliver focused care while shielding infants from unnecessary sensory input, thereby supporting neurodevelopment and fostering family confidence.

Illumination of Support Areas (Standard 25). Standard 25 specifies that illumination within NICUs must comply with the recommendations of the Illuminating Engineering Society (55). From a therapeutic design perspective, providing task-appropriate lighting in support zones is essential for effective, safe clinical practice while maintaining a healing environment for infants. Adequate lighting in staff areas enhances accuracy in documentation, medication preparation, and infection control procedures. At the same time, the ability to control and isolate lighting in these zones protects infants from unnecessary visual disturbance and reduces the risk of circadian disruption. Design strategies that separate the visual environment for staff from that for infants enhance staff performance and neonatal well-being.

Providing independent controls and shielding to prevent light spill from work areas supports the infant's need for low-stimulus surroundings that facilitate rest, energy conservation, and neurodevelopment (41,53,55).

Daylighting (Standard 26). From a therapeutic design perspective, integrating daylight affects both physiological and psychological well-being. Exposure to natural light is the primary external cue for circadian rhythm entrainment. Daylight also supports staff, clinicians, and family well-being. Daylight exposure has been shown to reduce stress, elevate mood, and mitigate fatigue in adult populations, particularly in high-intensity clinical environments (57, 58). These outcomes align with therapeutic design principles that emphasize the creation of restorative environments for infants, families, and staff. The application of daylight in NICUs requires careful management. Direct solar exposure can cause glare, heat gain, and unwanted visual or thermal variability. Infant stations should be positioned to avoid direct sunlight while maintaining visual access.

Acoustic Environment (Standard 28). Control of ambient sound levels is essential for neonatal physiological stability, staff and clinician performance, and family well-being. Design strategies to mitigate these risks include acoustic isolation of mechanical systems, the incorporation of sound-absorptive materials, and spatial planning to buffer infant rooms from external noise sources (59). Recent work highlights the need to move beyond decibel-based thresholds to consider the acoustic experience at the infant's ear, including tonal quality and the frequency of transient acoustic events, to better characterize and improve the soundscape of NICUs (60). By limiting both continuous and transient sound exposure, designers and clinicians can help support infant rest, protect neurodevelopment, reduce staff and clinician cognitive load, and promote a calmer experience for families.

***"The Recommended Standards for Newborn ICU Design provide important guidelines for developing NICUs, but designers should aim to exceed these parameters. One way to address this is to make creating a therapeutic environment a primary objective. This means reframing design decisions to align with the standard's objective."***

**Conclusion:**

The *Recommended Standards for Newborn ICU Design* provide important guidelines for developing NICUs, but designers should aim to exceed these parameters. One way to address this is to make creating a therapeutic environment a primary objective. This means reframing design decisions to align with the standard's objective. Examples include creating a calming environment rather than staying below a specific decibel level, or providing an environment that supports family interaction rather than just a space where people can sit together.

The therapeutic design features and strategies provided here are not all-encompassing. Rather, they serve as examples of our current knowledge and provide a basis for discussing the full range of therapeutic environment goals.

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**References:**

1. Lawton MP, Nahemow L. Ecology and the aging process. In: Eisdorfer C, Lawton MP, editors. The psychology of adult development and aging [Internet]. Washington: American Psychological Association; 1973 [cited 2025 Nov 3]. p. 619–74. Available from: https://content.apa.org/books/10044-020
2. Appleton J. The experience of landscape. London: Wiley; 1975.
3. Kaplan R, Kaplan S. The experience of nature: A psychological perspective. Cambridge University Press; 1989.
4. Ulrich RS. Effects of interior design on wellness: theory and recent scientific research. J Health Care Inter Des Proc Symp Health Care Inter Des Symp Health Care Inter Des. 1991;3:97–109.
5. Altimier L, Barton SA, Bender J, Browne J, Harris D, Jaeger CB, et al. Recommended standards for newborn ICU design. J Perinatol. 2023 Dec;43(1):2–16. doi:10.1038/s41372-023-01784-4
6. Tandberg BS, Flacking R, Markestad T, Grundt H, Moen A. Parent psychological well-being in a single-family room versus an open bay neonatal intensive care unit. PLOS ONE. 2019 Nov 5;14(11):e0224488.
7. Andrade CC, Devlin AS. Stress reduction in the hospital room: Applying Ulrich's theory of supportive design. J Environ Psychol. 2015 Mar;41:125–34.
8. White R. Gravens By Design: What the Ideal NICU Would Look Like. Neonatol Today. 2022;17(1):55–7.
9. Bazaid R, Pati D. Exploring Hospital Physical Environment Influencing Users First Impressions of the Healthcare Organizations: A Conceptual Framework Based on Literature Review. HERD Health Environ Res Des J. 2023 Oct;16(4):335–58.
10. Pijls R, Galetzka M, Groen BH, Pruyn ATH. Come in please: a virtual reality study on entrance design factors influencing the experience of hospitality. J Environ Psychol. 2023 Sept;90:102106.
11. Hatfield J, Job RS, Hede AJ, Carter NL, Peploe P, Taylor R, et al. Human response to environmental noise: The role of perceived control. Int J Behav Med. 2002 Dec;9(4):341–59.
12. Leonard AL, Verster A, Coetzee M. Developing family-friendly signage in a South African paediatric healthcare setting. Curationis. 2014 Oct 29;37(2):7 pages.
13. Shepley M. The role of positive distraction in neonatal intensive

care unit settings. J Perinatol. 2006 Oct 1;26(S3):S34–7.

14. Gupta G. NICU Environment and The Neonate. J Neonatol. 2001 Dec;15(4):7–15.

15. Philbin MK, Evans JB. Standards for the acoustic environment of the newborn ICU. J Perinatol. 2006 Oct 1;26(S3):S27–30.

16. Wolf M, Diehl T, Zanni S, Singer D, Deindl P. Indoor Climate and Air Quality in a Neonatal Intensive Care Unit. Neonatology. 2020;117(4):453–9.

17. Wu Q, Li N, Cai X, He Y, Du Y. Impact of indoor environmental quality (IEQ) factors on occupants' environmental perception and satisfaction in hospital wards. Build Environ. 2023 Nov;245:110918.

18. Qi Y, Yan Y, Lau SS, Tao Y. Evidence-Based Design for Waiting Space Environment of Pediatric Clinics—Three Hospitals in Shenzhen as Case Studies. Int J Environ Res Public Health. 2021 Nov 11;18(22):11804.

19. Mahmood FJ, Tayib AY. Healing environment correlated with patients' psychological comfort: Post-occupancy evaluation of general hospitals. Indoor Built Environ. 2021 Feb;30(2):180–94.

20. Madeninejad K. Curvilinearity in architecture: Emotional effect of curvilinear forms in interior design [Internet] [Ph.D. Thesis]. Texas A&M University; 2007. Available from: https://core.ac.uk/download/pdf/4272649.pdf

21. Shahheidari M, Homer C. Impact of the design of neonatal intensive care units on neonates, staff, and families: a systematic literature review. J Perinat Neonatal Nurs. 2012;26(3):260–6; quiz 267–8.

22. Harte D, Regrut L. Programming Interior Environments: Human Experience, Health and Well-being. In: K Menezes, V Woodworth, P de Oliveira-Smith, editors. Programming for Health and Well-being in Architecture. 1st ed. Routledge; 2021. p. 9–24.

23. Ali M. Communication 4: the influence of appearance and environment. Nurs Times. 2018;114(3):46–7.

24. Harris DD. The Influence of Flooring on Environmental Stressors: A Study of Three Flooring Materials in a Hospital. HERD Health Environ Res Des J. 2015 Apr;8(3):9–29.

25. Harris D. A Material World: A Comparative Study of Flooring Material Influence on Patient Safety, Satisfaction, and Quality of Care. J Inter Des. 2017 Mar;42(1):85–104.

26. Reason J. Human error: models and management. BMJ. 2000 Mar 18;320(7237):768–70.

27. Alexandre NMC, Benatti MCC. Occupational accidents involving the spine: Study on nurses at a university hospital. Rev Lat Am Enfermagem. 1998 Apr;6(2):65–72.

28. Almalki M, Gildea A, Boyle B. Parents' experiences of family-centred care in neonatal intensive care units: A qualitative thematic synthesis. J Neonatal Nurs. 2025 Jun;31(3):101655.

29. Shepley M, Watson A, Pitts F, Garrity A, Spelman E, Fronsman A, et al. Mental and behavioral health settings: Importance & effectiveness of environmental qualities & features as perceived by staff. J Environ Psychol. 2017 June;50:37–50.

30. Shahid S, Finn L, Bessarab D, Thompson SC. Understanding, beliefs and perspectives of Aboriginal people in Western Australia about cancer and its impact on access to cancer services. BMC Health Serv Res. 2009 July 31;9:132.

31. Machry H, Joseph A, White R, Allison D. Designing for Family Engagement in Neonatal ICUs: How Is the Interior Design of Single-Family Rooms Supporting Family Behaviors, From Passive to Active? HERD Health Environ Res Des J. 2023 July;16(3):238–60.

32. Mohammed S, Savage T, Smith J, Shepley MM, White RD. Reimagining the NICU: a human-centered design approach to healthcare innovation. J Perinatol. 2023 Dec;43(S1):40–4.

33. White RD. The next big ideas in NICU design. J Perinatol. 2016 Apr;36(4):259–62.

34. Mancini VO. The role of fathers in supporting the development of their NICU infant. J Neonatal Nurs. 2023 Oct;29(5):714–9.

35. Armstrong N, Herbert G, Aveling E, Dixon-Woods M, Martin G. Optimizing patient involvement in quality improvement. Health Expect [Internet]. 2013 Sept [cited 2025 Nov 3];16(3). Available from: https://onlinelibrary.wiley.com/doi/10.1111/hex.12039

36. Flacking R, Dykes F. 'Being in a womb' or 'playing musical chairs': the impact of place and space on infant feeding in NICUs. BMC Pregnancy Childbirth. 2013 Dec;13(1):179.

37. Beck SA, Weis J, Greisen G, Andersen M, Zoffmann V. Room for family-centered care – a qualitative evaluation of a neonatal intensive care unit remodeling project. J Neonatal Nurs. 2009 June;15(3):88–99.

38. Harris A. Continuing Emotional and Practical Support for the Whole Family. In: A Mancini, J Price, T Kerr-Elliott, editors. Neonatal Palliative Care for Nurses. Springer; 2020. p. 219–30.

39. Hepple J, Kipps M, Thomson J. The concept of hospitality and an evaluation of its applicability to the experience of hospital patients. Int J Hosp Manag. 1990 Jan;9(4):305–18.

40. Davidson JE, Powers K, Hedayat KM, Tieszen M, Kon AA, Shepard E, et al. Clinical practice guidelines for support of the family in the patient-centered intensive care unit: American College of Critical Care Medicine Task Force 2004–2005: Crit Care Med. 2007 Feb;35(2):605–22.

41. Reblin M, Uchino BN. Social and emotional support and its implication for health: Curr Opin Psychiatry. 2008 Mar;21(2):201–5.

42. O'Callaghan N, Dee A, Philip RK. Evidence-based design for neonatal units: a systematic review. Matern Health Neonatol Perinatol. 2019;5:6.

43. Spence CM, Stuyvenberg CL, Kane AE, Burnsed J, Dusing SC. Parent Experiences in the NICU and Transition to Home. Int J Environ Res Public Health. 2023 June 4;20(11):6050.

44. Merritt L, Verklan MT. A feasibility study to test the NICU paternal needs inventory. Adv Neonatal Care. 2024 Feb;24(1):86–93. doi:10.1097/ANC.0000000000001121

45. Johnstone S, Miller E, Tyurina A, Ness Wilson L, Winter A. Transforming the NICU Environment for Parent and Staff Well-being: A Holistic and Transdisciplinary Supportive Design Approach. In: Miller E, Winter A, Chari S, editors. How Designers Are Transforming Healthcare [Internet]. Singapore: Springer Nature Singapore; 2024 [cited 2025 Nov 3]. p. 77–99. Available from: https://link.springer.com/10.1007/978-981-99-6811-4_5

46. NHS England. Health Building Note 09-03: Neonatal units [Internet]. 2013. Available from: https://www.england.nhs.uk/publication/neonatal-units-planning-and-design-hbn-09-03/

47. Steele C, Short R. Centralized Infant Formula Preparation Room in the Neonatal Intensive Care Unit Reduces Incidence of Microbial Contamination. J Am Diet Assoc. 2008 Oct;108(10):1700–3.

48. Altimier LB. Neuroprotective Core Measure 1: The Healing NICU Environment. Newborn Infant Nurs Rev. 2015 Sept;15(3):91–6.

49. Doede M, Trinkoff AM, Gurses AP. Neonatal Intensive Care Unit Layout and Nurses' Work. HERD Health Environ Res Des J. 2018 Jan;11(1):101–18.

50. Fiske E. Nurse Stressors and Satisfiers in the NICU. Adv Neonatal Care. 2018 Aug;18(4):276–84.

51. Philbin MK. Planning the acoustic environment of a neonatal intensive care unit. Clin Perinatol. 2004 June;31(2):331–52.

52. Lewis P, Wild U, Pillow JJ, Foster RG, Erren TC. A systematic review of chronobiology for neonatal care units: What we know and what we should consider. Sleep Med Rev. 2024 Feb;73:101872.

53. Van Der Linden IA, Hazelhoff EM, De Groot ER, Vijlbrief DC, Schlangen LJM, De Kort YAW, et al. Characterizing light-dark cycles in the Neonatal Intensive Care Unit: a retrospective observational study. Front Physiol. 2023 Aug 16;14:1217660.

54. Rea MS, Figueiro MG. The NICU Lighted Environment. Newborn Infant Nurs Rev. 2016 Dec;16(4):195–202.

55. DiLaura DL, Houser K, Mistrick R, editors. The lighting handbook: reference and application. 10th ed. New York, NY: Illuminating Engineering Society of North America; 2011.

56. Kamianowska M, Szczepanski M. The level of noise and illumination intensity in the Neonatal Intensive Care Unit. Early Hum Dev. 2008 Nov;84:S54.

57. Edwards L, Torcellini P. Literature Review of the Effects of Natural Light on Building Occupants [Internet]. 2002 July [cited 2025 Nov 3] p. NREL/TP-550-30769, 15000841. Report No.: NREL/TP-550-30769, 15000841. Available from: http://www.osti.gov/servlets/purl/15000841-KDGMXg/native/

58. Choi JH, Beltran LO, Kim HS. Impacts of indoor daylight environments on patient average length of stay (ALOS) in a healthcare facility. Build Environ. 2012 Apr;50:65–75.

59. Puyana-Romero V, Núñez-Solano D, Hernández-Molina R, Jara-Muñoz E. Influence of the NICU on the Acoustic Isolation of a Neonatal Incubator. Front Pediatr. 2020 Sept 22;8:588.

60. Lam B, Fan PEM, Tay YY, Poon WB, Ong ZT, Ooi K, et al. Do neonates hear what we measure? Assessing neonatal ward soundscapes at the neonates' ears. Build Environ. 2025 Mar;272:112655.

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**NT**

***Corresponding Author:***

*Mardelle McCuskey Shepley, B.A., M.Arch., M.A. (Psych), D.Arch. WELL AP, LEED AP, and EDAC.*
*Department of Human Centered Design at Cornell University. Emerita*
*the American College of Healthcare Architects and in the American Institute of Architects, Emerita*
*9 Old Silver Ln, Falmouth, MA 02540*
*Telephone: 979-255-0344*
*Email:* mshepley@cornell.edu

*Nastaran Radmanesh, B.Arch, M.Arch, M.A., EDAC*
*Affiliation: Cornell University*

*Sabah Mohammed, B. Arch, M.S*
*EDAC, LEED GA, WELL AP*
*Affiliation: Grama Care*

*Robert D. White, MD*
*Director, Regional Newborn Program*
*Beacon Children's Hospital*
*615 N. Michigan St.*
*South Bend, IN 46601*
*Phone: 574-647-7141*
*Fax: 574-647-3672*
*Email:* Robert_White@pediatrix.com

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# Beyond Relief: Designing for Positive Emotions in Neonatal Intensive Care Unit Environments

*JungKyoon Yoon, PhD*

*"This paper presents a framework for designing Neonatal Intensive Care Unit (NICU) environments that deliberately foster nuanced positive emotions such as hope, pride, and gratitude, moving beyond the traditional focus on problem mitigation and utility."*

**Abstract:**

*This paper presents a framework for designing Neonatal Intensive Care Unit (NICU) environments that deliberately foster nuanced positive emotions such as hope, pride, and gratitude, moving beyond the traditional focus on problem mitigation and utility. Drawing on emotion-driven design theory and research on healthcare environments, we integrate three guiding principles, "Object, Value, and Function," to show how design can enable positive activities, identify personal values, and support distinct emotional effects that contribute to well-being. We propose that interventions grounded in these principles can reduce stress, enhance resilience, and strengthen social bonds among infants, families, and staff in high-stress NICU settings. By shifting from a deficit-oriented to an opportunity-oriented design approach, NICUs can cultivate frequent, diverse positive emotional experiences that generate upward spirals of well-being for all stakeholders.*

**Keywords:** *NICU design, positive emotions, family-centered care, emotion-driven design, therapeutic environment, well-being*

*"In the days immediately following infant hospitalization, approximately 28% of parents meet criteria for acute stress disorder, with a substantial proportion developing chronic psychological distress over time (2)."*

## Introduction:

The Neonatal Intensive Care Unit (NICU) represents one of healthcare's most emotionally charged environments. Parents of hospitalized infants experience elevated rates of depression, anxiety, and post-traumatic stress symptoms (1). In the days immediately following infant hospitalization, approximately 28% of parents meet criteria for acute stress disorder, with a substantial proportion developing chronic psychological distress over time (2). Sources of distress are multifaceted and persistent, including concerns about infant survival, feelings of helplessness during medical procedures, prolonged separation from the infant, and disruption of anticipated parental roles (3).

At the same time, the NICU is not solely a site of trauma. It is also a place where moments of hope, connection, and profound meaning emerge alongside crisis. Parents may experience deep joy in small milestones, pride in learning to care for their infant, and gratitude toward clinicians who support their family during a vulnerable period (4). For healthcare providers, the NICU similarly embodies emotional duality: high cognitive and emotional demands coexist with moments of professional pride, purpose, and relational connection. This coexistence of distress and possibility makes the NICU a uniquely fertile context for rethinking the role of design in healthcare environments.

Advances in neonatology have dramatically improved survival rates for preterm and medically fragile infants, including those born at very low birth weight (5). As survival has improved, attention has increasingly shifted toward the quality of the NICU experience for infants, families, and staff. A growing body of research demonstrates that physical environments influence psychological, emotional, and physiological outcomes, catalyzing interest in therapeutic and evidence-based healthcare design (6, 7). Existing design frameworks emphasize reducing environmental stressors, improving safety, supporting developmental care, and preventing burnout. While these efforts are essential, they largely adopt a deficit-oriented orientation (8): prioritizing the mitigation of negative experiences such as stress, anxiety, discomfort, and fatigue.

This paper argues for a paradigm shift in NICU design: from a deficit-oriented approach that seeks to eliminate problems toward an opportunity-oriented approach that deliberately fosters nuanced positive emotions such as hope, pride, gratitude, and joy. Drawing on Desmet's emotion-driven design theory (9) and Fredrickson's broaden-and-build theory of positive emotions (10), this paper presents a comprehensive framework organized around three guiding principles: Object, Value, and Function. These principles offer designers, healthcare administrators, and clinicians actionable strategies for creating NICU environments that support the emotional well-being of all stakeholders while maintaining clinical excellence.

*"Drawing on Desmet's emotion-driven design theory (9) and Fredrickson's broaden-and-build theory of positive emotions (10), this paper presents a comprehensive framework organized around three guiding principles: Object, Value, and Function."*

## Theoretical Foundations:

### Emotion-Driven Design:

Emotions serve fundamental adaptive functions in human experience. As Frijda (11) articulated, emotions are functional because they establish our position vis-à-vis the environment,

drawing us toward certain people, objects, actions, and ideas while pushing us away from others. This functional view of emotion underpins emotion-driven design, an approach that understands designed artifacts and environments not as neutral backdrops but as active mediators of emotional experience (12).

*"In healthcare contexts, every design decision, from the spatial layout of patient rooms to the interface design of medical monitoring equipment, influences emotional responses. Traditional approaches to healthcare design have focused primarily on ergonomics (ensuring safe and comfortable use), usability (enabling efficient, easy use), and, to some extent, pleasure (creating enjoyable user experiences). While these considerations remain essential, they represent only a portion of the design spectrum. At the far end lies the potential for design to facilitate meaningful experiences that contribute to lasting well-being (8)."*

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The distinction between preventing negative experiences and facilitating positive ones is therefore critical. Reducing discomfort, frustration, or fear does not inherently generate satisfaction, joy, or hope. Achieving a genuinely positive impact on well-being requires a different design orientation, one that deliberately creates opportunities for positive emotional experiences rather than merely minimizing sources of distress. In the NICU context, this shift entails designing not only to alleviate parental anxiety but also to foster moments of connection, pride, and hope amid ongoing uncertainty.

**The Diversity of Positive Emotions:**

Effective emotion-driven design requires moving beyond a simplistic dichotomy between positive and negative. While emotion research has long distinguished among negative emotions such as fear, anger, and sadness, positive emotions have often been treated as a homogeneous category and described using broad terms such as happiness or joy (13, 14). This imbalance is also reflected in design practice, where attention to emotion frequently centers on preventing frustration, anxiety, or dissatisfaction rather than on cultivating specific positive emotional states.

In contrast, the landscape of positive emotions is highly diverse. Desmet (15) identified twenty-five distinct positive emotions that arise in human–product interactions, including amusement, admiration, confidence, pride, hope, fascination, kindness, and compassion. These emotions differ not only in the conditions that elicit them but also in how they shape cognition, motivation, and behavior. Appreciating this diversity is essential for designers who aim to create healthcare experiences that are not only functional but also meaningful. At this point, the concept of emotional granularity becomes particularly relevant.

Emotional granularity refers to the ability to make precise distinctions between similarly valenced emotional experiences (16). Individuals with high emotional granularity can distinguish between feeling hopeful versus confident, or grateful versus relieved. Research demonstrates that emotional granularity is associated with more effective emotion regulation, better mental health outcomes, and enhanced well-being (17, 18).

For designers, clinicians, and administrators, developing emotional granularity enables more intentional, targeted design decisions, allowing them to specify which positive emotions are most appropriate for specific contexts and user groups. Are we designing to foster the *hope* that encourages resilience, the *pride* that builds motivation, or the *gratitude* that strengthens social bonds? The framework described in this paper intends to help practitioners deliberately consider diverse positive emotions to transform and enrich the NICU experiences.

*"Fredrickson's (10) broaden-and-build theory provides a compelling scientific rationale for designing to promote positive emotions in healthcare settings. The theory posits that positive emotions broaden individuals' momentary thought-action repertoires, expanding awareness, encouraging exploration, and facilitating creative problem-solving (see Figure 1)."*

**The Broaden-and-Build Theory:**

Fredrickson's (10) broaden-and-build theory provides a compelling scientific rationale for designing to promote positive emotions in healthcare settings. The theory posits that positive emotions broaden individuals' momentary thought-action repertoires, expanding awareness, encouraging exploration, and facilitating creative problem-solving (see Figure 1). Unlike negative emotions, which narrow attention and behavior toward specific survival-oriented responses, positive emotions open cognitive and behavioral possibilities. Critically, these broadened mindsets serve a building function: they help individuals develop enduring personal resources, including physical, intellectual, social, and psychological assets. Joy, for instance, creates urges to play and be creative, building skills through experiential learning. Interest sparks exploration and information-seeking, building knowledge. Gratitude motivates prosocial behavior, building and strengthening social bonds. Hope promotes resilience and goal-directed thinking. Over time, these accumulated resources enhance well-being, health, and survival (19).

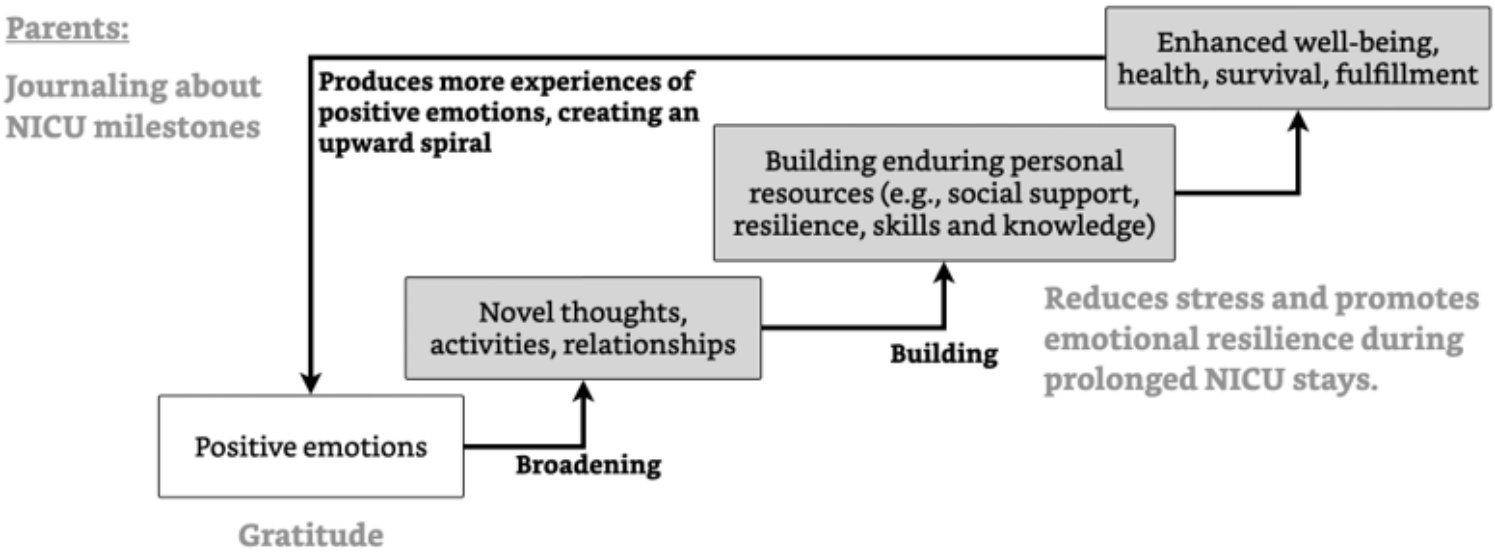


*Figure 1. Broaden-and-build theory applied to the context of NICU, adapted from Fredrickson (10)*

The theory suggests that positive emotions create upward spirals: experiencing positive emotions leads to broadened thinking, which promotes resource-building, which enhances well-being, which generates more positive emotions. Research in healthcare contexts supports these predictions. Positive emotional experiences have been associated with improved cardiovascular health, enhanced immune function, faster recovery times, and reduced pain perception (20). For NICU populations, including infants, families, and staff, these benefits are particularly valuable given the chronic stress and extended hospitalization characteristic of neonatal intensive care.

***"Importantly, research suggests that less intense but more frequent positive emotional experiences are more strongly associated with well-being than occasional intense positive experiences (21). This finding has significant implications for NICU design: rather than creating dramatic peak experiences, designers should focus on scaffolding multiple opportunities for small, everyday positive emotional moments for families and staff throughout the NICU journey."***

Importantly, research suggests that less intense but more frequent positive emotional experiences are more strongly associated with well-being than occasional intense positive experiences (21). This finding has significant implications for NICU design: rather than creating dramatic peak experiences, designers should focus on scaffolding multiple opportunities for small, everyday positive emotional moments for families and staff throughout the NICU journey. This body of evidence confirms that positive emotions are not a luxury but a fundamental component of health and well-being. To effectively design for them, however, we must move beyond general "happiness" and develop a more nuanced understanding of emotions experienced in NICU environments and systematically address them.

**A Framework for Designing Positive Emotions: Three Guiding Principles:**

Building on emotion-driven design theory (9) and the broaden-and-build framework (10), this paper describes three guiding principles for designing NICU environments that foster nuanced positive emotions: Object, Value, and Function. These principles address, respectively, the sources of emotional experience, the personal significance of those experiences, and the adaptive consequences they produce. Together, they provide a comprehensive framework for translating positive emotion research into actionable design strategies.

**Principle 1: Object — Design as an Enabler of Positive Activities:**

The first principle addresses the object of emotional experience, which elicits or enables emotion. A fundamental insight from emotion research is that most well-being-enhancing positive emotions arise not from products themselves but from the activities and experiences those products enable (22). Users are not typically emotional about a soccer ball; they are emotional about the game, given the competition, collaboration, and moments of triumph the ball facilitates. Similarly, in healthcare contexts, emotional significance resides primarily in caregiving activities, milestone celebrations, and relationship-building experiences rather than in the physical objects that support them.

This principle suggests that NICU design should prioritize enabling positive activities rather than focusing exclusively on the aesthetic or functional properties of products and spaces. Research demonstrates that when design serves as an enabler of positive activities, users report higher levels of well-being and a greater diversity of positive emotions than when design functions primarily as an aesthetic object or an instrumental tool (22). From this perspective, a family lounge is not merely a comfortable space; it is an enabler of peer connection, respite, and family togetherness. A breast pump is not merely an efficient device; it is a facilitator of maternal contribution and infant nourishment.

In the NICU context, positive activities that design might enable include celebrating an infant's developmental progress (e.g., first weight gain milestone), capturing and sharing meaningful moments (e.g., memory books documenting the NICU journey), engaging in positive mental time travel (e.g., visualizing discharge

day and planning for life at home), participating in caregiving (e.g., skin-to-skin contact), and connecting with peer support (e.g., other NICU families). Design decisions across multiple levels, from overall spatial organization to specific interface elements, should be evaluated in terms of their capacity to enable these positive activities.

*"Design decisions across multiple levels, from overall spatial organization to specific interface elements, should be evaluated in terms of their capacity to enable these positive activities."*

Peters and Calvo (23) propose a useful hierarchical framework for connecting experiential values to design decisions. At the highest level, designers should identify the experiential values they seek to promote (for example, fostering a sense of parental agency during their infant's care). These values then inform the activities that should be supported (e.g., accessing real-time updates on the infant's condition). Activities decompose into specific tasks (for example, viewing daily reports and photographs, sending messages to the care team). Finally, interface design decisions should support these tasks (for example, creating a calm, intuitive mobile application with reassuring notification tones). By beginning with experiential values rather than interface features, designers ensure that their work serves meaningful emotional goals. To apply this principle, practitioners could ask:

- What are the "positive activities" in the context of the NICU?
- What are the "enablers" and "barriers" to these positive activities?
- How can design "inspire" and "enable" these positive activities?

*"The second principle recognizes that emotional responses are fundamentally tied to personal values and goals. According to appraisal theories of emotion, individuals evaluate events and objects in relation to their concerns, and these evaluations, rather than objective stimulus properties, determine emotional responses (24)."*

**Principle 2: Value — Uncovering Stakeholder Needs Through Emotion**

The second principle recognizes that emotional responses are fundamentally tied to personal values and goals. According to appraisal theories of emotion, individuals evaluate events and objects in relation to their concerns, and these evaluations, rather than objective stimulus properties, determine emotional responses (24). Consequently, there are few one-to-one relationships between design features and emotional outcomes. The same design element may evoke different emotions in different users depending on their values, experiences, and current concerns.

Consider, for example, a sophisticated analytics display on NICU monitoring equipment. For some nurses, this display may evoke a sense of empowerment. They view analytics as a tool that streamlines workflows and reduces the potential for human error, aligning with their values of efficiency and evidence-based practice. For parents, however, the same display might trigger anxiety or fear, as the complex data representations signal an uncertain, high-stakes situation that conflicts with their desire for emotional connection and hands-on involvement in their baby's care.

This value-dependent nature of emotional experience has important implications for design. It suggests that understanding user emotions provides a window into their underlying values and needs. When parents express frustration with visitation policies, their frustration reveals the depth of their need for proximity and involvement. When nurses express pride in successful outcomes, their pride illuminates their commitment to clinical excellence. Emotion becomes an entry point for gaining deep insight into diverse user needs.

*"This principle highlights the inevitability of value conflicts in complex environments like the NICU. Desmet and Fokkinga (25) identify thirteen fundamental human needs that design may address, including autonomy, competence, relatedness, security, stimulation, and purpose."*

This principle highlights the inevitability of value conflicts in complex environments like the NICU. Desmet and Fokkinga (25) identify thirteen fundamental human needs that design may address, including autonomy, competence, relatedness, security, stimulation, and purpose. Most human activities and designed systems fulfill some needs while sacrificing others. For example, in the NICU, families may need privacy for bonding, emotional expression, and rest, while clinicians require visual access and continuous monitoring to ensure infant safety. The desire for intimate, family-centered space can therefore come into tension with the operational demands of observation and rapid response. Rather than framing such tensions as zero-sum conflicts, design can explore creative spatial and technological solutions, such as flexible partitions, layered visibility, and transparent communication systems that support both privacy and clinical oversight. Effective design acknowledges these tensions and seeks creative resolutions rather than ignoring competing values.

Practically, this principle recommends that designers explicitly map the values of different NICU stakeholders and identify potential conflicts early in the design process. Methods such as value-sensitive design (26) provide structured approaches for eliciting and analyzing stakeholder values. User research should explore not just what emotions users experience but why (i.e., what values and concerns underlie their emotional responses). Design solutions should then be evaluated in terms of their capacity to honor multiple stakeholder values or to find innovative ways of reconciling apparent conflicts. To apply this principle, practitioners could ask:

- What are the core needs/values of the NICU users and stakeholders?

- What are the needs/values that might conflict with each other?
- How can design resolve the conflicts?

*"The third principle focuses on how different positive emotions influence thoughts, behaviors, and long-term resource development. Building on the broaden-and-build theory, this principle emphasizes that each positive emotion serves distinct functions and generates distinct types of resources (19)."*

**Principle 3: Function — Shaping Behavior and Building Resilience:**

The third principle focuses on how different positive emotions influence thoughts, behaviors, and long-term resource development. Building on the broaden-and-build theory, this principle emphasizes that each positive emotion serves distinct functions and generates distinct types of resources (19). For example, joy creates urges to play and get involved, building skills through experiential learning. Gratitude generates creative motivation to be prosocial, building skills for showing care and strengthening social bonds. Serenity encourages savoring and integration, building new self-perspectives and recalibrated priorities. Interest promotes exploration and learning, building knowledge. Hope supports planning and resilience, building optimism and persistence. Pride inspires dreaming big and builds achievement motivation. Amusement triggers shared laughter, building social bonds. Inspiration motivates striving toward personal growth, fostering self-improvement. Awe facilitates absorption and accommodation, building new worldviews (19, 27).

As suggested in the first principle (i.e., object of emotion), this functional perspective enables designers to work backward from desired outcomes. If the goal is to strengthen parent-infant bonding, designs should target emotions that build relational resources such as love, gratitude, and amusement. If the goal is to enhance parental coping capacity, designs should foster hope and serenity, which build resilience and perspective. If the goal is to support staff well-being, designs should enable pride and recognition, which sustain motivation and prevent burnout.

Several examples illustrate this principle in action. A toy designed for pediatric isolation wards uses magnetic components that allow physically separated children to collaborate on creative construction activities through a glass barrier, aiming to foster amusement and shared joy to strengthen social connections despite medical constraints (28). A meditation installation uses responsive lighting and ambient sound to create personalized relaxation experiences, aiming to foster serenity and restore energy and perspective (29).

In the NICU context, this principle encourages designing environments and products that systematically evoke diverse positive emotions throughout the NICU journey: designing milestone celebration systems that evoke pride in infant progress and parental competence; peer support programs that foster gratitude for community and shared understanding; memory-making interventions that generate hope through positive anticipation of the future; and recognition systems for staff that cultivate pride in professional accomplishment and contribution to family well-being. To apply this principle, practitioners could ask:

- What "behavioral outcomes" should we address?
- Which "distinct emotions" drive these desired behavioral outcomes?
- How can we build these emotional responses into "users' experiences?"

*"Designers can move beyond conventional concerns of sterility and efficiency to create therapeutically supportive spaces."*

**Design Implications and Applications:**

Designers can move beyond conventional concerns of sterility and efficiency to create therapeutically supportive spaces. Applying the three principles to family-centered NICU design yields several intervention opportunities. The Object principle suggests creating systems that enable parents to participate in their infant's care actively and to celebrate developmental milestones. For example, parent education systems that build caregiving competence may generate pride and confidence. Discharge planning tools that help parents visualize life at home may support positive future-oriented thinking. For NICU healthcare providers, the Object principle suggests creating opportunities for staff to engage in meaningful activities beyond direct clinical care, such as mentoring, professional development, quality improvement, and relationship-building with families. These activities can generate purpose, competence, and connection.

The Value principle recommends designing for the diversity of values and needs. Some families may prioritize hands-on caregiving involvement, while others may value detailed medical information. Some may need private space for emotional processing, while others may benefit from peer connection. Flexible, customizable design solutions can accommodate this value diversity rather than imposing one-size-fits-all approaches. The Value principle also highlights the importance of recognizing diverse staff values and potential value conflicts. Clinical excellence, efficiency, compassionate care, work-life balance, and professional growth may compete for priority. Design solutions should acknowledge these tensions and seek to create conditions where multiple values can be honored. Staff spaces, scheduling systems, and workflow designs all present opportunities for value-sensitive intervention.

The Function principle suggests targeting specific positive emotions based on therapeutic goals. During initial hospitalization, when stress is highest, designs should prioritize hope and security. As the infant stabilizes, designs can shift toward pride and competence as parents develop caregiving skills. In preparation for discharge, designs should cultivate confidence and positive anticipation. Throughout the stay, designs should support gratitude for caregiver relationships and joy in moments of connection. For NICU healthcare providers, the Function principle illuminates opportunities that build resilience and prevent burnout. Peer appreciation systems (such as thank-you cards or recognition boards) can foster pride and gratitude. Spaces for decompression and reflection can promote serenity and perspective-taking. Celebration rituals for successful outcomes can generate joy and reinforce the meaning of the work.

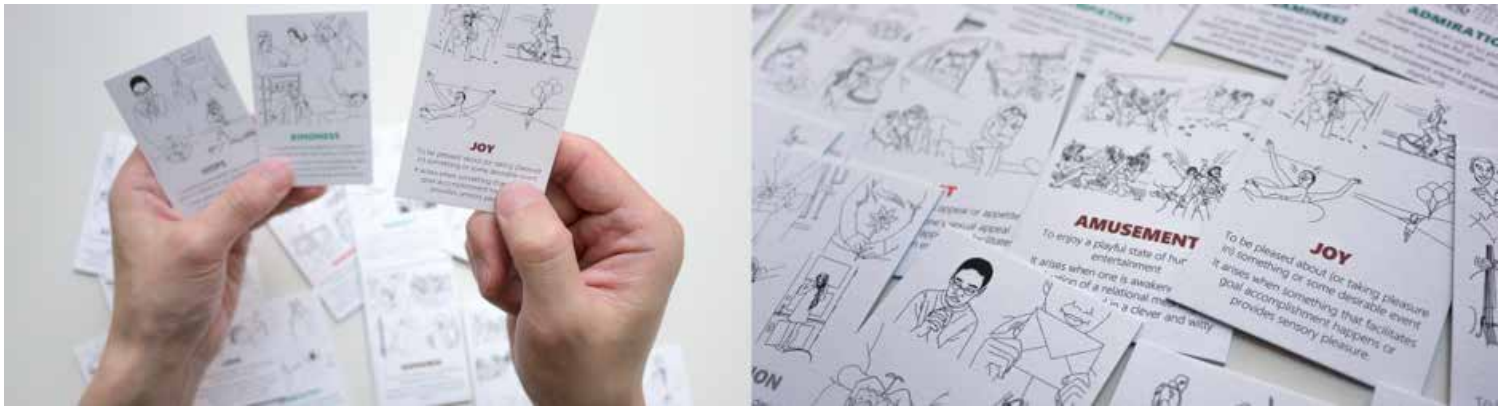


*Figure 2. An example of a design tool for emotion-driven design: Positive Emotional Granularity Cards (30)*

For practical purposes, the Positive Emotional Granularity Cards (30) serve as one example of a design tool that supports nuanced thinking about positive emotions. Similar tools, such as the typology of psychological needs (25), could be used specifically in NICU contexts, helping design teams identify target emotions, map stakeholder values, and evaluate design concepts against emotional goals. Training programs could help healthcare professionals and designers develop the emotional granularity needed to work effectively with this framework.

***"Note that the framework should be adapted for cultural contexts and institutional variations. Cultural norms shape emotional experience and expression; positive emotions that are valued and appropriate in one cultural context may differ from those in another. Healthcare delivery systems and NICU practices also vary across institutions and regions."***

Note that the framework should be adapted for cultural contexts and institutional variations. Cultural norms shape emotional experience and expression; positive emotions that are valued and appropriate in one cultural context may differ from those in another. Healthcare delivery systems and NICU practices also vary across institutions and regions. Effective implementation will require adaptation to local contexts while maintaining fidelity to core principles.

**Discussion:**

Current NICU design standards have increasingly recognized the importance of family-centered care and developmental support. The Recommended Standards for Newborn ICU Design (5) provide evidence-based guidance on environmental factors, including lighting, acoustics, spatial organization, and family accommodation. The Infant and Family Centered Developmental Care standards complement these physical environment considerations by addressing the functional aspects of care, including caregiver engagement and psychosocial support (31). However, neither framework explicitly foregrounds the deliberate cultivation of positive emotions as a design objective.

The three principles "Object, Value, and Function" described in this paper represent a paradigm shift in thinking about NICU design from a deficit-oriented approach focused on eliminating problems to an opportunity-oriented approach focused on cultivating positive emotional experiences. This shift does not diminish the importance of addressing negative experiences; reducing stress, minimizing anxiety, and preventing burnout remain essential goals. Rather, the principles extend the design agenda by recognizing that the absence of negativity is not sufficient for well-being. Flourishing requires the active presence of positive emotions, and design can deliberately foster them.

***"The three principles provide complementary lenses for design decision-making. The Object principle focuses attention on enabling positive activities rather than optimizing artifacts in isolation. The Value principle grounds design in an understanding of stakeholder concerns and the inevitability of value conflicts. The Function principle connects emotional goals to behavioral and developmental outcomes through the broaden-and-build mechanism. Together, these principles offer a framework for actionable healthcare design strategies."***

The three principles provide complementary lenses for design decision-making. The Object principle focuses attention on enabling positive activities rather than optimizing artifacts in isolation. The Value principle grounds design in an understanding of stakeholder concerns and the inevitability of value conflicts. The Function principle connects emotional goals to behavioral and developmental outcomes through the broaden-and-build mechanism. Together, these principles offer a framework for actionable healthcare design strategies.

Implementation of this framework requires interdisciplinary collaboration among designers, healthcare providers, researchers, and families. Designers bring expertise in creating environments and products that shape experience. NICU healthcare providers contribute clinical knowledge and understanding of care processes. Researchers offer methods for evaluating emotional outcomes

and testing design interventions. Families provide essential perspectives on the lived experience of NICU hospitalization. Successful positive emotion-focused design requires integrating all these viewpoints.

***"The NICU is a place of profound vulnerability and profound possibility. Within these walls, the most fragile humans fight for life while their families navigate uncertainty, grief, and hope. Healthcare providers commit daily to the challenging work of sustaining and nurturing these vulnerable lives. Design has the power to shape this experience, not merely by eliminating sources of distress but by actively cultivating sources of strength. The framework presented in this paper, integrating Object, Value, and Function principles grounded in theories of emotion-driven design and positive emotions, offers a roadmap for this opportunity-oriented approach"***

**Conclusion:**

The NICU is a place of profound vulnerability and profound possibility. Within these walls, the most fragile humans fight for life while their families navigate uncertainty, grief, and hope. Healthcare providers commit daily to the challenging work of sustaining and nurturing these vulnerable lives. Design has the power to shape this experience, not merely by eliminating sources of distress but by actively cultivating sources of strength. The framework presented in this paper, integrating Object, Value, and Function principles grounded in theories of emotion-driven design and positive emotions, offers a roadmap for this opportunity-oriented approach. By designing to enable positive activities, honor diverse values, and leverage the distinct functions of nuanced positive emotions, NICUs can become environments that not only save lives but also nurture the emotional well-being of all who inhabit them. For NICU families facing extended hospitalizations and chronic stress, moments of hope, pride, gratitude, and joy may prove as valuable as any clinical intervention. For healthcare providers navigating the emotional demands of neonatal intensive care, environments that support positive emotional experience may sustain the compassion and commitment that excellent care requires. By deliberately designing for positive emotions, we can transform the NICU from a place defined by what it prevents into one defined by what it enables: flourishing, resilience, and connection in the face of life's most challenging circumstances.

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**References:**

1. Hynan M, Steinberg Z, Baker L, Cicco R, Geller P, Lassen S, et al. Recommendations for mental health professionals in the NICU. Journal of Perinatology. 2015;35(1):S14-S8.
2. Shaw RJ, Deblois T, Ikuta L, Ginzburg K, Fleisher B, Koopman C. Acute stress disorder among parents of infants in the neonatal intensive care nursery. Psychosomatics. 2006;47(3):206-12.
3. Miles MS, Holditch-Davis D, editors. Parenting the prematurely born child: pathways of influence. Seminars in perinatology; 1997: Elsevier.
4. Gooding JS, Cooper LG, Blaine AI, Franck LS, Howse JL, Berns SD, editors. Family support and family-centered care in the neonatal intensive care unit: origins, advances, impact. Seminars in perinatology; 2011: Elsevier.
5. Altimier L, Barton SA, Bender J, Browne J, Harris D, Jaeger CB, et al. Recommended standards for newborn ICU design. J Perinatol. 2023;43(Suppl 1):2-16.
6. Browne JV. How NICU design and infant and family-centered developmental care act synergistically to support babies and families. Journal of Perinatology. 2023;43(Suppl 1):55-8.
7. Ulrich RS, Zimring C, Zhu X, DuBose J, Seo H-B, Choi Y-S, et al. A review of the research literature on evidence-based healthcare design. HERD: Health Environments Research & Design Journal. 2008;1(3):61-125.
8. Hassenzahl M. Experience design: Technology for all the right reasons. San Rafael, CA: Morgan & Claypool; 2010.
9. Desmet PMA, Fokkinga SF, Ozkaramanli D, Yoon J. Emotion-driven product design. Emotion Measurement: Elsevier; 2016. p. 405-26.
10. Fredrickson BL. The role of positive emotions in positive psychology. American Psychologist. 2001;56(3):218-26.
11. Frijda NH. The laws of emotion. American Psychologist. 1988;43(5):349-58.
12. Desmet PMA, Hekkert P. Framework of product experience. International Journal of Design. 2007;1(1):57-66.
13. Ekman P. Basic emotions. In: Dalgleish T, Power M, editors. Sussex, UK: John Wiley & Sons; 1999. p. 45-60.
14. Izard CE. Human emotions. New York: Plenum; 1977.
15. Desmet PMA. Faces of product pleasure: 25 positive emotions in human-product interactions. International Journal of Design. 2012;6(2):1-29.
16. Lindquist KA, Barrett LF. Emotional complexity. In: Lewis M, Haviland-Jones JM, Barrett LF, editors. 3rd ed. New York, NY: The Guilford Press; 2008. p. 513-30.
17. Kashdan TB, Barrett LF, McKnight PE. Unpacking emotion differentiation: Transforming unpleasant experience by perceiving distinctions in negativity. 2015;24(1):10-6.
18. Smidt KE, Suvak MK. A brief, but nuanced, review of emotional granularity and emotion differentiation research. Current Opinion in Psychology. 2015;3:48-51.

19. Fredrickson BL. Positive emotions broaden and build. Advances in Experimental Social Psychology. 2013;47:1-53. Epub 1.

20. Tugade MM, Shiota MN, Kirby LD, editors. Handbook of positive emotions. New York, NY: The Guilford press; 2014.

21. Sheldon KM, Boehm J, Lyubomirsky S. Variety is the spice of happiness: The hedonic adaptation prevention model. In: Boniwell I, David SA, Ayers AC, editors. Oxford: Oxford University Press; 2013. p. 901-14.

22. Yoon J, Kim C. Positive emodiversity in everyday human-technology interactions and users' subjective well-being. International Journal of Human-Computer Interaction. 2022;14:1-16.

23. Peters D, Calvo RA, Ryan RM. Designing for motivation, engagement and well-being in digital experience. Frontiers in Psychology. 2018;9:1-15.

24. Frijda NH. The laws of emotion. London: Lawrence Erlbaum Associates Publishers; 2007.

25. Desmet PMA, Fokkinga S. Beyond Maslow's pyramid: Introducing a typology of thirteen fundamental needs for human-centered design. Multimodal Technologies and Interaction. 2020;4(3):38.

26. Friedman B, Kahn PH, Borning A, Huldtgren A. Value sensitive design and information systems. Early engagement and new technologies: Opening up the laboratory. 2013:55-95.

27. Yoon J, Pohlmeyer AE, Desmet PMA. EmotionPrism: A design tool that communicates 25 pleasurable human-product interactions. Journal of Design Research. 2017;15(3/4).

28. Jansweijer J. KonneKt: Design for connection in pediatric isolation. Delft, NL: Delft University of Technology; 2015.

29. Swaminathan M. Adaptive relaxation space. Eindhoven: Philips, 2013.

30. Yoon J, Desmet PMA, Pohlmeyer AE. Developing usage guidelines for a card-based design tool: A case of the positive emotional granularity cards. Archives of Design Research. 2016;29(4):5-14.

31. Browne JV, Jaeger CB, Kenner C, Infant GCCo, Care FCD. Executive summary: standards, competencies, and recommended best practices for infant-and family-centered developmental care in the intensive care unit. Journal of Perinatology. 2020;40(Suppl 1):5-10.

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**NT**

***Corresponding Author:***

*Jay (JungKyoon) Yoon, PhD*
*Associate Professor*
*Director of Graduate Studies, Design & Environmental Analysis*
*Department of Human Centered Design*
*Meta Design & Technology Lab*
*Cornell University*
*Office: 3427 | Phone: 607-255-2011*
*Email:* jy846@cornell.edu

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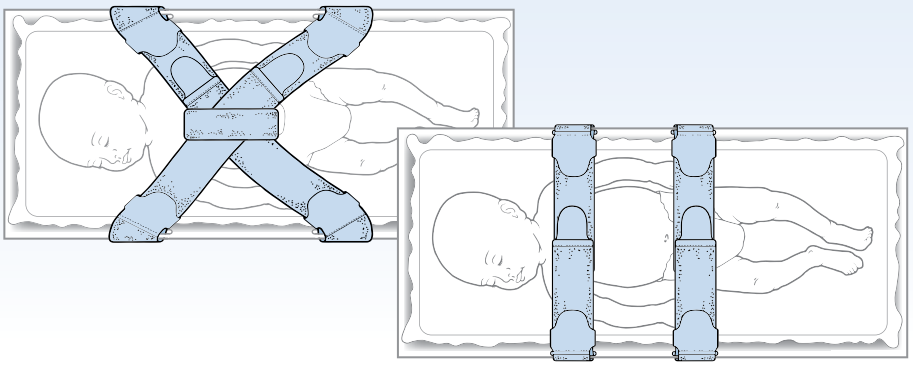

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# Systems Thinking and Therapeutic Design in the Neonatal Intensive Care Unit

*Carol Jaeger, DNP, RN, NNP-BC, Carole Kenner, PhD, RN, FAAN, FNAP, ANEF, IFDCOINN*

*"Neonatal intensive care units (NICUs) are among the most complex environments in health care. They are places where highly specialized technology, fragile infants, multidisciplinary teams, and families converge. Within this setting, both systems thinking and therapeutic design provide powerful frameworks for creating and sustaining a physical and practice environment that fosters healing and resilience for infants and their families."*

**Abstract:**

*Neonatal intensive care units (NICUs) are among the most complex environments in health care. They are places where highly specialized technology, fragile infants, multidisciplinary teams, and families converge. Within this setting, both systems thinking and therapeutic design provide powerful frameworks for creating and sustaining a physical and practice environment that fosters healing and resilience for infants and their families. When used together, they offer a roadmap for aligning a NICU's vision, culture, policies, and daily practice. This alignment will be the focus of this article.*

*"The framework for systems and systems thinking in the NICU begins with describing the interconnections of the component parts - therapeutic design and care environments, culture, operations, leadership, and care delivery."*

**Introduction:**

The concept of systems and systems thinking is vague to most health professionals. We use the terms, but do not fully understand the scope, applicability, and value of these concepts as they pertain to the structure and function of our NICU organizations and work environments. The framework for systems and systems thinking in the NICU begins with describing the interconnections of the component parts - therapeutic design and care environments, culture, operations, leadership, and care delivery.

*"In 1992, White and colleagues developed the first NICU design standards. (1) There were standards created by architects, health planners, health professionals, and parents for the purpose of providing evidence-based recommendations to support clinical care, growth and development of the infant, and emotional support of families."*

**Therapeutic Environment: The NICU Design:**

For almost 50 years, guidelines and recommendations have existed for the physical design of neonatal intensive care units. In 1992, White and colleagues developed the first NICU design standards. (1) There were standards created by architects, health planners, health professionals, and parents for the purpose of providing evidence-based recommendations to support clinical care, growth and development of the infant, and emotional support of families. These standards addressed room design, signage, furnishings, sound and light levels, temperature control, safety considerations, infection prevention, electrical and mechanical needs, handwashing, and support space for professional staff and parents, wall, ceiling, and floor surfaces, and adjacency to delivery room space. Now in its tenth edition, these recommendations stand as the "gold standard" for NICU design to create a therapeutic environment. But what is missing? The system's components that support care, the unit's vision, policies, clinical guidelines, signage, furnishings, leadership, and team structure-they too contribute to a therapeutic environment.

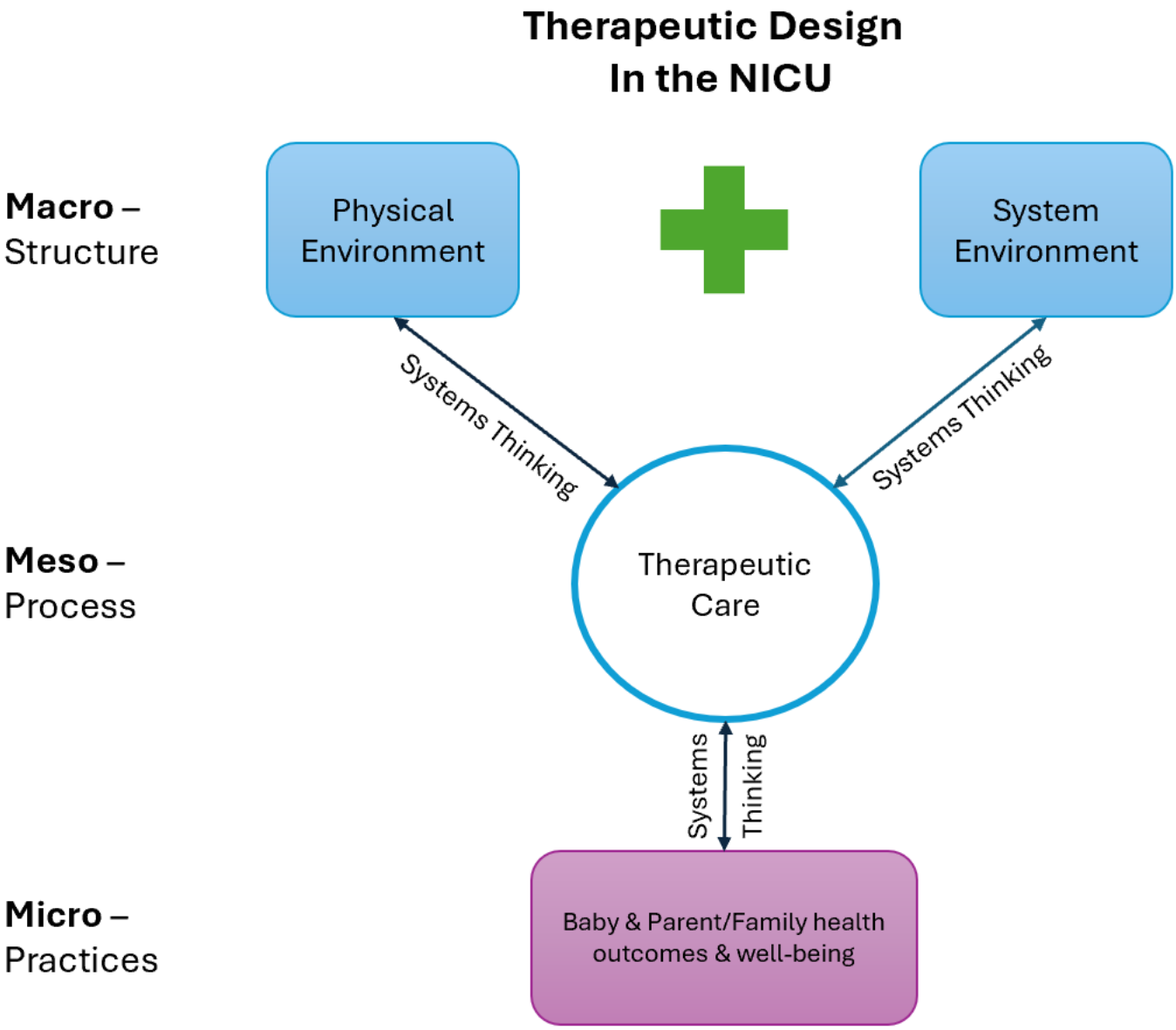


*Figure 1 Therapeutic Design in the NICU*

**Therapeutic Care: Infant and Family Centered Developmental Care:**

In 2020, the Consensus Committee on Infant and Family Centered Developmental Care (IFCDC) published recommended standards, competencies, and best practices based on mounting evidence for neuroprotective health care for babies and parents/families in the intensive care unit (ICU). (2, 3) This group of neonatal interprofessionals began collaborating in 2014 to identify practices that support the physical growth, physiological health, mental health, and neurodevelopment of preterm and sick babies, and the nurturing care and well-being of parents and families within the ICU environment. IFCDC practices include systems thinking; sleep and arousal of the newborn; pain and stress experienced by the baby and family; positioning and touch of the baby during care facilitation; skin-to-skin contact between intimate family members; and baby-led feeding, eating, and nutritional delivery.

The environment and practice must support communication and interaction between the baby and parents and be integrated as essential to planning, managing, decision-making, and caregiving for the baby. The nurturing relationship with the parents/family must be central to delivering care.

**Seeing the NICU as a Whole: Systems Thinking:**

Healthcare systems consist of macro, meso, and micro levels that are dynamic and ever-changing. Systems thinking is a process that considers differing stakeholders' perspectives and supports change by examining interconnected factors and setting boundaries. (4) Systems thinking examines the connections between the parts of the system that comprise the whole. This process views the NICU as more than a collection of parts—it encourages understanding of relationships, workflows, and interdependencies across the unit and supports evidence-based decision-making, teamwork, and continuing improvement. (See Figure 1)

*"In 2020, the Consensus Committee on Infant and Family Centered Developmental Care (IFCDC) published recommended standards, competencies, and best practices based on mounting evidence for neuroprotective health care for babies and parents/families in the intensive care unit (ICU). (2, 3)"*

**The Macro Environment:**

At the macro level, systems thinking focuses on the NICU's physical space, shared vision, and the health needs of the population served. The architecture—like family-friendly spaces, lighting, sound, and layout designed to reduce sensory overload—can reinforce a culture of therapeutic care. Such evidence-based design has been shown to reduce stress for patients, families, and staff, enhance safety, and improve outcomes, but unit design is just one aspect. (5-8) Coupling design standards with infant- and family-centered developmental care standards generates synergies that support better experiences and outcomes for both families and infants. (9)

*"At the macro level, systems thinking focuses on the NICU's physical space, shared vision, and the health needs of the population served. The architecture—like family-friendly spaces, lighting, sound, and layout designed to reduce sensory overload—can reinforce a culture of therapeutic care"*

**The Meso Environment:**

The meso environment is the interface between the baby/family (bedside care-micro environment) and the unit structure-policy and governance (macro environment). (10) It focuses on care coordination, workforce, resource management, and quality improvement. (10)

The meso interface is the structure of processes that underpin an evidence-based working system of the NICU – clinical guidelines, the role of multidisciplinary team members, education on practice and performance competence, evaluation of process outcomes, improvement and innovation, and sustainable health for the lifespan. The processes balance the values and social norms of how things should be, the regulatory rules of how things must be, and the reality of how things are. (10)

*"The meso environment is the interface between the baby/family (bedside care-micro environment) and the unit structure-policy and governance (macro environment). (10) It focuses on care coordination, workforce, resource management, and quality improvement. (10)"*

**The Micro Environment:**

The micro level is where policies, routines, and practices bring the unit's vision to life. From sound and lighting protocols to positioning strategies, pain management, and parental engagement, these practices translate design and philosophy into everyday care. (11) Models like NIDCAP and Family Integrated Care (FICare) further exemplify how structured micro-level approaches promote neurodevelopment, increased weight gain, promote breastfeeding, empower parental engagement, decrease maternal stress, and reduce lengths of stay. (12, 13)

*"The micro level is where policies, routines, and practices bring the unit's vision to life. From sound and lighting protocols to positioning strategies, pain management, and parental engagement, these practices translate design and philosophy into everyday care."*

**Alignment of Design and Operations: Systems Thinking:**

When macro, meso, and micro elements align, NICU care becomes cohesive and therapeutic. If architectural design supports family engagement but the policies treat the family as visitors or limit engagement, then alignment is absent, and the unit's vision is not realized. Does the unit signage embrace family support, empower families to be considered care team members, or suggest they are outsiders/visitors to the unit? Conversely, supportive policies fail when physical space or the unit's culture impedes their implementation. Strong alignment between the physical environment and operations enhances outcomes, engagement, and staff and family well-being. (14) (See Figure 2)

**Implications for Nursing Leadership:**

Nurse leaders are uniquely positioned to actualize systems thinking and ensure that the mission, vision, and policies align. Systems thinking requires examination of all facets of the unit that impact care and family support. This means unit design - does it encourage or deter family engagement? Do the policies support

| Therapeutic Design in the NICU | | |
|---|---|---|
| System Tiers | System Components | Outcome Benefits |
| Macro environment | ▯ Physical space<br>▯ Governance<br>▯ Population<br>▯ Vision<br>▯ Mission | ▯ Articulated shared vision<br>▯ Economic benefits of NICU physical design<br>▯ Lighting level<br>▯ Sound level<br>▯ Noise control<br>▯ Population demographics<br>▯ Socio-economic disparities |
| Meso environment | ▯ Care coordination:<br>▯ Admission to transition to home & follow-through<br>▯ Operational budget<br>▯ Workforce<br>▯ Resource management<br>▯ Quality improvement | ▯ Development of policy processes<br>▯ Multidisciplinary team<br>▯ Onboarding/continuing education/simulation training<br>▯ Performance competence<br>▯ Practice improvement<br>▯ Parent satisfaction with culture/comfortable environment/ communication/caregiving<br>▯ Staff satisfaction with the culture/working environment/practice<br>▯ Safety measures |
| Micro environment | ▯ Policies<br>▯ Clinical guidelines<br>▯ Practices<br>▯ Care patterns/routines | ▯ Parent presence & engagement with baby<br>▯ Growth anthropometrics – weight, length, head circumference<br>▯ Time to full enteric feeding<br>▯ Parent presence/holding at baby's first oral feeding<br>▯ Breastfeeding – Mother's own milk<br>▯ Breastmilk – Donor milk<br>▯ Maternal stress/well-being<br>▯ Sleep – quality & duration<br>▯ Bloodstream infection<br>▯ Length of Stay (LOS)<br>▯ Readmissions |

*Figure 2 Table of Therapeutic Design in the NICU*

family empowerment or not? Does the nurse orientation program include content on family support, infant developmental care, and the unit's expectation that this type of care is essential care? These are all aspects of applying a systems thinking approach. Nurses are the unit gatekeepers; they set the tone. Leadership, then, must understand how to employ systems thinking.

Systems thinking empowers nurses to unify the environment, operations, and culture proactively. Integrating systems thinking into nurse leadership fosters holistic approaches to quality care, safety, error reduction, resource allocation, decision-making, and culture shift. (15) By reflecting on alignment—asking, *Are our design, policies, and culture in harmony?*—Leaders can address gaps before they undermine therapeutic care.

***"The NICU will always be high-intensity—but it need not be fractured or divided between physical and infant and family-centered developmental care. Alignment between the unit's configuration and its policies/practices is needed to provide a positive, holistic environment. Systems thinking offers the lens; therapeutic design provides the heart. Together, they underscore a commitment to environments where healing is intentional and sustainable."***

**Moving Forward:**

The NICU will always be high-intensity—but it need not be fractured or divided between physical and infant and family-centered developmental care. Alignment between the unit's configuration and its policies/practices is needed to provide a positive, holistic environment. Systems thinking offers the lens; therapeutic design provides the heart. Together, they underscore a commitment to environments where healing is intentional and sustainable.

**References:**


1. Altimier L, Barton SA, Bender J, Browne J, Harris D, Jaeger CB, et al. Recommended standards for newborn ICU design, 10th edition. Journal of Perinatology. 2023;43(1):2–16.
2. Consensus Committee on Infant and Family-Centered Developmental Care. Report of the First Consensus Conference on Standards, Competencies and Best Practices for Infant and Family Centered Developmental Care in the Intensive Care Unit. https://nicudesign.nd.edu/nicu-care-standards/; 2020 February 2020.
3. Browne JV, Jaeger CB, Kenner C. Executive summary: standards, competencies, and recommended best practices for infant- and family-centered developmental care in the intensive care unit. Journal of perinatology: official journal of the California Perinatal Association. 2020;40(Suppl 1):5–10.
4. Khalil H, Lakhani A. Using systems thinking methodologies to address health care complexities and evidence implementation. JBI Evid Implement. 2021;20(1):3–9.
5. Soleimani F, Azari N, Ghiasvand H, Shahrokhi A, Rahmani N, Fatollahierad S. Do NICU developmental care improve cognitive and motor outcomes for preterm infants? A systematic review and meta-analysis. BMC pediatrics. 2020;20(1):67.
6. Jones CW, Moya F, Lynch N. Unintended Consequences of the Neonatal Intensive Care Unit Environment: Integrative Review of Single-Family Room Unit Design. Advances in Neonatal Care. 2023;23(2):151–9.
7. O'Callaghan N, Dee A, Philip RK. Evidence-based design for neonatal units: a systematic review. Matern Health Neonatol Perinatol. 2019;5:6.
8. Shepley MM, Sachs NA. Physical environments that support the mental health of staff and families in the NICU. Journal of perinatology: official journal of the California Perinatal Association. 2020;40(Suppl 1):16–21.
9. Browne JV. How NICU design and infant and family-centered developmental care act synergistically to support babies and families. Journal of Perinatology. 2023;43(1):55–8.
10. Windle A, Javanparast S, Freeman T, Baum F. Factors that influence evidence-informed meso-level regional primary health care planning: a qualitative examination and conceptual framework. Health Res Policy Syst. 2023;21(1):99.
11. Gómez-Cantarino S, García-Valdivieso I, Moncunill-Martínez E, Yáñez-Araque B, Ugarte Gurrutxaga MI. Developing a Family-Centered Care Model in the Neonatal Intensive Care Unit (NICU): A New Vision to Manage Healthcare. International journal of environmental research and public health. 2020;17(19).
12. Maleki M, Mardani A, Harding C, Basirinezhad MH, Vaismoradi M. Nurses' strategies to provide emotional and practical support to the mothers of preterm infants in the neonatal intensive care unit: A systematic review and meta-analysis. Womens Health (Lond). 2022;18:17455057221104674.
13. Moreno-Sanz B, Antón M, Montes MT, Cabrera-Lafuente M, Losantos-García I, Pellicer A. Short and mid-term neonatal outcomes in high-risk infants undergoing FICare: a case control study. Pediatric research. 2025;97(1):286–92.
14. Shepley MM, Smith JA, Sadler BL, White RD. The business case for building better neonatal intensive care units. Journal of perinatology: official journal of the California Perinatal Association. 2014;34(11):811–5.
15. Notarnicola I, Duka B, Grosha E, Gioiello G, Rocco G, Stievano A. Exploring the Role of Nurse Leadership Through a Systems Thinking Lens: A Systematic Review of Conceptual and Empirical Evidence. J Adv Nurs. 2025.


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**NT**

*Corresponding Author:*

*Carol Jaeger, DNP, RN, NNP-BC*
*Coordinator of the Consensus Committee on Infant- and Family-Centered Developmental Care*
*Adjunct Faculty*
*The Ohio State University College of Nursing*
*3143 Cranston Drive, Dublin, OH 43017*
*Email:* caroljaeger75@gmail.com

*Carole Kenner, PhD, RN, FAAN, FNAP, ANEF, IFDCOINN*
*Founder/CEO COINN*
*Council of International Neonatal Nurses, Inc. (COINN)*
*Carol Kuser Loser Dean/Professor*
*School of Nursing & Health Sciences*
*The College of New Jersey*
*Email:* ceo@coinnurses.org

Dr Jaeger serves as Adjunct Faculty at The College of Nursing at The Ohio State University and Coordinator of the Consensus Panel of Infant and Family Centered Developmental Care. She is a board certified Neonatal Nurse Practitioner, served in the Army Nurse Corps, and retired from the U.S. Army. Dr Jaeger received her Bachelor of Science degree from Syracuse University, and her Master of Science degree and Doctorate of Nursing Practice from The Ohio State University.

Dr. Kenner is the Dean & Professor at The College of New Jersey and Chief Executive Officer of the Council of International Neonatal Nurses, Inc. (COINN). She holds a Bachelor of Science in Nursing from the University of Cincinnati and a Master of Science in Nursing and Doctorate in Nursing (PhD) from Indiana University. She holds fellowship in the American Academy of Nursing, the National Academies of Practice, Academy of Nursing Education, and Council of International Neonatal Nurses, Inc. (COINN).

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# Centering Family Voices in Neonatal Intensive Care Unit Design: A Framework for Family-Centered Environments

*Malathi Balasundaram, MD, Morgan Kowalski, NICU Parent*

*"The design of Neonatal Intensive Care Units (NICUs) has significant implications for infant outcomes, parental well-being, and the delivery of family-centered care. Increasing evidence demonstrates that the physical environment of the NICU influences parental presence, participation in care, stress levels, and the development of parent–infant bonding (1-3)."*

**Introduction:**

The design of Neonatal Intensive Care Units (NICUs) has significant implications for infant outcomes, parental well-being, and the delivery of family-centered care. Increasing evidence demonstrates that the physical environment of the NICU influences parental presence, participation in care, stress levels, and the development of parent–infant bonding (1-3). As such, NICU design should be understood not merely as an architectural or operational endeavor, but as a critical component of equitable, family-centered healthcare delivery. Centering family voices throughout the design process is essential to ensuring that NICU environments align with the lived realities, needs, and values of the families they serve.

**Family Partnership Councils as Decision-Making Bodies:**

The formation of a NICU-specific Family Partnership Council (FPC) provides a structured mechanism for embedding family perspectives into NICU quality improvement and processes, including design governance. Such councils should include parents and family members who have experienced a NICU stay and who represent diverse backgrounds and lived experiences. They should reflect variation in race, ethnicity, language, socioeconomic status, family structure, and infant diagnoses and outcomes.

Importantly, Family Partners should participate directly in design meetings and decision-making processes, rather than serving solely in advisory or consultative roles. Equitable participation requires intentional preparation, inclusive meeting practices, and recognition of family expertise as complementary to clinical and technical knowledge. When families are positioned as equal stakeholders, design outcomes are more likely to reflect authentic family needs and promote shared ownership of the resulting space. This looks like adopting a framework like the NEC Society's All In Meeting Guidelines, which aims to dismantle the hierarchy in healthcare and empower everyone to contribute, by providing meeting materials in advance so Family Partners can adequately prepare and decode acronyms and other medical jargon.

*"Family engagement in NICU design should occur early and be sustained throughout the planning and implementation phases. Traditionally, families are consulted during late-stage feedback or evaluation periods, limiting their meaningful influence on core design decisions."*

**Early and Continuous Family Engagement:**

Family engagement in NICU design should occur early and be sustained throughout the planning and implementation phases. Traditionally, families are consulted during late-stage feedback or evaluation periods, limiting their meaningful influence on core design decisions. Early involvement enables families to contribute to the establishment of guiding principles, identify priorities, and highlight unmet needs that may not be apparent to clinicians, administrators, or design professionals.

*"Centering family voices in NICU design necessitates intentional inclusion of families from historically marginalized or underrepresented groups, including non-English language preference (NELP) families and parents with disabilities."*

Ongoing engagement throughout the design process allows for iterative refinement and ensures that family perspectives remain integrated as budgets, timelines, and priorities evolve. This continuous approach positions families as partners rather than passive stakeholders, thereby strengthening alignment between design intent and real-world use.

*"Participatory co-design methods offer a practical way to translate family input into actionable design solutions. Focus groups, mock room walkthroughs, and simulated environments allow Family Partners to interact with proposed layouts and provide experiential feedback prior to construction."*

**Accessibility, Inclusivity, and Equity Considerations:**

Centering family voices in NICU design necessitates intentional inclusion of families from historically marginalized or underrepresented groups, including non-English language preference (NELP) families and parents with disabilities. Without deliberate outreach and accommodation, design processes risk privileging a narrow subset of experiences.

Inclusive NICU environments should incorporate multilingual communication tools, universally accessible layouts, and design features that accommodate a range of physical, sensory, and cognitive needs. Soliciting feedback from parents navigating linguistic or cultural barriers and those with disabilities ensures that design decisions promote equity and reduce structural obstacles to participation in care.

*"Family-centered NICU design must be grounded in an understanding of families' daily lived experiences during prolonged hospitalizations. Parents in the NICU frequently assume caregiving responsibilities while managing physical exhaustion, emotional stress, and logistical challenges."*

**Co-Design Through Participatory Methods:**

Participatory co-design methods offer a practical way to translate family input into actionable design solutions. Focus groups, mock room walkthroughs, and simulated environments allow Family Partners to interact with proposed layouts and provide experiential feedback prior to construction.

These methods enable assessment of factors such as room configuration, lighting quality, acoustic conditions, ventilation, and the clarity of wayfinding and signage. Families often identify usability challenges that may not be evident in architectural plans, particularly under conditions of stress or fatigue. They may also identify accessibility challenges as it relates to recovery from childbirth, including considerations for parents recovering from traumatic births and/or cesarean sections. Incorporating iterative feedback through co-design processes enhances usability, reduces the likelihood of costly post-construction modifications, and promotes environments that better support family well-being.

**Designing for the Daily Realities of NICU Families:**

Family-centered NICU design must be grounded in an understanding of families' daily lived experiences during prolonged hospitalizations. Parents in the NICU frequently assume caregiving responsibilities while managing physical exhaustion, emotional stress, and logistical challenges. Design strategies should therefore prioritize functionality, comfort, and proximity. Key design considerations include the availability of spaces that support parental rest, layouts that facilitate continuous proximity to the infant, and infrastructure that enables sustained participation in feeding and pumping. Attention to these elements acknowledges parents as integral members of the care team and supports their capacity to remain present and engaged.

Pumping spaces, in particular, should be intentionally designed to support frequent, sustained milk expression by locating them in proximity to the infant's bedside whenever feasible. Proximity reduces physical and psychological barriers to pumping, minimizes time away from the infant, and supports parental presence and engagement in care. These spaces should provide visual and acoustic privacy, adequate and secure storage for personal belongings and expressed human milk, and immediate access to hygienic cleaning and handwashing facilities. Integrating pumping infrastructure inside patient rooms acknowledges lactation as a core component of neonatal care rather than an ancillary activity, and reinforces the role of parents as active participants in their infant's treatment and development.

**Transparency and Accountability in the Design Process:**

Transparent communication is essential to sustaining trust and meaningful engagement with Family Partners. Families who contribute to NICU design efforts should receive regular updates regarding design decisions and clear explanations of how their feedback has influenced outcomes.

When constraints limit the feasibility of certain recommendations, openly communicating the rationale for these decisions reinforces accountability and respect. Transparency transforms family engagement from a symbolic exercise into a substantive partnership and supports long-term collaboration beyond the design phase.

*"Transparent communication is essential to sustaining trust and meaningful engagement with Family Partners. Families who contribute to NICU design efforts should receive regular updates regarding design decisions and clear explanations of how their feedback has influenced outcomes."*

*"Through early and continuous engagement, the establishment of Family Partnership Councils, participatory co-design methods, attention to daily lived realities, inclusive practices, transparent communication, and examination of international approaches, NICU environments can be intentionally aligned with the needs of families."*

**Northern European Approaches to Family-Centered NICU Design:**

Exploring design and care models implemented in other countries, particularly in Northern Europe, can further expand the possibilities for family-centered NICU environments. Many Northern European NICUs have long prioritized continuous parental presence, integrated caregiving roles, and physical designs that support parents as primary caregivers rather than visitors (4-6).

Examining these international approaches can help illuminate alternative spatial configurations, workflows, and cultural norms that may not be readily apparent within U.S.-based systems. Limitations are often assumed to be fixed when, in fact, they are products of historical design choices and institutional culture. Without intentional efforts to look beyond familiar models, stakeholders may envision only incremental improvements rather than transformative change. Incorporating international case studies and comparative learning into the design process encourages stakeholders to question entrenched assumptions, broaden their conceptual frameworks, and reimagine NICU environments from principles grounded in family needs rather than legacy constraints.

**Conclusion:**

Centering family voices in NICU design represents a critical strategy for advancing family-centered, equitable neonatal care. Through early and continuous engagement, the establishment of Family Partnership Councils, participatory co-design methods, attention to daily lived realities, inclusive practices, transparent communication, and examination of international approaches, NICU environments can be intentionally aligned with the needs of families.

Ultimately, NICU design that is informed by family expertise contributes not only to improved physical spaces but also to a broader culture of partnership, respect, and shared responsibility in neonatal care.

**References:**


1. Shepley MM, Harris DD, White R. Open-bay and single-family room neonatal intensive care units - Caregiver satisfaction and stress. Environ Behav. 2008;40(2):249-68. doi: 10.1177/0013916507311551. PubMed PMID: WOS:000253456900006.
2. Pineda RG, Neil J, Dierker D, Smyser CD, Wallendorf M, Kidokoro H, et al. Alterations in brain structure and neurodevelopmental outcome in preterm infants hospitalized in different neonatal intensive care unit environments. J Pediatr. 2014;164(1):52-60 e2. Epub 20131017. doi: 10.1016/j.jpeds.2013.08.047. PubMed PMID: 24139564; PubMed Central PMCID: PMC3872171.
3. Franck LS, O'Brien K. The evolution of family-centered care: From supporting parent-delivered interventions to a model of family integrated care. Birth Defects Res. 2019;111(15):1044-59. Epub 20190521. doi: 10.1002/bdr2.1521. PubMed PMID: 31115181.
4. Ortenstrand A, Westrup B, Brostrom EB, Sarman I, Akerstrom S, Brune T, et al. The Stockholm Neonatal Family Centered Care Study: effects on length of stay and infant morbidity. Pediatrics. 2010;125(2):e278-85. Epub 20100125. doi: 10.1542/peds.2009-1511. PubMed PMID: 20100748.
5. O'Brien K, Robson K, Bracht M, Cruz M, Lui K, Alvaro R, et al. Effectiveness of Family Integrated Care in neonatal intensive care units on infant and parent outcomes: a multicentre, multinational, cluster-randomised controlled trial. Lancet Child Adolesc Health. 2018;2(4):245-54. Epub 20180208. doi: 10.1016/S2352-4642(18)30039-7. PubMed PMID: 30169298.
6. Heinemann AB, Hellstrom-Westas L, Hedberg Nyqvist K. Factors affecting parents' presence with their extremely preterm infants in a neonatal intensive care room. Acta Paediatr. 2013;102(7):695-702. Epub 20130508. doi: 10.1111/apa.12267. PubMed PMID: 23590800.



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**NT**


***Corresponding Author:***

*Malathi Balasundaram, MD*
*Clinical Professor*
*Stanford School of Medicine*
*FCC Committee Chair*
*El Camino Hospital*
*Mountain View, CA, United States*
*Email:* malathib@stanford.edu

*Corresponding Author*

*Morgan Kowalski*
*Director of Operations,*
*Family-Centered Care Taskforce*
*Email:* familycenteredcaretaskforce@gmail.com

# The Importance of Personalizable Family Space in the Neonatal Intensive Care Unit

*Karen Bong, B.A.*

*"Patient care areas in neonatal intensive care units are necessarily functional and standardized. However, making provision for space dedicated to the family, personalized for them and their baby, is an important design consideration. The uniformity and sterility of healthcare institutions are alienating in the context of something as intimate and loving as a family's relationship with their new baby."*

**Introduction:**

Patient care areas in neonatal intensive care units are necessarily functional and standardized. However, making provision for space dedicated to the family, personalized for them and their baby, is an important design consideration. The uniformity and sterility of healthcare institutions are alienating in the context of something as intimate and loving as a family's relationship with their new baby. Providing families with their own space that can be personalized for their baby sends constant messaging embedded in the structure of the patient care space: that this is a kind of home for the family, that there is a place for families at the bedside, that opportunities for parental care are built into the NICU, and that their baby is a person with individuality and identity.

The author's background as a NICU parent and later a NICU Family Support Specialist provides examples of how personalized family space can support family presence, enhance parental interaction with their baby and staff, and facilitate other activities that contribute to family well-being.

**NICU as a Home:**

For a baby admitted to the NICU, the unit is their first home. In instances where the baby dies in-hospital, it will be the only home they ever have and the only space within which the baby, their parents, siblings, and relatives will ever be together as a family. Regardless of medical outcome, admission to the NICU represents a loss of the concept of home that parents wish to offer their children: a personal space of safety, privacy, nurturing, and togetherness. An institutional setting where the parental role as primary caregiver is displaced is the exact opposite of what families envision as home.

The space where the baby lives, being cared for as a patient, situationally becomes a home for family caregivers and parents (hereafter collectively referred to as "parents") by virtue of it being where their baby is, but the structure of this space can vary in degrees of perceived welcome and family belonging.

*"An ideal NICU design provides living space for parents that allows for the basic necessities of life (sleep, mental rest, nourishment, hygiene), the actions of NICU parenting (particularly for parents pumping human milk), and the option for privacy (parents are aware their actions and well-being are under continuous assessment by staff)."*

**Personalizable Space:**

An ideal NICU design provides living space for parents that allows for the basic necessities of life (sleep, mental rest, nourishment, hygiene), the actions of NICU parenting (particularly for parents pumping human milk), and the option for privacy (parents are aware their actions and well-being are under continuous assessment by staff).

The furnishings that enable these activities of living and presence provide opportunities for parents to personalize space for their baby or family. Walls, separators or doors, cupboards, shelving, sleeping spaces, storage spaces; all have some capacity for personalization, from decoration to a place for personal effects from home that are hospital policy-compliant.

In NICUs that do not achieve the ideal of dedicated family space in patient areas, the presence of some personalizable space remains valuable. Small areas like a simple cabinet, wall space, the back of a door, and even the movable arm of the bedside monitor offer opportunities for family personalization.

**A More Welcoming Home:**

Personalizable space sends a message that the NICU is a place for parents, a place that makes room for families. Parents may display photos, artwork, religious symbols, decorations, and keepsakes. Personalizable space welcomes the family's identity, values, priorities, and faith. It shows consideration for items that provide emotional comfort. It provides an outlet for individual celebration and creativity. The locus of intensive medical care takes on a less impersonal, more familiar air.

Parents often express feelings of isolation while their baby is in the NICU. Personalizable space can be used to display expressions of care from the family and the wider community: decorations displaying the baby's name, cards from well-wishers, gifts for the baby, certificates celebrating milestones, and the like; their visibility is an expression of parents' love for and a reminder of the community's care for the baby. In the space where painful procedures may take place, unwelcome medical news may be shared, and a physical separation might be medically necessary,

these visual signs of love and community support can offer comfort.

Lengthy hospitalizations may include cultural or religious holidays with a baby in the NICU rather than at home. This can reinforce a feeling that the family is left behind or out of sync with the larger world. Personalizable space can help families close that psychological gap by providing a place to observe and celebrate holidays. During the December holidays, the author has seen impressive festive decorations, including themed toys, strings of lights, seasonal baby outfits, and, on one memorable occasion, a two-foot-tall Christmas tree complete with ornaments. As they would in their private abode, families can personalize their space to celebrate culturally significant holidays in ways adapted from what they do at home.

*"Parents commonly express that reading to their baby can help them forget the medicalized environment for a while and makes them feel like a "normal" parent. Space that fosters nurturing, mutually enjoyable parent-baby interactions indicates that these interactions are desired and encourages parental presence to enable them."*

**Enhanced Interactions:**

Personalizable space provides opportunities for enhanced interactions between parents and their baby.

Shelves for displaying or storing storybooks can encourage parents to read to their baby, an activity that promotes neurodevelopment and is archetypal for parents of young children. Parents commonly express that reading to their baby can help them forget the medicalized environment for a while and makes them feel like a "normal" parent. Space that fosters nurturing, mutually enjoyable parent-baby interactions indicates that these interactions are desired and encourages parental presence to enable them.

Another common use of personalizable space is to display certificates celebrating the baby's milestones. There is a wide range of possible milestones, including those based on a baby's age, medical progress, interactions with family, holidays, and participation in typical baby activities (e.g., wearing clothes, going for stroller walks, first bath). These milestone certificates document a baby's personal journey and serve as reminders of each family's NICU story. Having space for visible markers of a baby and their family's journey encourages parents to celebrate progress, however small. It encourages parents to view their baby in light of their achievements, rather than only as a patient in intensive care. Openly documenting milestones in a family's NICU story can also feel validating to the parents who are going through medical events that may be typical for the NICU but stressful and traumatic for the family.

On the subject of positive interactions, not to be forgotten are crafts and keepsakes, often made by nurses with personalized elements such as the baby's name or handprints and footprints. The majority of families gladly receive these crafts. The making and giving of these crafts communicate the nursing staff's recognition of each child's specialness and their deep caring for the babies who are inpatients. This tangible expression of staff care can help build a trusting rapport between NICU staff and families, who are entrusting their critically ill babies to strangers. Rapport and psychological safety promote better care team performance, including the integration of parents in the care team.

*"Emotional peer support groups and parent education sessions were partially effective. However, for many reasons, including cultural norms, psychological state, and personal preference, a meaningful cohort of parents was not interested in such activities."*

**Facilitating Other Activities that Promote Family Well-Being:**

In the author's work as a NICU Family Support Specialist, various approaches were taken to support and engage current NICU parents. Emotional peer support groups and parent education sessions were partially effective. However, for many reasons, including cultural norms, psychological state, and personal preference, a meaningful cohort of parents was not interested in such activities.

Hosting crafting sessions, in which the art materials, equipment, and finished examples were provided, and inviting NICU parents to make something for their baby proved to have wide appeal. Parents who regularly attended parent program groups, as well as those who never participated in support or education groups, responded positively to the opportunity to construct something for their baby. The desire to personalize the art with their baby's name was universal. Name plates, keepsake shadow boxes, commemorative or holiday cards all held appeal as something parents could make for and give to their baby. These crafts consistently ended up displayed in the NICU areas provided for families to keep personal effects or decorate.

Besides fulfilling a parental need to express love, pride, or hope to their baby, engaging parents in a crafting activity had other benefits. A tactile task requiring creativity provided a short period of mental quiet for many parents whose days were filled with NICU parenting activities or worry.

When a baby's parents participated in crafting together, the experience enabled low-stakes, positive collaboration between them. It also provided an avenue to express parental love in a manner the other parent could see. Patient care areas, filled with medical machinery and constant alarms, can be stress-inducing, with ever-present worry crowding out expressions of parental love. Nevertheless, seeing one's co-parent express parental love is important for emotional closeness in a co-parenting relationship. Facilitating that expression directly benefits family well-being.

*"Large portions of NICU parenting responsibilities (such as pumping milk, holding skin-to-skin, and doing routine baby care) are driven by the hope of positive outcomes that may be either invisible or only visible in the future. Giving parents an activity that produced immediate, visible results encouraged feelings of satisfaction and pride. It was a welcome change to have a tangible, positive result in the midst of an uncertain journey where the results of actions might only be seen years later."*

Large portions of NICU parenting responsibilities (such as pumping milk, holding skin-to-skin, and doing routine baby care) are driven by the hope of positive outcomes that may be either invisible or only visible in the future. Giving parents an activity that produced immediate, visible results encouraged feelings of satisfaction and pride. It was a welcome change to have a tangible, positive result in the midst of an uncertain journey where the results of actions might only be seen years later.

Crafting presented a low-pressure situation that still involved gathering with other NICU parents. During the process of artistic creation and the sharing of crafting materials, participants often became familiar with other NICU parents, whether through visual recognition that prompted later interactions or through introductions and conversations during the crafting activity. Peer connections are important for reducing feelings of isolation, and crafting activities successfully engaged some parents who were not interested in support or education groups.

The suggestion "make something to decorate your baby's space" can be an effective way to encourage parents to engage in activities that promote their psychological and social well-being. Its efficacy is strengthened by the presence of a dedicated space in the NICU where crafts can be displayed and kept close to their baby. Preparing a home for the arrival of a new baby is a deep-seated, human ritual. Providing a personalizable space in the NICU, along with materials and opportunities to decorate it, enables parents to participate in this normal and universal ritual. In the NICU, where so much of what parents consider normal is taken away by medical necessity, giving back some normalcy promotes family well-being.

**Conclusion:**

Space in the NICU for families to personalize may seem like a nice-to-have, extra feature, but its inclusion in NICU design is important. The presence of personalizable family space can signal welcome and support for the family's identity and values, encourage family presence and positive parental interactions with their baby, and support positive interactions between the NICU staff and the family. It can prompt parents to engage in normal parental rituals, such as decorating a home-like space for their baby's use and making personalized crafts for that space, which can be a beneficial activity in itself. Personalizable space helps the NICU feel as close to home as possible. It helps families experience the NICU as not only a place of trauma and fear but one that includes comfort, belonging, family togetherness, and celebration of their baby.

*"Space in the NICU for families to personalize may seem like a nice-to-have, extra feature, but its inclusion in NICU design is important."*

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**NT**

*Corresponding Author*

*Karen Bong, B.A.*
*The Canadian Premature Babies Foundation*
*321-45 Dunfield Avenue*
*Toronto, ON M4S 2H4*
*Canada*
*Email:* karen@cpbf-fbpc.org
*ORCID: 0000-0002-5150-3332*

Karen Bong is the parent of Lucy, who was born at 25 weeks' gestational age, and Jesse, a subsequent baby born full-term. Lucy was in the NICU at Sunnybrook Health Sciences Centre (Toronto, Canada) for 109 days, where the strong culture of family integrated care and supportive unit design enabled Karen and her husband Andrew to be fully involved as part of their daughter's NICU team.

After discharge, Karen was a Sunnybrook NICU volunteer and then staff member, providing peer support and parent programs for NICU families. She spent nine years working directly with current NICU families and has had ongoing dialogue with NICU family support specialists across North America for over a decade, through collaborations facilitated by the Vermont Oxford Network, the Canadian Neonatal Network-EPIQ, and the Canadian Premature Babies Foundation. Her past and ongoing work in NICU family support provides the professional experience informing the views of this paper.


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# Finding Our Way: How Thoughtful Wayfinding Supports Neonatal Intensive Care Unit Families in Times of Stress

*Julia Jude, AIA, EDAC, Hayley Freilich, EDAC, PMP, Riley Atlas, Jess Schultz, Anya Vanecek, MPH, Assoc. AIA*

*"Wayfinding is more than just signage. When people initially try to orient themselves and find their way, they first rely on the rapid processing of perceptual cues rather than conscious reasoning. People read the visual language of the space around them to form an immediate sense of where they are and how to move."*

**Introduction:**

Wayfinding is more than just signage. When people initially try to orient themselves and find their way, they first rely on the rapid processing of perceptual cues rather than conscious reasoning. People read the visual language of the space around them to form an immediate sense of where they are and how to move. When these cues are coherent and legible, navigation feels natural and requires minimal cognitive effort. When they are fragmented or ambiguous, movement becomes demanding, taxing attention, and straining working memory.

By influencing perception, the built environment functions as a continuous, nonverbal information system that communicates where people are, what actions are expected, and whether they are moving in the right direction. When the visual language is clear, users can anticipate what comes next and reserve cognitive resources for more important tasks, such as clinical decision making, caregiving, or emotional regulation. When it is unclear, wayfinding becomes an additional cognitive and psychological burden in already demanding environments.

These challenges intensify in healthcare settings, especially within the Neonatal Intensive Care Unit (NICU). Families and staff often navigate these environments while fatigued, under time pressure, or managing significant emotional and informational demands. Under such conditions, attentional capacity narrows, processing speed slows, and the ability to interpret complex signage and spatial layouts diminishes. Wayfinding systems that support rapid visual comprehension rather than prolonged analytical effort become essential for maintaining safety, orientation, and confidence.

*"These challenges intensify in healthcare settings, especially within the Neonatal Intensive Care Unit (NICU). Families and staff often navigate these environments while fatigued, under time pressure, or managing significant emotional and informational demands."*

This article examines NICU wayfinding through a human-factors lens, focusing on how design can better support perception, cognition, and attention. The article begins by acknowledging the diverse navigational needs of NICU users and how those needs shift under stress. Next, it identifies the importance of visual language and nonverbal communication in the wayfinding experience. It outlines fundamental strategies for transforming fragmented, high–cognitive-load navigation into coherent systems that preserve orientation and reduce mental effort. Finally, it highlights key design considerations that enable effective wayfinding in one of healthcare's most emotionally complex environments.

*"Designing wayfinding systems for the NICU requires recognizing that users navigate differently based on age, language, culture, cognitive processing styles, physical abilities, familiarity with the environment, and current stress levels. Each of these factors shapes how individuals perceive, interpret, and move through space."*

**Inclusive Navigation & Navigation Under Stress:**

Designing wayfinding systems for the NICU requires recognizing that users navigate differently based on age, language, culture, cognitive processing styles, physical abilities, familiarity with the environment, and current stress levels. Each of these factors shapes how individuals perceive, interpret, and move through space.

Language and culture play a particularly important role in how

users interpret environmental cues. Visual landmarks and intuitive visual communication, such as through color, imagery, distinct landmarks, and recognizable symbols, have become especially important for multilingual communities. In the absence of legible signage, visual landmarks provide a reliable way to confirm location and direction. Children tend to navigate more successfully when environmental cues extend beyond text.

*"Cognitive and physical diversity also influence how people navigate through space. People process information at different rates: some individuals may rely heavily on pattern recognition, and those with sensory sensitivities may benefit from environments with reduced visual noise and simplified decision points."*

Cognitive and physical diversity also influence how people navigate through space. People process information at different rates: some individuals may rely heavily on pattern recognition, and those with sensory sensitivities may benefit from environments with reduced visual noise and simplified decision points. Individuals with certain physical needs may require clear, unobstructed sightlines; pathways sized for assistive mobility; consistent ground-plane cues; and accessible sign placement. By designing through the lens of diverse user needs, the wayfinding system becomes not only functional but also equitable and dignifying for all who enter the NICU.

*"Inclusive design strategies become even more critical when users are under stress, which is a common reality in the NICU (1). Stress is known to impair working memory, slow processing speed, and narrow attentional focus, reducing an individual's ability to decode information and navigate unfamiliar environments (2)."*

Inclusive design strategies become even more critical when users are under stress, which is a common reality in the NICU (1). Stress is known to impair working memory, slow processing speed, and narrow attentional focus, reducing an individual's ability to decode information and navigate unfamiliar environments (2).

In practical terms, a parent arriving overnight after an urgent phone call may enter the hospital with limited cognitive capacity and low tolerance for ambiguity. If early decision points, such as elevator banks, corridor splits, or unit thresholds, are not immediately legible, they are more likely to struggle.

Under conditions of stress, people tend to rely on the most salient and immediately visible features of the environment. Smaller signs, directories, or subtle spatial cues are easily overlooked. This attentional narrowing can result in unnecessary delays and repeated navigation errors, compounding stress in moments when emotional and cognitive resources are already constrained. In high-stakes healthcare environments like the NICU, where uncertainty, fatigue, and urgency frequently occur, wayfinding systems must be designed to function reliably under degraded cognitive conditions, supporting orientation even when users cannot slow down, reread, or reassess their surroundings.

*"Just as the built environment can trigger stress and frustration, it can also subtly reassure individuals that they are safe, supported, and cared for. The difference between stressful and supportive spaces often comes down to visual language."*

**Visual Language and Nonverbal Communication:**

Just as the built environment can trigger stress and frustration, it can also subtly reassure individuals that they are safe, supported, and cared for. The difference between stressful and supportive spaces often comes down to visual language.

Visual coherence can be especially impactful in spaces where people are functioning with limited attention or experiencing high emotional strain. Design elements such as color, visual contrast, pattern, and lighting quality have been shown to help regulate stress responses and make navigation through healthcare environments easier (3). Even subtle signals can create a sense of coherence that quietly supports emotional stability. Visual clarity in circulation paths, distinct boundary cues between public and private zones, and predictable repetitions of motifs or forms also contribute to cognitive ease (4). When individuals can quickly and intuitively interpret their environment, they conserve mental and emotional energy for other tasks, such as decision-making, connecting with loved ones, or focusing on patient care.

Changes in visual language can signal transitions in the intended use and experiential character of spaces throughout a journey. Shifts in aesthetics, materiality, or lighting can cue people to anticipate change and adjust their behavior as they move among spaces associated with urgency, focus, and rest. Within a demanding environment such as the NICU, these transitions help users maintain orientation by aligning perceptual cues with expectations about what comes next.

Similarly, introducing brief moments of visual relief throughout the journey can provide perceptual "breathers." These moments support navigation by temporarily lowering cognitive load,

restoring attentional capacity, and allowing users to reorient before encountering the next decision point. When thoughtfully integrated, elements such as color variation, artwork, or softer forms can function as stabilizing reference points, quietly reinforcing a sense of coherence and supporting continued movement without requiring sustained analytical effort.

to create environments that are both navigable and supportive under stress. When applied intentionally, these tools become essential components of effective wayfinding strategies, helping translate complex clinical settings into spatial systems that users can understand, anticipate, and move through with confidence.

*Figure 1. Kahler Slater [Internet]. Milwaukee: Carle Danville Medical Office Center at The Riverfront. [updated 2023; cited 2026 May 1]. Available from: https://www.kahlerslater.com/expertise/health-care/carle-at-the-riverfront-medical-campus-ambulatory-care-center-pediatric-care*

Photo Caption:

***Visual Language:** A cohesive visual language that integrates materials, lighting, color, and signage to support intuitive wayfinding. Changes in flooring and ceiling treatments distinguish public circulation from departmental areas, while elevator graphics create a landmark at a key decision point. Artwork and blue accent wall paint create a boundary for the waiting area. Ceiling-mounted directional signage provides reassurance along the path, and destination signage clearly signals arrival.*

Ultimately, visual language encompasses the tools designers use

**The Fundamentals of Wayfinding:**

An effective wayfinding strategy supports three basic human needs: understanding where you are, knowing what to do next, and being able to keep moving without friction. Wayfinding systems meet these needs by giving people a clear sense of structure, reliable cues they can recognize and remember, and paths that make progress feel natural rather than effortful. When these elements work together, people spend less time interpreting their surroundings and more time moving with confidence. The environment begins to do some of the cognitive work for them, reducing uncertainty and allowing attention to stay focused on what brought them there in the first place.

When these principles are integrated across virtual resources, the built environment, architecture, interior design, experiential branding, and signage, they reinforce one another to create a clear and continuous experience. From the user's perspective, these layers are perceived as a single, cohesive whole, one in

which clarity emerges through alignment rather than any single element acting alone.

*"Wayfinding begins before the hospital is ever entered. Resources such as virtual tours, online or printed maps, and wayfinding apps for mobile devices can help people orient themselves to the facility before arrival. These resources help families know what to expect upon arrival and throughout their stay, and can also help train new providers, staff, and volunteers."*

**Wayfinding Beyond the Physical Environment:**

Wayfinding begins before the hospital is ever entered. Resources such as virtual tours, online or printed maps, and wayfinding apps for mobile devices can help people orient themselves to the facility before arrival. These resources help families know what to expect upon arrival and throughout their stay, and can also help train new providers, staff, and volunteers. Advanced preparation can help lessen the stress of navigating an unfamiliar environment.

*"Once people arrive at the hospital, distinct visual identities for specific areas or units give them an immediate sense of where they are within the larger environment. Regions operate at a broad, contextual level, allowing orientation to happen quickly and intuitively, before active navigation begins."*

**Create Unique Regions (supporting orientation):**

Once people arrive at the hospital, distinct visual identities for specific areas or units give them an immediate sense of where they are within the larger environment. Regions operate at a broad, contextual level, allowing orientation to happen quickly and intuitively, before active navigation begins. Rather than asking users to interpret signs or analyze information, regions establish a clear framework that helps people recognize which part of the facility they are in and what kind of space they have entered.

One way to accomplish this is to establish visual neighborhoods, groups of related spaces unified by a shared identity. Color, pattern, iconography, and supportive architectural cues are among the most common and effective tools for creating these distinctions (5). When applied at an appropriately coarse scale, these cues allow people to grasp the organization of a complex environment without needing to process fine details or hold multiple pieces of information in mind.

For example, a facility themed around local flora and fauna could pair birds with patient care areas and flowers with family respite areas. The designer might further differentiate regions by assigning bird species to units: cardinals to the ED, chickadees for general surgery, robins for the NICU, and so on. The interior design of the NICU might incorporate wood-look finishes, tree and leaf graphics, and robin 's-egg-blue accents, taking inspiration from robin's woodland habitat and distinctive colors to create a cohesive, logical visual identity. The "robin" theme would be incorporated into all wayfinding and navigation tools.

Effective regions also define meaningful boundaries and transitions. They help people recognize when they have arrived, when one condition ends, and another begins, and when expectations should shift. By grouping related spaces into recognizable areas, regions reduce the amount of information people need to manage at once, making unfamiliar environments feel more learnable and less overwhelming.

When regional identity is consistently applied across the environment, it becomes a stable point of reference that users can rely on during repeated visits. This stability is especially important in settings like the NICU, where families return frequently under varying emotional and cognitive states. A clear regional framework ensures orientation remains dependable even as circumstances change, setting the stage for confident navigation and sustained flow.

*"Once people are oriented to the larger environment, they rely on cues to make decisions and confirm their progress as they move from place to place. Landmarks support navigation by providing recognizable points of reference that people can use to guide action, remember routes, and verify that they are moving in the right direction (4)."*

**Use Landmarks to Anchor Memory (supporting navigation):**

Once people are oriented to the larger environment, they rely on cues to make decisions and confirm their progress as they move from place to place. Landmarks support navigation by providing recognizable points of reference that people can use to guide action, remember routes, and verify that they are moving in the right direction (4). Unlike regions, which establish context, landmarks operate at the level of choice, helping users decide what to do next without stopping to reassess their surroundings. When they reflect the theme that defines their region, they can become key signals that a person has arrived at their destination (6).


*Figure 2. Metcalfe [Internet]. Philadelphia (PA): Environmental Graphics, Children's Hospital of the King's Daughters - Photographed by Halkin Mason Photography. [Updated 2022, cited 2026, May 1]. Available from: https://metarchdesign.com/work/environmental-graphics.*

*Photo Caption:*

***Landmark:** A memorable hot air balloon graphic creates a visual landmark at an elevator lobby within The Children's Pavilion at The Children's Hospital of the King's Daughters. The easily recognizable symbol and large floor number identifier anchor a key touchpoint in the navigational journey, helping patients and visitors quickly orient themselves.*

Effective landmarks are perceptible at moments of decision. They stand out from their immediate context, are easy to recognize from different viewpoints, and remain consistent over time. By anchoring movement to recognizable reference points, landmarks reduce the cognitive effort required to navigate complex environments, allowing decisions to feel more intuitive and less analytical.

Landmarks are especially important for memory (7). People tend to recall routes not as abstract sequences of turns, but as a series of recognizable moments tied to distinctive features along the way. For example, "turn left at the big tree, then a right at the nurse's station, then another right at the cardinal" is a more memorable set of instructions than "turn left, then right, then right again," especially for people with limited literacy skills. Human minds have evolved around storytelling, and when we weave stories into our wayfinding, they can be a powerful tool for alleviating stress and introducing clarity. When stable reference points support navigation, routes become easier to remember and repeat. Over time, this reduces hesitation, backtracking, and reliance on external assistance.

In environments like the NICU, where families and staff often traverse the same paths repeatedly under varying emotional and cognitive conditions, landmarks become trusted cues. They provide reassurance during movement, support learning through repetition, and allow navigation to become increasingly automatic. By reinforcing decision points and confirming progress, landmarks help people move with confidence even when attention is limited or stress is high.

**Streamlining Pathways (Flow):**

As people move through a hospital, guided by a sense of where they are and cues indicating where to go next, pathways support flow by keeping movement continuous and assured. Effective pathways make forward progress feel natural, so attention can remain relaxed between destinations and become more focused only when a choice needs to be made.

*"As people move through a hospital, guided by a sense of where they are and cues indicating where to go next, pathways support flow by keeping movement continuous and assured."*

Pathways work best when they are organized around decision points. As people move through an environment, they periodically approach moments where a choice becomes necessary. Leading up to these moments, they look for reassurance that they are still on the right path. At the point of choice, they need clear direction. Immediately afterward, they seek confirmation that the decision was correct. A well-structured wayfinding system supports this sequence by introducing information in proportion to the moment, providing broad guidance during movement, offering clearer direction at the decision point, and confirming once the choice is made, thereby allowing momentum to continue without prolonged hesitation.

Hierarchy is essential to making this possible. Primary pathways should be read as the obvious route forward, while secondary paths support localized access and transition. This hierarchy is established first through architectural and interior planning, including how circulation is organized, how public, shared, and staff-only zones are differentiated, and how back-of-house movement is kept distinct, and then reinforced through wayfinding cues that clarify and confirm that structure. When spatial organization and informational cues work together, navigation feels intuitive rather than effortful.

*"Pathways also vary in character, and these differences play an important role in shaping experience. Some routes function as primary circulation spines, supporting shared movement, staff workflows, and operational flow across the building."*

Pathways also vary in character, and these differences play an important role in shaping experience. Some routes function as primary circulation spines, supporting shared movement, staff workflows, and operational flow across the building. These pathways benefit from openness, visibility, and a clear sense of progression, helping people navigate complex environments efficiently without confusion. Other pathways, however, serve more contained or sensitive functions and benefit from being quieter, more narrowly focused, or visually calmer.

*"When pathway character aligns with use, the building communicates how spaces are intended to be occupied, helping people move confidently while also supporting care, privacy, and recovery."*

In environments such as the NICU, this distinction becomes especially meaningful. Separating primary public routes from quieter family and patient pathways helps reduce unnecessary stimulation while still maintaining clarity and ease of movement. Thoughtful zoning, distinguishing public, shared, and staff-only circulation, and keeping back-of-house movement legible yet unobtrusive, allow the environment to support both operational needs and a more restorative experience. When pathway character aligns with use, the building communicates how spaces are intended to be occupied, helping people move confidently while also supporting care, privacy, and recovery.

When pathways are structured consistently, flow becomes dependable over time. People hesitate less, recover more quickly from moments of choice, and rely less on staff for directions. Movement becomes familiar and steady, allowing the environment itself to support confidence and ease across repeated journeys.

**NICU Pathways Beyond the Unit:**

Since NICU hospital stays can be lengthy, families are likely to rely on hospital and community amenities throughout their stay. Providing clear pathways to amenities such as dining, laundry, sleep, outdoor gardens, and relaxation helps preserve a family's sense of autonomy and dignity. These spaces should ideally be placed within or in proximity to the NICU. Where proximity is not possible, a digital or printed guide can advertise available resources and provide clear directions to them.

As important as it is for families to find their way to and through the NICU, transitions out of the unit are significant in their own right. Families may leave each day for work, to care for a sibling, or to manage daily responsibilities. Some will eventually depart to bring their newborn home. Others may leave under circumstances of loss. These departures often occur under time pressure, fatigue, and heightened emotional strain, when navigation becomes harder and environmental support matters more.

Wayfinding can reduce burden during these transitions by making routes clear, predictable, and easy to follow. Thoughtful attention to pathways between the NICU and key destinations, such as bereavement rooms, mortuary exits, and discrete egress routes, can support families in difficult moments. Clear directions to exits, parking garages, public transportation, ride shares, and taxis can also reduce stress during departures, helping families move through important transitions with greater steadiness and privacy.

**Key Considerations for Effective Wayfinding:**

Once the fundamental strategies of wayfinding are integrated into a project, three key considerations can be used to refine the design. Visual hierarchy, legibility, and consistency work together to provide clear, intuitive, and reliable directions as people navigate a complex environment.

***"Establishing a clear hierarchy throughout a wayfinding system can help people quickly understand the hospital's visual language. A wayfinding system should be broken down into primary, secondary, and tertiary levels (or more). This hierarchy helps families and staff quickly zero in on the type of location they are looking for."***

**1) Establish a Logical Hierarchy:**

Establishing a clear hierarchy throughout a wayfinding system can help people quickly understand the hospital's visual language. A wayfinding system should be broken down into primary, secondary, and tertiary levels (or more). This hierarchy helps families and staff quickly zero in on the type of location they are looking for.

*Figure 3. Metcalfe [Internet]. Philadelphia (PA): Burger Center Phase I - Photographed by Laurie Beck-Peterson. [Updated: 2015, cited May 1, 2026] Available from: https://metarchdesign.com/work/buerger-center-phase-i.*

Photo Caption:

***Hierarchy:*** *The difference in scale of the oversized 3 and the smaller Check In sign in the distance demonstrates a visual hierarchy. The change in scale provides a clear distinction between the types of key information patients and families use to navigate as they arrive on each floor within the Buerger Center for Advanced Pediatric Care at the Children's Hospital of Philadelphia.*

Hierarchy can be established using visual cues that differentiate destination types along a pathway. Designers can deliberately treat the look of an entry point from that of a throughway, or a space designed for families, or a staff-only zone. The entrance to a primary location, such as the NICU, should look different than the entrance to a secondary location, such as an electrical closet.

To distinguish a primary location, designers can use methods that convey importance: architectural features, such as decorative soffits at doorways; accent finishes; distinct lighting; landmarks, such as artwork and wall graphics; and prominent signage. For secondary or tertiary categories, opt for subtler design elements.

In establishing a hierarchy, balance is important. Designs should create sufficient distinction between categories and ensure the whole system functions cohesively. Introducing too much variation risks creating a disjointed and distracting experience.

**2) Prioritize legibility:**

In times of stress, a wayfinding system's legibility is critical to its effectiveness. For wayfinding to be legible under stress, signage and pathways must be highly visible and easy to understand.

Several factors affect signage legibility. Legible signage design optimizes placement, size, contrast, and clarity. Signs should be placed in well-lit locations that are directly visible from key navigation points, such as elevators and unit entrances. Signs should be appropriately scaled to their spaces. Choosing sign colors and materials that contrast with their backgrounds helps signage stand out. Plain descriptions written in multiple languages and using a clear, minimal typeface help ensure readability. Bold graphic symbols assist users with limited literacy and impaired cognition (8).

Many of these factors also affect pathway legibility. Clear sightlines are created by limiting turns and removing unnecessary obstructions. Where consistent lighting signals continuation of a given path, changes in lighting quality or light fixtures can highlight destinations or route changes. In addition to signage, pathways can be defined by other graphical elements, such as flooring accents, wall colors, murals, and themed artwork.

*Figure 4. Metcalfe [Internet]. Philadelphia (PA): King of Prussia Inpatient Hospital, Children's Hospital of Philadelphia - Photographed by Halkin Mason Photography. [Updated 2022, cited 2026, May 1]. Available from: https://metarchdesign.com/work/king-of-prussia-pediatric-inpatient-hospital.*

Photo Caption:

***Line of Sight:*** *Upon arrival at the lobby of The Middleman Family Pavilion at the Children's Hospital of Philadelphia, visitors have an unobstructed line of sight to several key amenities they may need during hospital stays at this inpatient facility. Within a single field of view, they see Admissions, a central shared lounge, cafe, and coffee shop. This open view allows visitors to orient themselves upon arrival with minimal effort.*

**3) Keep Things Consistent:**

Designers should ensure consistency across all elements of a wayfinding system. Using consistent aesthetics and language in signage, maps, websites, and written communications creates an intuitive navigation experience.

Aesthetic consistency helps people know what to look for as they navigate. Once a visitor notices a trail of breadcrumbs, they look for more breadcrumbs. They may even begin to filter out other visual cues, especially during high-stress situations. Whether breadcrumbs, symbols, themed graphics, or other visual languages, consistency throughout the trail helps a visitor travel intuitively from point to point. Visual cues such as signage, landmarks, and artwork should be used consistently throughout the journey to minimize confusion.

***"Language should also be simple, consistent, and attuned to families' emotional needs. For some, their NICU stay may be their first experience in a hospital, let alone an intensive care unit. "***

Language should also be simple, consistent, and attuned to families' emotional needs. For some, their NICU stay may be their first experience in a hospital, let alone an intensive care unit. Place names and descriptions must be clear, but sensitive. Over time,

staff, volunteers, and even families may adopt colloquial acronyms and nicknames for locations within the NICU that diverge from standard naming conventions. These names may bring welcome levity to the unit but can create confusion for newcomers. When appropriate, nonstandard place names should be adopted across all navigation materials, including signage.

***"Navigating complex care environments during moments of acute stress is challenging. To support navigation during stressful moments, wayfinding cues must be clear, bold, and intuitive. Landmarks should be highly visible from multiple vantage points; decision points should be minimized; and signage should be placed directly within natural lines of sight rather than relying on users to scan the environment."***

**Conclusion:**

Navigating complex care environments during moments of acute stress is challenging. To support navigation during stressful moments, wayfinding cues must be clear, bold, and intuitive. Landmarks should be highly visible from multiple vantage points; decision points should be minimized; and signage should be placed directly within natural lines of sight rather than relying on users to scan the environment. Using consistent color-coding, thoughtful iconography, and predictable spatial patterns ensures that, even when users are overwhelmed, they can rely on instinctive, not analytical, navigation strategies. Ultimately, designing for stressed users means designing for real users and acknowledging that the NICU experience inherently involves fluctuating emotional capacity throughout the day. Because people interpret space emotionally before they process it logically, effective wayfinding design must attend to both perceptual and physiological realities. When thoughtfully implemented, signage, environmental cues, and spatial hierarchy become tools for compassionate care.

**Works Cited**


1. Bernardo, J., Rent, S., AriasShah, A., Hoge, M. K., & Shaw, R. J. Parental stress and mental health symptoms in the NICU: Recognition and interventions. *NeoReviews*. 2021; 22(8), e496–e505.
2. Arnsten, A. F. T. Stress signaling pathways that impair prefrontal cortex structure and function. *Nature Reviews Neuroscience*. 2009; 10(6), 410–422.
3. Ulrich, R. S., Zimring, C., Zhu, X., DuBose, J., Seo, H.B., Choi, Y.S., Quan, X., & Joseph, A. A review of the research literature on evidencebased healthcare design. *HERD: Health Environments Research & Design Journal*. 2008; 61-125.
4. Devlin, A. S. Wayfinding in Healthcare Facilities: Contributions from Environmental Psychology. *Behavioral Sciences*. 2014; (4) 423–436.
5. Saleh Kalantari, Vidushi Tripathi, James D. Rounds, Armin Mostafavi, Robin Snell, Jesus G. Cruz-Garza. Evaluating Wayfinding Designs in Healthcare Settings through EEG Data and Virtual Response Testing. *Journal of Environmental Psychology*. 2021
6. Lynch. The image of the city. *Cambridge : MIT Press,* 1960.
7. Passini, R. Wayfinding design: Logic, application, and some thoughts on universality. *Design Studies.* 1995; (17) 319-331.
8. Rodrigues, Coelho & Tavares. Healthcare Signage Design: A Review on Recommendations for Effective Signing Systems. *HERD: Health Environments Research & Design Journal.* 2018.


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***Corresponding Author***

*Julia Jude, AIA, EDAC*
*Pediatric Practice Leader, Kahler Slater*
*Master of Architecture*
*Member of Pediatric Environment Network with Center for Health Design, Association of Medical Facilities Professionals, and American Institute of Architects*
*I have no conflicts of interest relevant to the manuscript.*
*Email:* Jjude@kahlerslater.com

*Hayley Freilich, EDAC, PMP*
*Director of Healthcare and Patient Experience, Metcalfe Architecture & Design*
*Bachelor of Science in Graphic Design*

*Riley Atlas*
*Creative Director, Brand Design, Kahler Slater*
*Design Academy Eindhoven, The Netherlands (NL); B.A. Man & Communication (New Media Design)*

*Jess Schultz*
*Senior Brand Designer, Kahler Slater*
*Bachelor of Arts in Graphic Design & Illustration*
*Member SEGD (Society for Experiential Graphic Design)*

*Anya Vanecek, MPH, Assoc. AIA*
*Project Specialist, Kahler Slater*
*Master of Public Health – Health Policy, Master of Architecture*

Peer Reviewed

# Designing for Love, Ritual, and Grief in the Neonatal Intensive Care Unit: A Framework for Sensitive Design Conversations

*Anya Vanecek, MPH, Julia Jude, AIA, EDAC*

*"NICUs are clinically and emotionally intense environments in which families share some of their first moments of joy alongside profound losses. Some of these losses, such as the potential loss of a beloved child, are profound and obvious."*

**Introduction:**

NICUs are clinically and emotionally intense environments in which families share some of their first moments of joy alongside profound losses. Some of these losses, such as the potential loss of a beloved child, are profound and obvious. Others are subtler, but potentially just as disruptive. Grief may arise from the unraveling of daily life and the rituals, relationships, and plans that can follow a NICU admission. The impact of these compounding emotions can be lasting for individuals and families.

Due to the strong emotions and discomfort these experiences evoke, discussions of grief and loss are difficult and often avoided during design meetings. Nevertheless, when designers do not discuss and address the needs of those experiencing loss, the design can unintentionally exacerbate grief. As NICU designers, our task is to create spaces that can accommodate the full depth and complexity of intense emotions, better supporting people through these very impactful experiences.

*"To prompt more accessible and productive design discussions, this paper approaches the task of designing space for grief using a framework that shifts the focus to the related experiences of ritual, connection, and love."*

To prompt more accessible and productive design discussions, this paper approaches the task of designing space for grief using a framework that shifts the focus to the related experiences of ritual, connection, and love. First, we frame grief as a complex experience rooted in love, processed through ritual, which implicates design. Next, we share design elements that support this journey and present case studies from Boston Children's Hospital, Nationwide Children's Hospital, Beacon Children's Hospital, and the George Mark Children's House. Finally, we propose actionable design considerations that can inform future NICU design efforts. Beginning difficult conversations with compassion and candor can open the door to transformative designs.

*"NICU care is intense and precarious, which can be deeply distressing (1, 2). With the most critical cases requiring months-long hospitalizations, providing moments of reprieve from that distress becomes essential (3). Designing more intentional, thoughtful, and meaningful responses that better support compassionate care begins by acknowledging deep emotions as inextricable elements of this space."*

**Love, Ritual, Grief, and Space**:

NICU care is intense and precarious, which can be deeply distressing (1, 2). With the most critical cases requiring months-long hospitalizations, providing moments of reprieve from that distress becomes essential (3). Designing more intentional, thoughtful, and meaningful responses that better support compassionate care begins by acknowledging deep emotions as inextricable elements of this space.

The complex, interrelated experiences of love, ritual, and grief inevitably converge in the NICU, where loss is layered and pervasive. Their physical and emotional expressions have direct spatial implications: the presence or absence of places to express love, practice ritual, or even store the supplies that support these behaviors signals permission to engage fully and authentically with one's lived experience. This autonomy is foundational to psychological wellbeing (4).

Designers cannot meaningfully create space for any one of these experiences without some understanding of how they manifest and interact with the built environment. As an overarching best practice, design teams are encouraged to engage deeply with

their clients to understand which experiences are critical to their NICU care journey. This article proposes a framework for these design discussions based on the themes described below.

Love is self-evident and where grief begins (5). Although often associated the death of a loved one, grief is distinct from bereavement. It stems from a variety of losses, including those of intangible and seemingly ordinary things. It encompasses many internal emotions and external expressions. While it can be processed, coped with, and accepted, grief does not end. Suppressing it impedes recovery after a loss and can contribute to trauma; structuring it around ritual facilitates expression and outlet. The act of loving can serve as a powerful counter to the threat of loss (2).

***"As both practical and sacred expressions of love and care, ritual serves multiple functions in the NICU. Rituals of everyday life such as self-care, family bonding, and spiritual or religious rituals can sustain positive emotions, while memorializing rituals help process feelings of grief. Self-care rituals empower caretakers to attend to their physical and mental well-being amidst competing priorities"***

As both practical and sacred expressions of love and care, ritual serves multiple functions in the NICU. Rituals of everyday life such as self-care, family bonding, and spiritual or religious rituals can sustain positive emotions, while memorializing rituals help process feelings of grief. Self-care rituals empower caretakers to attend to their physical and mental well-being amidst competing priorities. Family bonding rituals, such as shared meals or skin-to-skin care, help to build and maintain strong family systems and contribute to a sense of being "at home." Spiritual or religious rituals help people connect with the divine, foster community, and provide a structure for navigating life's challenges. Memorial rituals, such as funerals or photographs, help families cherish their child's life and memory. Rituals, both mundane and sacred, create conditions for reflection and presence. Accordingly, performing rituals infuses a space with emotional safety and resonance.

Space and emotion are co-creative. Emerging work in neuroarchitecture has begun to link elements of the built environment with activity in brain regions associated with emotion, stress, and cognition (6). These findings support the idea that place becomes understood through bodily perception and memory (7). Creating space for any emotional experience is therefore less about dedicating rooms and more about designing environments that support the emotional safety of those who inhabit them.

Unsurprisingly, NICUs designed with the explicit goal of supporting families and caregivers tend to produce better outcomes. Research suggests that families often desire to care for their child and do so more easily in spaces that explicitly afford them this ability (8), experiencing better mental health throughout their experience because of it (9). However, while tremendous work has been done in NICUs to support families emotionally, spaces designed explicitly to engage and support families remain understudied (10).

***"Over time, repeated losses also affect NICU providers and staff through burnout and related conditions (2). As a strategy to prevent such negative outcomes, designing NICUs to support people through grief can be considered an investment in human-centered care."***

**Designing for Love, Grief, and Ritual in Space:**

The imperative for spaces that soften and support grieving caregivers is well-established in the literature. As many as forty percent of NICU parents leave the experience with PTSD, a condition that can have long-term deleterious health effects for both themselves and their children (1, 11). Over time, repeated losses also affect NICU providers and staff through burnout and related conditions (2). As a strategy to prevent such negative outcomes, designing NICUs to support people through grief can be considered an investment in human-centered care.

Our case studies identified two main approaches to designing for love, ritual, and grief in the NICU. The first centralizes families' experiences within a private patient room. The second offers one or more private, non-clinical room(s) that can host certain emotional events outside of the main patient room. In both approaches, the key design goal is to help families make themselves "at home" in the NICU.

In the first approach, private patient rooms are designed to accommodate patients and families throughout all stages of a clinical care journey, from admission through bereavement rituals. Designated family spaces within these rooms support family bonding and self-care rituals for one or more family caregivers. The room is augmented to support secondary uses as they arise. Mobile supply carts, furniture, and equipment are brought in from designated storage spaces in or near the unit to support personalized experiences. Symbols, such as a butterfly, placed on or near the room entryway, communicate the patient(s)' status, so that staff can align their communication and avoid triggering grief. This approach treats the private patient room as a flexible space with both clinical and non-clinical uses.

The second approach provides families with one or more rooms for end-of-life care, larger gatherings, sensitive conversations, and other activities they may prefer to have away from the patient room. These rooms are designed to feel less clinical, with living room-style seating, hidden storage, a headwall, and, where possible, access to a private balcony or garden. Although their names imply a specific use case, the best version of this room offers a variety of uses. This approach treats the patient room

and the grieving room as conceptually distinct, giving families the opportunity to create separate emotional memories. Because spaces tend to embody emotions over time, families may find it easier to experience moments of hope and moments of grief in entirely separate spaces.

***"The success of either approach depends on design strategies that reflect the best emotional elements of home: agency, emotional safety, dignity, connection, and love. During periods in which families have little control, providing them with the ability to make choices that align with their emotional state supports their mental well-being. As a design goal, virtually all spaces within and related to the NICU, as well as the pathways among these spaces, are capable of supporting such agency in different ways."***

The success of either approach depends on design strategies that reflect the best emotional elements of home: agency, emotional safety, dignity, connection, and love. During periods in which families have little control, providing them with the ability to make choices that align with their emotional state supports their mental well-being. As a design goal, virtually all spaces within and related to the NICU, as well as the pathways among these spaces, are capable of supporting such agency in different ways. For example, intimate settings foster vulnerability and trust that sustain both immediate and long-term caregiving, while warm, domestic settings offer reprieve and affirm humanity. Special attention to materiality, lighting, and design composition can further enhance a successful design approach with beauty and comfort.

**Case Studies:**

To examine how care teams design and adapt spaces for love, grief, and ritual over the course of care, we conducted interviews with three NICUs and one pediatric respite home. These conversations revealed recurring priorities and design strategies to reflect their compassionate care beyond medical intervention. Across settings, clinicians articulated a shared ethic of care in which space is treated as an active participant in caregiving. These conversations underscored the emotional and relational dimensions of the clinical experience.

Boston Children's Hospital NICU

Level IV NICU, 30 Beds (located in the Hale Family Building)

*"We're trying to provide some control in a moment when people have no control."*

The Boston Children's Hospital NICU centers care in private patient rooms. These rooms vary in size, allowing admissions teams to align patients' and families' needs with their room assignments. Private rooms allow for personalization and flexibility to accommodate a range of needs throughout the episode of care.

To help families move in and feel at home, each private room includes a dedicated family zone designed around common rituals of everyday life. Amenities include a full bathroom with a shower, a pull-out couch for overnight stays, a locked safe for personal storage, a rocking chair, and a television. Shades at the exterior and interior windows and door allow families to adjust privacy and daylight, offering meaningful agency during periods of profound uncertainty.

***"Private patient rooms also provide space for end-of-life care and rituals. Families are invited to work with staff to design these personalized experiences. Visitors, food, music, and other resources can be brought in to transform the room for these occasions. Taken together, the room design embodies a commitment to meeting psychosocial needs as an important element of care."***

Private patient rooms also provide space for end-of-life care and rituals. Families are invited to work with staff to design these personalized experiences. Visitors, food, music, and other resources can be brought in to transform the room for these occasions. Taken together, the room design embodies a commitment to meeting psychosocial needs as an important element of care.

Areas outside the patient room offer moments of reprieve from the medical experience. The unit provides multiple spaces, varying in size and aesthetics, for consultations and difficult conversations, allowing families to choose where to have these experiences. To support the whole family, a sibling playroom staffed by Child Life Specialists provides children with opportunities to engage in age-appropriate play and help the sibling process their emotions. Two rooftop gardens are available to NICU patients, families, and staff, and can be set up to bring patients outside to experience fresh air, daylight, and nature. While these outdoor gardens are not dedicated to the NICU, they are designed with areas of greater privacy for intimate moments, including end-of-life.

In some cases, families may wish to remain with the patient's body after it leaves the NICU. A large viewing room next to the morgue has comfortable furniture and soothing design features to accommodate family gatherings and funerary rituals. A dedicated and discreet entrance near the viewing room provides a dignified passageway for both the patient and their family members. Though not often used by NICU families, it has provided an essential area

for family members who may have missed the final moments of the patient's life to gather and grieve. Throughout the NICU's circulation paths and in the hospital's viewing room, sophisticated and elegant artwork that speaks to love and loss brings comfort, respectfully honoring the experiences.

***"Space for grief in the NICU extends beyond its own walls and the episode of care. Each year, the hospital hosts a memorial service that gathers families and the community to honor the lives of children who have died. Music, readings, and a ceremony provide families with an opportunity to share their grief with others who have had similar losses. This service illustrates how creating space for grief can extend beyond the place and moment of loss."***

Space for grief in the NICU extends beyond its own walls and the episode of care. Each year, the hospital hosts a memorial service that gathers families and the community to honor the lives of children who have died. Music, readings, and a ceremony provide families with an opportunity to share their grief with others who have had similar losses. This service illustrates how creating space for grief can extend beyond the place and moment of loss.

Nationwide Children's Hospital NICU

Level IV NICU, 130 Beds

*"The care journey continues even after the patient is deceased. We still have the patient's family."*

At Nationwide Children's Hospital, the NICU experience is framed as a journey. At the center of this journey is the private patient room. Pull-out couches and rocking recliners allow two caregivers to become deeply involved in care, stay overnight, and build stronger relationships with their care team. Symbolic signs on the door communicate the patient's status to providers and staff, enabling them to interact with the family across disparate care episodes without missing critical milestones, such as the loss of a twin or a transition into end-of-life care. By supporting continuity and clear communication, these elements of the room design play an active role in building strong relationships among all those who care for the patient, in and beyond the NICU.

While most care and conversations happen at the bedside, families are offered options regarding where and how events unfold throughout the care experience. Mobile resources and equipment augment the patient room as needed, and families may choose to relocate portions of the care journey to an outdoor patio or to *Caroline's Room*, a dedicated bereavement room.

Located just outside the unit, *Caroline's Room* is a larger space resembling a living room, with two couches and rocking chairs around a central coffee table, concealed storage, and a full headwall. The design supports both clinical uses, such as end-of-life care, and non-clinical uses, such as baptisms and difficult conversations between providers and parents. In its redesigned NICU (anticipated completion in 2028), a second bereavement room will help families externalize painful experiences from spaces that might later hold more positive memories.

The paths along which families travel during their care experience can also profoundly impact the experience of grief. Many families have a cultural obligation to conduct private burials and will take their child's body out of the hospital themselves. In recent years, the hospital intentionally redesigned the pathways among the units, the autopsy room, the morgue, the viewing room, and the discrete exit as *Laurel Lane.* The previously back-of-house hallways were refreshed with new finishes and laurel-leaf artwork, symbolically honoring the deceased patient's life while providing families with a more clearly defined and dignified end to their journey.

***"The NICU care team at Beacon Children's Hospital has made bereavement a critical part of their practice. The relative infrequency of loss and grief makes designated spaces for family grief difficult to specify. So, the team has worked to find shared, multipurpose spaces with specific attention to what can support families through difficult experiences."***

Beacon Memorial Children's Hospital NICU

Level III NICU, 39 Beds

*"The space can become sacred, even in this tragedy that's happening."*

The NICU care team at Beacon Children's Hospital has made bereavement a critical part of their practice. The relative infrequency of loss and grief makes designated spaces for family grief difficult to specify. So, the team has worked to find shared, multipurpose spaces with specific attention to what can support families through difficult experiences. Through both intentional and adaptive design efforts, the NICU has developed a balanced approach that pairs up needs, so that space for grief is available when needed but active in other ways when it is not.

Private patient rooms hold space for patient care, medical decision-making, and memorializing throughout the episode of care. A whiteboard is updated daily with a family goal. Chaplains perform naming services and baptisms at bedside by wheeling in supplies and loosening visitor limits for the occasion. Photographs are often taken close to the windows, where babies in Moses Baskets are framed in natural light. Over the course of care, it can

become a sacred space for families.

Particularly difficult conversations can be taken out of the NICU to the conference room, atrium, or outdoor family balcony, all of which are directly accessible from the NICU. The family balcony is connected to the family lounge. Decorated with hummingbird feeders and flower planters, and offering beautiful sunset views, it provides a sanctuary for families during times of both joy and grief. Although shared, these spaces can be closed off for an individual family when needed.

When nursing staff identified a need for storage for bereavement care materials, they transformed an underutilized physician charting space into a library of bereavement supplies and donated books. A cart with baptism and footprint casting supplies sits alongside a built-in cabinet system storing baby clothes, angel gowns, blankets, memory box materials, and other nurse supplies. One computer and workspace for charting remains. In this form, the space is wholly back-of-house. In another iteration, an ideal space might store bereavement supplies within locked, home-like cabinetry and comfortable furniture, so that it could also provide reprieve from the clinical environment.

***"Beacon Children's Hospital NICU was unique among the case studies in the number and diversity of spaces designated for staff well-being. The staff balcony, accessible from the unit, provides a haven for sunshine and fresh air breaks and offers solitude during difficult shifts. In warmer months, it is a frequent lunch break location. Separating this space from the family balcony allows staff to use the outdoors in a way particularly suited to their needs, without the pressure of families present."***

Beacon Children's Hospital NICU was unique among the case studies in the number and diversity of spaces designated for staff well-being. The staff balcony, accessible from the unit, provides a haven for sunshine and fresh air breaks and offers solitude during difficult shifts. In warmer months, it is a frequent lunch break location. Separating this space from the family balcony allows staff to use the outdoors in a way particularly suited to their needs, without the pressure of families present.

George Mark Children's House

Pediatric Hospice Center, 10 Beds

"*How do you want your child to live?"*

The George Mark Children's House is grounded by the principle that life, not death, should define the experience of serious pediatric illness. Children with complex medical needs come to GMCH to receive transitional, end-of-life, and respite care in an environment that intentionally departs from the visual and spatial language of hospitals.

The facility combines intensive medical support with a residential setting that emphasizes joy, autonomy, and connection. Eight light-filled patient rooms feature whimsical, age-appropriate murals, private bathrooms, daybeds for overnight guests, and direct access to outdoor patios. Two family suites offer a larger living space for extended family stays. Patient rooms are integrated into a network of living, playing, and learning spaces, situated within an expansive green space that includes walking paths, gardens, and gathering areas, where patients experience a freedom of movement, discovery, and expression that is often unavailable to them in medical settings.

***"Bereavement spaces are both physical and temporal. A nondenominational sanctuary provides space for families to hold memorial services, and a garden wall displays legacy tiles created by children and their families. Staff are given their own space to grieve at a memorial fountain, where they gather after a loss to place a stone inscribed with the child's name during a dedicated ceremony."***

Bereavement spaces are both physical and temporal. A nondenominational sanctuary provides space for families to hold memorial services, and a garden wall displays legacy tiles created by children and their families. Staff are given their own space to grieve at a memorial fountain, where they gather after a loss to place a stone inscribed with the child's name during a dedicated ceremony. Each year, the house invites families back for its Service of Remembrance, a gathering that honors the children who have died through familyprovided photos and artwork, music and readings, and roses laid beside each child's stone at the fountain. Through these spaces, grief is both embraced and decentered.

Clinicians report that most families want to engage openly about their child's prognosis. These conversations tend to be easiest in familiar spaces such as on couches, under trees, and during moments of levity. By offering settings that support intimacy and vulnerability, medical decision-making can unfold within relationships rather than transactions, reinforcing dignity for both children and families.

**Reframing The Discussion Around Grief**

The four case studies described here are united by a shared level of exquisite attention to the emotional needs of their patient

families and staff. Even the best possible outcomes can be painful experiences. This reality can be challenging to discuss, especially for designers typically shielded from these experiences. However, these challenging conversations are essential to the design process.

***"Rather than focusing on uncomfortable topics, design conversations can foster a broader understanding of grief, reframing it in more approachable terms. What is fundamentally at the heart of grief is not loss but love. What supports us through grief is not only time and space but relationships."***

Rather than focusing on uncomfortable topics, design conversations can foster a broader understanding of grief, reframing it in more approachable terms. What is fundamentally at the heart of grief is not loss but love. What supports us through grief is not only time and space but relationships. What a NICU design can provide is not an escape from grief but dignified places in which to process and express emotions. Love, relationships, and dignity offer productive areas for designers and healthcare clients to explore as they work to create emotionally supportive spaces.

*Love* **-** Anything that is loved can be lost, and anything lost can be grieved. The most obvious loss experienced in a NICU is that of an infant's life or health. Alongside may be countless other losses, less overt but deeply felt. Exploring what people love may reveal opportunities to soften the experience of grief by preventing hidden losses. Even small interventions, such as an empty shelf in the patient room, can help family members hold onto photos, artworks, and other beloved items. Family spaces large enough to host two adults overnight allow loved ones to make the most of their time together. Designated activity areas, potentially shared with other hospital units, can enable family members to engage in practices they might otherwise miss during their NICU experience, such as fitness routines, spiritual rituals, or professional work. Beautiful spaces, designed intentionally to nurture meaningful connections between people and the lives they love, can help reduce the sense of accumulated losses and create pathways for acceptance and healing.

*Relationships* - NICU care requires close working relationships characterized by high levels of collaboration, trust, and understanding (12). Many of these relationships continue beyond the NICU stay: patients may return to the hospital for care; family members may require ongoing emotional support; and care teams will collaboratively serve other NICU patients and families. Identifying the key players in a patient's care and life can help plan spaces around the formation and maintenance of strong relationship bonds that outlast the NICU stay. Thoughtfully laid-out, human-scaled spaces with seating for eye-level interactions can foster a sense of safety and facilitate connection among the various members of a patient's extended care team. In addition to workspaces, private places of respite for staff give care team members a place to share moments of connection and support one another through tough experiences.

*Dignity* - In high-acuity inpatient units, the intensity of the risk is evident in the acuity of the care provided. Acknowledging and addressing that reality is a matter of dignity for both families and staff. Designs can offer agency by providing individual controls for certain elements in key spaces, such as lights and window shades in patient rooms. Autonomy can be promoted by integrating wayfinding elements that help people navigate confidently through the NICU and other key hospital spaces. Particular attention may be paid to the paths along which people travel after a baby dies, and to the private spaces people may go to cry. Designing those places and pathways both beautifully and functionally dignifies those along that journey.

***"Taken together, love, relationships, and dignity offer a pragmatic and human-centered framework for addressing grief in NICU design. Rather than treating grief as an episodic experience triggered only by acute loss, this lens recognizes it as a pervasive consequence of the NICU experience, also driven by anticipatory and abstract losses."***

Taken together, love, relationships, and dignity offer a pragmatic and human-centered framework for addressing grief in NICU design. Rather than treating grief as an episodic experience triggered only by acute loss, this lens recognizes it as a pervasive consequence of the NICU experience, also driven by anticipatory and abstract losses. Design exercises focused on strategies to sustain love, foster relationships, and uphold dignity can help identify opportunities to support people through vulnerable moments. These efforts can help mitigate long-term harm while affirming the humanity of care and caregiving itself.

**Conclusion:**

Care in the NICU is already deeply emotional, relational, and ethically demanding. When environments move beyond accommodating tasks and moments to intentionally braid emotional, relational, and ethical needs into the fabric of care, they strengthen providers' ability to support patients, families, and one another.

Grief is both common and ambient in the NICU. Without explicit expression, it can embed itself into certain places, transform into maladaptive behavior, or become repressed. Nevertheless, approaching grief through design directly risks reducing the experience to something singular and containable within a discrete space. Instead, the lenses of love, relationships, and dignity offer a practical way to engage with the full complexity of grief. These lenses reframe grief as evidence of deep attachment,

responsibility, and humanity: qualities that deserve spatial expression. This broader perspective can help create intentional design solutions that respect the complexity of the experience.

Across the cases studied, spaces that successfully support grief often do so by allowing love to be expressed despite conditions of uncertainty and stress. Everyday acts of care, memory-making, and decision-making within supportive environments empower families to externalize their feelings of love into tangible, present, and affirming forms.

***"Supporting grief also involves sustaining relationships among family members, between families and clinicians, and within care teams. Both the care journey and experience of grief are shaped by others. Where spaces can reinforce trust and strengthen bonds, the built environment becomes an active participant in caregiving, shaping how care is delivered, felt, and remembered."***

Supporting grief also involves sustaining relationships among family members, between families and clinicians, and within care teams. Both the care journey and experience of grief are shaped by others. Where spaces can reinforce trust and strengthen bonds, the built environment becomes an active participant in caregiving, shaping how care is delivered, felt, and remembered.

Dignity is the guiding principle undergirding such a design process. Designing for love, grief, and ritual with dignity holds space for death and loss without surrendering the primacy of life. Refusing to relegate loss to peripheral spaces affirms grief without compounding it. When grief is acknowledged within the design of a space, it becomes life-affirming: a powerful permission to pursue a full life despite the limitations and pressures of the NICU.

***"Dignity is the guiding principle undergirding such a design process. Designing for love, grief, and ritual with dignity holds space for death and loss without surrendering the primacy of life."***

When NICU environments are designed to hold love, support relationships, and uphold dignity, grief is met with care that strengthens both human well-being and the ethical foundations of neonatal care.

**Appendix – Resources:**

*The Journey-Through-Grief Map* – Journey maps are a common tool used by designers to develop a schematic concept of a healthcare space based on key areas, pathways, and pain points. To create a journey map, the designer creates a fictional persona (e.g., patient, parent, provider) to represent a common journey through the hospital. This persona's character traits, diagnosis, and care needs inform where and how they move through the hospital. The details of these personas matter: they often help determine which design elements receive careful attention.

Consider the journey of someone who experiences a loss. They enter the hospital much like any other person: parking in the lot and navigating from the lobby to the NICU. The end of their journey is likely to look entirely different. How do they mourn, where, and for how long? Where is their loved one's body moved after death? Do they accompany the body? Identifying key moments along the journey through grief should be considered an essential task in any NICU design project.

***"Consider the journey of someone who experiences a loss. They enter the hospital much like any other person: parking in the lot and navigating from the lobby to the NICU. The end of their journey is likely to look entirely different."***

*Bereavement Approach* – Determining a bereavement approach can streamline the design process by presupposing key spaces. For example, a single-space approach suggests private patient rooms with centralized storage for supplies, with supplies brought into the patient rooms as needed. A multi-space approach suggests one or more dedicated bereavement rooms with supplies concealed within locked cabinets and other furnishings. Though primarily designed for end-of-life care and rituals, these rooms are often useful for a wide range of purposes. Providers and staff also benefit from consideration of when, where, and how they can grieve within the NICU. Collective grief rituals require a large, private space for gathering, while individual grief may benefit from more intimate, explicitly nurturing spaces.

*Conversation Topics* – Love, connection, and dignity exist amidst the grief and struggle of a NICU stay. The following questions may reveal innovative solutions to uncomfortable design challenges.

- Love: How does the design incorporate cherished elements of everyday life?
  - How should families be able to personalize the space and "make themselves at home?"
  - Where and how should the design support rituals of daily life?
  - Where should ceremonies take place?
  - How should the design offer privacy during moments of

vulnerability?

- What items are needed to support memory making, and where are they stored?

- Relationships: How can this space inspire trust, confidence, and collaboration among the users of this space?
  - Who are all the people that support families through the grief journey?
  - How does the support team size and needs change throughout the day?
  - How do family sizes and needs change throughout the day?
  - How can the space empower family members to actively participate in family-centered care?
  - How are staff supported after a loss, and where can they go for respite?
- Dignity: What emotional tone is appropriate for this space, and how can the design honor those feelings?
  - Where and how can spaces transform to support end-of-life care and rituals?
  - What cultures need to be considered in the design, and are there specific rituals they require?
  - How should the design provide autonomy and control?
  - What are the pathways and places outside the NICU that families and staff travel after a loss?

*Design Considerations* – Some common elements of NICU design offer ready solutions for providing space for love, grief, and ritual.

- **Comfortable family spaces** finished with warm, familiar materials and including elements such as a pull-out sofa, rocking recliner, television, locked personal storage, shelves for personal decorations, and private bathrooms can help family members feel at home.
- **Respite spaces** that support rituals of daily life and offer reprieve from the clinical environment can minimize abstract losses and provide avenues for emotional expression. A variety of spaces, such as quiet rooms, family lounges, and outdoor gardens, should be considered.
- **Clinical support areas** that provide adequate storage for essential supplies and offer private respite spaces help staff manage both daily stressors and exceptional needs, for themselves and others.
- **Wayfinding systems** that integrate signage along simple pathways defined by beautiful artwork, resilient finishes, and concealed storage help reduce stress.
- **Integrated symbolic communication** that notifies care team members about critical health status changes and losses helps reduce avoidable pain among grieving families.
- **Warm, biophilic design elements such as natural, adjustable (circadian) lighting, views to nature, outdoor access, nature-inspired artwork, and natural material finishes** to support overall well-being.

**Works Cited**


1. Alsallum FS, Boyle B, McLaughlin D, McGowan I. Risk factors of post-traumatic stress disorder among parents of neonatal intensive care unit infants: a systematic review. J Neonatal Nurs. 2025;31(2):101620.
2. Huixin H, et al. Impact of dying neonates on doctors' and nurses' personhood: a systematic scoping review. *J Pain Symptom Manage.* 2022 Jan;63(1):e59–e74.
3. Edwards EM, Ehret DEY, Soll RF, Horbar JD. Survival of Infants Born at 22 to 25 Weeks' Gestation Receiving Care in the NICU: 2020–2022. Pediatrics. 2024 Oct;154(4):e2024065963.
4. Babnik K, Benko E, von Humboldt S. Ryff's Psychological Well-Being Scale. In: Gu, D., Dupre, M.E. (eds) Encyclopedia of Gerontology and Population Aging. Springer, Cham. 2021.
5. Perel E. Grief Begins With Love With Julia Samuel [podcast]. Ester's Office Hours: Where Should We Begin? With Ester Perel. 2025 Aug 18 (cited 2025 Nov 5). Available at: https://www.estherperel.com/podcasts/grief-begins-with-love-with-julia-samuel
6. Shemesh A, Leisman G, Grobman YJ. Bridging space perception, emotions, and neuroarchitecture. *Brain Sci.* 2026;16(2):131.
7. Higuera-Trujillo JL, Llinares C, Montañana A. Psychological and emotional responses to architectural space. *Front Psychol*. 2021;12:673733. doi:10.3389/fpsyg.2021.673733.7.
8. Machry H, Joseph A, White R, Allison D. (2023). Designing for family engagement in neonatal ICUs: How is the interior design of single-family rooms supporting family behaviors, from passive to active? *HERD: Health Environments Research & Design Journal*, in press.
9. Ruth O, Amiri S, Baughcum AE, et al. Meeting the emotional and behavioral health needs of bereaved NICU parents. *J Perinatol*. 2025;45:1023–1028.
10. Castilla-Puentes R, Isidoro AF, Orosito A, et al. Perinatal bereavement rooms: a narrative review of physical space in perinatal grief. *Arch Gynecol Obstet.* 2025;312,1515–1527.
11. Merrick MT, Ford DC, Ports KA, et al. Vital Signs: Estimated Proportion of Adult Health Problems Attributable to Adverse Childhood Experiences and Implications for Prevention — 25 States, 2015–2017. *MMWR Morb Mortal Wkly Rep.* 2019;68:999-1005.
12. White RD, Smith JA, Shepley MM, et al. NICU design and family-centered care outcomes. *J Perinatol.* 2015;35:523–531.
13. Yui, Y., Pazandak, C.C., Barbeau, D.Y. *et al.* Promoting bonding and secure attachment in the NICU to improve parent-infant mental health: recommendations for clinical practice. *J Perinatol*. 2026.



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**NT**

*Corresponding Author*

*Julia Jude, AIA, EDAC*
*Pediatric Practice Leader, Kahler Slater*
*Master of Architecture*
*Member of Pediatric Environment Network with Center for Health Design, Association of Medical Facilities Professionals, and American Institute of Architects*
*I have no conflicts of interest relevant to the manuscript.*
*Email:* Jjude@kahlerslater.com

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*Anya Vanecek, MPH, Assoc. AIA*
*Project Specialist, Kahler Slater*
*Master of Public Health – Health Policy, Master of Architecture*

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# Neonatal Intensive Care Unit Design in the Service of Self-Determination

*Colonel Robert Erick Ridout, U.S. Army, Retired*

***"In October 1960, the first American Neonatal Intensive Care Unit (NICU) opened at Yale New Haven Hospital under the direction of Dr. Louis Gluck (1). Historically, preterm infants would be admitted to Special Care Nurseries and placed in isolated cubicles. Dr. Gluck's NICU layout was a large, open-bay design with each infant placed in an incubator, allowing for a centralized location from which direct visual patient assessment and the implementation of evolving technologies could occur (2). The open-bay design focused on efficient care delivery and improved infant survival by enabling immediate medical intervention from the centrally located care team."***

In October 1960, the first American Neonatal Intensive Care Unit (NICU) opened at Yale New Haven Hospital under the direction of Dr. Louis Gluck (1). Historically, preterm infants would be admitted to Special Care Nurseries and placed in isolated cubicles. Dr. Gluck's NICU layout was a large, open-bay design with each infant placed in an incubator, allowing for a centralized location from which direct visual patient assessment and the implementation of evolving technologies could occur (2). The open-bay design focused on efficient care delivery and improved infant survival by enabling immediate medical intervention from the centrally located care team.

Over the ensuing decades, there has been an emphasis on Neonatal Levels of Care, with specific focus on standardizing the minimum technologies, services, and personnel a program should have to meet each level of NICU care (3). The Standards do include language supporting family-centered care, including the capability to address the physiologic, psychosocial, and developmental requirements of NICU patients and their families. However, the Standards are silent on NICU design elements that would support holistic psychological well-being for everyone: infants, families, and the broader medical team. According to Self-Determination Theory (SDT), each member of the care team has a fundamental need for the "Essential Nutrients" of Autonomy, Mastery, and Relatedness to achieve fulfillment, optimal psychological functioning, growth, intrinsic motivation, and overall well-being (4). Enabling every member of the care team to realize their full potential would be a powerful benefit of thoughtful NICU design.

For infants, particularly those born preterm, autonomy is characterized not by the power of choice but by the preservation of internal logic, defined as the ability to maintain physiological homeostasis without excessive external interference (5). In the womb, the fetus receives continuous biological support. The maternal abdomen and amniotic fluid act as a low-pass filter, shielding the developing brain from high-frequency sounds and attenuating everything above 500 Hz by 20-50dB (6). Furthermore, the uterine wall provides a nested proprioceptive boundary, offering constant tactile feedback that reinforces the infant's motor system and reinforces the sense that they are safe, cared for, and connected, and is foundational for what becomes the psychological experience of love and security (7, 8).

***"The transition to a traditional open-bay NICU represents a profound autonomy crisis. In this environment, the infant's immature nervous system is effectively overwhelmed by environmental stimuli as it undergoes critical periods of synaptogenesis and myelination. Emotional and higher-level regulation pathways may be inappropriately pruned through neuroplasticity, resulting in impaired emotional regulation and attachment later in life (9, 10). "***

The transition to a traditional open-bay NICU represents a profound autonomy crisis. In this environment, the infant's immature nervous system is effectively overwhelmed by environmental stimuli as it undergoes critical periods of synaptogenesis and myelination. Emotional and higher-level regulation pathways may be inappropriately pruned through neuroplasticity, resulting in impaired emotional regulation and attachment later in life (9, 10). Further, when noise levels exceed the uterine threshold, frequently reaching 70–80 dB in open-bay designs, the infant's body triggers

an involuntary stress response. Their internal logic is subsumed by a biological reflex, leading to the Amygdala stress pathways being reinforced and resulting in a hyper-reactive response to stress later in life (9, 11).

The Synactive Theory of Development serves as the primary framework for understanding an infant's internal logic. This theory suggests that the infant's development includes five interacting subsystems: Autonomic (physiology); Motor (tone and movement); State (smooth sleep and wake cycles); Attention/Interaction (environmental engagement); Self-Regulatory (balancing the 4 subsystems) (12). In a high-stress, open-bay environment, the infant's neural circuits undergo a functional decoupling. Rather than operating as an integrated whole, the autonomic and motor systems become isolated from one another. The surge of excitatory neurotransmitters, left unfiltered by immature inhibitory pathways, triggers erratic respiratory rhythms and motor overflows, such as finger splaying (13, 14). The infant enters a disorganized, reflexive state of survival as the environment disrupts their internal equilibrium. The infant perceives the loud, chaotic environment as a life-threat (15). Clinically, the infant manifests apnea, bradycardia, or shut-down behavior. While an observer might mistake a quiet, still infant for one who is sleeping soundly, they are often witnessing a state of metabolic conservation. The infant's nervous system opts for shut-down because the external environment has made active growth and engagement impossible- this represents the ultimate loss of autonomy.

***"In the framework of Self-Determination Theory (SDT), the parent's transition from a passive visitor to an active primary caregiver is the most critical factor in successful discharge and long-term family resilience (17). To achieve this, the physical environment must be engineered to support the provision of the essential nutrients of Mastery and Relatedness."***

The psychological trauma parents experience in the NICU is frequently rooted in a profound sense of helplessness, characterized by a systemic deprivation of agency that leads to parental role alteration (16). In the framework of Self-Determination Theory (SDT), the parent's transition from a passive visitor to an active primary caregiver is the most critical factor in successful discharge and long-term family resilience (17). To achieve this, the physical environment must be engineered to support the provision of the essential nutrients of Mastery and Relatedness.

The shift from open-bay pods to Single-Family Rooms (SFRs) is the architectural realization of relatedness. In a shared ward, a mother attempting to engage in Kangaroo Care (skin-to-skin contact) or breastfeeding is subject to the auditory and visual gaze of strangers and the medical team. This social surveillance triggers a state of chronic evaluation and performative parenting (18). From a neurobiological perspective, perceived privacy deficits activate the sympathetic nervous system, which directly inhibits the pulsatile release of oxytocin, a neuropeptide essential for attachment, social buffering, and lactation (19). Simultaneously, the environment triggers elevated maternal cortisol levels, which can be transmitted to the infant through breast milk (5, 20). An SFR with a dedicated family zone provides the necessary separation to cultivate this bond, allowing the parent-infant dyad to move towards emotional and biological availability.

To achieve mastery, a parent must feel competent in interpreting and responding to their infant's needs. However, competence is difficult to achieve in a chaotic environment (21). In open-bay settings, the sensory noise of competing alarms, medical team conversations, and mechanical hums creates a cognitive load that prevents parents from focusing on their infant's subtle communication and cues.

***"An SFR acts as a quiet laboratory for parental learning. Without the distraction of extraneous stimuli, parents can develop the high-level observational skills required to decode an infant's disengagement cues (22). These cues are the infant's only form of autonomy, signaling their need for a break from stimulation: facial grimacing, finger spaying, and gaze aversion as examples."***

An SFR acts as a quiet laboratory for parental learning. Without the distraction of extraneous stimuli, parents can develop the high-level observational skills required to decode an infant's disengagement cues (22). These cues are the infant's only form of autonomy, signaling their need for a break from stimulation: facial grimacing, finger spaying, and gaze aversion as examples.

By mastering these subtle dialects of preterm infant communication, often referred to as the 'voice of baby,' in a controlled, quiet environment, parents transition from feeling in the way to feeling in charge (23). After NICU discharge, this autonomy-supportive parenting ensures that the family has the intrinsic motivation and clinical competence to continue complex care at home, reducing the risk of readmission (17, 24).

Effective NICU design utilizes zoning to define space: The Clinical Zone, where the medical team manages technology and supplies; The Patient Zone, centered around the incubator, the site of shared care; and The Family Zone, a distinct space with furniture, storage, electrical outlets, and private bathrooms. When these zones are clearly defined, it reduces territorial anxiety (25). In an open-bay unit, the parent is often a transient presence in a clinical space. In a well-designed SFR, the presence of furniture designed for sleep and personal hygiene signals that the parent is a

permanent, essential member of the care team. This architectural validation of the parental role is a fundamental nutrient for the family unit's psychological well-being (4).

*"The very environment designed to facilitate neonatal intensive care may be undermining the medical team's need for Mastery and Relatedness. In the high-acuity setting of the NICU, neonatologists, nurses, and respiratory therapists serve as the infant's peripheral brain, performing complex regulatory functions that the neonate cannot yet perform. However, the architectural design of many legacy units induces a state of directed attention fatigue, compromising clinical judgment and eroding professional relatedness (25, 26)."*

The very environment designed to facilitate neonatal intensive care may be undermining the medical team's need for Mastery and Relatedness. In the high-acuity setting of the NICU, neonatologists, nurses, and respiratory therapists serve as the infant's peripheral brain, performing complex regulatory functions that the neonate cannot yet perform. However, the architectural design of many legacy units induces a state of directed attention fatigue, compromising clinical judgment and eroding professional relatedness (25, 26). Mastery for a medical team is defined by the ability to detect, interpret, and respond to subtle pathophysiological changes. However, the din in an open-bay NICU may impair this response as the human brain has a limited capacity for directed attention. When the background noise floor rises to meet the loudest peak, the cognitive energy required to filter out non-actionable data increases exponentially, exhausting the team (23, 10). Alarm fatigue is the primary clinical manifestation of this cognitive overload. Nurses may be exposed to hundreds of alarms per shift, 90% of which are non-actionable, resulting in desensitization of the sensory gating mechanism. This desensitization erodes the sense of mastery, as the nurse can no longer trust their environment to signal true emergencies (27).

Architectural Intervention: To restore competence, design must move toward Decentralized Nursing Sub-stations. By dispersing the medical team into smaller clusters or alcoves immediately outside patient rooms, the auditory density is diffused, reducing the cognitive load of monitoring an entire ward and allowing medical team members to focus exclusively on their assigned patients (28). This structural shift restores the members' ability to decode subtle clinical trends, representing the true mastery of neonatal intensive care, before they escalate into crises (29).

*"For a medical team member to maintain Autonomy and Relatedness, they must have control over their own cognitive and emotional state. In a traditional NICU, the member is on stage for 12 hours, with no transition between the high-stress bedside and communal areas (30). The emotional reserves required for relatedness become depleted, leading to Compassion Fatigue (31)."*

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According to Attention Restoration Theory, human focus is a finite biological resource (26). To maintain the relatedness required for high-stakes care, medical team members need access to Off-Stage Respite Areas that provide psychological distance from the clinical environment. These spaces must meet four specific criteria for restoration: Being Away: A total sensory break from medical equipment and alarms; Extent: A space that feels expansive; Fascination: Stimuli that hold attention effortlessly (nature); Compatibility: A setting that aligns with the individual's need for quiet or reflection (32). The most critical design element for medical team well-being is the integration of Biophilic Design. Research indicates that exposure to nature, whether through direct views or 'analogous' representations such as natural wood and organic patterns, can trigger a parasympathetic reset (33). Within three to five minutes of exposure to biophilic elements, medical team members show lowered heart rates, reduced blood pressure, and a decrease in perceived stress. In the context of burnout prevention, these areas are not luxuries; they are biological charging stations. When the design supports the medical team's mental health, it prevents the transition from empathy to burnout, ensuring that the team is better equipped to deliver the nutrients of Mastery and Relatedness to the families they serve (34).

Mastery is also inextricably linked to the unit's physical ergonomics. While Single-Family Rooms (SFRs) offer superior acoustics, they can increase corridor fatigue because the team must walk significantly more miles per shift than in open-bay units (35). Architectural mastery involves optimizing the Distance to Care by placing supplies, charting stations, and medical gases in identical, intuitive locations across all rooms. These environmental modifications reduce the cognitive load of search-and-rescue during emergencies (36). When the environment supports the medical team's physical presence and minimizes

extraneous motor tasks, their sense of professional competence and relatedness is reinforced (37).

***"The Essential Nutrients of Self-Determination Theory—Autonomy, Mastery, and Relatedness—cannot be realized in isolation. In the high-stakes ecosystem of the NICU, the provision of these nutrients requires a feedback mechanism, or a continuously reinforcing loop, in which the architectural support provided to one individual directly enhances the biological and psychological capacities of the others."***

The Essential Nutrients of Self-Determination Theory—Autonomy, Mastery, and Relatedness—cannot be realized in isolation. In the high-stakes ecosystem of the NICU, the provision of these nutrients requires a feedback mechanism, or a continuously reinforcing loop, in which the architectural support provided to one individual directly enhances the biological and psychological capacities of the others. The loop begins with the preservation of Infant Autonomy (Biological Homeostasis). When the architecture provides an acoustic and visual protective shell (such as a Single-Family Room with high-performance sound attenuation), the infant is shielded from the metabolic tax of environmental stress (23, 38). An infant who is not in a state of chronic sympathetic arousal (allostatic load) can more clearly communicate their needs (12, 39). Their cues are clear, their sleep-wake cycles are more stable, and they are better able to engage socially during wakeful periods (40). This physiological stability is the primary fuel for Parental Mastery. When a parent successfully soothes their child, a feat made possible by the environment's quietude, it triggers a powerful sense of mastery (41). This mastery reinforces the parent's intrinsic motivation to remain at the bedside, engage in Kangaroo Care, and participate fully in their infant's cares. Protecting the infant's internal logic allows for the full expression of the parent's biological potential. The loop continues as the parent gains mastery. In traditional open-bay designs, the parent is often a source of clinical interference; however, when the environment supports Parental Relatedness and Mastery, the parent ceases being a visitor and becomes an active member of the care team (42, 43).

This shift has a profound impact on Clinical Relatedness. When parents are autonomous and developing mastery, the clinician's role shifts from task-oriented care provision to parent-included team-based care, effectively reducing the moral distress often felt by nurses in legacy units who must frequently ask parents to step away or keep quiet. In an autonomy-supportive design, the medical team sees the family thriving, which reinforces their own sense of relatedness. The NICU design has reduced friction within the care dyad, allowing the team member to focus their finite Directed Attention on complex medical interventions rather than managing environmental chaos (29).

Finally, the loop closes with the medical team member's own well-being. Decentralized Nursing Stations and access to Biophilic Respite enable team members to maintain higher levels of cognitive bandwidth (44), which is critical for the infant's autonomy.

A cognitively depleted team member is more prone to procedural haste and less likely to engage in Clustered Care, defined as the practice of grouping interventions to allow the infant long periods of undisturbed sleep (26, 44). A restored, purpose-driven team member has the patience and presence of mind to protect the infant's Sleep-Wake Cycles, thereby directly supporting the infant's neurodevelopmental autonomy (26, 32).

The Standards of neonatal care have historically focused on the availability of technology (Level III vs. Level IV), but they have remained silent on NICU design in the service of autonomy. An autonomy-supportive environment is a precursor to this continuously reinforcing loop framework; in its absence, the newest technologies alone fall short. A ventilator can provide oxygen, but only a quiet, private, biophilic environment can provide the "essential nutrients" the brain needs to use that oxygen for growth rather than just survival.

Thoughtful NICU design—utilizing Single-Family Rooms, biophilic elements, and decentralized clinical workflows—is a way to ensure that the entire care team enjoys the "Essential Nutrients" of SDT. By acknowledging that the infant, the parent, and the clinician are a single biological unit, we can design environments that do more than help infants survive; we can design environments that allow families and the medical team members to reach their full potential.

The transition from the open-bay "Gluck Model" to the modern Single-Family Room represents more than an architectural trend; it is a fundamental realignment with the neurobiology of the human infant.

Preserving an infant's neurodevelopmental trajectory, protecting parents' psychological health, and preventing medical team burnout are not competing goals. They are the three sides of a single triangle. Evidence-Based design must be recognized as a clinical standard of care, ensuring that NICU design in the service of autonomy is accessible to every individual, in every unit, in every hospital.

**References:**

1. Gluck, L. (1985). The first American NICU: Yale New Haven Hospital. Journal of Perinatology.
2. Gluck, L. (1970). Design of a perinatal center. Pediatric Clinics of North America, 17(4), 777-791.
3. McEwen, B. S. (2007). Physiology and neurobiology of stress and adaptation: Central role of the brain. Physiological Reviews, 87(3), 873-904.
4. Ortenstrand, A., et al. (2010). Early self-management of preterm infants and their parents: A quasi-experimental study. Pediatrics, 126(2).

5. Rost, M., De Clercq, E., Elger, B. S. (2018). Arno Gruen's understanding of autonomy in children: Experiencing and integrating one's own feelings and needs. Swiss Medical Weekly, 148(w14620). https://doi.org/10.4414/smw.2018.14620

6. Gerhardt, K. J., Abrams, R. M. (2000). Fetal exposures to sound and vibroacoustic stimulation. Journal of Perinatology, 20(8), S21–S30.

7. Mellor, D. J., Diesch, T. J. (2007). "Birth and the fetal-to-neonatal transition: Thinking about the 'unborn infant'.» Journal of Neonatal-Perinatal Medicine.

8. Mellor, D. J. (2019). "Preparing for Life After Birth: Introducing the Concepts of Intrauterine and Extrauterine Sensory Entrainment in Mammalian Young." Animals, 9(10), 736.

9. Smith, G. C., et al. (2011). "Neonatal intensive care unit stress is associated with structural brain development in preterm infants." Annals of Neurology, 70(3), 431-440.

10. Schore, A. N. (2001). "The effects of early relational trauma on right brain development, affect regulation, and infant mental health." Infant Mental Health Journal.

11. Newnham, C. A., Milgrom, J., Skouteris, H. (2009). "Effectiveness of a sensory-oriented early intervention program for anticipatory and reactive stress in hospitalised preterm infants." Journal of Reproductive and Infant Psychology.

12. Als, H. (1982). Toward a synactive theory of development: Promise for the assessment and support of infant individuality. Infant Mental Health Journal, 3(4), 229-243.

13. Anand, K. J. S. (2000). "Effects of perinatal pain and stress." Progress in Brain Research.

14. Blackburn, S. (1998). Environmental influences on infant development. In C. Kenner, J. W. Lott, A. A. Flandermeyer (Eds.), Comprehensive Neonatal Nursing: A Physiologic Perspective (2nd ed., pp. 273–302). W.B. Saunders.

15. Porges, S. W. (2011). The Polyvagal Theory: Neurophysiological foundations of emotions, attachment, communication, and self-regulation. W. W. Norton Company.

16. Miles, M. S., Funk, S. G., Kasper, M. A. (1992). "The Maternal Stressor Scale: Pediatric Intensive Care Unit." Nursing Research.

17. O'Brien, K., et al. (2018). "A multi-centre, cluster-randomised controlled trial of family integrated care in neonatal intensive care units." The Lancet Child & Adolescent Health.

18. Flacking, R., Dykes, F., Ewald, U. (2007). "The experience of emotional closeness through skin-to-skin contact and breastfeeding." Qualitative Health Research.

19. Vittner, D., McGrath, J., Robinson, J., Lawhon, G., Cusson, R., Eisenfeld, L., Walsh, S., Young, E., Henderson, W. A. (2018). Biological underpinnings of Oxytocin and Cortisol in preterm infants and their parents during Skin-to-Skin Contact. Biological Research for Nursing, 20(4), 430–440. https://doi.org/10.1177/1099800418771545

20. Waters, S. F., West, T. V., Mendes, W. B. (2014). Stress contagion: Physiological covariation between mothers and infants. Psychological Science, 25(4), 934–942. https://doi.org/10.1177/0956797613518352

21. Verhoeven, M., Selemijer, J. M., Deković, M. (2007). Parenting self-efficacy: Conceptualizations, predictors and correlates. European Journal of Developmental Psychology, 4(2), 163–183. https://doi.org/10.1080/17405620701201372

22. Lester, B. M., et al. (2014). Single-family room care and neurodevelopment of preterm infants: A randomized controlled trial. Pediatrics, 134(4), 754–760. https://doi.org/10.1542/peds.2013-4252

23. White, R. D. (2011). The sensory environment of the NICU: Scientific and design principles. Clinics in Perinatology, 38(4), 609–620.

24. Deci, E. L., Ryan, R. M. (2000). "The 'What' and 'Why' of Goal Pursuits: Human Needs and the Self-Determination of Behavior." Psychological Inquiry, 11(4), 227–268.

25. White, R. D., et al (2023). Recommended standards for newborn ICU design. Journal of Perinatology, 43(s 1), S2-S16. doi:10.1038/s41372-023-01784-4

26. Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. Journal of Environmental Psychology, 15(3), 169–182. https://doi.org/10.1016/0272-4944(95)90001-2

27. Sendelbach, S. (2012). Alarm fatigue: A patient safety concern. AACN Advanced Critical Care, 23(4), 375–380. https://doi.org/10.1097/NCI.0b013e31826bb33d

28. Shepley, M. M., et al. (2012). "The impact of hospital design on clinical outcomes: A 5-year study of a neonatal intensive care unit." Health Environments Research & Design Journal (HERD), 5(3), 125–151. https://doi.org/10.1177/193758671200500308

29. Johnson, T. S. (2015). "Single-Family Room NICU: A Review of the Evidence." Newborn and Infant Nursing Reviews, 15(2), 54–62. https://doi.org/10.1053/j.nainr.2015.04.001

30. Goffman, E. (1959). The Presentation of Self in Everyday Life. Doubleday.

31. Figley, C. R. (2002). Compassion fatigue: Psychotherapists' hypertension of the soul. Psychotherapy: Theory, Research, Practice, Training, 39(2), 143–153. https://doi.org/10.1037/0033-3204.39.2.143

32. Shepley, M. M., et al. (2016). Mental health and social outcomes of neonatal intensive care unit design. Journal of Perinatology, 36(s1), S37–S42. https://doi.org/10.1038/jp.2016.31

33. Ulrich, R. S. (2008). Biophilic design and health care: Evidence-based design for healing environments. Biophilic Design.

34. Domanico, R., et al. (2011). "Overcoming the barriers to implementing a single-family room NICU models." Advances in Neonatal Care, 11(2), 71–83. https://doi.org/10.1097/

ANC.0b013e318210d11c

35. Reiling, J. G., Hughes, R. G., Murphy, M. R. (2008). The impact of facility design on patient safety. In R. G. Hughes (Ed.), Patient Safety and Quality: An Evidence-Based Handbook for Nurses (pp. 425–440). Agency for Healthcare Research and Quality (U.S.).

36. Zborowsky, T., et al. (2010). "The impact of design on nursing care: A comparative analysis of a centralized and a decentralized nurse station design." Health Environments Research & Design Journal (HERD), 3(4), 65–82.

37. Lester, B. M., et al. (2014). "18-month follow-up of infants cared for in a single-family room neonatal intensive care unit." The Journal of Pediatrics, 165(4), 687–694. https://doi.org/10.1016/j.jpeds.2014.06.019

38. McEwen, B. S. (2000). "The neurobiology of stress: from serendipity to clinical relevance." Brain Research, 886(1-2), 172–189.

39. Graven, S. N., Browne, J. V. (2008). Sleep and brain development: The critical role of sleep in fetal and early neonatal life. Newborn and Infant Nursing Reviews, 8(4), 173–181. https://doi.org/10.1053/j.nainr.2008.10.008

40. Verhoeven, M., Bogels, S. M., van Bakel, H. J. (2012). Parenting self-efficacy in the pathogenesis of child adjustment problems. Journal of Abnormal Child Psychology, 40(1), 99–114. https://doi.org/10.1007/s10802-011-9551-x

41. O'Brien, K., Robson, K., Bracht, M., Cruz, M., Lui, K., Alvaro, R., Johnston, C., Entwistle, P., Ip, E., Ye, X. Y., Lee, S. K. (2018). Effectiveness of Family Integrated Care in neonatal intensive care units on infant and parent outcomes: A multicentre, randomised controlled trial. The Lancet Child & Adolescent Health, 2(4), 245–254. https://doi.org/10.1016/S2352-4642(18)30039-7

42. Franck, L. S., Cox, S., Allen, A., Winter, I. (2005). The integrated NICU: Family-centered care from a parent's perspective. Journal of Perinatology, 25(2), 112–119. https://doi.org/10.1038/sj.jp.7211210

43. Pati, D., Harvey, T. E., Jr., Barach, P. (2012). An empirical examination of the influence of decentralized nursing unit design on nurses and the care process. Health Environments Research & Design Journal (HERD), 6(1), 67–87. https://doi.org/10.1177/193758671200600105

44. Coughlin, M., Gibbins, S., Hoath, S. (2009). Core measures for developmentally supportive care in neonatal intensive care units: Theory, precedence, and practice. Newborn and Infant Nursing Reviews, 9(2), 109–120. https://doi.org/10.1053/j.nainr.2009.03.002

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***Corresponding Author***

*Colonel Robert Erick Ridout, MD, U.S. Army, Retired, FAAP*
*Clinical Associate Professor, Department of Pediatrics, John A. Burns School of Medicine at the University of Hawai'i at Manoa. Honolulu, Hawaii*
*Neonatologist, Hawaii Pacific Health*
*Neonatologist, St George Regional Hospital*
*Phone: 4357059208*
*Email:* ridoutre72@gmail.com

***Erick Ridout, M.D., is blessed to be a husband, the dad to two amazing kids, granddaddy to three extraordinary grandsons and two granddaughters, and currently serves the babies, their families, and the caregivers in the Newborn ICU in Southwestern Utah, the Newborn ICU in Honolulu, Hawaii, and as Vermont Oxford Network Faculty. Additionally, Colonel Ridout proudly served in the United States Army for 23 years, including 11 years as the State Surgeon for the Nevada Army National Guard. He was among the first Army Medical Corps Officers to become a Lean Six Sigma Green Belt and has applied the learned principles to relentlessly eliminate patient, staff, and organizational harm in all its forms. He has lectured nationwide on Just Culture, Harm Reduction, Value-Added Care, and Servant Leadership. He passionately believes that all patients and caregivers deserve to experience care delivery free of harm. To that end, he seeks to influence MEDICINE to embrace the principles of servant leadership and team-based family-centered care, to send all members of the care team home each day feeling Safe, Valued, and Loved, returning to the bedside fully engaged with heart and mind, all the while seeking to only do for the patient and never to the patient.***

***"Rather than being the main instigators of an accident, operators tend to be the inheritors of system defects created by designers, builders, paymasters, and managers. Their part is that of adding the final garnish to a lethal brew whose ingredients have already been long in the cooking." Dr. James Reason (1)***

Peer Reviewed

# Couplet Care in Women's and Infant Services: Findings from the HKS Women's and Infants Subject Matter Expert Group

*Shawna Langworthy DNP, MBA, RN, NEA-BC, EDAC, Caitlin Potter, AIA, ACHA, LSSYB*

*"As the landscape of neonatal and postpartum care continues to evolve, one model has emerged as a powerful, evidence-based framework that fundamentally redefines how hospitals care for mothers and their newborns: Couplet Care. For healthcare facilities and the architects and planners who design them, understanding this model is essential to creating environments that support both clinical outcomes and the deep human experience of new parenthood."*

**Introduction: What Is Couplet Care?**

As the landscape of neonatal and postpartum care continues to evolve, one model has emerged as a powerful, evidence-based framework that fundamentally redefines how hospitals care for mothers and their newborns: Couplet Care. For healthcare facilities and the architects and planners who design them, understanding this model is essential to creating environments that support both clinical outcomes and the deep human experience of new parenthood.

Couplet care for a postpartum mother and a low-acuity NICU baby is an evidence-based, family-centered care model where the mother and her infant are kept together in the same room throughout their hospital stay to prevent separation. In this model, specialized care for the infant—such as care for late-preterm infants, feeding issues, or mild respiratory distress—is provided in the mother's postpartum room or in a designated NICU couplet room. This approach stands in contrast to the traditional model, where the baby is admitted to a separate Neonatal Intensive Care Unit (NICU), by treating the mother-infant dyad as a single, unified unit of care.

**Core Components of Couplet Care:**

The foundational principles of couplet care are built around zero separation—the mother-newborn dyad remains together at all times. A single nurse delivers integrated care, often cross-trained in both postpartum and nursery/neonatal care, or by a team consisting of a postpartum nurse and a NICU nurse working collaboratively in the same room. The infant remains at the mother's bedside even when undergoing low-acuity interventions such as phototherapy, feeding tube support, or IV antibiotics. Furthermore, pediatricians and specialists conduct assessments and examinations in the mother's room rather than transporting the baby to a separate nursery or procedure area.

*"Eligibility criteria for couplet care vary by institution and are driven by local clinical protocols, staffing capacity, monitoring capability, and the physical environment. In some hospitals, couplet care is focused on term and late preterm infants (often ≥34 weeks) who are stable but require specialized low-level or intermediate care. In other programs, eligibility is not restricted by gestational age, and mothers and infants across the full spectrum of prematurity are cared for together."*

**Eligible Infants and Physical Requirements:**

Eligibility criteria for couplet care vary by institution and are driven by local clinical protocols, staffing capacity, monitoring capability, and the physical environment. In some hospitals, couplet care is focused on term and late preterm infants (often ≥34 weeks) who are stable but require specialized low-level or intermediate care. In other programs, eligibility is not restricted by gestational age, and mothers and infants across the full spectrum of prematurity are cared for together. The physical environment requires a private room designed for both maternal recovery and neonatal monitoring, sometimes referred to as a "transitional bed" or "NICU Couplet Care Room." The benefits of this model are well-documented and include earlier breastfeeding initiation, improved mother-infant bonding, increased parental confidence in infant care, and improved physiologic regulation of the baby's temperature and heart rate. (1)

**Couplet Care: A Spectrum of Models:**

Couplet care is not a single, uniform program—it exists on a spectrum of care integration—and understanding the distinctions between models is essential for institutions planning implementation and for design teams shaping their environments. The HKS SME Group identified four primary models currently in practice across national facilities, each representing a different

degree of integration between maternity and neonatal services.

*"In this model, the NICU infant is primarily cared for in the mother's room but is transported to an on-unit specialty care nursery for specific clinical needs rather than to a separate NICU floor. The infant returns to the mother's room as soon as possible, preserving the couplet bond while enabling higher-acuity interventions when needed. This model maintains distinct OB and NICU units while creating a bridge between them. "*

**Specialty Care Nursery:**

In this model, the NICU infant is primarily cared for in the mother's room but is transported to an on-unit specialty care nursery for specific clinical needs rather than to a separate NICU floor. The infant returns to the mother's room as soon as possible, preserving the couplet bond while enabling higher-acuity interventions when needed. This model maintains distinct OB and NICU units while creating a bridge between them.

**Couplet Care:**

The most commonly referenced model: the mother and her low-acuity NICU infant receive care together in the same room, with the infant's care delivered either in the maternity unit (baby comes to mom's room) or, in some configurations, with the mother receiving care in the NICU unit (mom goes to baby). Distinct OB and NICU departments remain operationally separate, but care for the dyad is co-located.

*"In this model, the full continuum of maternal and infant care—Labor, Delivery, Recovery, Postpartum, and NICU couplet care—is delivered within a single room."*

**Couplet Care with Integrated Delivery (LDRP):**

In this model, the full continuum of maternal and infant care—Labor, Delivery, Recovery, Postpartum, and NICU couplet care—is delivered within a single room. Patient movement is eliminated, and care transitions happen in place. This model is particularly well-suited for new construction or major renovation projects where the physical environment can be purpose-designed from the outset.

**Integrated Maternity-Neonatal Unit:**

The most advanced expression of the couplet care philosophy: the maternity and neonatal units are fully integrated into a single, unified care environment with no operational division between them. This model reflects a holistic view of the mother-infant dyad as one patient population, supported by a fully multidisciplinary team. This model is more common internationally but represents an aspirational benchmark for domestic health systems pursuing true family-centered care.

**HKS SME Group Findings: National and International Perspectives:**

The HKS Women's and Infants Subject Matter Expert (SME) Group conducted an extensive review of couplet care programs across numerous national and international hospital facilities, including established NICU and maternity centers as well as institutions actively considering implementation of this care model. The findings presented here reflect direct conversations with hospital departments, clinical leadership, and design teams, and represent a comprehensive picture of the current state of couplet care in practice.

*"The most universally cited benefit across all institutions engaged in this study was the profound impact of keeping mother and baby together. Hospital teams consistently described the reduction in stress for both mother and infant as a primary driver for implementing couplet care."*

**Clinical and Emotional Benefits: Keeping Families Together:**

The most universally cited benefit across all institutions engaged in this study was the profound impact of keeping mother and baby together. Hospital teams consistently described the reduction in stress for both mother and infant as a primary driver for implementing couplet care. This finding is strongly supported by existing research: a 2019 study published in Birth Defects Research, "Journey to mother baby care: Implementation of a combined care/couplet model in a Level 2 neonatal intensive care unit," specifically noted that "mothers in the NICU report separation from their newborn as the highest source of stress." [2] The couplet care model directly addresses this pain point by eliminating the physical and psychological distance between mother and child.

Many of the hospitals in our study emphasized that couplet care represented a meaningful shift toward true family-centered care. This philosophy was reported to be impactful not only for families but also for clinical staff. Nursing teams and care providers described a sense of purpose and satisfaction that came from supporting the mother-infant bond in real time, rather than caring for an infant in isolation. Several institutions highlighted the significant mental health benefit for mothers: the continuous presence of their baby was found to substantially decrease the separation anxiety that so often accompanies a NICU admission, supporting maternal psychological well-being during an already vulnerable period.

Many hospitals also reported an additional clinical benefit unique to the couplet care environment: the ability to manage certain low-level postpartum complications for the mother within the same care setting, avoiding the need to separate her from her infant for

maternal treatment. This dual-patient capability further reinforced the model's value as an integrated approach to the postpartum-neonatal continuum.

**Patient and Family Satisfaction as a Strategic Driver:**

Patient and family satisfaction emerged as a clear and recurring driver of the decision to implement couplet care among the hospitals and health systems included in our findings. A few institutions reported compelling accounts of families selecting their delivery hospital specifically because of the availability of couplet care—particularly when the family anticipated or had experienced the need for NICU-level support for their newborn. Interestingly, for some families, the availability of this model was a decisive factor in their choice of birth location, positioning couplet care as both a clinical imperative and a meaningful competitive differentiator for health systems.

Several hospitals also highlighted the importance of shared decision-making in the couplet care environment. When families are present with their infant from day one, they naturally become active participants in the care process, engaging with the care team, asking questions, and contributing to treatment decisions in ways that promote trust, transparency, and better outcomes. This partnership model was described as transformative for both families and clinical staff.

Some facilities cited research linking parental participation in infant care to improved recovery outcomes, increased breastfeeding initiation rates, and faster discharge home for the baby. These clinical benefits, combined with elevated satisfaction scores, created a compelling case for investment in couplet care programs and the physical environments designed to support them.

*"While the clinical and satisfaction-driven benefits of couplet care are clear, implementation is not without its operational complexities. Staffing was consistently cited as one of the most significant challenges hospitals faced in our study."*

**Operational Considerations: Staffing, Eligibility, Communication:**

While the clinical and satisfaction-driven benefits of couplet care are clear, implementation is not without its operational complexities. Staffing was consistently cited as one of the most significant challenges hospitals faced in our study. The care model requires clinical expertise spanning two traditionally distinct specialties—postpartum/maternity nursing and NICU nursing—and institutions approached this challenge in various ways.

The most common model observed was a paired-nurse approach, in which a postpartum nurse assumed responsibility for the mother's care while a NICU nurse cared for the infant—both operating in the same room. Only a small number of hospitals had implemented a single cross-trained nurse caring for both patients. The primary barrier to the single-nurse model was the breadth of specialized skills required to competently manage both the postpartum mother and the low-acuity NICU infant simultaneously. One particularly innovative institution implemented a hybrid model in which one nurse cared for both patients, supported by a resource nurse from both the NICU and the maternity unit who remained on standby to provide specialized assistance as needed. This approach balanced the intimacy and continuity of the single-nurse model with the safety net of specialized backup expertise.

Another staffing consideration noted by several institutions was professional identity and practice preference. Nurses who had specialized in either NICU or postpartum care sometimes expressed a preference to remain within their area of expertise, and this cultural dynamic was an important factor for administrators to navigate during implementation. Honoring the specialized nature of each discipline while building bridges between them was identified as a key to successful staff engagement.

*"Eligibility criteria varied considerably across institutions, with hospitals establishing their own parameters based on clinical protocols, staffing capacity, and physical environment. Common eligibility parameters included physiological stability, airway and oxygen support requirements, IV access needs, and in some programs, gestational age thresholds (often ≥34 weeks)."*

Eligibility criteria varied considerably across institutions, with hospitals establishing their own parameters based on clinical protocols, staffing capacity, and physical environment. Common eligibility parameters included physiological stability, airway and oxygen support requirements, IV access needs, and in some programs, gestational age thresholds (often ≥34 weeks). Across all sites, clear, consistent, and compassionate communication with families regarding eligibility was universally described as essential. A significant lesson learned by multiple hospitals was the importance of not overpromising: not every postpartum mother and NICU baby will qualify for couplet care. Setting appropriate expectations early prevents disappointment and maintains trust with families whose infants require a higher level of care.

The timing of discharge also created a logistical challenge in some settings. Many times, the mother is medically ready for discharge before her infant, leaving teams to determine how to support the dyad once the mother is no longer considered a patient. Some facilities allow the family to remain in the couplet care room after maternal discharge. This is often the arrangement families and staff prefer when the infant's stay is expected to be brief. Other units, due to capacity or predicted infant length of stay, feel pressure to free up the couplet room and transition the infant to a standard NICU room or nearby single-family room. In some programs, that relocation still preserves continuous family presence and the "no separation" intent of couplet care. In others, limited family accommodations can unintentionally revert to a more traditional NICU experience. Clear communication, defined criteria for when to remain versus relocate, and standardized transition protocols were consistently identified as critical to a well-functioning couplet care program.

*"For architects and planners at HKS, the findings of this study are particularly relevant to the design of women's and infants' facilities. The physical environment is not simply a backdrop for couplet care—it is a fundamental enabler of the model's success."*

**Design and Physical Environment: Planning for Couplet Care:**

For architects and planners at HKS, the findings of this study are particularly relevant to the design of women's and infants' facilities. The physical environment is not simply a backdrop for couplet care—it is a fundamental enabler of the model's success. Hospitals that had intentionally planned and designed with couplet care in mind consistently reported better outcomes and fewer operational challenges than those attempting to retrofit existing spaces.

Room size was a universal concern: couplet care rooms must be large enough to accommodate the full complexity of maternal and neonatal care simultaneously. This includes appropriate space for neonatal monitoring and intervention equipment, maternal recovery needs, support for the significant other or family support person, and the clinical team. Many hospitals emphasized the need for thoughtful layouts that accommodate a partner or family member without compromising care delivery. Several institutions incorporated accommodation for twins, including additional headwall infrastructure and space planning to support simultaneous dual-infant care.

*"A recurring theme among facilities that had purpose-built their couplet care rooms was the strategic value of designing for flexibility. Administrators found that larger, well-equipped couplet rooms could be compellingly marketed to hospital leadership precisely because of their versatility: when not in use for a mother-infant couplet, these rooms could accommodate NICU twins or triplets, two distinct NICU infants at varying acuity levels, or serve as transition rooms for higher-acuity NICU families not yet eligible for the full couplet model."*

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A notable and widely shared recommendation regarding room layout was the preferred patient positioning: the baby space should be located nearest the door, with the mother's space beyond it, and the family space beyond that. This configuration supports efficient clinical access to the infant—who may require more frequent monitoring or intervention—while protecting the mother's privacy and recovery space, and creating a natural gradient from the clinical zone to the family zone within the room.

Some hospitals had integrated couplet care within Labor, Delivery, Recovery, and Postpartum (LDRP) rooms, finding significant benefits in providing all phases of care within a single space, eliminating patient movement and transfer disruptions. This all-in-one approach was viewed as particularly beneficial for the couplet care population, where stability and continuity of the environment directly contribute to the well-being of both mother and infant.

Capacity was also a practical limiting factor for several institutions. Some facilities had as few as two rooms dedicated to couplet care, which constrained the program's reach and highlighted the importance of early, strategic planning for the number and configuration of couplet care rooms within a new or renovated facility.

*"Among the most illuminating dimensions of the HKS SME Group's research were the perspectives gathered from international facilities—particularly those in Western Europe and Canada—where the couplet care model is often expressed in a more fully integrated and philosophically distinct form."*

**International Perspectives: A Different Framework for Family-Centered Care:**

Among the most illuminating dimensions of the HKS SME Group's research were the perspectives gathered from international facilities—particularly those in Western Europe and Canada—where the couplet care model is often expressed in a more fully integrated and philosophically distinct form. While the clinical outcomes sought are similar, the underlying motivations, staffing cultures, and operational structures differ markedly from the domestic experience, offering both instructive contrast and a compelling vision of what is possible.

Internationally, couplet care tends to reflect a fully integrated maternal-neonatal care continuum in which the mother, infant,

and accompanying family members are regarded as a single, holistic unit of care—not as individual patients to be managed by separate departments. The care environment itself is often organized to reflect this philosophy, with maternity and neonatal services blended into unified units rather than maintained as adjacent but distinct programs.

The motivations behind this approach also differ significantly from those most commonly cited by domestic institutions. Where U.S. health systems frequently frame couplet care as a competitive differentiator—a service line enhancement that attracts patients and elevates satisfaction scores—international facilities are more likely to approach it as the ethically and clinically correct standard of care, grounded in evidence-based research and driven by a healthcare culture that prioritizes family well-being as a primary outcome in its own right. Internationally, the question is less often "should we offer couplet care?" and more often "how do we continue to advance it?"

***"Staffing presents far fewer barriers internationally, where multidisciplinary care teams and cross-training across maternal and neonatal specialties are more deeply embedded in clinical culture. The professional siloing that poses a significant implementation challenge for many domestic institutions is less pronounced abroad, enabling a more fluid and integrated approach to the dyad's care."***

Staffing presents far fewer barriers internationally, where multidisciplinary care teams and cross-training across maternal and neonatal specialties are more deeply embedded in clinical culture. The professional siloing that poses a significant implementation challenge for many domestic institutions is less pronounced abroad, enabling a more fluid and integrated approach to the dyad's care.

Perhaps most strikingly, the discharge timing challenges that several domestic facilities identified as a logistical pain point—when a mother is medically ready to leave before her infant—are far less disruptive in many international settings, where families are welcomed and expected to remain in the hospital alongside their infant for as long as clinically necessary. The hospital stay is understood as a family experience, not a patient throughput event, and this cultural orientation removes one of the most common friction points in the domestic couplet care model. For U.S. institutions charting a course toward more holistic, family-centered care, the international experience offers both a benchmark and an inspiration.

**Conclusion:**

The findings from the HKS Women's and Infants Subject Matter Expert Group paint a compelling picture of couplet care as a model whose time has come. Across national and international institutions, the evidence is consistent: keeping mothers and their low-acuity NICU infants together produces measurable clinical benefits, enhances patient and family satisfaction, supports staff fulfillment, and advances the broader goal of truly family-centered care.

***"For healthcare systems considering this model, the lessons from our study are clear. Success requires thoughtful staffing strategies that respect specialized expertise while fostering cross-disciplinary collaboration. It requires transparent communication with families about eligibility and expectations."***

For healthcare systems considering this model, the lessons from our study are clear. Success requires thoughtful staffing strategies that respect specialized expertise while fostering cross-disciplinary collaboration. It requires transparent communication with families about eligibility and expectations. Moreover, it requires physical environments that are purposefully designed from the outset to support the full complexity of co-located maternal and neonatal care.

As architects and planners committed to advancing healthcare environments, HKS brings this evidence-based understanding to every woman's and infant project we undertake. Couplet care is not simply a clinical protocol—it is a philosophy of care that begins with design.

**References:**

1. National Institutes of Health. (n.d.). *Couplet care: Evidence-based definition and core components of rooming-in and family-centered neonatal care models.* National Library of Medicine, National Center for Biotechnology Information. https://www.ncbi.nlm.nih.gov

2. Erdei, C., McAvoy, L., Gupta, M., Alksninis, K., & Litt, J. S. (2019). Journey to mother baby care: Implementation of a combined care/couplet model in a Level 2 neonatal intensive care unit. *Birth Defects Research, 111*(17), 1294–1301.

3. Curley, A., Jones, L.K., & Staff, L. (2023). Barriers to Couplet Care of the Infant Requiring Additional Care: Integrative Review. Healthcare, 11(7), 737. https://doi.org/10.3390/healthcare11050737

4. White, R. D. (2024). Couplet Care—The Next Frontier of Care in the Newborn Intensive Care Unit. Critical Care Nursing Clinics of North America, 36(1), 35–39. https://doi.org/10.1016/j.cnc.2023.08.002

5. Anthropic. (2026). *Claude.ai* [Large language model]. https://claude.ai

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*Corresponding Author*

*Shawna Langworthy DNP, MBA, RN, NEA-BC, EDAC*
*Sr. Manager Advisory*
*Vice President*
*HKS*
*125 S Clark St, #1100, Chicago, IL 60603*
*Telephone +1 312 346 5899*
*Email:* slangworthy@hksinc.com

\

*Caitlin Potter, AIA, ACHA, LSSYB*
*Sr. Medical Planner*
*Vice President*
*HKS*
*350 N Saint Paul St, #100, Dallas, TX 75201*

# CASE STUDY:
# BEACON CHILDREN'S HOSPITAL

**Location:**
*South Bend, Indiana*

**Project Architects:**
*ZGF*

**Researching Architects:**
*HKS*

**Unit Area + Couplet Counts:**
*31,468 SF*
*9 Couplet Care rooms*

**Overview:**
*Built in 2017, the new 39-bed Neonatal Intensive Care Unit (NICU) at Beacon Children's Hospital features enhanced single-family rooms (SFR) and 9 couplet care rooms (CCR), two new room designs that expand clinical functionality and family accommodation in the ICU. Beacon's CCRs were driven by exposure to early family-integrated NICU care in Sweden, making Beacon the first hospital in the United States to implement this model.*

**NICU Couplet Care Type:**
*Type 2*
*Couplet Care within NICU - Level IV*

## Key Design Strategies

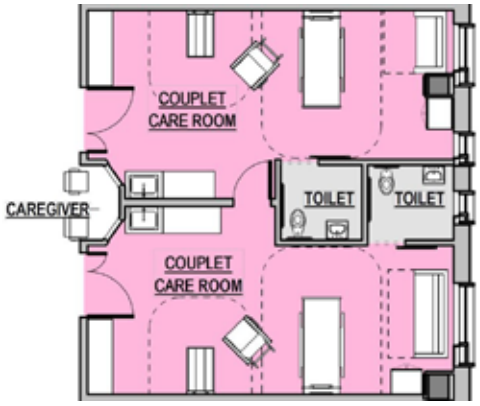
- *Generous room footprint to accommodate the sickest babies that require the most equipment*
- *Rooms are multi-use for scenarios such as: couplet care; kangaroo care; twins / multiple births; hospice care; overflow postpartum, and group-care for 2-3 babies whose families can't be at the bedside*
- *Rigorous sound-control targets set early and tested through the full-build mockups*
- *Trash built into the nurse servers which can be emptied from the corridor without entering rooms*
- *Creating a benchmark for family accommodations for the hospital by including sleep accommodations, toilets, and other amenities*

## Lessons Learned

- *"Flexibility is key" operationally: rooms must flex between very sick single babies, multiples, group-care, and overflow postpartum. This flexibility is a potential selling point for this room type when trying to get staff or administration on board*
- *Mothers with lower-acuity babies often want their infants physically closer, so configure headwalls and equipment (e.g., multiple gas/power locations, extended or dual headwalls, or ceiling booms) to support both closer mother–baby proximity and farther-apart configurations as acuity requires*
- *For Beacon, the hardest part of NICU couplet care isn't the room,it's the staffing model. There is no single ideal pattern; success comes from clear criteria, multiple staffing models, and a long-range cross-training strategy.*

## Staffing

- *Making only post-2014 hires dual-trained created a split workforce: newer couplet-ready nurses leave more often, while long-tenured staff remain NICU-only. Future models should intentionally cross-train all*
- *Many nurses see themselves as NICU or OB, not both. Couplet requires clear expectations and culture change, including hiring for a dual-competency mindset*
- *Build in flexibility: mother–baby nurses can float to NICU for lower-acuity infants, NICU nurses can occasionally take moms, and the model can shift based on census.*
- *"One nurse for both mom and baby" is often preferred, but high-acuity moms (e.g., on magnesium) still need separate maternal care—so plan for both single-caretaker and dual-nurse configurations.*




*Source:*
*https://www.zgf.com/work/603-beacon-health-system-beacon-children-s-hospital-expansion*
*https://www.beaconhealthsystem.org/news/2019/11/20/moms-spend-more-time-skin-to-skin-with-their-nicu-babies-in-couplet-care-rooms/*
*https://www.tradelineinc.com/reports/2018-10/reimagining-nicu-support-couplet-and-family-care-beacon-childrens-hospital*

HKS

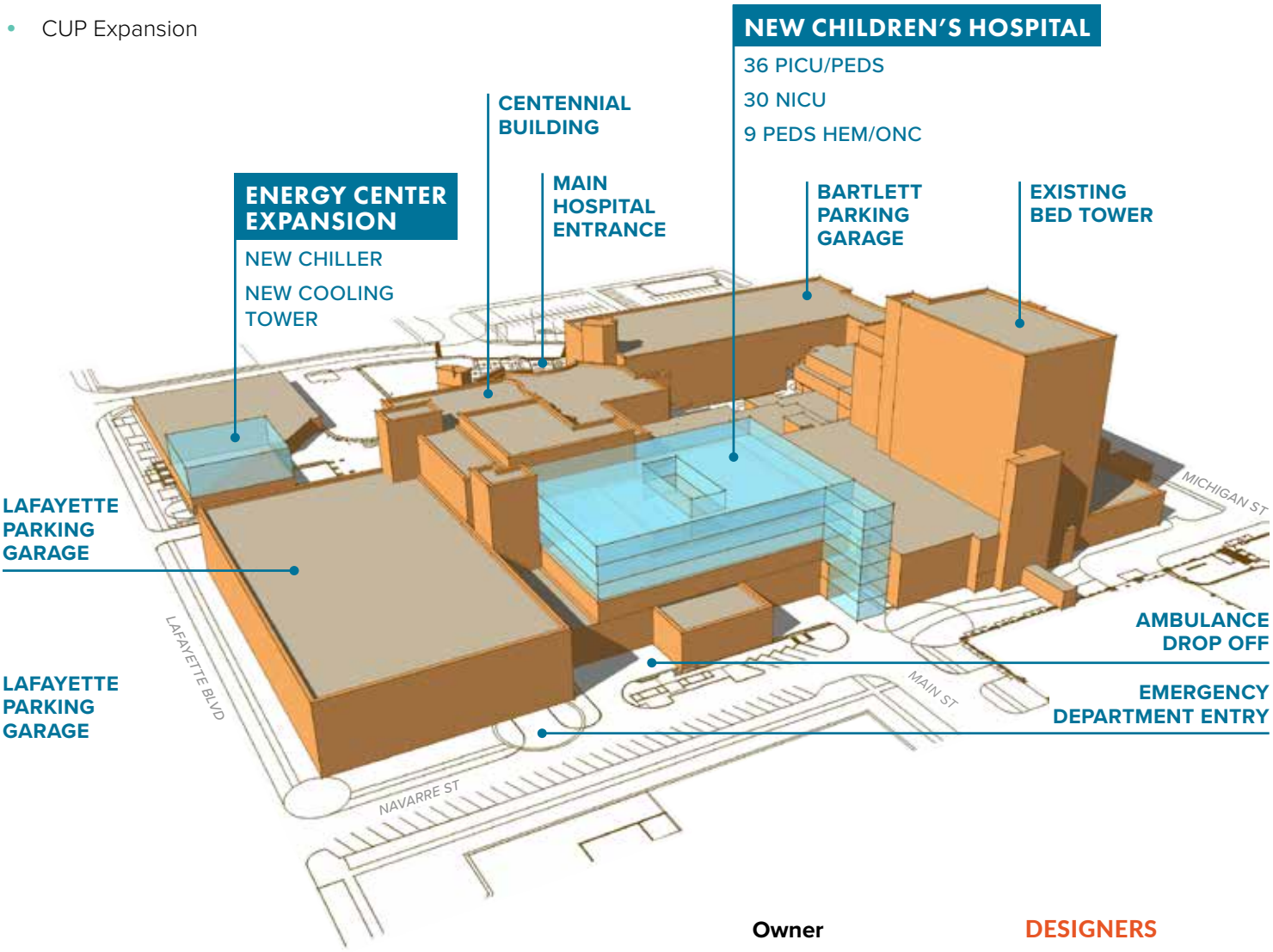
# BEACON CHILDREN'S HOSPITAL

## NICU TOUR

# BEACON CHILDREN'S HOSPITAL

## SOUTH BEND, INDIANA

- Pediatric Acute Care
- Pediatric Intensive Care
- Pediatric Hematology
- Neonatal Intensive Care
- CUP Expansion




**Owner**
Beacon Health System

**Location**
South Bend, Indiana

**Size**
101,530 total SF
39,000 SF NICU

**Project Cost**
$45M

**Completion Date**
May 2017

### DESIGNERS

**Architect /Interior Designer**
ZGF Architects LLP

### CONSULTANTS

**Structural Engineer**
Magnusson Klemencic Associates, Inc.

**Contractor**
Balfour Beatty Construction


# VISION

## FUTURE STATE

### GOALS

- Integrate families into the NICU environment
- Enhance the family experience
- Provide access to nature for families and staff
- Promote and support Kangaroo Care
- Accommodate postpartum mothers into the NICU

## PLANNING: INTEGRATED DESIGN EVENTS

### INCORPORATING INNOVATIVE CONCEPTS

- Vertical and horizontal adjacencies
- Prioritizing use of limited space
- Opportunities for outdoor space
- Daylighting

Level 4 - PHO and Mechanical

Level 5 - PICU and PEDS

Level 6 - NICU

# MOCK-UPS-NICU

## EARLY DEVELOPMENT

- Multi-disciplinary approach
- Focus on process flow
- Design for parents as the focus of care

# RESEARCH

## EVIDENCE-BASED DESIGN

### NICU DESIGN CONSIDERATIONS

- Single Family Room (SFR)
- Couplet Care
- Family Integrated Care
- Maternal / Child Bonding
- Daylight
- Circadian Rhythms

## PARENTAL PRESENCE AND HOLDING

# NEONATAL INTENSIVE CARE UNIT

## LEVEL 6


## PLANNING CONCEPTS

1. Single Family Rooms
2. Family Amenity Space
3. Multipurpose/Atrium
4. Family Outdoor Terraces
5. Staff Outdoor Terrace
6. Zen and Napping Rooms
7. Couplet Care Room


2


3


3

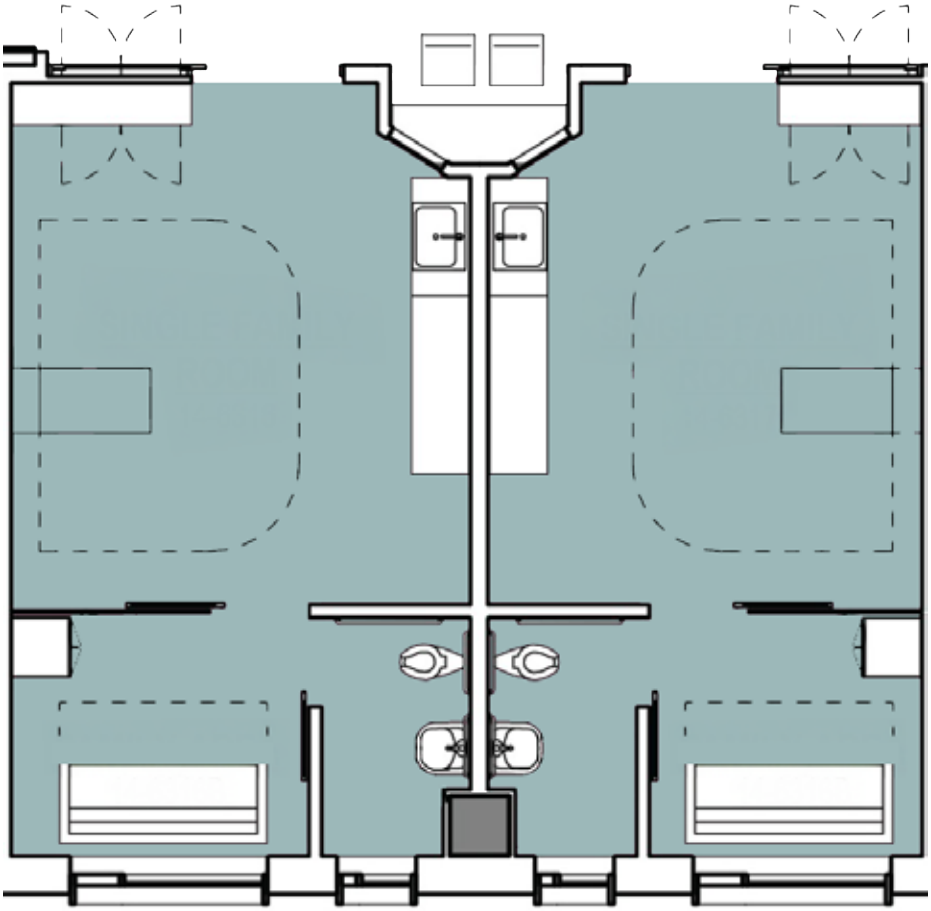

4

## PLANNING CONCEPTS

- Provides private healing environment for patients and families
- Daylight in every room
- Private sleeping accommodations and toilet/shower support family stays
- Decentralize care station supports visualization and access to patient
- Kangaroo Chair promotes skin-to-skin cuddling with infant
- Daylight in every room
- Sleeping area with sliding doors, open during the day
- Parent sleeping area closed off at night
- Footwall lighting color personalizes space for family

# PLANNING

## SINGLE FAMILY ROOM



**The NICU at Beacon Children's Hospital of South Bend integrates the latest thinking in single family room design. Families can stay together for weeks or months in private rooms that facilitate skin-to-skin contact—also known as kangaroo care—between parent and baby.**

Kangaroo care, which is common in Sweden and Canada, has been shown to reduce mortality, infection rates and lengths of hospital stays in preterm babies, while improving infant growth and breast-feeding rates.

Both types of rooms have linen pickup just outside of the room to prevent interruptions, private bathrooms with showers, breast pumps, lockable drawers, refrigerators for breast milk, and lighting that can be changed to suit the mood and be kept from shining in a baby's eyes. Most also have sleeping space for two on a pullout sofa bed.

"Skin-to-skin care is a biological imperative for the sensory development of preterm babies," Dr. White says. "It reduces stress levels and helps preterm infants adapt to life outside the womb, improves breast-feeding and leads to healthy weight gain."

## 1 "KANGAROO" CHAIR

Allows a parent to lean back and safely hold the baby skin-to-skin for extended periods.

**Purpose:** Under the kangaroo care method, mothers hold their nearly naked newborns in an upright position against their chest. Skin-to-skin bonding with the mother reduces babies' stress levels and helps infants adapt to life outside the womb. It also improves breast-feeding and weight gain, and lowers infection rates, and it is important to the sensory development of a preterm baby. When practiced for six hours a week for eight weeks, it has been shown to accelerate brain maturation in EEG trackings of infant brain activity.

## 2 SOUND CONTROL

The room and NICU unit are designed to be very quiet. Acoustical ceiling tile, heavily insulated walls, carpeted corridors and other features are designed to keep sounds under 40 decibels—about the level of a babbling brook. The alarm controls at the bedside are silent, with signals going to the nurse's communication device, and the HVAC system is designed to make as little noise as possible.

**Purpose:** Reducing unwanted noise and increasing appropriate sounds for a newborn baby, such as a mother's speech and lullabies, promotes the baby's development.

## 3 WINDOW TO THE OUTSIDE

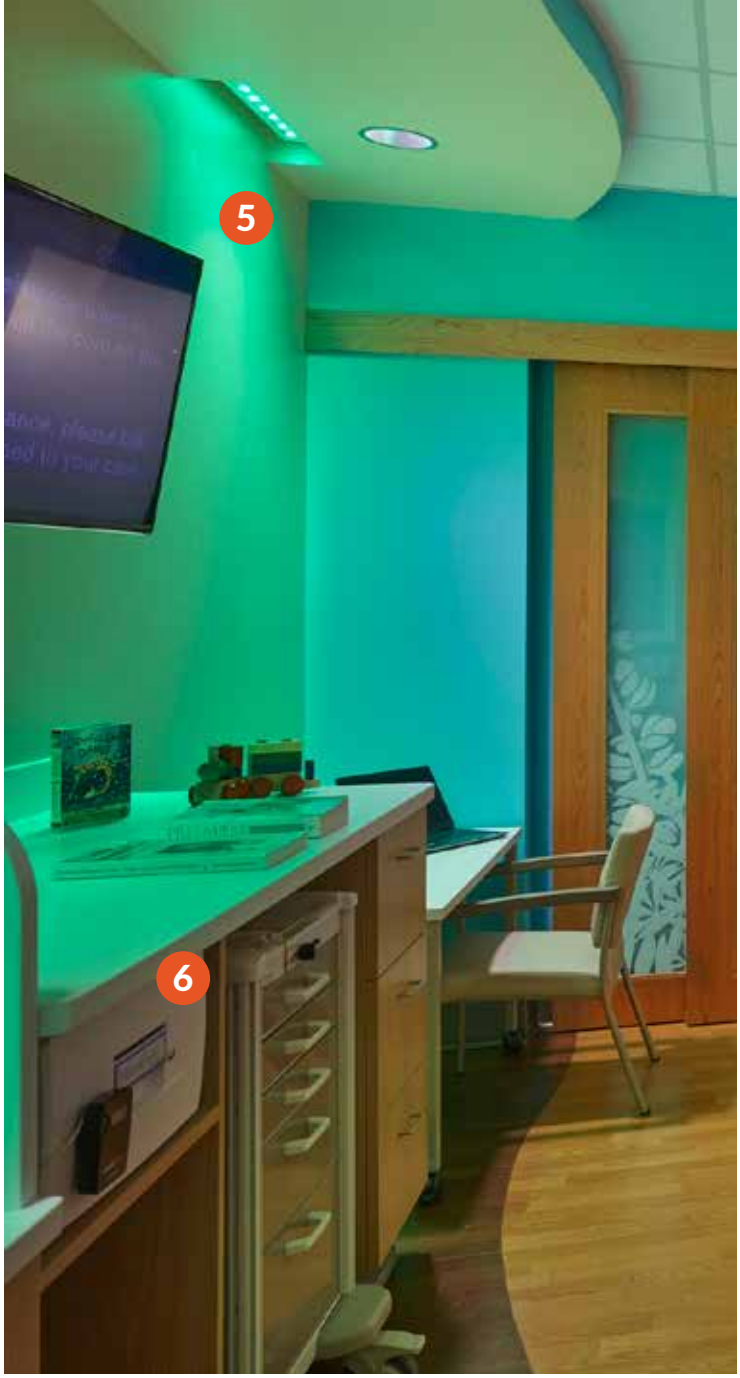
The layout of the NICU unit puts as many rooms as possible on external walls, and there is a large central atrium so that all the rooms receive abundant natural light. Here the view is into a glass-covered atrium, which has a treehouse and plants in it.

**Purpose:** Exposure to natural light helps maintain circadian rhythms for babies, parents and staff, and views of nature reduce stress and anxiety.

## 4 PULL OUT SOFA

Most NICU rooms have a sleeper sofa with space for two family members.

**Purpose:** To encourage family to be there as much as possible so that the baby will receive lots of human contact. The décor is designed to be homey, with color and natural finishes, and families are encouraged to add personal touches. There is also a full bathroom with a shower.




## 5 DIMMABLE LIGHT SOURCES

Rather than the standard big light in the center of a room, there are dimmable controls, and no lights are located over a baby's bed to avoid having light shine directly into an infant's eyes. One wall of each room is lighted by a bank of LED lights that can be controlled by the family to wash that wall with a color of their choice. The color on the left wall is a parent-selected color. A stronger light for medical procedures is mounted on an adjustable arm.

**Purpose:** Enables parents and staff to dim the lights and control the ambiance, making the room feel less institutional. None of the lights are in the direct view of the baby because preemies have very thin eyelids and cannot turn over or otherwise turn away from an unpleasant light source.


## 6 BREAST-MILK REFRIGERATOR

Every room has a breast pump and a separate refrigerator for breast milk. The refrigerator is built in below the counter on the left side

**Purpose:** To facilitate breast-feeding.

## 7 ROOM SIZE

All NIC2 rooms are more than 260 square feet.

**Purpose:** The large size allows for care of critically ill babies who may require more equipment for life support and a large care team for specialized care. If an infant needs surgery and is too fragile to move, the NIC2's larger size allows space to perform a procedure.

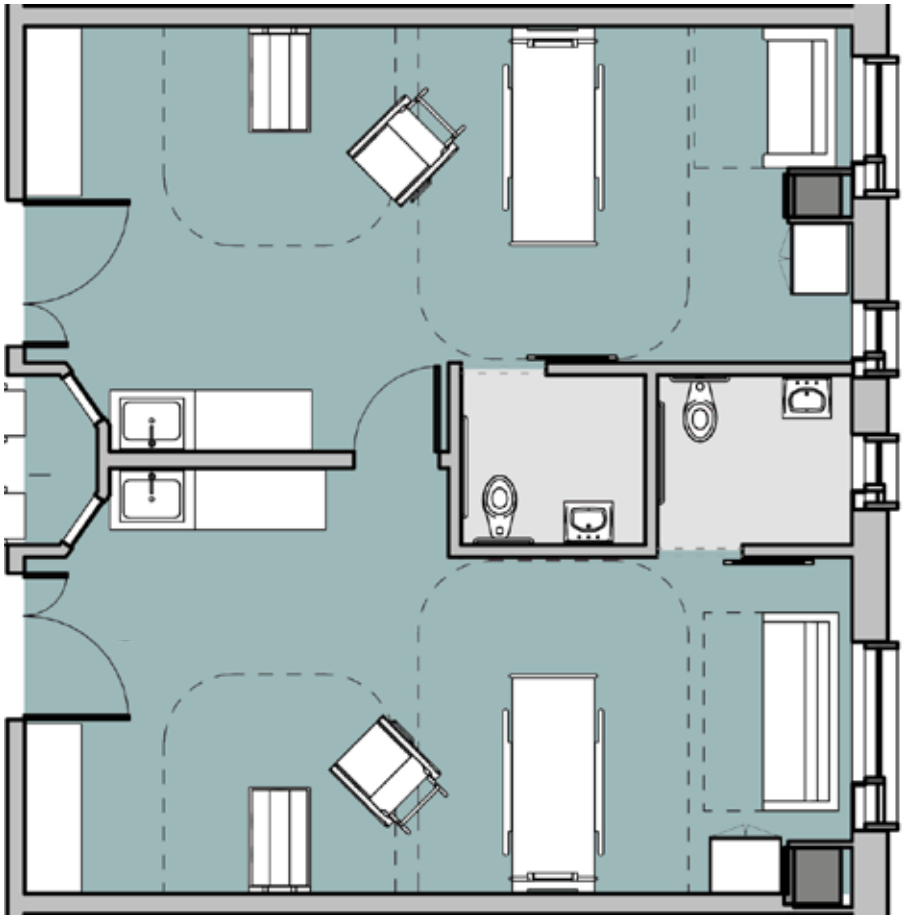
## 8 ARTICULATING ARMS

These arms on the head wall can hold a procedure light (shown), IV pumps and other medical equipment,

**Purpose:** The head wall behind a hospital bed contains outlets for oxygen, air suction and electricity, and mounts for other support equipment. In ordinary ICUs, there is limited flexibility for movement of the babies. Here, articulating arms allow these devices to be repositioned easily when the baby is transferred from the incubator to a parent's arms.

# PLANNING

## COUPLET CARE ROOM



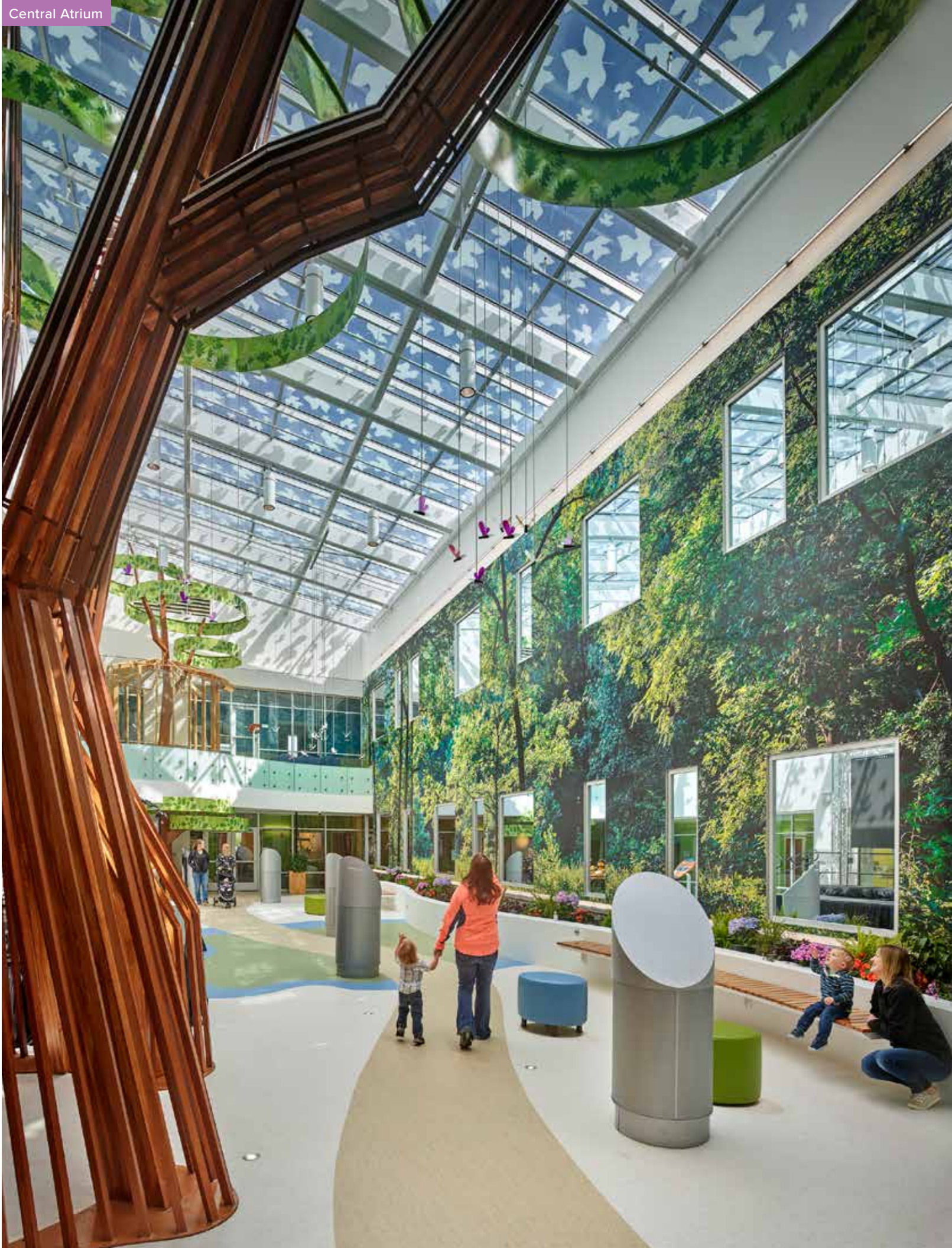
### NEW NICU PROTOTYPE ROOM

- Provides headwalls for baby and mother with infant and adult hospital beds- supports couplet care
- When paired, provides space for families with multiple births
- Larger size supports multiple care scenarios

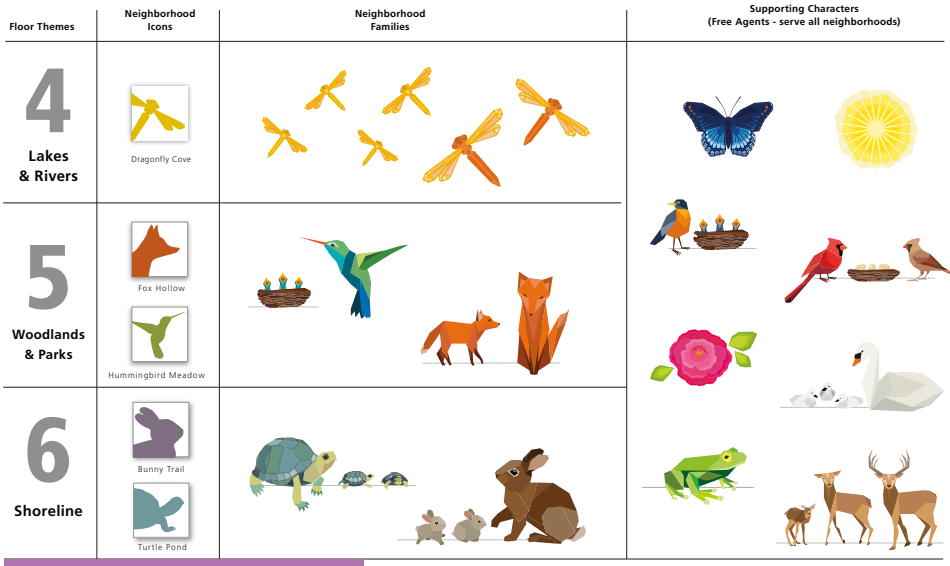
### PROMOTING BONDING AND FAMILY SUPPORT

- Allows mother to recover with infant in same room
- Kangaroo care can begin right away
- Promotes Family bonding
- Adequate space for additional equipment for critical infants
- Multiples and parents remain together
- Adequate space for hospice or end of life care
- Prevents isolation for infants in open cribs whose parents are unable to be present daily

Beacon's facility has so-called NIC2 rooms for mothers who are still patients after delivery and their babies. When the mother is discharged, she and her baby would move to a room set up for mother as parent rather than patient, but otherwise similar to the NIC2 rooms.


Central Atrium

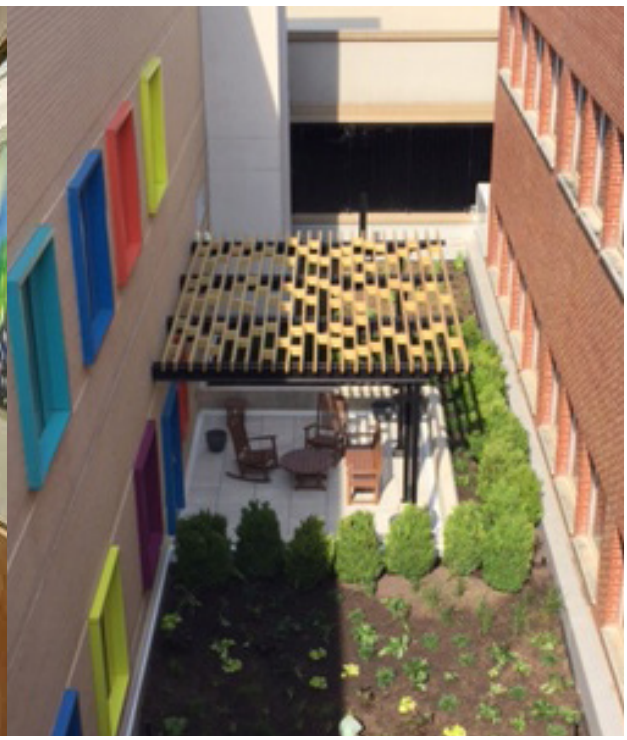
# INNOVATION




Themed Floors and Artwork

- Pass Through Cabinets
- Colored Personalized Lighting
- Themed Floors and Artwork
- Butterfly Room and Placement
- Care Porch

Butterfly Room

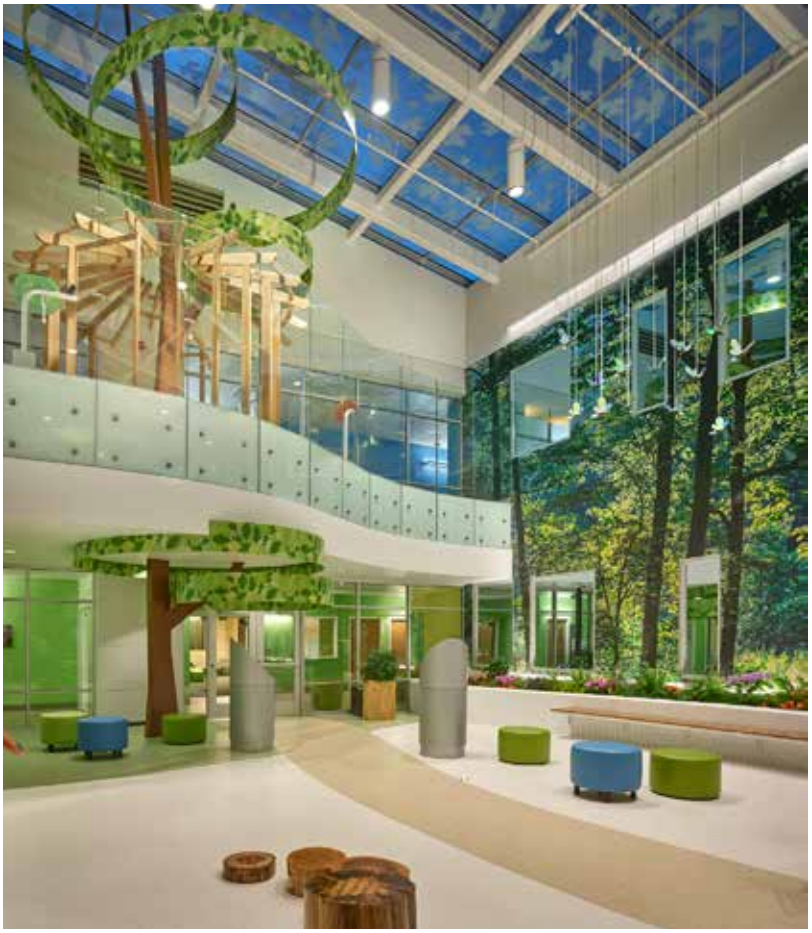


## DAYLIGHT & CIRCADIAN RHYTHMS

- Central Atrium
- Windows in every NICU patient room
- Welcoming and calming daylit entrance

## DAYLIGHT & ACCESS TO NATURE

- Garden Courtyard provides views of nature from every corridor, year round
- Informal places of respite with views into Garden Courtyard with Tree sculpture in the foreground



# ATRIUM

## LESSONS LEARNED

The atrium serves as a multipurpose space that unifies the building, bringing together its various functions while enhancing the overall experience. It introduces abundant natural light into all patient rooms and functions as both a central gathering area for the unit and a therapeutic environment.

Because the space is top-lit, careful consideration was given to controlling glare and heat gain. This was achieved through a custom frit pattern inspired by the leaf of the state tree, the tulip tree, allowing for both functional performance and a meaningful design reference.

Acoustics were a primary concern, as patient rooms open directly into the atrium. To address this, the design incorporates triple-pane windows along with a Snaptex acoustical panel system. This system includes sound-absorbing batts combined with a Clipso perforated wall covering, featuring a custom photographic image by Henry Domke integrated into the fabric.

Custom “Firefly” light fixtures by Winona Lighting are thoughtfully placed within both the soil-filled planters and at the skylight, adding a dynamic and cohesive lighting element throughout the space.

Heating and cooling are delivered through a series of large cylindrical units distributed along the main pathways. These elements are creatively integrated into the design, disguised with engaging graphics and interactive “seek-and-find” features on their tops, contributing both functionality and a sense of playfulness to the environment.

# MOCKUPS

## LESSONS LEARNED

A full-scale mockup of a each of the patient rooms was constructed to test, validate, and refine the design before construction begins.

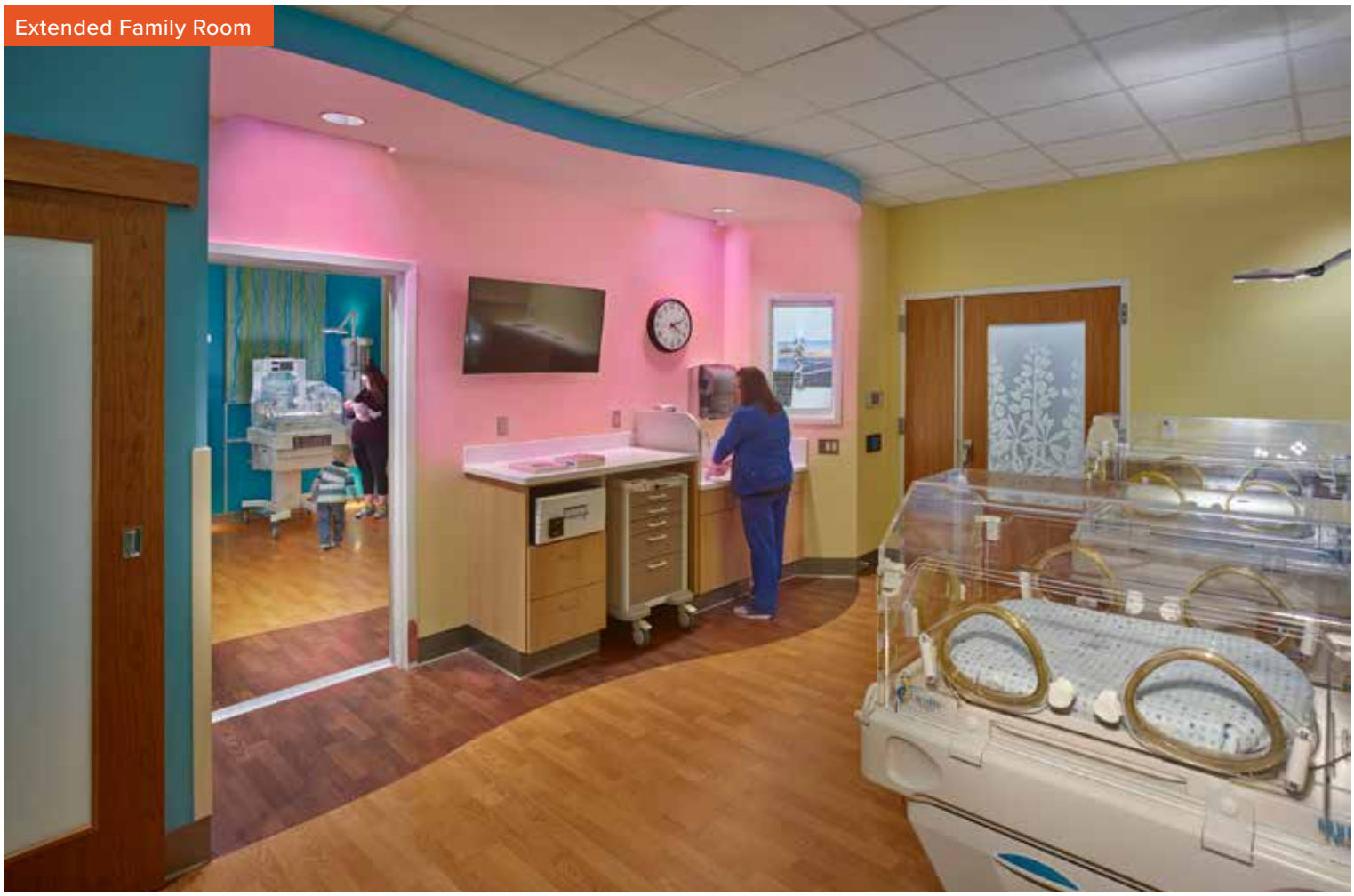
1. **User Testing and Workflow Validation**
   - Clinicians (nurses, doctors, support staff) can physically simulate care scenarios before the spaces is occupied.
   - Helps identify inefficiencies in layout—like awkward reach distances, poor equipment placement, or circulation conflicts. Improves patient safety by verifying visibility, access, and response times.
2. **Patient Experience and Comfort**
   - Patients and families can provide feedback on privacy, lighting, noise, and overall comfort.
   - Allows refinement of elements like window placement, furniture layout, and family zones.
3. **Safety and Infection Control**
   - Tests for compliance with safety protocols (e.g., clearances around beds, handwashing station location, PPE access)
4. **Equipment Coordination**
   - Ensures all medical equipment, headwalls, and utilities fit correctly and function together.
   - Identifies clashes between architectural, structural, and MEP systems early.
5. **Design Decision-Making**
   - Owners can compare options in real scale (materials, lighting, finishes, fixtures).
   - Helps avoid costly changes later by making decisions with confidence.
6. **Acoustics and Lighting Evaluation**
   - Real-world testing of noise levels, sound transmission, and lighting quality. In the mockup we tested and implemented the color changing light fixtures
7. **Donor opportunity**
   - Touring potential donors through the mockups shows them a tangible visual of where their money is going.
8. **Risk Reduction and Cost Savings**
   - Catching issues in a mockup is far cheaper than fixing them during or after construction. Reduces change orders, delays, and operational problems post-occupancy.

Atrium Skylight

Access to Daylight

Waiting Room


Extended Family Room



## CONTACT


**PROJECT ARCHITECT**

**Kristina Thomsen**
1223 SW Washington Street
Suite 200, Portland, OR 97205
**E** kristina.thomsen@zgf.com
**T** 503.863.2437

**ASSOCIATE ARCHITECT**

**Shive Hattery** (formally Design Organization)
57 Franklin Street
Valparaiso, IN 46383
**T** 219.476.1400

**STRUCTURAL ENGINEER**

**MKA**
1301 Fifth Avenue
Suite 3200, Seattle ,WA 98101-2699
**T** 312.683.0058

**CIVIL ENGINEER**

**DLZ**
2211 East Jefferson Blvd
South Bend, IN 46615
**T**574.236.4400

**MEP**

**Heapy Engineers**
1400 West Dorothy Lane
Dayton, OH 45409
**T** 937.271.1804

**LANDSCAPE**

**Hitchcock Design Group**
22 E Chicago Ave
Suite 200A, Naperville, IL 60540
**T** 630.961.1787

**EQUIPMENT**

**Walsh Consulting Group**
1275 Milwaukee Ave
Suite 333, Glenview, IL 60025
**T** 847.699.2500

**SIGNAGE**

**Knot Studio** (formally Anderson Krygier)
350 SE Mill Street
Suite 02, Portland, OR 97214
**T** 503.243.2060

ZGF


**PORTLAND**
1223 SW Washington Street
Suite 200
Portland, OR 97205
**T** 503.224.3860

**SEATTLE**
925 Fourth Avenue
Suite 2400
Seattle, WA 98104
**T** 206.623.9414

**LOS ANGELES**
515 South Flower Street
Suite 3700
Los Angeles, CA 90071
**T** 213.617.1901

**DENVER**
1800 Wazee Street
Suite 300
Denver, CO 80202
**T** 303.557.6420

**WASHINGTON, DC**
600 14th Street NW
Suite 800
Washington, D.C. 20005
**T** 202.380.3120

**NEW YORK**
39 W 19th St 12th Floor
New York, NY 10011
**T** 212.624.4754

**VANCOUVER, BC**
355 Burrard Street
Suite 350
Vancouver, BC V6C 2G8
Canada
**T** 604.558.8390

**www.zgf.com**

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# Family-Centered Therapeutic Neonatal Intensive Care Unit Design: A Checklist

*Mardelle McCuskey Shepley, B.A., M.Arch., M.A. (Psych), D.Arch., Rebecca L. Ames, Ph.D., Beverley H. Johnson, FAAN, Sabah Mohammed, B. Arch, M.S., EDAC, LEED GA, WELL AP, Judith Smith, MHA, Nastaran Radmanesh, B.Arch, M.Arch, M.A., EDAC, Robert D. White, MD*

*"Historically, healthcare design decisions have been informed by building standards and architectural precedent. While these forms of guidance provide important baseline requirements and shared points of reference, they also tend to reflect professional assumptions rather than the lived experiences of patients, families, and frontline staff. This limitation has become more visible as healthcare models increasingly prioritize experiential and relational dimensions, such as dignity, comfort, and social support, alongside operational and safety metrics (1, 2)"*

Historically, healthcare design decisions have been informed by building standards and architectural precedent. While these forms of guidance provide important baseline requirements and shared points of reference, they also tend to reflect professional assumptions rather than the lived experiences of patients, families, and frontline staff. This limitation has become more visible as healthcare models increasingly prioritize experiential and relational dimensions, such as dignity, comfort, and social support, alongside operational and safety metrics (1, 2). These evolving expectations are especially evident in high-acuity, family-centered settings such as newborn intensive care units (NICUs). As healthcare systems increasingly recognize patients and families as valued partners in both care and design, the need for tools that evaluate environments from these broader experiential perspectives has grown. However, tools to support the comprehensive evaluation of therapeutic design in NICU environments have been slow to emerge.

In NICU settings, two complementary frameworks have emerged to guide environment-centered improvements: therapeutic design and family-centered care. Therapeutic design refers to the intentional shaping of physical environments to support healing, reduce stress, and promote positive health outcomes for patients, families, and staff in healthcare settings (3). In the NICU context, this includes features such as access to natural light, acoustic control, and spatial configurations that support developmental care (Altimier et al., 2023). Family-centered care is an approach to planning, delivering, and evaluating healthcare that recognizes families as essential partners in care and decision-making, acknowledging their continuity throughout their infant's life and their vital role in ensuring their infant's health, development, and well-being (4). The integration of these frameworks recognizes that the physical environment shapes not only clinical outcomes but also the relationships and experiences that are central to neonatal care (4, 5). Despite growing recognition of their importance, practical tools for systematically evaluating how NICU environments support these principles remain limited.

*"While tools tailored to therapeutic design priorities in NICUs remain scarce, instruments developed to evaluate other healthcare environments provide a clear precedent for structured tool development and application."*

**Healthcare Environmental Assessment Tools and Development:**

While tools tailored to therapeutic design priorities in NICUs remain scarce, instruments developed to evaluate other healthcare environments provide a clear precedent for structured tool development and application. Often described in the literature as environmental audits, checklists, or walkthrough assessments, these tools support the systematic documentation of a predefined set of design features understood to shape care experiences, workflows, and safety and well-being outcomes. By consistently and transparently capturing these conditions, environmental assessment tools make otherwise abstract design qualities visible and comparable, supporting research, benchmarking, and targeted improvement efforts. These structured assessments can be deployed at different stages of the design cycle—before construction begins, immediately after completion, or once a facility is operational—commonly referred to as a post-occupancy evaluation (POE).

In recent years, attention to the unique demands of different healthcare settings has resulted in the development of more targeted environmental assessment instruments. For instance, tools have been developed to evaluate patient-centered and universal design in general healthcare environments (2, 6), elder-friendly emergency departments (7), and safety conditions in psychiatric wards (8), as well as adaptations for specific cultural contexts, such as Palese et al.'s (9) validation of a nursing home assessment tool in Italian facilities. In maternity care, the Birth Unit Design Spatial Evaluation Tool (BUDSET) was developed to assess hospital birth environments from the perspective of the birthing woman (10) and later adapted to accommodate and better support people in these settings (11).

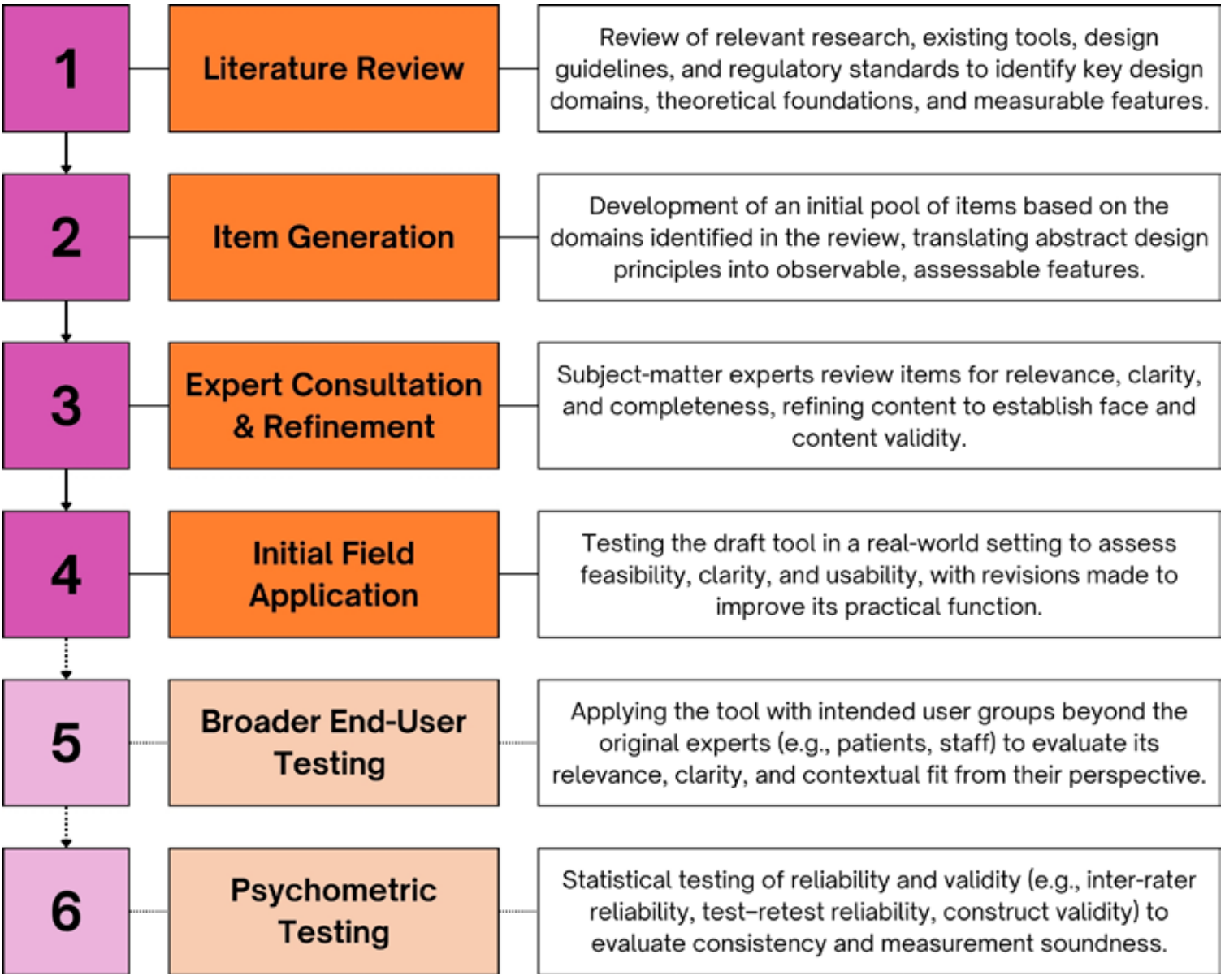
Environmental assessment tools are typically developed through a recognizable sequence of steps, although the rigor applied to each stage can vary considerably across studies (12). Most begin by reviewing existing literature, design standards, and clinical guidelines to identify relevant environmental domains and features. Draft items are then refined through consultation with subject-matter experts to establish face and content validity. Pilot testing often follows, in which the draft tool is applied in

real-world contexts to assess clarity, feasibility, and usability. Pilot testing may also involve broader end-user groups—such as patients, families, or frontline staff—particularly when those users differ from the experts involved in early development and are the tool's intended end users. Iterative revision based on expert feedback and pilot testing is common, and a smaller subset of tools proceeds to further psychometric testing. However, comprehensive psychometric testing remains uncommon across the field, and many tools are applied and refined in practice without undergoing formal statistical validation (12). Importantly, the variability in methodological rigor likely reflects, at least in part, the challenges inherent to validating environmental assessment tools in real-world healthcare settings, where ethical, logistical, and contextual factors constrain research design.

Experience of the built environment is inherently subjective, but it is not random. Evidence-based design research conducted over the last two decades has repeatedly linked the design of healthcare environments with patterns of use, comfort, stress, and safety (13). In this context, environmental assessment tools are best understood as structured frameworks that translate abstract design principles into observable criteria, providing a systematic way to document environmental conditions and supporting intentional, evidence-informed design decision-making. In parallel, the growing emphasis on end-user experience in tool development, rather than solely technical criteria, reflects evolving assumptions about what constitutes quality and who is best positioned to evaluate it.

***"Evidence-based design research conducted over the last two decades has repeatedly linked the design of healthcare environments with patterns of use, comfort, stress, and safety (13)."***

Despite the proliferation of context-sensitive tool development, comparable instruments tailored to the unique demands of NICU environments remain limited. While some therapeutic design principles may be generalizable across healthcare contexts, NICUs present distinct clinical, developmental, and relational demands that must be explicitly addressed in guidance and evaluation tools. These environments combine high-acuity care with prolonged family presence and the treatment of medically



fragile infants, amplifying the impact of design decisions on infant development, family well-being, and staff capacity to provide trauma-informed and family-centered care.

*"The Family-Centered Therapeutic NICU Design Checklist was developed to fill this gap, building on established best practices in tool development while addressing contextual gaps in the existing tool landscape. It was developed in consultation with experts in neonatal care, healthcare design, and family-centered practice, following extensive review of relevant literature and existing design guidance, including the Recommended Standards for Newborn ICU Design (10th Edition) (5)."*

**Methods:**

The Family-Centered Therapeutic NICU Design Checklist was developed to fill this gap, building on established best practices in tool development while addressing contextual gaps in the existing tool landscape. It was developed in consultation with experts in neonatal care, healthcare design, and family-centered practice, following extensive review of relevant literature and existing design guidance, including the Recommended Standards for Newborn ICU Design (10th Edition) (5). The authors undertook multiple iterations to refine the clarity, relevance, and scope of the items. The resulting checklist translates principles of therapeutic design and family-centered care into observable environmental criteria for evaluating NICU environments. A more in-depth review of these principles is described in a companion paper in this special issue (14).

*"The items focus on observable environmental features associated with therapeutic outcomes in the literature and are intended as a practical starting point for systematic evaluation and discussion rather than a comprehensive assessment of all recommended standards."*

The checklist was designed to be completed during a structured walkthrough of the NICU environment, an approach informed by structured observation practices used in healthcare quality improvement, including leadership walkarounds and Lean-based Gemba Walks (15), adapted here for environmental design evaluation in NICUs. Structured walkthroughs support real-time observation of environmental conditions as they are actually experienced, accounting for spatial relationships, sensory conditions, and contextual factors that may not be captured through retrospective reports alone. The items focus on observable environmental features associated with therapeutic outcomes in the literature and are intended as a practical starting point for systematic evaluation and discussion rather than a comprehensive assessment of all recommended standards. Walkthrough teams should include representatives from across relevant disciplines – clinical staff, design professionals, administrators, and NICU families – with at least one member well acquainted with the Recommended Standards. Incorporating multiple perspectives supports comprehensive evaluation of how the built environment shapes care experiences and clinical workflows, helping teams identify design strengths and opportunities for improvement.

*"The items focus on observable environmental features associated with therapeutic outcomes in the literature and are intended as a practical starting point for systematic evaluation and discussion rather than a comprehensive assessment of all recommended standards."*

**Recommended Use:**

- **Structured Walkthrough:** This checklist is intended to be completed during a structured walkthrough of the NICU experience. Begin at the hospital entry and follow the path families typically take, observing each space in real time.
- **Diverse Perspectives:** It is important to involve individuals with diverse perspectives (e.g., clinical staff, family partners, design representatives).
- **Documentation:** Document observations as needed using notes, photographs, sketches, or other materials. These records can support discussion, planning, and improvement efforts. Dedicated note-taking space is provided at the end of each section.
- **Actionable Results:** Use completed assessments to guide discussion and identify improvement priorities. Resulting action items should reflect stakeholder input and align with the evaluation's goals, whether focused on design, operations, or strategic planning.

# FAMILY-CENTERED THERAPEUTIC NICU DESIGN: CHECKLIST

This 49-item checklist supports the evaluation of neonatal intensive care unit environments in relation to **therapeutic design** and **family-centered care principles.**

The checklist is organized into **six sections** aligning with how families typically move through the NICU experience:
(1) Arrival & First Impressions
(2) Look & Feel
(3) Sensory Experience,
(4) Infant Care Areas (Clinical Workflow & Family Participation)
(5) Staff Support Spaces
(6) Family Support Spaces

**Instructions**
For each item, indicate how well your NICU meets the criteria described using the scale, from 'Not at all' to 'Fully. At the end of each section, you will have space to identify 1-2 priority areas for improvement based on your ratings and any context-specific needs, and to jot down notes as you go.

A scoring key is included on the final page for teams that want to quantify and compare results across sections, though the checklist can be used without it.

**Figure 2**

While a formal pilot study is planned to examine the tool's feasibility and preliminary measurement properties, a preliminary version of the tool is provided below to support teams actively engaged in NICU planning, renovation, or evaluation (see Figure 2).

**References:**


1. Vischer JC. Towards a user-centred theory of the built environment. Building Research & Information. 2008 Jun;36(3):231–40. doi:10.1080/09613210801936472
2. LaVela SL, Etingen B, Hill JN, Miskevics S. Patient perceptions of the environment of care in which their healthcare is delivered. HERD. 2016 Apr;9(3):31–46. doi:10.1177/1937586715610577
3. Ulrich RS, Zimring C, Zhu X, DuBose J, Seo HB, Choi YS, Quan X, Joseph A. A review of the research literature on evidence-based healthcare design. HERD: Health Environments Research & Design Journal. 2008 Apr;1(3):61-125. doi.org/10.1177/193758670800100
4. Browne JV. How NICU design and infant and family-centered developmental care act synergistically to support babies and families. Journal of Perinatology. 2023 Dec;43(Suppl 1):55-8. doi: 10.1038/s41372-023-01746-w
5. Altimier L, Barton SA, Bender J, Browne J, Harris D, Jaeger CB, et al. Recommended standards for newborn ICU design. J Perinatol. 2023 Dec;43(1):2–16. doi:10.1038/s41372-023-01784-4
6. Mosca EI, Capolongo S. Design for all A.U.D.I.T. (Assessment Universal Design & Inclusion Tool). A tool to evaluate physical, sensory-cognitive, and social quality in healthcare facilities. Acta Biomedica Atenei Parmensis. 2023 Aug 30;94(S3):e2023124. doi:10.23750/abm.v94iS3.14288
7. McCusker J, Minh Vu TT, Veillette N, Cossette S, Vadeboncoeur A, Ciampi A, et al. Elder□friendly emergency department: Development and validation of a quality assessment tool. J American Geriatrics Society. 2018 Feb;66(2):394–400. doi:10.1111/jgs.15137
8. Vahidi M, Namdar Areshtanab H, Ebrahimi H, Asghari Jafarabadi M. Development of "The Safe Psychiatric Ward Battery." Clin Nurs Res. 2023 Feb;32(2):375–83. doi:10.1177/10547738221085614
9. Palese A, Decaro A, Bressan V, Marin M, Achil I, Hayer M, et al. Measuring the therapeutic properties of nursing home environments in the Italian context: Findings from a validation and cross-sectional study design. Ann Ig. 2020 Feb 20;32(2):117–31. doi:10.7416/ai.2020.2236
10. Foureur MJ, Epi GDC, Leap N, Davis DL, Forbes IF, Homer CSE. Developing the birth unit design spatial evaluation tool (BUDSET) in Australia: a qualitative study. HERD. 2010 Jul;3(4):43–57. doi:10.1177/193758671000300405
11. Harte JD, Sheehan A, Stewart S, Foureur M. Application of the childbirth supporter study to advance the birth unit design spatial evaluation tool. HERD. 2024 Jan;17(1):148–63. doi:10.1177/19375867231177304
12. Elf M, Nordin S, Wijk H, McKee KJ. A systematic review of the psychometric properties of instruments for assessing the quality of the physical environment in healthcare. J Adv Nurs. 2017 Dec;73(12):2796–816. doi:10.1111/jan.13281
13. Elf M, Lipson-Smith R, Kylén M, et al. A Systematic Review of Research Gaps in the Built Environment of Inpatient Healthcare Settings. HERD: Health Environments Research & Design Journal. 2024;17(3):372-394. doi:10.1177/19375867241251830
14. Shepley MM, Radmanesh N, Mohammed S, White R. Therapeutic environments for neonatal intensive care units. Neonatol Today. 2025; [this issue].
15. Martin G, Ozieranski P, Willars J, McKee L, Charles K, Minion J, Dixon-Woods M. Walkrounds in practice: corrupting or enhancing a quality improvement intervention? A qualitative study. The Joint Commission Journal on Quality and Patient Safety. 2014 Jul 1;40(7):303-10. doi: 10.1016/S1553-7250(14)40040-0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***Corresponding Author:***

*Mardelle McCuskey Shepley, B.A., M.Arch., M.A. (Psych), D.Arch. WELL AP, LEED AP, and EDAC.*
*Department of Human Centered Design at Cornell University. Emerita*
*the American College of Healthcare Architects and in the American Institute of Architects, Emerita*
*9 Old Silver Ln, Falmouth, MA 02540*
*Telephone: 979-255-0344*
*Email:* mshepley@cornell.edu

*Rebecca L. Ames, Ph.D.*
*Cornell University*

*Beverley H. Johnson, FAAN*
*Institute for Patient- and Family-Centered Care*

*Robert D. White, MD*
*Director, Regional Newborn Program*
*Beacon Children's Hospital*
*615 N. Michigan St.*
*South Bend, IN 46601*
*Phone: 574-647-7141*
*Fax: 574-647-3672*
*Email:* Robert_White@pediatrix.com

*Sabah Mohammed, B. Arch, M.S*
*EDAC, LEED GA, WELL AP*
*Affiliation: Grama Care*

*Judith Smith, MHA*

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# Upgrading Technology and Connectivity in the Modern Neonatal Intensive Care Unit, The Connected Neonatal Intenive Care Unit: From Monitoring to Presence

*Mitchell Goldstein, MD, MBA, CML*

*"Technology no longer merely supports the Neonatal Intensive Care Unit (NICU); it defines it. The modern NICU has evolved from an environment primarily focused on physiologic monitoring into a highly interconnected digital ecosystem in which patient care, communication, imaging, predictive analytics, artificial intelligence, education, and family engagement converge continuously."*

Technology no longer merely supports the Neonatal Intensive Care Unit (NICU); it defines it. The modern NICU has evolved from an environment primarily focused on physiologic monitoring into a highly interconnected digital ecosystem in which patient care, communication, imaging, predictive analytics, artificial intelligence, education, and family engagement converge continuously.

However, despite the sophistication of bedside medical equipment, many NICUs continue to operate within technological infrastructures designed for an earlier generation of healthcare delivery. While ventilators, monitors, infusion systems, imaging platforms, and electronic health records (EHRs) have become increasingly advanced, the underlying communication architecture that supports these systems often remains fragmented, underpowered, and insufficiently integrated. The concept that NICUs must evolve from passive remote viewing toward active "digital presence" is strongly supported by recent evidence. A cluster randomized controlled trial of virtual family-centered rounds (FCR) in the NICU found that offering families the option to participate virtually increased parent attendance by nearly 5-fold (IRR 4.81, 95% CI 3.65–6.32) and reduced 30-day emergency department revisits (aOR 0.37, 95% CI 0.18–0.75). (1)

This mismatch creates growing tension between:

- The expectations of modern family-centered care
- The demands of increasingly data-intensive neonatal medicine
- The cybersecurity requirements of connected healthcare
- The physical design of newer NICU environments
- The bandwidth and latency demands of emerging technologies
- The operational realities of hospitals under financial pressure

The NICU of the future cannot function as a collection of isolated devices. Instead, it must become a coordinated digital environment that securely supports continuous communication among clinicians, families, monitoring systems, imaging platforms, AI-assisted analytics, and remote participants.

The future NICU is therefore not simply a location where critically ill infants receive intensive care. It is an intelligent communications environment that supports collaborative healing, distributed expertise, and persistent family presence. A quality improvement initiative that deployed telehealth visits in a Level III NICU demonstrated that virtual engagement was not only feasible but also highly satisfying to both providers and parents, and that it critically reduced disparities. (2)

*"The future NICU is therefore not simply a location where critically ill infants receive intensive care. It is an intelligent communications environment that supports collaborative healing, distributed expertise, and persistent family presence. A quality improvement initiative that deployed telehealth visits in a Level III NICU demonstrated that virtual engagement was not only feasible but also highly satisfying to both providers and parents, and that it critically reduced disparities. (2)"*

**The Limitations of Existing Hospital Networks:**

Most hospitals currently maintain several overlapping but poorly integrated digital environments:

- Public or guest wireless networks
- Administrative hospital networks
- Clinical information system networks
- Biomedical device networks
- EHR communication systems
- Telemedicine systems
- Security and surveillance systems
- Vendor-specific cloud platforms

Historically, these systems were built independently and incrementally. As a result, many hospitals now operate complex technological "patchworks" rather than unified infrastructures.

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The public-facing wireless network used by patients and visitors is fundamentally unsuitable for critical NICU communication. These systems prioritize convenience and broad accessibility rather than reliability, deterministic performance, or cybersecurity rigor.

Common public network activities include:

- Video streaming
- Social media browsing
- Gaming
- Ride-sharing applications
- Personal cloud backups
- Personal video conferencing
- Consumer smart-device synchronization

These activities create unpredictable bandwidth demands and may introduce cybersecurity vulnerabilities or signal congestion.

By contrast, the NICU increasingly depends upon systems that require:

- Continuous uptime
- Predictable low latency
- Prioritized traffic routing
- Device authentication
- Encrypted communication pathways
- Redundant connectivity
- Real-time interoperability
- Protected health information safeguards
- Resilient failover systems
- Audit-capable communication tracking

Without a dedicated clinical infrastructure, even advanced bedside technologies become unreliable or unsafe.

**Reframing Family-Centered Care Through Connectivity:**

Family-Centered Care (FCC) has long emphasized the importance of parental presence within the NICU. Physical proximity allows families to bond with their infant, participate in caregiving, communicate with clinicians, and develop confidence before discharge.

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However, modern realities increasingly challenge this model.

Barriers to physical visitation may include:

- Seasonal respiratory viral outbreaks
- Influenza restrictions
- Pandemic-related policies
- Geographic distance
- Transportation limitations
- Financial hardship
- Military deployment
- Work obligations
- Childcare responsibilities
- Immigration concerns
- Custody or guardianship complications
- Maternal illness or postoperative recovery

In many circumstances, even parents may be unable to remain continuously present. Extended family members—including grandparents, siblings, and support persons—may face even greater restrictions. A Cochrane systematic review confirmed that maintaining consistent NICU presence is "highly challenging, especially for low-income mothers," with barriers including transportation, childcare, accommodation, lost income, and direct medical costs. (3) Neighborhood-level socioeconomic disadvantage was independently associated with decreased odds of kangaroo care (OR 0.16) and visitation (OR 0.14). (4) Social and structural disparities, including race, language, and insurance status, were associated with lower family presence and engagement across six Massachusetts NICUs.(5) Qualitative research identified "costly accommodations, unreliable transportation, lack of child care, and inadequate maternity leave policies" as structural barriers limiting parental engagement. (6)

Current NICU communication systems are often inadequate. Many offer only passive remote infant viewing via camera systems that allow families to observe the baby but not meaningfully participate in care. A pilot RCT of 24-hour webcam access in a Japanese NICU found that continuous webcam access significantly reduced parental anxiety (STAI scores decreased from 48.0 to 37.3 in mothers, $p<0.001$), with 92% of nurses supporting the technology. However, bonding scores did not differ significantly between groups. (7)

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While emotionally valuable, passive viewing alone does not constitute true family integration. A systematic review found "promising indications" that webcams enhance parent-infant attachment by strengthening feelings of closeness and reducing stress, but also identified negative impacts in a small proportion of parents. (8) However, webcam use was associated with lower parental stress levels and had no effect on nursing stress or burnout, contradicting nurses' beliefs that webcams increase stress. (9)

The next-generation NICU must therefore move beyond "remote viewing" toward "digital presence."

Digital presence implies:

- Active participation in rounds
- Inclusion in multidisciplinary conferences
- Real-time communication with bedside staff
- Participation in developmental care teaching
- Engagement during procedures when appropriate
- Inclusion in discharge planning
- Access to educational resources
- Secure asynchronous communication
- Shared decision-making support
- Emotional continuity during prolonged hospitalization

This transformation fundamentally changes the definition of presence within the NICU.

The family no longer needs to be physically at the bedside to remain meaningfully involved in care.

*"The future NICU may require the development of persistent virtual patient environments—secure digital ecosystems linked to the infant's hospitalization and care trajectory."*

**Building Persistent Virtual Care Environments:**

The future NICU may require the development of persistent virtual patient environments—secure digital ecosystems linked to the infant's hospitalization and care trajectory.

These environments would extend beyond simple video conferencing platforms.

Instead, they could become comprehensive digital care portals that integrate:

- Live bedside audiovisual communication
- Family conferencing
- Clinical updates
- Educational modules
- Feeding progression tracking
- Developmental milestones
- Medication explanations
- Laboratory trend visualization
- Imaging review
- AI-assisted translation
- Secure messaging
- Care team introductions
- Personalized discharge preparation
- Family support resources
- Social work communication
- Spiritual care access
- Post-discharge transition planning

Such systems could function as digital extensions of the NICU bedside itself.

Families might securely "enter" their infant's care environment remotely and participate in care interactions in ways that approximate physical presence.

This model raises profound operational and ethical questions:

- Should bedside conferences be recorded?
- Who controls access to archived recordings?
- Do recordings become part of the legal medical record?
- Can AI-generated summaries replace traditional documentation?
- How should emotionally sensitive conversations be handled?
- What consent structures are required?
- How long should audiovisual records be retained?
- How should conflicting family preferences be managed?

Hospitals will need governance structures that address:

- Medicolegal implications
- Documentation standards
- Consent management
- Data ownership
- Privacy protection
- Retention policies
- Interoperability standards
- Family access hierarchies

**Cybersecurity and Identity Verification in the NICU:**

The increasing digitalization of healthcare introduces substantial cybersecurity challenges.

The NICU represents an especially vulnerable environment because it combines:

- High-acuity patients
- Emotionally vulnerable families
- Continuous data transmission
- Remote communication
- Multiple connected devices
- Sensitive personal information
- Time-critical clinical decision-making

The emergence of artificial intelligence, voice synthesis, and deepfake technologies creates entirely new risks.

Potential future threats include:

- Impersonation of family members
- Fraudulent participation in care conferences
- Unauthorized access to patient information
- Manipulation of consent discussions
- Interception of audiovisual communications
- Device spoofing
- Malware infiltration through connected systems
- Compromise of biomedical equipment
- Cloud storage breaches
- AI-generated misinformation

Accordingly, NICUs will increasingly require enterprise-grade digital identity management systems.

Necessary security technologies may include:

- Multi-factor authentication
- Biometric identity verification
- Device registration and certification
- Geofencing
- IP verification
- Session encryption
- Role-based access control
- Automated anomaly detection
- Audit logging
- Time-limited communication sessions
- AI-assisted threat monitoring
- Continuous network surveillance
- Vendor cybersecurity certification
- Zero-trust network architecture

These protections should not be optional add-ons. They must become foundational elements of NICU infrastructure.

***"Most EHR platforms already contain communication capabilities, but these are often fragmented, underutilized, or inaccessible at the bedside."***

**The EHR as a Communication Ecosystem:**

Electronic Health Records were originally designed primarily as documentation systems. Over time, they evolved into repositories for laboratory data, imaging, medication administration, and clinical workflows.

However, modern NICUs increasingly require the EHR to function as a communication ecosystem. EHRs evolving from passive documentation systems into active collaborative care platforms are supported by emerging evidence. ICU clinicians expressed cautious support for electronic portals to enhance communication, identifying benefits including improved education, patient/family engagement, and improved clinician workflow, while noting concerns about technology replacing human connection and the tension between informing families without overwhelming them. (10) Patient portal activation in pediatric settings improved from 12.9% to 85.4% after quality improvement interventions, with 70% of parents reporting portal use and portal users showing significantly fewer no-show appointments. (11)

Most EHR platforms already contain communication capabilities, but these are often fragmented, underutilized, or inaccessible at the bedside.

Current limitations commonly include:

- Complex authentication workflows

- Separate communication applications
- Poor interoperability between devices
- Limited patient-facing interfaces
- Inconsistent remote access functionality
- Lack of family participation integration
- Inadequate audiovisual documentation workflows
- Minimal support for multilingual communication

In many hospitals, clinicians must activate special virtual private networks (VPNs) or use separate applications to communicate with families securely.

This fragmentation creates operational inefficiency and reduces transparency.

The next-generation NICU EHR should support:

- Integrated bedside conferencing
- Secure remote family participation
- Real-time physiologic data sharing
- Family-facing dashboards
- AI-assisted transcription
- Automated visit summaries
- Interpreter integration
- Shared educational resources
- Secure image and video exchange
- Interactive discharge planning
- Consent workflows
- Documentation synchronization
- Cross-platform interoperability

The EHR must evolve from a passive storage system into an active collaborative care platform.

**Infrastructure Requirements for the Modern NICU**

Infrastructure is the central enabler of all future NICU technologies.

A modern Level IV NICU generates enormous data demands through:

- Continuous bedside telemetry
- High-resolution physiologic monitoring
- Echocardiography transmission
- Point-of-care ultrasound (POCUS)
- Video electroencephalography (EEG)
- AI-assisted monitoring systems
- Continuous ventilator analytics
- Smart infusion devices
- Centralized waveform archiving
- Multidisciplinary conferencing
- Remote consultations
- Digital imaging transfer
- Cloud-based analytics
- Predictive algorithms
- Bedside educational platforms

These systems require far greater network capability than older hospital infrastructures were designed to support.

Essential infrastructure upgrades may include:

- High-capacity fiber-optic backbone systems
- Redundant network pathways
- Clinical-grade wireless segmentation
- Edge computing infrastructure
- Localized processing nodes
- Expanded server capacity
- Low-latency switching architecture
- Intelligent traffic prioritization
- Backup power redundancy
- Environmental controls for networking hardware
- Real-time network monitoring
- Cybersecurity operations integration

Importantly, bandwidth planning should anticipate future expansion rather than merely current utilization.

Hospitals that design infrastructure solely around current needs may rapidly become obsolete as AI systems, imaging technologies, and communication demands continue to expand.

**The Architectural Impact of Single-Family Room NICUs:**

The neurodevelopmental benefits of single-family room (SFR) NICUs are robustly supported. A retrospective study of 1,017 infants born <29 weeks found that SFR care was associated with lower odds of significant neurodevelopmental impairment at 18–30 months (aOR 0.51, 95% CI 0.34–0.76), along with lower rates of hearing loss, retinopathy of prematurity, and mortality. (12) A prospective quasi-experimental study demonstrated that SFR infants weighed more at discharge, had less sepsis, showed better attention, and exhibited less physiologic stress, with improvements mediated by increased developmental support and maternal involvement. (13) SFR care was associated with 2.55-point and 3.70-point increases in Bayley cognitive and language scores, respectively. (14) Preterm neonates in SFR

NICUs exhibited significantly fewer stress behaviors and more self-regulation behaviors. (15) Single-family room NICUs are increasingly recognized as beneficial for:

- Neurodevelopmental protection
- Noise reduction
- Privacy
- Family bonding
- Kangaroo care
- Sleep preservation
- Infection control
- Parent participation

***"The neurodevelopmental benefits of single-family room (SFR) NICUs are robustly supported. A retrospective study of 1,017 infants born <29 weeks found that SFR care was associated with lower odds of significant neurodevelopmental impairment at 18–30 months (aOR 0.51, 95% CI 0.34–0.76), along with lower rates of hearing loss, retinopathy of prematurity, and mortality. (12)"***

However, these designs significantly complicate the networking and communication infrastructure but reflect well-recognized architectural and engineering challenges.

Larger physical footprints require:

- More wireless access points
- Expanded cabling infrastructure
- Increased signal redundancy
- Elimination of wireless dead zones
- Enhanced roaming optimization
- Expanded equipment closets
- Additional power backup systems
- Greater cybersecurity monitoring coverage

Building materials themselves may interfere with wireless signal propagation:

- Lead-lined walls
- Reinforced concrete
- Medical equipment shielding
- Specialized glass systems

Consequently, technology planning must occur during the earliest architectural design phases.

Networking can no longer be treated as an afterthought added after construction.

Instead, digital infrastructure must become a core architectural element of NICU design.

***"Artificial intelligence will increasingly depend upon integrated NICU infrastructures capable of continuous data acquisition and analysis. A systematic review of 24 studies found AI applications in NICUs primarily focused on predicting comorbidities (75%), mortality (17%), and length of stay (8%), though no studies reported a fully integrated AI ecosystem, and most remained in exploratory phases. (16)"***

**Artificial Intelligence and the Networked NICU:**

Artificial intelligence will increasingly depend upon integrated NICU infrastructures capable of continuous data acquisition and analysis. A systematic review of 24 studies found AI applications in NICUs primarily focused on predicting comorbidities (75%), mortality (17%), and length of stay (8%), though no studies reported a fully integrated AI ecosystem, and most remained in exploratory phases. (16) For predictive sepsis detection specifically, heart rate characteristics (HRC) monitoring has been validated across multiple studies. An HRC index >2 was associated with late-onset sepsis with an OR of 7.1 (95% CI 2.6–19.0). (17) Machine learning models combining heart rate and SpO2 data predicted sepsis up to 24 hours before clinical suspicion with an AUC of 0.82. (18)

Future AI applications may include:

- Predictive sepsis detection
- Early NEC risk identification
- Automated ventilator optimization
- Hemodynamic instability prediction
- Neurodevelopmental monitoring
- Feeding readiness assessment
- Smart alarm suppression
- Automated documentation assistance
- Staffing optimization

- Workflow analysis
- Family communication summarization
- Clinical deterioration alerts
- Device self-diagnostics
- Population health analytics

These systems require:

- Continuous interoperable data exchange
- Standardized communication protocols
- Reliable low-latency networks
- Large-scale data storage
- Real-time computational capability
- Advanced cybersecurity safeguards
- Transparent governance structures
- Ethical oversight

*"A consensus review emphasized that while AI development is rapidly expanding, challenges including data quality, model generalization, ethical considerations, and the need for standardized reporting remain significant barriers to clinical implementation. (19) "*

A consensus review emphasized that while AI development is rapidly expanding, challenges including data quality, model generalization, ethical considerations, and the need for standardized reporting remain significant barriers to clinical implementation. (19) The NICU network itself may eventually function as an active clinical participant rather than merely a communication medium. Recent work has highlighted that successful AI deployment requires a sociotechnical framework addressing clinical workflows, clinician burnout, trust, data security, and model transparency. (20)

**Strategic Plan for Upgrading NICU Technology and Connectivity:**

**Phase 1: Governance, Assessment, and Strategic Planning:**

**Establish a NICU Digital Transformation Committee:**

This multidisciplinary committee should include:

- Neonatologists
- Nursing leadership
- Respiratory therapists
- Biomedical engineering
- Hospital IT leadership
- Cybersecurity experts
- EHR specialists
- Family advisory representatives
- Social workers
- Legal and compliance officers
- Quality improvement leaders
- Facilities management
- Telemedicine experts

The committee should define:

- Strategic priorities
- Clinical workflows
- Security standards
- Family communication goals
- Infrastructure timelines
- Budgetary planning
- Vendor evaluation criteria
- AI governance principles

**Perform a Comprehensive Infrastructure Assessment:**

A detailed audit should evaluate:

- Existing bandwidth capacity
- Wireless coverage gaps
- Device interoperability
- Latency performance
- Server utilization
- EHR communication capability
- Current cybersecurity vulnerabilities
- Backup system adequacy
- Physical infrastructure limitations
- Future scalability potential

**Develop Governance Policies:**

Hospitals should establish formal policies addressing:

- Remote participation in rounds
- Recording of conferences
- Consent requirements
- AI-generated documentation

- Device authentication
- Data retention
- Family access hierarchies
- Communication escalation pathways
- Emergency downtime procedures
- Vendor security requirements

**Phase 2: Core Infrastructure Modernization:**

**Build Dedicated Clinical Wireless Networks:**

NICUs should implement segmented network architectures, separating:

- Public guest access
- Clinical communication systems
- Biomedical devices
- Imaging transmission
- AI analytics platforms
- Family communication systems
- Administrative systems

This segmentation improves:

- Security
- Reliability
- Performance predictability
- Cyberattack containment
- Traffic prioritization

**Upgrade Physical Network Infrastructure:**

Necessary upgrades may include:

- Fiber-optic backbone expansion
- High-capacity switching systems
- Redundant routers
- Edge computing nodes
- Distributed wireless controllers
- Battery-backed failover systems
- Expanded server rooms
- Advanced cooling systems
- Environmental monitoring
- Secure equipment enclosures

**Improve Network Resilience:**

Hospitals should develop:

- Automatic failover systems
- Redundant internet providers
- Disaster recovery protocols
- Cyberattack response plans
- Real-time network analytics
- Continuous uptime monitoring
- Predictive maintenance systems

**Phase 3: Family Communication Integration:**

**Deploy Secure Bedside Communication Platforms**

Communication systems should support:

- Encrypted two-way video conferencing
- Multi-user participation
- Interpreter integration
- AI-assisted transcription
- Family education delivery
- Secure media exchange
- Mobile device compatibility
- Cross-platform interoperability

**Integrate Communication Into Clinical Workflow**

Systems should enable:

- Remote family rounds
- Scheduled bedside conferences
- Automated family notifications
- EHR-linked communication documentation
- Secure messaging
- Educational module assignment
- Follow-up communication after discharge

**Create Robust Digital Identity Standards:**

Cybersecurity must be foundational, not optional. An analysis across 36 countries found that medical devices purchased by national health services had 661 distinct vulnerabilities, more than half of which were deemed critical or high-severity, with approximately 3.2 years of system exposure from purchase to vulnerability announcement. (21) A scoping review identified 12 subfactors of vulnerability in healthcare systems, with complex system design (21% of studies) and integration of new technology (20%) as the most frequently cited challenges. (22) Healthcare is described as “an attractive target for cybercrime for two fundamental reasons: it is a rich source of valuable data and its defences are weak”. (23) Security systems should incorporate:

- Multi-factor authentication

- Biometric identity verification
- Access expiration controls
- Family permission hierarchies
- Session auditing
- AI-assisted fraud detection
- Secure credential recovery systems

*"Cybersecurity must be foundational, not optional. An analysis across 36 countries found that medical devices purchased by national health services had 661 distinct vulnerabilities, more than half of which were deemed critical or high-severity, with approximately 3.2 years of system exposure from purchase to vulnerability announcement. (21) A scoping review identified 12 subfactors of vulnerability in healthcare systems, with complex system design (21% of studies) and integration of new technology (20%) as the most frequently cited challenges. (22)"*

**Phase 4: Smart NICU and AI Readiness:**

**Develop Device Interoperability Standards:**

The paper's emphasis on HL7 compatibility and FHIR interoperability as essential device standards is supported by the US DHHS unified approach to health data exchange. FHIR has become the consensus-based standard for sharing health data, enabling "app-based exchange that allows health IT systems to operate more like interactive platforms akin to smartphones rather than closed systems". (24)

Hospitals should require:

- HL7 compatibility
- FHIR interoperability
- Vendor-neutral communication protocols
- Open API support
- Real-time data exchange capability

**Build AI-Compatible Infrastructure**

Infrastructure should support:

- Predictive analytics

*"The paper's emphasis on HL7 compatibility and FHIR interoperability as essential device standards is supported by the US DHHS unified approach to health data exchange."*

- Real-time physiologic analysis
- Smart alarm management
- Clinical decision augmentation
- Automated documentation assistance
- Population health monitoring

**Establish AI Governance Frameworks:**

Policies should address:

- Algorithm transparency
- Clinical oversight
- Bias mitigation
- Validation requirements
- Accountability structures
- Data ownership
- Ethical review

**Phase 5: Long-Term Innovation and Research:**

**Create the "Virtual NICU"**

Future systems may support:

- Persistent family communication environments
- Remote developmental care participation
- Virtual discharge preparation
- Post-discharge tele-follow-up
- Integrated home monitoring transition
- Longitudinal developmental education

**Develop Research and Industry Partnerships:**

Collaborative initiatives may focus on:

- AI validation studies
- Human factors engineering
- Family-centered communication technologies
- Cybersecurity innovation
- Device interoperability

- Workflow optimization
- Digital equity initiatives

***"Virtual family engagement increases parental participation and reduces disparities; SFR NICUs improve neurodevelopmental outcomes; AI-based predictive tools show promise but remain largely in exploratory phases; FHIR/HL7 interoperability is becoming the national standard; healthcare cybersecurity vulnerabilities are extensive and growing; and socioeconomic barriers to NICU visitation are well-documented. The paper's forward-looking vision of a "connected, intelligent NICU" is aspirational but grounded in the trajectory of current research and policy. "***

**Conclusion:**

The NICU has evolved from a technologically assisted care environment into a digitally dependent ecosystem. Nevertheless, many units continue to function using infrastructures designed for an earlier era of healthcare delivery.

Future NICUs must support:

- Continuous high-bandwidth communication
- Secure family participation
- AI-enabled analytics
- Device interoperability
- Persistent digital engagement
- Cybersecure clinical operations
- Real-time collaborative care

Virtual family engagement increases parental participation and reduces disparities; SFR NICUs improve neurodevelopmental outcomes; AI-based predictive tools show promise but remain largely in exploratory phases; FHIR/HL7 interoperability is becoming the national standard; healthcare cybersecurity vulnerabilities are extensive and growing; and socioeconomic barriers to NICU visitation are well-documented. The paper's forward-looking vision of a "connected, intelligent NICU" is aspirational but grounded in the trajectory of current research and policy. The challenge is no longer whether these technologies exist. The challenge is whether hospitals are prepared to invest in the infrastructure, governance, cybersecurity, and operational redesign necessary to use them safely and effectively.

The NICU of the future must become more than connected.

It must become intelligent, resilient, family-integrated, secure, interoperable, and fully prepared for the next generation of neonatal care.

**References:**


1. Rosenthal JL, Hoffman KR, Tancredi DJ, Marcin JP, Ketchersid A, Horath ET, et al. NICU Virtual Family-Centered Rounds: A Cluster Randomized Controlled Trial. Pediatrics. 2026;157(2). doi: 10.1542/peds.2025-073588. PubMed PMID: 41571012; PubMed Central PMCID: PMC12884875.
2. Kelleher J, Cooke D, Holzman JBW, Santisteban A, Huber K, Bowler L, et al. A quality improvement initiative to increase family engagement and reduce disparities in visitation via telehealth in a level III neonatal intensive care unit. J Perinatol. 2026. Epub 20260105. doi: 10.1038/s41372-025-02527-3. PubMed PMID: 41490926; PubMed Central PMCID: PMC13016469.
3. Wróblewska-Seniuk K, Wallman-Stokes A, Edwards E, Fiander M, Bruschettini M, Soll RF. Financial incentives for family members of hospitalized neonates for improving family presence. Cochrane Database of Systematic Reviews. 2024(12). doi: 10.1002/14651858.CD014572. PubMed PMID: CD014572.
4. Wallace LS, Okito O, Mellin K, Soghier L. Associations between Parental Engagement in the Neonatal Intensive Care Unit and Neighborhood-Level Socioeconomic Status. Am J Perinatol. 2025;42(1):34–42. Epub 20240503. doi: 10.1055/a-2318-5942. PubMed PMID: 38701858.
5. Anand NS, Kalluri NS, Cordova-Ramos EG, Peaceman A, Fraust-Wylie M, Kubicka Z, et al. Social and structural disparities in family presence and engagement in the NICU. J Perinatol. 2026. Epub 20260401. doi: 10.1038/s41372-026-02641-w. PubMed PMID: 41922789.
6. Lewis TP, Andrews KG, Shenberger E, Betancourt TS, Fink G, Pereira S, et al. Caregiving can be costly: A qualitative study of barriers and facilitators to conducting kangaroo mother care in a US tertiary hospital neonatal intensive care unit. BMC Pregnancy Childbirth. 2019;19(1):227. Epub 20190704. doi: 10.1186/s12884-019-2363-y. PubMed PMID: 31272398; PubMed Central PMCID: PMC6610951.
7. Ozawa Y, Sasagawa A, Kikuchi K, Mogi M, Douo N, Takemata K, et al. A Pilot Randomized Controlled Trial of 24-h Webcam Access in the Neonatal Intensive Care Unit. Neonatology. 2026:1–16. Epub 20260413. doi: 10.1159/000551980. PubMed PMID: 41973655.
8. Gibson R, Kilcullen M. The Impact of Web-Cameras on Parent-Infant Attachment in the Neonatal Intensive Care Unit. J Pediatr Nurs. 2020;52:e77–e83. Epub 20200201. doi: 10.1016/j.pedn.2020.01.009. PubMed PMID: 32014335.
9. Kubicka Z, Zahr E, Clark P, Williams D, Berbert L, Arzuaga B. Use of an internet camera system in the neonatal

intensive care unit: parental and nursing perspectives and its effects on stress. J Perinatol. 2021;41(8):2048–56. Epub 20210128. doi: 10.1038/s41372-021-00934-w. PubMed PMID: 33510415; PubMed Central PMCID: PMC7841755.

10. Bell SK, Roche SD, Johansson AC, O'Reilly KP, Lee BS, Sands KE, et al. Clinician Perspectives on an Electronic Portal to Improve Communication with Patients and Families in the Intensive Care Unit. Ann Am Thorac Soc. 2016;13(12):2197–206. doi: 10.1513/AnnalsATS.201605-351OC. PubMed PMID: 27700144.

11. Sriraman S, Saadoon R, Bochner R, Khandakar S. Improving Patient Portal Activation for Newborns in the Well Baby Nursery. Pediatrics. 2024;154(1). doi: 10.1542/peds.2023-063274. PubMed PMID: 38867690.

12. Ellebany M, Raghuram K, Kanburoglu MK, Ibrahim J, Shah PS, Mohamed A. Association of NICU design on neurodevelopmental outcomes in preterm neonates born at less than 29 weeks' gestation: a retrospective observational study. J Perinatol. 2025;45(12):1795–800. Epub 20251010. doi: 10.1038/s41372-025-02446-3. PubMed PMID: 41073768.

13. Lester BM, Salisbury AL, Hawes K, Dansereau LM, Bigsby R, Laptook A, et al. 18-Month Follow-Up of Infants Cared for in a Single-Family Room Neonatal Intensive Care Unit. J Pediatr. 2016;177:84–9. Epub 20160726. doi: 10.1016/j.jpeds.2016.06.069. PubMed PMID: 27470693.

14. Vohr B, McGowan E, McKinley L, Tucker R, Keszler L, Alksninis B. Differential Effects of the Single-Family Room Neonatal Intensive Care Unit on 18- to 24-Month Bayley Scores of Preterm Infants. J Pediatr. 2017;185:42–8.e1. Epub 20170224. doi: 10.1016/j.jpeds.2017.01.056. PubMed PMID: 28238479.

15. Silva NF, Linhares MBM, Gaspardo CM. Stress and self-regulation behaviors in preterm neonates hospitalized at open-bay and single-family room Neonatal Intensive Care Unit. Infant Behav Dev. 2024;76:101951. Epub 20240425. doi: 10.1016/j.infbeh.2024.101951. PubMed PMID: 38663037.

16. Tudor S, Bhatia R, Liem M, Wani TA, Boyd J, Raza Khan U. Opportunities and Challenges of Using Artificial Intelligence in Predicting Clinical Outcomes and Length of Stay in Neonatal Intensive Care Units: Systematic Review. J Med Internet Res. 2025;27:e63175. Epub 20251003. doi: 10.2196/63175. PubMed PMID: 41043137; PubMed Central PMCID: PMC12534773.

17. Rio L, Ramelet AS, Ballabeni P, Stadelmann C, Asner S, Giannoni E. Monitoring of heart rate characteristics to detect neonatal sepsis. Pediatr Res. 2022;92(4):1070–4. Epub 20211216. doi: 10.1038/s41390-021-01913-9. PubMed PMID: 34916625.

18. Honoré A, Forsberg D, Adolphson K, Chatterjee S, Jost K, Herlenius E. Vital sign-based detection of sepsis in neonates using machine learning. Acta Paediatr. 2023;112(4):686–96. Epub 20230127. doi: 10.1111/apa.16660. PubMed PMID: 36607251.

19. Husain A, Knake L, Sullivan B, Barry J, Beam K, Holmes E, et al. AI models in clinical neonatology: a review of modeling approaches and a consensus proposal for standardized reporting of model performance. Pediatr Res. 2025;98(2):412–22. Epub 20241217. doi: 10.1038/s41390-024-03774-4. PubMed PMID: 39681669; PubMed Central PMCID: PMC12961963.

20. Barrett R, Lawler B, Liu S, Park WY, Davoodi M, Martin B, et al. Transforming neonatal care through informatics: A review of artificial intelligence, data, and implementation considerations. Semin Perinatol. 2025;49(7):152144. Epub 20250918. doi: 10.1016/j.semperi.2025.152144. PubMed PMID: 40973564; PubMed Central PMCID: PMC13191498.

21. Bracciale L, Loreti P, Bianchi G. Cybersecurity vulnerability analysis of medical devices purchased by national health services. Sci Rep. 2023;13(1):19509. Epub 20231109. doi: 10.1038/s41598-023-45927-1. PubMed PMID: 37945583; PubMed Central PMCID: PMC10636100.

22. Ewoh P, Vartiainen T, Mantere T. Sociotechnical Cybersecurity Framework for Securing Health Care From Vulnerabilities and Cyberattacks: Scoping Review. J Med Internet Res. 2025;27:e75584. Epub 20251015. doi: 10.2196/75584. PubMed PMID: 40838797; PubMed Central PMCID: PMC12572753.

23. Coventry L, Branley D. Cybersecurity in healthcare: A narrative review of trends, threats and ways forward. Maturitas. 2018;113:48–52. Epub 20180422. doi: 10.1016/j.maturitas.2018.04.008. PubMed PMID: 29903648.

24. Abbasi AB, Layden J, Gordon W, Gregurick S, DeLew N, Grossman J, et al. A Unified Approach to Health Data Exchange: A Report From the US DHHS. JAMA. 2025;333(12):1074–9. doi: 10.1001/jama.2025.0068.

***Disclosures:*** *The author has no relevant disclosures.*

**NT**

*Mitchell Goldstein, MD, MBA, CML*
*Professor of Pediatrics*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics*
*Email:* mgoldstein@llu.edu

# Letters to the Editor

## Letter to the Editor: "Neonatal Intensive Care Unit Design in the Service of Self-Determination"

Dear Editor,

Thank you for the opportunity to read the manuscript "Neonatal Intensive Care Unit Design in the Service of Self-Determination," which offers a fascinating look at the subtle topic of Self-Determination Theory. Six decades after the first American Neonatal Intensive Care Unit (NICU) opened its doors in Yale New Haven Hospital, our field continues to focus on models that directly undermine the neurodevelopmental and psychological care that we strive to protect.

*"Six decades after the first American Neonatal Intensive Care Unit (NICU) opened its doors in Yale New Haven Hospital, our field continues to focus on models that directly undermine the neurodevelopmental and psychological care that we strive to protect."*

As noted in the manuscript, the open-bay NICU design, created to allow ease of visual access and quick intervention, actually results in a continuous state of a lack of autonomy for preterm infants. The infant's immature nervous system is exposed to sound levels that exceed the protective intrauterine thresholds. As the author describes, "when noise levels exceed the uterine threshold, frequently reaching 70–80 dB in open-bay designs, the infant's body triggers an involuntary stress response". This repeated exposure may reinforce stress pathways during critical stages of development and thus may potentially cause neurological injury.

*"This repeated exposure may reinforce stress pathways during critical stages of development and thus may potentially cause neurological injury. "*

The author also notes that the parents can experience psychological distress in this open-bay type environment. This psychological harm in the NICU for parents often stems from a sense of helplessness, where there is a "deprivation of agency". The design of open-bay units limits parental interaction and opportunities for intimate attachment, including privacy and breastfeeding. Single-Family Rooms are described as a fix for this issue by offering the opportunity to enhance both Relatedness and Mastery, two important components of Self-Determination Theory that predict long-term family resilience.

The author also describes the importance of the medical team's well-being. Alarm fatigue, attention overload, and the lack of restorative spaces all contribute to the breakdown of the team's Mastery and Relatedness. The manuscript provides evidence that decentralized nursing stations and quiet, biophilic environments improve cognitive functioning and, therefore, directly impact the quality of care that can be provided. These improvements are essential and provide actual interventions that enhance care.

NICU design guidelines could be improved beyond simply specifying equipment and staffing. The very architecture of the NICU has these silent elements that directly affect neurodevelopment, parental well-being, and the care team's performance. Just as a ventilator can assist in maintaining life, an environment designed for autonomy equally plays an essential role in allowing infants, parents, and clinicians to thrive.

*"The transition from open-bay units to Single-Family Rooms with thoughtful biophilic design and decentralized workflows is not just a preference but an opportunity to advance modern neonatology towards its full potential."*

Finally, as the author states, the neonatal community must recognize that evidence-based NICU design is a "clinical standard of care". The transition from open-bay units to Single-Family Rooms with thoughtful biophilic design and decentralized workflows is not just a preference but an opportunity to advance modern neonatology towards its full potential.

Thank you for this captivating and meaningful contribution to neonatology.

Sincerely,

Nickolas Yedgarian, OMS3

Western University of Health Sciences

**Reference:**

1. Ridout, R. E. (n.d.). Neonatal Intensive Care Unit Design in the Service of Self-Determination. Neonatologytoday.org.

Dear Nikolas Yedgarian, OMS3

Thank you for your thoughtful and insightful letter regarding the manuscript, "Neonatal Intensive Care Unit Design in the Service of Self-Determination." Your commentary highlights an issue of growing importance within neonatology: the recognition that the NICU environment itself profoundly influences neurodevelopmental outcomes, parental well-being, and the performance of the healthcare team.

As you describe, many traditional NICU models were developed during an era when visibility, rapid access, and technological intervention were prioritized above developmental and psychological considerations. While these priorities emerged from understandable clinical needs, our field increasingly recognizes that excessive sensory stimulation, lack of privacy, fragmented family engagement, and staff cognitive overload may themselves contribute to adverse outcomes. The manuscript's discussion of Self-Determination Theory provides a compelling framework for reconsidering the NICU not merely as a site of intensive care but as a therapeutic developmental ecosystem.

*"As you describe, many traditional NICU models were developed during an era when visibility, rapid access, and technological intervention were prioritized above developmental and psychological considerations. While these priorities emerged from understandable clinical needs, our field increasingly recognizes that excessive sensory stimulation, lack of privacy, fragmented family engagement, and staff cognitive overload may themselves contribute to adverse outcomes."*

Importantly, many of the barriers that historically limited the implementation of Single-Family Room models and individualized developmental environments may become increasingly solvable through future innovation and technological advancement. Emerging technologies are already reshaping the possibilities for NICU design. Advances in integrated physiologic monitoring, artificial intelligence-assisted predictive analytics, remote visualization systems, wireless communication platforms, adaptive alarm management, telemedicine infrastructure, and environmental control systems may eventually allow clinicians to maintain continuous situational awareness while simultaneously reducing noise, minimizing unnecessary stimulation, and preserving family autonomy and privacy.

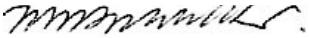
Similarly, future innovations in smart-room technologies, decentralized workflow coordination, virtual collaboration tools, and intelligent infrastructure design may help reconcile the longstanding tension between developmental care principles and operational efficiency. These advances hold the potential to create NICU environments that are simultaneously safer, quieter, more humane, and more neuroprotective for infants and families, while also supporting clinician wellness and cognitive performance.

At Neonatology Today, we believe the future NICU will increasingly integrate architecture, neuroscience, human factors engineering, digital health technologies, and family-centered care into a unified model of developmental intensive care. The ideas presented in this manuscript—and emphasized in your letter—reflect an important evolution in how our field conceptualizes healing environments for our most vulnerable patients.

***"We appreciate your engagement with this important discussion and thank both you and the author for contributing to an ongoing dialogue that will help shape the next generation of neonatal care."***

We appreciate your engagement with this important discussion and thank both you and the author for contributing to an ongoing dialogue that will help shape the next generation of neonatal care.

Sincerely,



Mitchell Goldstein, MD, MBA, CML

Editor in Chief

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c/o Mitchell Goldstein, MD

11175 Campus Street, Suite #11121

Loma Linda, CA 92354

Tel: +1 (302) 313-9984

LomaLindaPublishingCompany@gmail.com



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**Erratum (Neonatology Today April, 2026**

*There are no erratum to report for Aprill, 2026*

*Corrections can be sent directly to* LomaLindaPublishingCompany@gmail.com. *The most recent edition of Neonatology Today including any previously identified erratum may be downloaded from* www.neonatologytoday.net.

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Neonatology Today welcomes your editorial commentary on previously published manuscripts, news items, and other academic material relevant to the fields of Neonatology and Perinatology.

Please address your response in the form of a letter. For further formatting questions and submissions, please contact Mitchell Goldstein, MD at LomaLindaPublishingCompany@gmail.com.

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# 39th Annual Gravens Conference

On the Environment of Care for
High Risk Newborns and Their Families

**June 1518, 2026**

***"Sensitive Issues in Sensational Times"***

**Monday, June 15th**
**Let the Festivities Begin!**

| TIME | SESSION / EVENT | LOCATION |
|---|---|---|
| 8:00 pm4:00 pm | Reimagining the NICU - Troy Savage<br>*Optional Pre Conference with Separate Registration* | |
| 4:00 pm7:00 pm | Registration Desk Open | |
| 7:00 pm9:00 pm | Welcome Reception<br>*Cash Bar Only* | Podium at Embassy Suites |

**Tuesday, June 16th**
**Science & Application**
*Welcome, Breaks, Awards, and Closing Do Not Count for CME/CE*

| TIME | SESSION / EVENT | LOCATION |
|---|---|---|
| 7:00 am5:00 pm | Registration Desk Open | |
| 7:00 am8:00 am | Continental Breakfast Provided (1 hour) | |

**8:00 am5:00 pm Plenary Sessions Downes Ballroom - Corbett Family Hall Moderator: (Robert White and Joy Browne)**

| TIME | SESSION / EVENT | PRESENTER |
|---|---|---|
| 8:00 am8:15 am | Welcome & Introductions | Joy Browne |
| 8:15 am9:00 am | FamilyCentered Collaborative Care Models that Support Families and Optimize Preterm Infant and Child Health Outcomes | Jessica DiBari |
| 9:00 am9:45 am | Care of the Mother is Care for the Baby | Heather Burris |
| **9:45 am10:15 am Break (30 min)** | | |
| 10:15 am11:00 am | Central Autonomic Network Connectivity is Altered in an ExtraUterine Environment | Catherine Limperopoulos |
| 11:00 am11:45 am | All Care is Brain Care: Lessons learned from an international quality improvement collaborative to improve brain health and outcomes (Part 1) | Roger Soll, Elizabeth Rogers, Sonia Bonifacio |
| **11:45 am1:00 pm Lunch (75 min)** | | |
| 1:00 pm2:30 pm | All Care is Brain Care: Lessons learned from an international quality improvement collaborative to improve brain health and outcomes (Part 2) | Roger Soll, Elizabeth Rogers, Sonia Bonifacio |
| **2:30 pm3:00 pm Break (30 min)** | | |
| 3:00 pm3:30 pm | Gravens Recognition Award Presentation | Mitch Goldstein |

| TIME | SESSION / EVENT | LOCATION |
|---|---|---|
| 3:30 pm4:15 pm | Sensitive Issues for Babies, Parents, and their Relationships | Joy Browne |
| 4:15 pm4:45 pm | Panel Discussion Among NICU Parents on RealWorld Impact of Topics Presented | Molly FraustWylie, Susanne Klawetter, Alex Zavala |
| 4:45 pm5:00 pm | Family CenteredCare (FCC) Scholars Introduction | Malathi Balasundaram |
| 5:00 pm5:15 pm | Final Thoughts and TakeHome Messages | Robert White |
| **6 30 pm8:30 pm Reception & Poster Walk Poster Session - Jordan Hall Galleria**<br>*Substantial Snacks Provided*<br>7 00 pm7:45 pm, Poster Authors Available<br>8 10 pm8:30 pm, Door Prize Raffle: Vincent C. Smith | | |

## Wednesday, June 17th
## Themed Tracks
*Welcome, Breaks, and Closing Do Not Count for CME/CE*

| TIME | SESSION / EVENT | LOCATION |
|---|---|---|
| 6:30 am7:15 am | Run, Walk, Skip Around Notre Dame Campus | |
| 7:00 am8:00 am | Continental Breakfast Provided / Networking Tables (1 hour) | |
| 7:30 am1:30 pm | Registration Desk Open | |

**8:00 am1:00 pm Themed Tracks**

| Track A Infant and FamilyCentered Developmental Care Jordan Hall Room 101 Moderator: Joy Browne | | Track B Newborn ICU Design Jordan Hall Room 105 Moderator: Robert White | |
|---|---|---|---|
| 8:00 am8:15 am | Introductions & Announcements | 8:00 am8:15 am | Introductions & Announcements |
| 8:15 am8:45 am | The Importance of a Developmental Point of View of Sensory Processes - Robert Lickliter | 8:15 am9:00 am | Therapeutic Design - Mardelle Shepley |
| 8:45 am9:30 am | Clinical Application from Chemosensory Research - Julie Mennella | 9:00 am9:45 am | Designing NICU Spaces for Ritual and Healing - Anya Vanacek and Julia Jude |
| 9:30 am10:15 am | Development and Clinical Application from Embodied Vocal Presence Research - Manuela Filippa | 9:45 am10:30 am | Soundscapes - Bobbi Pineda |
| 10:15 am10:45 am | Break (30 min) | | |
| | | 10:30 am11:00 am | Break (30 min) |
| 10:45 am11:30 am | Reflections on Sensory Developmental Ecology and Its Applications for Care - Jeff Alberts | *Exhibitors to Break Down* | |
| 11:30 am12:00 pm | Clinical Application of the Environment of Care from the NICU Parents' Perspective –Jessica DiBari, Mia Malcolm, Jessi Barnes | 11:00 am11:45 am | New Unit Presentation - Brianna Leigh, and Karizma Maxson |
| 12:00 pm12:05pm | Summary & Next Steps - Joy Browne | 11:45 am12:45 pm | Using AI for NICU Design - Troy Savage |

| | | | |
|---|---|---|---|
| 12:05 pm12:35pm | Break (30 min) | 12:45 pm1:00 pm | Summary & Next Steps - Robert White |
| 12:35 pm 1:00 pm | Development and Clinical Application from Auditory Tactile Research - Nathalie Maitre *(nonCME) This session is not designated for continuing education credit. This is in no way a reflection of the integrity or quality of the content.* | | |
| **1:00 pm4:00 pm Lunch, Rest, Play, Network, NICU Tour**<br>*Lunch Not Provided* **Tour of the Beacon Children's Couplet Care/Single Family Room NICU** | | | |
| **4:00 pm4:45 pm Welcome Back & Networking**<br>*Coffee and Light Snacks Provided* | | | |
| **4:45 pm6:00 pm Workshops (75 min)** | | | |
| **TIME** | **SESSION / EVENT** | | **MODERATOR** |
| 4:45 pm6:00 pm | A: Culture Club: Culture as a Foundation for Quality Improvement Elizabeth Rogers and Sonia Bonifacio (Room: Jordan Hall 101) | | **Mitch Goldstein** |
| | B: Taking Steps Toward Postpartum Care in the NICU - Heather Burris and Katey Mari (Room: Jordan Hall 105) | | **Morgan Kowalski** |
| | C: Reimagining the NICU: Wrap Up - Troy Savage (Room: Jordan Hall 412) | | **Robert White** |
| | D: Are We Really Seeing Delirium in Babies? A Conversation About Behavioral Assessment and Intervention - Jeff Alberts (Room: Jordan Hall 310) | | **Kathleen Kolberg** |
| | E: Support for NICU Fathers and NonBirthing Parents - Cameron Boyd, Alex Zavala, and Craig Garfield (Room: Jordan Hall 322) | | **Molly FraustWylie** |
| | F: Partnering with NICU parents and professionals: Methodological lessons from developing the PATH program - Susanne Klawetter (Room: Jordan Hall 402/405) | | **Mardelle Shepley** |
| **6:30 pm9:00 pm Dinner Banquet Heritage Hall - Joyce Center**<br>*Included with Conference Registration* | | | |

| **Thursday, June 18, Family Topics & Reflections Abstracts & Workshops**<br>*Welcome, Breaks, and Closing Do Not Count for CME/CE* | | |
|---|---|---|
| **TIME** | **SESSION / EVENT** | **LOCATION** |
| 6:30 am7:15 am | Run, Walk, Shuffle Around Notre Dame Campus | |
| 7:00 am8:00 am | Continental Breakfast Provided (1 hour) | |
| 7:00 am11:15 am | Registration Desk Open | |

| | | |
|---|---|---|
| **8:00 am12:00 pm Plenary Session Downes Ballroom - Corbett Family Hall Moderators: (Vincent C. Smith and Molly FraustWylie)** | | |
| 8:00 am8:10 am | Introductions and Announcements | Vincent C. Smith & Molly FraustWylie |
| 8:10 am8:40 am | A NICU Dad's Perspective | Alex Zavala |
| 8:40 am9:15 am | Experiences of NICU Fathers and NonBirthing Parents | Cameron Boyd |
| 9:15 am10:00 am | NICU Discharge Planning Considerations for NICU Fathers and NonBirthing Parents | Craig Garfield |
| **10:00 am10:30 am Break (30 min)** | | |
| 10:30 am11:05 am | Audience Engagement Activity | Troy Savage |
| 11:05 am11:50 am | Parent Panel | Molly FraustWylie & Mia Malcolm |
| 11:50 am12:00 pm | Acknowledgement & Celebration of Juneteenth Wrap Up/Warm Send Off | Joy Browne & Robert White |
| **12:00 pm1:15 pm**<br>*Planning Committee Meeting*<br>**Lunch (75 min)** | | |
| **1:15 pm2:30 pm Abstracts (75 min)** | | |
| **TIME** | **ABSTRACT** | **MODERATOR** |
| 1:15 pm2:30 pm | Developmental Care (Room: Jordan Hall 322):<br>1. ParentDelivered Neurodevelopmental Care: Standardizing an Approach to Parent Education - Grace King, Tierney Morrison, Aimee Godett, Marge Day, Emily Whitesel (Abstract 30)<br>2. Interventions Designed to Improve the Postpartum Health and Wellbeing of Parents of Infants in the NICU: A Scoping Review - Sarah Verbiest, Wayne Price, Kimarie Bugg (Abstract 19)<br>3. Multidisciplinary Journey to Reliable Social Determinants of Health Screening for NICU Families: Navigating Barriers in the NICU Village - Rosanne Buck, Dory Ziperstein, Molly FaustWylie, Erika Sevieri, Gina Story, Emily Whitesel, Yarden Fraiman (Abstract 7) | **Vincent C. Smith** |
| | Family Support (A) (Room: Jordan Hall 101):<br>1. Harmonizing Developmental and Medical Communication in the NICU: A Dynamic Digital Platform to Augment FamilyCentered Care - Ansul Asad, Yaya Ren, Bree Andrew (Abstract 36)<br>2. Early Parental Presence in the NICU: Social Determinants and Maternal Mental Health Shape Family Engagement for High Risk Infants - Jaclyn Ruggiero, Allison Davidson (Abstract 47)<br>3. FamilyCentered Care: Increasing Positive Family Engagement and Interactions with Infants in the NICU - Terri Sandoval, Alison | **Malathi Balasundaram** |

| | | |
|---|---|---|
| | Smith, Jamie Lujan, Jennifer Guadalupe, Rachel Carlos, Candice Martinez (Abstract 4) | |
| | Developmental Care/FamilyCentered Care (Room: Jordan Hall 310):<br>1. The Journey to a Developmental Care Continuum: An Interdisciplinary Collaborative Approach to Developmental Care in the NICU - Tiara Bolden, Lisa Miller, Cynthia Ruggles, Mary Beth Sanders, Laura Schacht, Lindsay Schuler, Kelly Crombie, Janet Dierstein, Susannah Dillender, Christine Houlihan, Amy Salisbury (Abstract 51)<br>2. Designing the NICU of the Future: National Survey Insights on Workforce Support, Digital Integration, and Family Partnership - Lisa Davenport, Jaylee Hilliard (Abstract 32)<br>3. Reimagining the NICU Environment of Care: Applying Human Factors and Ergonomics to Support Safe, Sustained SkintoSkin (Kangaroo) Care for High Risk Infants and Families - Yamile Jackson (Abstract 6) | **Molly FraustWylie** |
| | Family Support (B) (Room: Jordan Hall 105):<br>1. Mapping Neonatal Transfer Patterns to Inform FamilyCentered Care: Capacity and Distance Across Levels of Care - Amanda Luff, Emily Malloy, Veronica Fitzpatrick (Abstract 15)<br>2. Advancing Family Engagement in the NICU: A Qualitative Exploration of Barriers and Facilitators - Laura Rose, Kayla Schmittau, Kristen Schaffer, Alejandro Chavez, Katherine LopezLepe, Linda Franck, Henry Lee (Abstract 8)<br>3. Effect of Parent Education Classes on Confidence and Stress of Parents of Infants Admitted to the NICU of a Tertiary Care Hospital in India - Pooja Dekhane, Puja Padbidri, Madhura Gandhi, Madhuri Patil, Eilish Byrne (Abstract 22) | **Mia Malcom** |
| | Potpourri (Room: Jordan Hall 412):<br>1. Reaching NICU Families: Feasibility of Recruiting High Risk Infants - Ashlee Vance, Eman Dannaway (Abstract 33)<br>2. Beyond Just Cuddles: Creating a Medical Student Cuddlers Program for an Evolving Level 4 NICU - Stephanie Bernard, Lauren Felzani, Rivky Barnetsky, Likhitha Patlolla, Jordan Bryan, Donessa Jenae Colley, Andrea Weintraub (Abstract 17)<br>3. Development of a Conceptual Framework for Financial Hardship in Neonatal Care - Ashlee Vance (Abstract 26) | **Joy Browne** |
| | Design (Room: Jordan Hall 402/405):<br>1. Acoustic Comfort in Newborn Intensive Care - Kathleen Philbin (Abstract 52)<br>2. Beyond SingleFamily Rooms: A Hybrid NICU Model Responsive to Community Demographics - Zoraya Stern, Maria D'Souza, Whitney K. Fuessel (Abstract 24) | **Robert White** |
| **2:30 pm3:00 pm Break (30 min)** | | |
| **3:00 pm4:15 pm Workshops (75 min)** | | |

| | | |
|---|---|---|
| 3:00 pm4:15 pm | A: FamilyCentered Care in Action: Collaboration, Measurement, and Improvement- Malathi Balasundaram and Morgan Kowalski (Room: Jordan Hall 105) | **Malathi Balasundaram** |
| | B: Words Matter: Navigating Sensitive Situations with Intentional Language in the NICU - Ramya Kumar (Room: Jordan Hall 310) | **Judy Smith** |
| | C: TraumaInformed Expectations for Gratitude in the NICU - Mia Malcolm and Jessica Barnes (Room: Jordan Hall 402/405) | **Mia Malcolm** |
| | D: D.R.I.V.E. Better Care: Developing Emotionally Present NICU Teams to Strengthen FamilyCentered Care - Weston Brandon (Room: Jordan Hall 322) | **Mitch Goldstein** |
| | E: Relationships in the NICU: Will AI Foster or Hinder? - Jim Gray and Bridget Davern (Room: Jordan Hall 101) | **Vincent C. Smith** |
| | F: The Second Edition of the Infant and FamilyCentered Developmental Care Standards: Discussion and Dissemination - Tiara Bolden, Carol Jaeger and Joy Browne (Room: Jordan Hall 412) | **Joy Browne** |
| 4:15 pm | Safe Travels, See You at the Next Gravens Conference! | |

**Friday, June 19th**

**HAPPY JUNETEENTH!**

***Juneteenth is a United States federal holiday commemorating the end of slavery.***

The Gravens Conference
on the Environment of Care for High Risk Newborns

**THE VOICES OF ALL PROFESSIONALS WHO WORK WITHIN THE ENVIRONMENT OF CARE FOR HIGH RISK NEWBORNS AND THEIR FAMILIES NEED TO BE HEARD.**

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The Gravens Conference
on the Environment of Care for High Risk Newborns

Pictured: Baby Kole with his Dad

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## Empowering Families with Knowledge through Connection and Technology

WHEN: March 3-5

WHERE: Hilton St. Louis at the Ballpark

OBJECTIVES:

- Examine the evolving digital information ecosystem in perinatal care.
- Evaluate the role of artificial intelligence in clinical care and patient education.
- Promote "intelligence amplification" through human–technology collaboration.
- Address equity and access in the digital health landscape.
- Build partnerships between healthcare systems, technologists, and families.

National Perinatal Association

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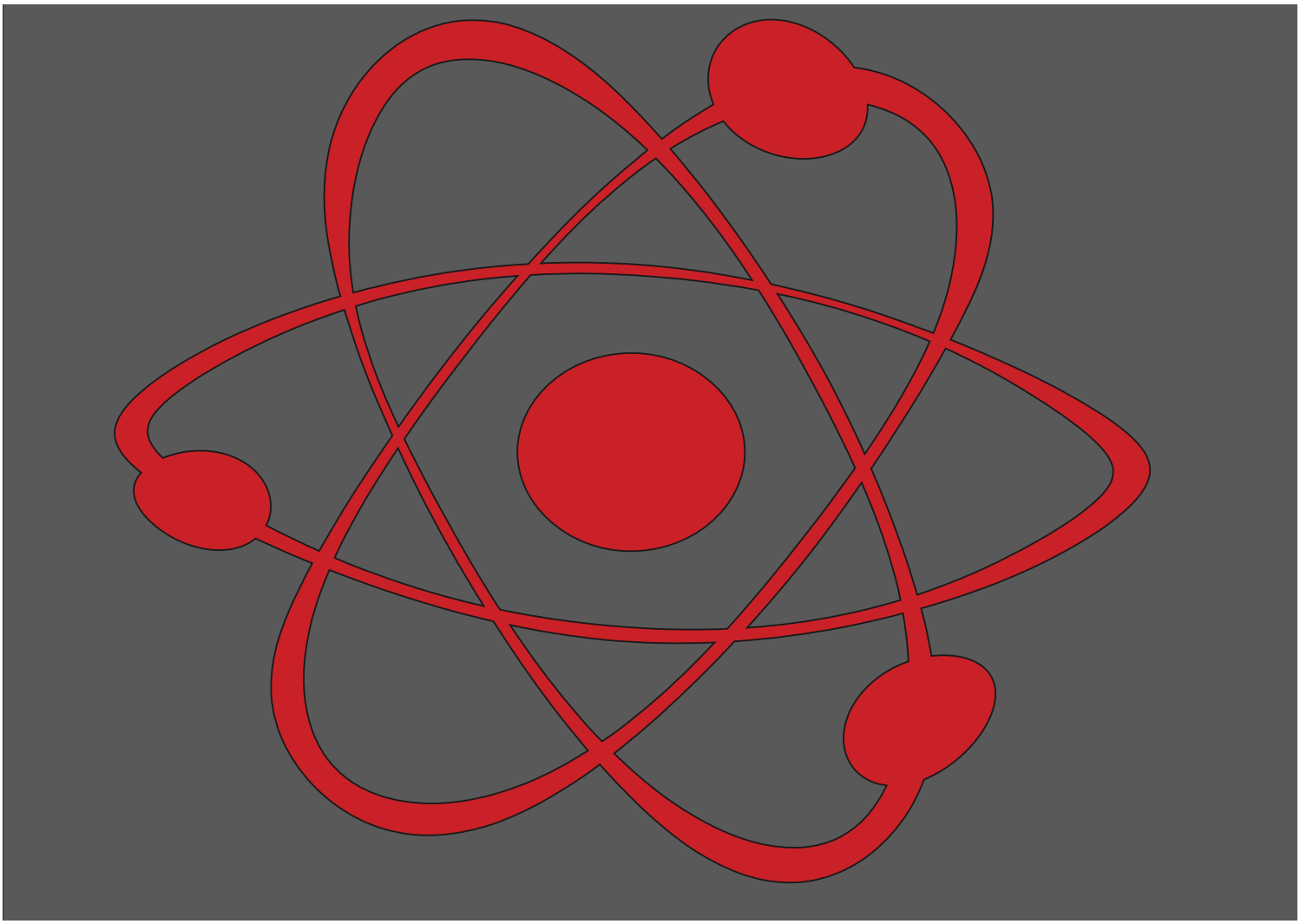

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*American Academy of Pediatrics (AAP) 2026 NCE is scheduled for October 2–6, 2026, in San Diego, California.*

*The 11th Annual Conference of the International Neonatology Association (INAC) will take place in Amsterdam, The Netherlands, from 19-22 November 2026*

*Hot Topics in Neonatology*
*December 7–9, 2026*
*Gaylord National, National Harbor, Maryland*

*NEO: The Conference for Neonatology*
*February 17-19, 2027 | Las Vegas, NV*
*https://www.pediatrix.com/for-clinicians/neo-conference-save-the-date*

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*Mar 03, 2027– Mar 05, 2027,*
*Hilton St. Louis at the Ballpark, 1 South Broadway, Saint Louis, Missouri, 63102*

*For up to date Meeting Information, visit NeonatologyToday.net and click on the events tab.*


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Mitchell Goldstein, MD
Loma Linda Publishing Company
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Loma Linda, CA 92354
www.NeonatologyToday.net
Tel: +1 (302) 313-9984
LomaLindaPublishingCompany@gmail.com

Editorial and Subscription
Mitchell Goldstein, MD
Neonatology Today
11175 Campus Street
Suite #11121
Loma Linda, CA 92354


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## Neonatology and the Arts

This section focuses on artistic work which is by those with an interest in Neonatology and Perinatology. The topics may be varied, but preference will be given to those works that focus on topics that are related to the fields of Neonatology, Pediatrics, and Perinatology. Contributions may include drawings, paintings, sketches, and other digital renderings. Photographs and video shorts may also be submitted. In order for the work to be considered, you must have the consent of any person whose photograph appears in the submission.

Works that have been published in another format are eligible for consideration as long as the contributor either owns the copyright or has secured copyright release prior to submission.

Logos and trademarks will usually not qualify for publication.

This month we feaure the Golden Dome from Notre Dame University in Notre Dame, IN, the site of the 2026 Gravens Conference on the Environement of Care for Highrisk Newborns and their Families: "Sensitive Issues in Sensational Times." This photo was submitted by Sarah Hanlon, Conference & Event Specialist, College of Science, 214 A-4 Jordan Hall, Notre Dame, IN 46556, 574-631-7443, sborgeli@nd.edu.

Lily Martorell, MD

Arts Editor
Associate Professor
Loma Linda University Children's Hospital
Loma Linda, CA

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2. All material should be emailed to: LomaLindaPublishingCompany@gmail.com in a Microsoft Word, Open Office, or XML format for the textual material and separate files (tif, eps, jpg, gif, ai, psd, SVG, or pdf) for each figure. Preferred formats are ai, SVG, psd, or pdf. tif and jpg images with sufficient resolution so as not to have visible pixilation for the intended dimension. In general, if acceptable for publication, submissions will be published within 3 months.

3. There is no charge for submission, publication (regardless of number of graphics and charts), use of color, or length. Published content will be freely available after publication. There is no charge for your manuscript to be published. NT does maintain a copyright of your published manuscript.

4. The title page should contain a brief title and full names of all authors, their professional degrees, their institutional affiliations, and any conflict of interest relevant to the manuscript. The principal author should be identified as the first author. Contact information for the principal author including phone number, fax number, e-mail address, and mailing address should be included.

5. A brief biographical sketch (very short paragraph) of the principal author including current position and academic titles as well as fellowship status in professional societies should be included. A picture of the principal (corresponding) author and supporting authors should be submitted if available.

6. An abstract may be submitted.

7. The main text of the article should be written in formal style using correct English. The length may be up to 10,000 words or longer with prior approval. Abbreviations which are commonplace in neonatology or in the lay literature may be used.

8. References should be included in standard "NLM" format (APA 7th is no longer acceptable). Bibliography Software should be used to facilitate formatting and to ensure that the correct formatting and abbreviations are used for references. EndNote X9 is suggested.

9. Figures should be submitted separately as individual separate electronic files. Numbered figure captions should be included in the main file after the references. Captions should be brief.

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*Corresponding Author:*

*Giang Truong, MD*
*Associate Professor of Pediatrics*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics*
*Loma Linda, CA*
*Email:* gtruong@llu.edu

Erika Goyer
Family Advocate
Director of Communications, National Perinatal Association
Co-Chair NPA 2018 conference, Perinatal Substance Use: Evidence-Based Solutions and Support for the Family
egoyer@nationalperinatal.org

*Corresponding Author:*

*Aida Simonian, MSN, RNC-NIC, SCM, SRN*
*Chief Executive Officer*
*Perinatal Advisory Council: Leadership, Advocacy and Consultation (PAC/LAC)*
*1010 N Central Ave | Glendale, CA 91202*
asimonian@paclac.org
http://paclac.org
*www.facebook.com/paclac*

*Corresponding Author:*

*Deb Discenza*
*Founder and Chief Executive Officer*
*PreemieWorld*
www.PreemieWorld.com

*Professor Adrienne Foran MSc, MD, MRCPI,*
*Medical Director,*
*Children's University Hospital, Temple Street*
*Consultant Neonatologist,*
*Rotunda Hospital,*
*Dublin, Ireland*
*Clinical Associate Professor*
*Royal College of Surgeons in Ireland*

Cris Glick, MD IBCL
Director of Mississippi Lactation Services
Past President, National Perinatal Association
Emeritus Board, Natinoal Perinatal Association
cglick@nationalperinatal.org

*Anita Patel, MD*
*Fellow*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics*
*Loma Linda, CA*

*Aprille Febre, MD*
*Assistant Professor of Pediatrics*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics*
*Loma Linda, CA*

# Perinatal Substance Use

## 5 ways you can improve care during pregnancy and beyond

Pregnancy presents unique opportunities for patients to make positive changes in their substance use. When you become an informed provider you empower patients to make those changes.

### Educate Yourself

Learn more about the pharmacology of substance use. Promote evidence-based care by communicating with patients in a way that separates fact from fiction. Understand the cycles of sobriety and relapse so that you can help patients plan for their recovery. Advise on the risks associated with polysubstance use.

### Use the Right Words

Know the difference between substance use, substance misuse, and Substance Use Disorders (SUDs). Recognize that substance use is stigmatized and that stigma is a barrier to seeking care. Reject language that shames. Embrace the principles of Harm Reduction as a way to support any positive change.

### Screen Every Patient

Talking about substance use should be a routine part of everyone's medical care. Get comfortable discussing it. Ask questions and listen to what your patients have to say. You may be the first person to ever ask.

### Get Trained to Offer MAT

Medication-Assisted Treatment is the Standard of Care during pregnancy, but there are not enough providers. Contact SAMHSA to become an OTP*. Make naloxone available to all your patients who use opioids.

*opioid treatment program

### End the Stigma and Criminalization of Drug Use

Embrace people who use substances. Meet them where they are. Abide by your medical ethics. Practice beneficence. Promote public health. Advocate for decriminalization.

## Your Advocacy Matters

Learn more at
www.nationalperinatal.org

National Perinatal Association

# TOP 10

## RECOMMENDATIONS FOR THE PSYCHOSOCIAL SUPPORT OF NICU PARENTS

SUPPORT 4 NICU PARENTS

Essential evidence-based practices that can transform the health and well being of NICU families and staff

based on the National Perinatal Association's
Interdisciplinary Recommendations for Psychosocial Support of NICU Parents

### 1 PROMOTE PARTICIPATION

Honor parents' role as primary caregiver. Actively welcome parents to participate during rounds and shift changes. Remove any barriers to 24/7 parental involvement and avoid unnecessary separation of parents from their infants.


### 2 LEAD IN DEVELOPMENTAL CARE

Teach parents how to read their baby's cues. Harness your staff's knowledge, skills, and experience to mentor families in the principles of neuroprotection & developmental care and to promote attachment.

### 3 FACILITATE PEER SUPPORT

Invest in your own NICU Parent Support program with dedicated staff. Involve veteran NICU parents. Partner with established parent-to-parent support organizations in your community to provide continuity of care.

### 4 ADDRESS MENTAL HEALTH

Prioritize mental health by building a team of social workers and psychologists who are available to meet with and support families. Provide appropriate therapeutic interventions. Consult with staff on trauma-informed care - as well as the critical importance of self-care.

### 5 SCREEN EARLY AND OFTEN

Establish trusting and therapeutic relationships with parents by meeting with them within 72 hours of admission. Follow up during the first week with a screening for common maternal & paternal risk factors. Provide anticipatory guidance that can help normalize NICU distress and timely interventions when needed. Re-screen prior to discharge.

### 6 OFFER PALLIATIVE & BEREAVEMENT CARE

Support families and NICU staff as they grieve. Stay current with best practices in palliative care and bereavement support. Build relationships with service providers in your community.

### 7 PLAN FOR THE TRANSITION HOME

Set families up for success by providing comprehensive pre-discharge education and support. Create an expert NICU discharge team that works with parents to find specialists, connect with service providers, schedule follow-up appointments, order necessary medical supplies, and fill Rx.

### 8 FOLLOW UP

Re-connect with families post-discharge. Make follow-up calls. Facilitate in-home visits with community-based service providers, including Early Intervention. Partner with professionals and paraprofessionals who can screen families for emotional distress and provide timely therapeutic interventions and supports.

### 9 SUPPORT NICU CARE GIVERS

Provide comprehensive staff education and support on how to best meet families' psychosocial needs, as well as their own. Acknowledge and address feelings that lead to "burnout."



### 10 HELP US HEAL

Welcome the pastoral care team into your NICU to serve families & staff.

SUPPORT4NICUPARENTS.ORG

**Corresponding Author**

*Lily Martorell-Bendezu, M.D.,*
*Associate Professor of Pediatrics*
*Loma Linda University School of Medicine*
*Division Chair*
*Division of Neonatology*
*Department of Pediatrics*
*Loma Linda University Children's Hospital*
*Loma Linda, CA*
*Email:* lmartorell@llu.edu

*Hayley R. Bottino, MS, CGC*
*Maternal Fetal Medicine Genetic Counselor*
*Department of Obstetrics and Gynecology*
*Loma Linda University Health*
*Email:* hbottino@llu.edu

*Alexandra Sasha Fowler, BS*
*Graduate student*
*Candidate for Master of Science in Human Genetics and Genetic Counseling*
*Keck Graduate Institute*
*Email:* afowler23@kgi.edu

*Laura A. Wilson, MD*
*Clinical and Medical Biochemical Geneticist*
*Division of Genetics*
*Division of Pediatrics*
*Email:* laurawilson@llu.edu

*Corresponding Author*

*Noel D. Tan, MD*
*Neonatologist*
*Envision Healthcare*
*email:* noeldtan.md@gmail.com

*Keith Bockhold, PharmD*
*BCPPS NICU/Peds Clinical Pharmacist*
*HCA Florida Oakhill Hospital*

Maryanne F. Laffin, RN, FNP, CNM, LM, MS, FACNM
Clinical Assistant Professor
SUNY Downstate
Past-President
National Perinatal Association
mlaffin@nationalperinatal.org

*Corresponding Author*

*Shabih Manzar, MD, MPH*
*Associate Professor of Clinical Pediatrics*
*Louisiana State University Health Sciences Center at Shreveport*
*1501 Kings Hwy, Shreveport, LA, 71103*
*Phone: 318-675-7275*
*Fax: 318-675-6059*
*Email:* shabih.manzar@lsuhs.edu/shabihman@hotmail.com

*Anthony Orsini, D.O.*
*Vice-chairman of Neonatology at*
*Winnie Palmer Hospital*
*Orlando, FL*
info@bbnprogram.com

*Corresponding Author*

*Jenene Woods Craig, Ph.D., MBA, OTR/L, CNT*
*Director of Education for National Association of Neonatal Therapists (NANT)*
*770-595-7728*
jcraig@brenau.edu

*Corresponding Author*

*Anamika Banerji, MD, MS, FAAP*
*Medical Director, Tiny Baby Program LLUCH NICU*
*Associate Program Director, Neonatal-Perinatal Fellowship*
*Assistant Professor of Pediatrics*
*Division of Neonatology-Perinatal Medicine*
*Loma Linda University Children's Hospital*
*abanerji@llu.edu*

*Corresponding Author*

*Sherri L. McMullen PhD, RN, FNP, NNP-BC*
*Assistant Professor*
*Assistant Dean of Outcomes, Evaluation, and Enrollment Management*
*College of Nursing*
*SUNY Upstate Medical University*
*'Sherri McMullen' <*mcmulles@upstate.edu*>*

Corresponding Author

*Jenna Bollard, MA, MT-BC, CCLS, NICU-MT*
*Music Therapist*
*UCLA Mattel Children's Hospital*
*UCLA Healthcare System*
*Los Angeles, CA*
*Contact: jbollard@mednet.ucla.edu*
*310-267-9426*

*Sandra Cheah, MT-BC*
*Research Assistant*
*David Geffen School of Medicine*
*UCLA Mattel Children's Hospital*
*UCLA Healthcare System*
*Los Angeles, CA*

*Isabell Purdy Ph.D., NP*
*Professor Department of Pediatrics*
*David Geffen School of Medicine*
*UCLA Mattel Children's Hospital*
*UCLA Healthcare System*
*Los Angeles, CA*

Corresponding Author

*Benjamin Hopkins, DO*
*Pediatric Resident*
*University of California, San Francisco*
*Department of Pediatrics*
*Fresno Campus*
*Email: Benjamin.hopkins@ucsf.edu*

*Kristina Casale, MT-BC*
*Research Assistant*
*David Geffen School of Medicine*
*UCLA Mattel Children's Hospital*
*UCLA Healthcare System*
*Los Angeles, CA*

*William Benitz, MD*
*Professor in Neonatology, Emeritus*
*Member, Maternal and Child Health Research Institute*
*Email: benitzwe@stanford.edu*

*Michael D. Schreiber, MD*
*Section Chief, Neonatology,*
*Professor of Pediatrics*
*Vice Chairman, Pediatrics.*
*Pritzker School of Medicine*
*University of Chicago*
*MC6060*
*5841 S. Maryland Ave.*
*Chicago, IL 60637*

***Corresponding Author***

*Authors Name: Phat Tran, OMS III*
*Osteopathic Medical Student*
*Western University of Health Science – College of Osteopathic Medicine of the Pacific, Pomona, California*
*Email –* phat.tran@westernu.edu

*Brandi N. Parker, MSN, MBA, RN*
*Clinical Director NICU/CTCU/MTCU*
*UChicago Medicine Comer Children's*
*University of Chicago*
*MC6060*
*5841 S. Maryland Ave.*
*Chicago, IL 60637*

*Jaylee Hilliard, MSN, RN, NEA-BC, CPXP*
*Senior Director of Clinical Strategy*
*Angel Eye*

*Jill Colontuono, APN, NNP-BC, CPNP*
*Senior Clinician Educator*
*Pritzker School of Medicine*
*University of Chicago*
*MC6060*
*5841 S. Maryland Ave.*
*Chicago, IL 60637*

***Corresponding Author***

*Jerry Ballas, MD, MPH*
*Past President*
*National Perinatal Association*
*Associate Professor, Maternal-Fetal Medicine*
*University of California, San Diego*
*Email:* Jerry Ballas <jerry.ballas@nationalperinatal.org>

**Corresponding Author**

*Nicole Nyberg, MSN, APRN, NNP-BC*
*Clinical Product Specialist, Angel Eye*
*CEO and Founder, Empowering NICU Parents*
*Host, Empowering NICU Parents Podcast*
*Parent of Ex-premie*
Email: nnyberg@angeleyehealth.com
*AngelEye Health*
*4322 Harding Pike, Suite 417*
*Nashville, TN 37205*
*630.339.6273*

*Christopher Rand*
*Chief Executive Officer*
*Angel Eye*

**Corresponding Author**

*Jenene W. Craig, Ph.D., MBA, OTR/L, CNT*
*Program Director and Professor*
*Infant and Early Childhood Mental Health and Development PhD and MA Programs*
*Fielding Graduate University*
*2020 De la Vina Street, Santa Barbara, CA 93105*
*NANT Annual Conference Co-Chair and Ignite Mentoring Program Co-Lead*
*National Association of Neonatal Therapists (NANT)*
*Telephone: 770-595-7728*
*Email: JCraig@Fielding.edu*

**Corresponding Author**

*Bernadette Mercado BS.RT, RRT-NPS*
*Academy of Neonatal Care Respiratory Coordinator*
*Academy of Neonatal Care Inc.*
*La Quinta, California, United States*
*Email:* beme715@gmail.com

**Corresponding Author**

*Vishakha Nanda, MD, FAAP*
*Attending Neonatologist*
*John H Stroger Hospital of Cook County*
*Chicago, Illinois*
*Email: Vishakhananda@yahoo.com*

**Corresponding Author**

*Kimberly Hillyer, PhD, RN, DNP*
*Neonatal Nurse Practitioner*
*Neonatal Intensive Care Unit*
*Loma Linda University Health Advanced Care Practice Services*
*Email:* KHillyer @llu.edu

*Corresponding Author*

*Megan Honor Pesch, MD*
*Board Member, National CMV Foundation*
*Cliinical Assistant Professor*
*Department of Pediatrics*
*Developmental Behavioral Pediatrics*
*University of Michigan*
*Pediatric Behavioral Clinic*
*C. S. Mott Children's Hospital*
*1540 E Hospital Dr, Floor 6 Reception C*
*Ann Arbor, MI 48109*

*Corresponding Author*

*Geert Lingier*
*Head nurse*
*NICU University Hospital*
*Ghent, Belgium*

*Email:* Geert.Lingier@uzgent.be

*Mary Uran, MPH*
*Board Chair/President*
*National CMV Foundation*
*Managing Director of Compass Pro Bono*
*St. Paul, MN*

*Khaliliah Fleming, EdD, MPH, MCHES*
*Executive Director*
*National CMV Foundation*
*Email: khaliah.fleming@nationalcmv.org*
*Office Phone: (813) 539-9500*
*Tampa, FL*

*Tiara Bolden, BSN, RN, TIP*
*Virginia Commonwealth University School of Nursing*
*Email: boldentm@vcu.edu*

***Corresponding Author:***

*Scott D. Duncan, MD, MHA*
*Professor and Chief*
*Division of Neonatal Medicine*
*University of Louisville*
*571 S. Floyd St.*
*Suite 342*
*Louisville, KY 40202*
*P:502-852-8470*
*F:502-852-8473*
*Email:sddunc02@louisville.edu*

*Maria Mooney, MPH*
*Virginia Commonwealth University School of Nursing*
*Email: mooneymf@vcu.edu*

***Corresponding Author***

*Amy L. Salisbury, PhD, APRN, PMH-CNS, BC, FAAN*
*Virginia Commonwealth University School of Nursing*
*Email: salisburya@vcu.edu*

**Corresponding Author**

*Jaylee Hilliard, MSN, RN, NEA-BC, CPXP*
*Vice President of Clinical Strategy, AngelEye Health;*
*NICU Parent*
*Email: JayleeHilliard1@gmail.com*

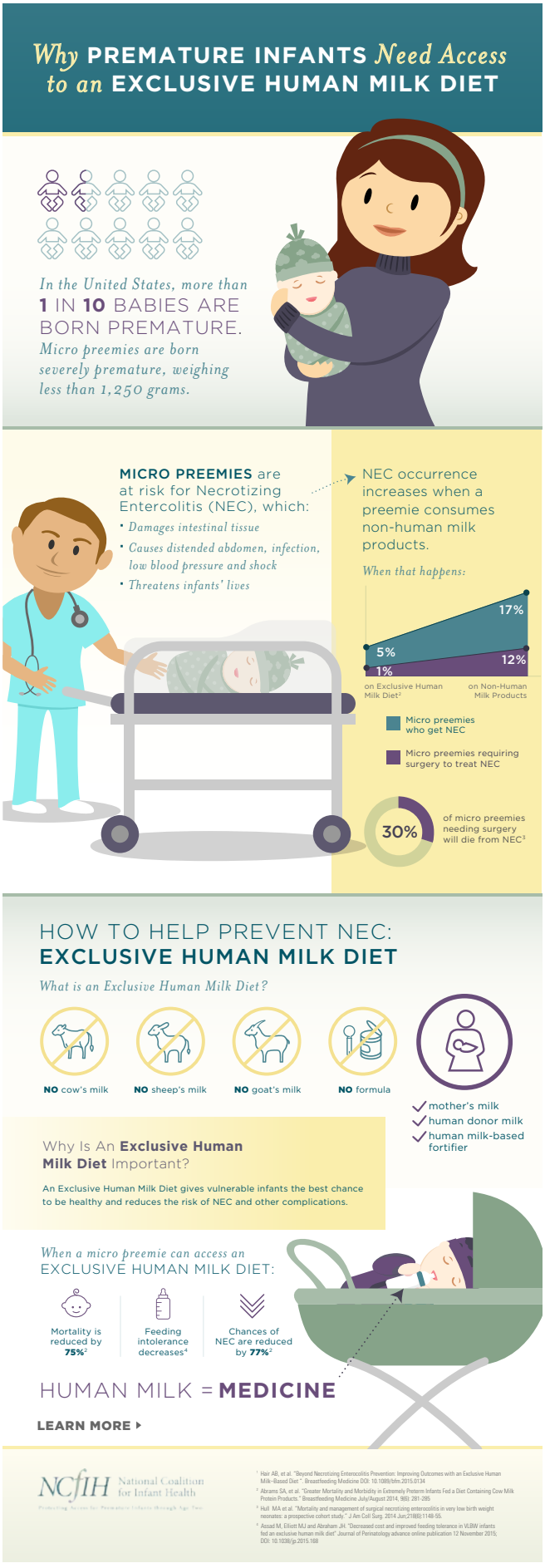


*Caroline Yu, MD*
*Fellow, PGY-6*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics*
*Loma Linda, CA*



**Corresponding Author**

*Nicole Harlot*
*Founder & President*
*Perinatal Resource Collaborative*
*PRC SPARK Fund 501(3)c*
*Seedlinks: Virtual Business Cards*
*T: 386-845-5243*
*E: nicole@jointheprc.com*

*Corresponding Author*

*Barb Hipsak, RD*
*Director of Education and Programs and Services*
*First Candle*
*2211 Jefferson Davis Hwy, Suite 203*
*Northern Virginia*
*barb@firstcandle.org*
*Telephone: 1-203-966-1300*
*For Grief Support: 1-800-221-7437*
*Email: barb@firstcandle.org*

1. National Correct Coding Initiative Edits. Centers for Medicare & Medicaid Services. https://www.cms.gov/Medicare/Coding/NationalCorrectCodInitEd. Accessed May 13, 2020, 2020.
2. A Quick Reference Guide to Neonatal Coding and Documentation. American Academy of Pediatrics; 2016.

***"How can the medical provider ensure they are accurately documenting the patient's condition? First, determine if the patient's diagnoses "MEAT"s criteria: if a condition is Measured, Evaluated, Assessed, or Treated, it is the clinical significance that is documented in the medical record."***

***Corresponding Author***

*Benjamin Hopkins, DO*
*Pediatric Resident*
*University California San Francisco - Fresno*
*Community Regional Medical Center*
*Valley Children's Hospital*
*Email: BHopkins.med@gmail.com*

***Corresponding Author***

*Mark R. Schleiss, MD*
*University of Minnesota Medical School*
*Department of Pediatrics*
*2001 6th Street SE*
*Minneapolis, MN 55455*
*Phone: 612-626-9913*
*FAX: 612-626-9924*
*Email: schleiss@umn.edu*
*ORCID: https://orcid.org/0000-0002-2108-9433*

*Arun Pramanik, MBBS, MD, DCH, FAAP, FIAP*
*Professor of Pediatrics*
*Louisiana State University School of Medicine*
*1501 Kings Hwy*
*Department Of Pediatrics, Section Of Neonatology*
*Shreveport, LA 71103*

*Andrew Hopper, MD*
*Professor of Pediatrics*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics*


# Your Pregnancy and Substance Use

4 Things you can do to improve your health and lower your risk for complications

## Get Prenatal Care

Start early. Go to all your visits. Empower yourself with information so you can make smart decisions. Build relationships with providers who understand Substance Use Disorders (SUDs) and know how to help. Partner with them to reach your goals. But remember, you do not need to be abstinent from substance use to get care. Go now.

## Reduce Your Use

There are simple things you can do to limit the harm substances might do.

- Use fewer substances
- Use smaller amounts
- Use less often
- Learn how to use safer

Reducing or quitting smoking is a good place to start. Set your goals, then ask for help.
One of the best things you can do is to stop using alcohol. We know that even small amounts are risky. And when combined with benzos and opioids, alcohol can kill.

## Use Opioid Agonist Therapy (OAT) if you are opioid dependent

Methadone and Buprenorphine (Subutex® or Suboxone®) are the "Standard of Care" during pregnancy because they:

- Eliminate the risks of illicit use
- Reduce your risk for relapse
- Can be a positive step towards recovery

## Take Good Care of Yourself

You deserve a healthy pregnancy & childbirth.

- Eat healthy and take your prenatal vitamins
- Find the right balance of rest and exercise
- Surround yourself with people who care

## Your Health Matters

Academy of Perinatal Harm Reduction
www.perinatalharmreduction.org

National Perinatal Association
www.nationalperinatal.org

**Corresponding Author**

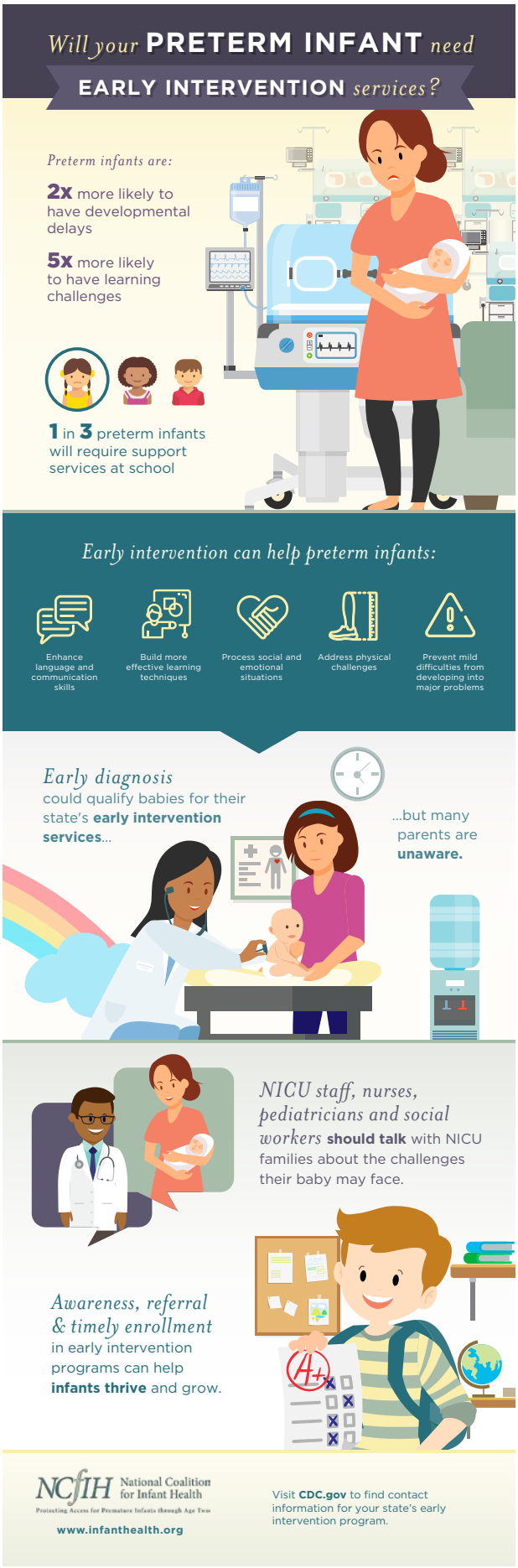
*Joseph B. Philips, III, MD*
*Professor of Pediatrics*
*University of Alabama at Birmingham*
*Email: jphilips@uabmc.edu*

**Corresponding Author**

*Kimberly Hillyer, PhD, RN, DNP*
*Neonatal Nurse Practitioner*
*Neonatal Intensive Care Unit*
*Loma Linda University Health Advanced Care Practice Services*
*Email: KHillyer @llu.edu*

**Corresponding Author**

*Jessica Daigle, MD, FAAP*
*NICU Consultant| I help companies & organizations serving NICU families strengthen their services, support, and impact| Neonatal Hospitalist serving 10 states | NICU Grad Specialty Clinic | Life Coach| NICU Mom*
*Atlanta, GA*
*Email: drjessdaiglemd@gmail.com*



**Corresponding Author**

*Kelly Welton-Lewis, BA, RRT-NPS*
*Academy of Neonatal Care*
*Website: www.AcademyofNeonatalCare.org*
*877-884-4587*
*LinkedIn: https://www.linkedin.com/in/kelwel*
*Email: kelwelrt@gmail.com*

*Corresponding Author*

*Mia Malcolm*
*Parent advocate*
*Member Graven's Conference Planning Committee*

*Leslie Caldarelli, MD*
*Medical Director, Neonatal Intensive Care Unit, Northwestern Medicine's Prentice Women's Hospital*
*Associate Professor of Pediatrics (Neonatology), Northwestern University Feinberg School of Medicine*
*Ann & Robert H. Lurie Children's Hospital of Chicago*
*225 E. Chicago Ave.*
*Chicago, Illinois 60611*

***Corresponding Author:***

*Hua Wang, MD, PhD*
*Loma Linda University School of Medicine*
*Division of Genetics*
*Department of Pediatrics*
*Email: huawang@llu.edu*

***Corresponding Author***

*Paige Terrien Church, MD*
*Beth Israel Deaconess Medical Center*
*330 Brookline Avenue*
*Boston, Massachusetts 02215*
*Harvard Medical School*
*Department of Pediatrics*
*75 Francis Street*
*Boston, Massachusetts 02115*

*Mary Coughlin, MS, NNP-NCC-E*
*Trauma Informed Professional™, Caritas Coach®*
*President & Founder*
*Caring Essentials Collaborative, LLC*
*Office: +1 (774) 619-7967*
*Email: info@caringessentials.net*
*Website: www.caringessentials.net*

*Corresponding Author*

*Samantha Butler, PhD*
*Department of Psychiatry and Behavioral Sciences*
*Boston Children's Hospital*
*1 Autumn Street, room 335*
*Boston, MA 02115.*
*Department of Psychiatry (Psychology)*
*Harvard Medical School, Boston, MA, United States.*
*email: samantha.butler@childrens.harvard.edu*

*Kaitlyn Ludder, M.Sc.*
*Department of Cardiology,*
*Boston Children's Hospital,*
*Boston, MA*

***Corresponding Author***

*Kevin Kafaja, MS III*
*College of Osteopathic Medicine of the Pacific*
*Western University of Health Sciences*
*Email:* kevin.kafaja@westernu.edu

*Corresponding Author*

*Chavis A. Patterson, Ph.D.*
*Assistant Professor of Clinical Psychiatry*
*Children's Hospital of Philadelphia*
*Division of Neonatology, 2 Main, Room 2NW59A*
*3401 Civic Center Boulevard*
*Philadelphia, PA 19104*
*Email: PattersonC1@email.chop.edu*


*Corresponding Author*

*Pamela A. Geller, Ph.D.*
*Director, Clinical Training*
*Associate Professor, Ob/Gyn and Public Health*
*Drexel University*
*Department of Psychology*
*3141 Chestnut Street, Room 280*
*Philadelphia, PA 19104*
*email pg27@drexel.edu*

*Dorothy Vittner, PhD, RN, FAAN*
*Egan School of Nursing and Health Studies*
*Fairfield University*
*Fairfield, CT*
*Connecticut Children's Medical Center*
*Hartford, CT*

***Corresponding Author***

*Raouth R. Kostandy, PhD, MSN, RN, CKC.*
*JoAnn Gay Dishman School of Nursing, Lamar University*
*Email address: rrkostandy@yahoo.com*
*Phone number: 440-840-1145*

***Corresponding Author***

*Carolyn TenEyck, RN*
*Senior Director, Patient & Family Advocacy*
*AngelEye Health*
*Email: cteneyck@angeleyehealth.com*

**Corresponding Author**

*Gina Porto, RN, MSN, CBC*
*Developmental Specialist, Neonatal Intensive Care Unit*
*Ann & Robert H. Lurie Children's Hospital of Chicago*
*Chicago, IL 60622*
*Email:* gporto@luriechildrens.org

*John Sullivan, MD, PhD*
*Professor of Health and Basic Sciences*
*Touro University*
*New York, NY.*

*Susan Horner, PhD, APRN-CNS, RNC-NIC, CBC*
*Nurse Scientist & Developmental Specialist, Neonatal Intensive Care Unit*
*Ann & Robert H. Lurie Children's Hospital of Chicago*

*Corresponding Author*

*Yamile Jackson, PhD, PE, PMP*
*CEO and Engineer*
*Nurture by Design*
*Sugar Land, TX*
*email:* intouch@thezaky.com

**Corresponding Author**

*Erin N. L. Thrasher, MD*
*Department of Pediatrics, Division of Neonatology*
*UAB Heersink School of Medicine*
*Women and Infant's Center, Suite 9380*
*University of Alabama at Birmingham*

**Corresponding Author**

*Brian Scottoline, M.D., Ph.D.*
*Professor of Pediatrics*
*Division of Neonatology*
*Department of Pediatrics*
*Oregon Health & Science University*
*Portland, OR 97212*
*Email:* scottoli@ohsu.edu

**Corresponding Author**

*Robin Clark, MD*
*Professor, Pediatrics*
*Loma Linda University School of Medicine*
*Division of Genetics*
*Department of Pediatrics*
*Email:* rclark@llu.edu

*Samuel J. Gentle, MD*
*Assistant Professor*
*Yale University School of Medicine*

**Corresponding Author**

*Subhadra Ramanathan MSc, MS, CGC*
*Assistant Professor*
*Loma Linda University School of Medicine*
*Division of Genetics*
*Department of Pediatrics*
*Email:* SRamanathan@llu.edu

**Corresponding Author**

*Dr. Jaques Belik*
*Emeritus Professor of Pediatrics*
*University of Toronto*
*The Hospital for Sick Children*
*Peter Gilgan Centre for Research and Learning*
*Toronto, Ontario, M5G 0A4 Canada*
*Email:* jaques.belik@utoronto.ca

*Mitchell Goldstein, MD*
*Professor of Pediatrics*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics*
*Email:* mgoldstein@llu.edu

*Waldemar A. Carlo, MD*
*Edwin M. Dixon Professor of Pediatrics*
*Distinguished Professor*
*Director, Division of Neonatology*
*University of Alabama Heersink School of Medicine*

*Corresponding Author*

*Alison Jacobson*
*Chief Executive Officer*
*First Candle*
*49 Locust Avenue, Suite 104*
*New Canaan, CT 06840*
*Telephone: 1-203-966-1300*
*For Grief Support: 1-800-221-7437*
alison@firstcandle.org
*www.firstcandle.org*

***Corresponding Author***

*Mita Shah, MD*
*Medical Director*
*Neonatal Intensive Care Unit*
*Queen of the Valley Campus/Emanate Health*
*Assistant Professor of Pediatrics*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics*
*Email:* mgoldstein@llu.edu

***Corresponding Author***

*Leith Greenslade, MPA, MBA*
*Founder & CEO*
*JustActions*
http://justactions.org
*@JustActions*

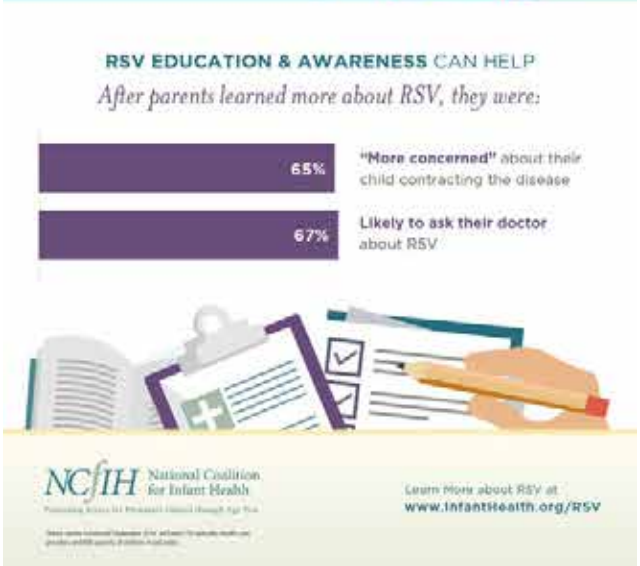
*Augusto Sola, MD,*
*Director General de SIBEN®, SIBEN, Profesor Emérito de SIBEN, EUA*
*e-mail:* augusto.sola@siben.net

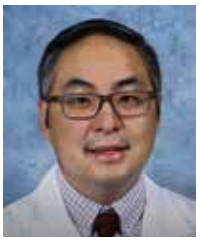
***Corresponding Author***

*Gustave H. Falciglia, MD*
*Assistant Professor of Pediatrics (Neonatology),*
*Northwestern University*
*Feinberg School of Medicine*
*Ann & Robert H. Lurie Children's Hospital of Chicago*
*225 E. Chicago Ave.*
*Chicago, Illinois 60611*
*Email:* GFalciglia@luriechildrens.org

***Corresponding Author***

*Hun-Seng Chao, MD*
*Senior Associate Editor*
*Neonatology Today*
*Neonatologist Emeritus*
*Orange County, CA*
*email:* hunseng.chao@gmail.com

*Larry Ngo, MD*
*Assistant Professor of Pediatrics*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics Loma Linda, CA*
*Email: LANgo@llu.edu*

***Corresponding Author***

*Carol Jaeger, DNP, RN, NNP-BC*
*Adjunct Faculty*
*The Ohio State University College of Nursing*
*Columbus, OH*
*3143 Cranston Drive*
*Dublin, OH 43107*
*Email: Caroljaeger75@gmail.com*

*Carole Kenner, PhD, RN, FAAN, FNAP, ANEF, IDFCOINN*
*Carol Kuser Loser Dean & Professor*
*School of Nursing & Health Sciences*
*The College of New Jersey, Ewing, NJ*
*Founder & CEO, Council of International Neonatal Nurses, Inc. (COINN)*

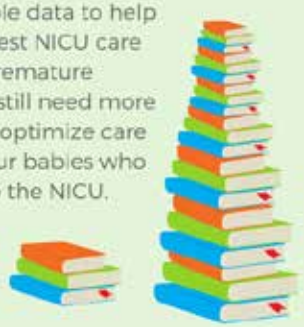
National Perinatal Association

# NICU AWARENESS MONTH

nationalperinatal.org/NICU_Awareness

## WE NEED MORE RESEARCH

We have valuable data to help us deliver the best NICU care for small and premature babies. But we still need more data to help us optimize care for the rest of our babies who are admitted to the NICU.



Educate. Advocate. Integrate.

NATIONAL PERINATAL ASSOCIATION

## Update: CORONAVIRUS COVID-19

According to data published in The Lancet

**Because of the risk of developing severe pneumonia, pregnant women and newborn babies should be considered key at-risk populations.**

National Perinatal Association

www.nationalperinatal.org

OPIOIDS and NAS

When reporting on mothers, babies, and substance use

# LANGUAGE MATTERS

## I am not an addict.

I was exposed to substances in utero. I am not addicted. Addiction is a set of behaviors associated with having a Substance Use Disorder (SUD).

## I was exposed to opioids.

While I was in the womb my mother and I shared a blood supply. I was exposed to the medications and substances she used. I may have become physiologically dependent on some of those substances.

## NAS is a temporary and treatable condition.

There are evidence-based pharmacological and non-pharmacological treatments for Neonatal Abstinence Syndrome.

## My mother may have a SUD.

She might be receiving Medication-Assisted Treatment (MAT). My NAS may be a side effect of her appropriate medical care. It is not evidence of abuse or mistreatment.

## My potential is limitless.

I am so much more than my NAS diagnosis. My drug exposure will not determine my long-term outcomes. But how you treat me will. When you invest in my family's health and wellbeing by supporting Medicaid and Early Childhood Education you can expect that I will do as well as any of my peers!

Learn more about Neonatal Abstinence Syndrome at www.nationalperinatal.org

National Perinatal Association

**Corresponding Author**

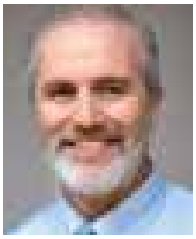
*Jorge Pleitez Navarrete, MD*
*Profesor asistente de SIBEN®,*
*Consejero Consensos clínicos SIBEN®,*
*Neonatólogo del Instituto Nacional de Salud (INS), El Salvador*
*Teléfono +503 7180 1916*
*e-mail: pleite : pleitez.siben@gmail.com*

*María Teresa Montes Bueno,*
*Consejo de enfermería de SIBEN®,*
*Enfermera de neonatología, Hospital Universitario La Paz, Madrid, España*
*e-mail: mariateresa.montes.bueno@siben.net*

*Carmen Dávila Aliaga MD*
*Profesor asistente de SIBEN®,*
*Consejero Consensos clínicos SIBEN®,*
*Neonatóloga del Instituto Nacional Materno Perinatal, Lima Perú*
*e-mail: cdavila.siben@gmail.com*

*Cristian Muñoz*
*Consejo de enfermería de SIBEN®,*
*Maternidad Provincial Dra. Teresita Baigorria. San Luis. Argentina*
*e-mail: cristian.munoz@siben.net*

*Lourdes Lemus-Varela MD*
*Profesor titular de SIBEN®,*
*Consejero Consensos clínicos SIBEN®,*
*Departamento de Neonatología, CMNO, IMSS Guadalajara, Jalisco, México*
*e-mail: lulalemus@gmail.com*



*Sergio Golombek, MD,*
*Director de la Unidad de Relaciones Internacionales de SIBEN®,*
*Consejero Consensos clínicos SIBEN®,*
*SUNY Downstate Health Sciences University, Brooklyn, NY, Estados Unidos*
*e-mail: sergio.golombek@siben.net*

*Corresponding Author*

*Chelsea Cieslak, DNP[1]*
*Rush University College of Nursing*
*2453 W. Erie St. Chicago, Il 60612*
*chelsea.cieslak@gmail.com*
*630-460-4645*

*Kelly Sulo, DNP, MSN-Ed[2]*
*Rush University Medical Center*
*Chicago, IL*

*Margaret F. Connors, DNP*
*DuPage Neonatology Associates*
*Hinsdale, IL*

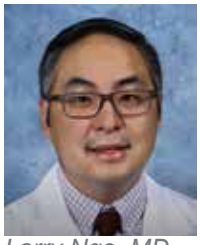
***Corresponding Author***

*Troy Savage*
*Senior Associate | Director,*
*Strategic Projects and Innovation*
*Mazzetti*
*Executive Director, Sextant Foundation*
*Email tsavage@mazzetti.com*



*Christina Vernon Sanborn, AIA, LEED AP, CDP*
*Principal | Sustainability Practice Leader*
*Mazzetti*

**Corresponding Author**



*Larry Ngo, MD*
*Assistant Professor of Pediatrics*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics Loma Linda, CA*
*Email: LANgo@llu.edu*

*Joseph J. Krzak, PT, PhD, PCS*
*Professor*
*Physical Therapy*
*Midwestern University*
*Downers Grove, IL*

*Corresponding Author*

*Carolyn TenEyck, RN*
*Senior Director, Patient & Family Advocacy*
*AngelEye Health*
*Email: cteneyck@angeleyehealth.com*

*Jane Sweeney, PT, PhD, MS, PCS, FAPTA*
*Professor*
*Physical Therapy*
*Rocky Mountain University of Health Professions*
*Provo, UT*

*Douglas D. Deming, MD*
*Professor of Pediatrics*
*Division of Neonatology*
*Loma Linda School of Medicine*

**Corresponding Author**

*Carrie Crozier-Arena, PT, DPT, NTMC, CNT, DCS*
*Neonatal Physical Therapist/Developmental Care Specialist*
*UChicago AdventHealth NICU*
*Hinsdale Hospital*
*Hinsdale, IL*
*Doctor of Philosophy Candidate*
*Rocky Mountain University of Health Professions, Provo, UT*
*Cell: 630-873-0276, Fax: 708-598-600*
*Email: Carrie.crozierarena@rm.edu,*

**Corresponding Author**

*Danielle Groot, MSN, NNP-BC, RNC-NIC*
*Neonatal Nurse Practitioner*
*Loma Linda University Children's Hospital*
*11234 Anderson Street, Loma Linda, CA 92354*
*Email:* DGroot@llu.edu

*Van Anh Nguyen, OMS-IV*
*Touro University Nevada,*
*College of Osteopathic Medicine*
*Henderson, NV*

**Corresponding Author**

*Golden Reeves, OMS-IV*
*Touro University Nevada,*
*College of Osteopathic Medicine*
*Henderson, NV*
*Email: greeves2@student.touro.edu*

*Lisa Kirby, RN, MSN, NNP-BC*
*Neonatal Nurse Practitioner Lead*
*Loma Linda University Children's Hospital*
*11234 Anderson Street, Loma Linda, CA 92354*
*Email:* lkirby@llu.edu

*Plaiphon Vaidyanuvatti, OMS-IV*
*Touro University Nevada,*
*College of Osteopathic Medicine*
*Henderson, NV*

*Toby Richards, DNP, NNP-BC*
*Neonatal Nurse Practitioner Program Coordinator*
*Loma Linda University| School of Nursing*
*11262 Campus St, Loma Linda, CA 92354*
*Email: TRichards@llu.edu*

**Corresponding Author**

*Maria Martes Gomez, DO*
*Department of Pediatrics*
*Loma Linda, CA*
*Email:* MMartesGomez@llu.edu

*Walid Hussain, MD*
*Associate Professor of Pediatrics*
*The University of Chicago*
*Department of Pediatrics*
*Email:* whussain1@uchicago.edu

*Shaina Khan Lodhi, MD*
*Assistant Professor of Pediatrics*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics Loma Linda*, CA

*Email:* SLodhi@llu.edu

**Corresponding Author**

*Lily J. Lou, MD, FAAP*
*Immediate Past Chair, AAP Section on Neonatal-Perinatal Medicine*
*Co-chair, SONPM Advocacy Committee*
*Immediate Past President, AAP-Alaska Chapter*
*Professor of Clinical Pediatrics*
*Director of Government Relations*
*Assistant Neonatology Co-chair, UIC-IDPH Administrative Perinatal Center*
*University of Illinois at Chicago*
*Division of Neonatology, MC 856, Department of Pediatrics*
*Chicago, IL 60612*
*Email:* lilylou@mindspring.com
*(312) 996-4185 office*

*Shaina Khan Lodhi, MD*
*Assistant Professor of Pediatrics*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics*
*Loma Linda*, CA
*Email:* SLodhi@llu.edu

*Shiloh Eastin, Psy.D.*
*Columbia University Irving Medical Center*

*Jessalyn Kelleher, Psy.D.*
*University of Colorado School of Medicine*

*Brenda J. Papierniak, Psy.D.*
*Ascension Saint Alexius Women & Children's Hospital*

*Sage N. Saxton, Psy.D.*
*Oregon Health & Science University*

*Shelby Alsup, PhD*
*Pacific University*

**Corresponding Author**

*Joseph R. Hageman, MD*
*Senior Clinician Educator*
*Pritzker School of Medicine*
*University of Chicago*
*5841 S. Maryland Ave.*
*Chicago, IL 60637*
*Phone: 773-702-7794*
*Fax: 773-732-0764*
*Email:josephhageman6@gmail.com*

*Myisha Driver, Ph.D.*
*Children's Hospital Los Angeles*

**Corresponding Author**

*Lolita Alcocer Alkureishi, MD*
*Associate Professor of Pediatrics*
*Assistant Director,*
*Ambulatory Care Residency Program*
*Director, Pediatric Clerkship*
*The University of Chicago Medicine*
*5841 S. Maryland Avenue*
*Chicago, IL 60637*

**Corresponding Author**

*Tiffany Gladdis, PsyD*
*Children's Mercy Hospital*
*University of Missouri Kansas City*
*ph: 816-782-6784*
*fax: 816-302-9898*
*2401 Gillham Road*
*Kanas City, MO 64108*
*email: tngladdis@cmh.edu*

*Lacy Chavis, Psy.D.*
*Tampa General Hospital*

**Corresponding Author**

*Gil Wernovsky, MD, FAAP, FACC*
*Senior Consultant in Pediatric Cardiology and Cardiac Critical Care*
*Children's National Hospital*
*Professor of Pediatrics*
*George Washington School of Medicine and Health Sciences*
*Washington DC, USA*
*Email:* gwernovsky@childrensnational.org

*Anthony Shoo, MD*
*Assistant Professor*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics*
*Loma Linda University Childrens Hospital*
*Loma Linda, CA*
*Email:* ashoo@llu.edu

**Corresponding Author**

*Daved van Stralen, MD, FAAP*
*Associate Professor, Pediatrics*
*Department of Pediatrics*
*Loma Linda University School of Medicine*
*11175 Campus Street*
*CP-A1121*
*Loma Linda, CA 92350*
*Email:* DVanStra@llu.edu

*Sean McKay*
*Executive Partner / Director, Disruptive Rescue & Austere Medicine*
*Element Rescue - Response Solutions within Nonlinear Complex Environments*
*Greenville, South Carolina, United States*

*Thomas A. Mercer*
*Rear Admiral*
*United States Navy (Retired)*

**Corresponding Author**

*Shabih Manzar, MD, MPH*
*Associate Professor of Clinical Pediatrics*
*Louisiana State University Health Sciences Center at Shreveport*
*1501 Kings Hwy, Shreveport, LA, 71103*
*Phone: 318-675-7275*
*Email:* shabih.manzar@lsuhs.edu/shabihman@hotmail.com

*Corresponding Author*

*Christy Gliniak, PhD, OTR/L, CNT, CPXP, NTMTC*
*Associate Professor, Fielding Graduate University*
*Neonatal Therapist*
*Communications Manager/Conference Co-Chair*
*National Association of Neonatal Therapists® (NANT)*
*Email:* christyg@neonataltherapists.com

*Kshama Shah, MD*
*Assistant Professor of Pediatrics*
*The University of Chicago Medicine*
*5841 S. Maryland Avenue*
*Chicago, IL 60637*

**Acknowledgments**

Karl Weick, Rensis Likert Distinguished University Professor of Organizational Behavior and Psychology, Emeritus, University of Michigan

Errol van Stralen, Ancora Corporate Training

William J. Corr, formerly with the Los Angeles City Fire Department

H. Stefan Bracha, University of University of Hawai'i at Mānoa, United States Department of Veterans Affairs

Adrian Wolfberg, PhD, Senior Program Officer at the National Academy of Sciences

*Minesh Khashu, MBBS, MD, DCH, FRCPCH, FRSA*
*Consultant Neonatologist & Professor of Perinatal Health*
*Founder of SIGNEC UK – Special Interest Group NEC*
*Co-Founder Global Newborn Society*
*Professor of Perinatal Health at Bournemouth University*
*Poole, England, United Kingdom*

*Warren Rosenfeld, MD*
*Clinical Professor of Pediatrics*
*Chair, Department of Pediatrics*
*Mount Sinai South Nassau Hospital*
*Icahn School of Medicine at Mount Sinai*

**Corresponding Author**

*Pinchi Srinivasan, MD*
*Associate Professor of Pediatrics*
*Chief, Division of Newborn Medicine*
*Vice Chairman, Department of Pediatrics*
*Icahn School of Medicine at Mount Sinai*
*Mount Sinai South Nassau Hospital*
*One Healthy Way, Oceanside, NY 11572*
*email:* Pinchi.srinivasan@snch.org
*516-632-3455*

*Ditian Li, MPH*
*Center for Biostatistics*
*Icahn School of Medicine at Mount Sinai*

*Lincoln Ferguson, MD*
*Associate Professor of Pediatrics*
*Chairman, Department of Pediatrics*
*Mount Sinai South Nassau Hospital*
*Icahn School of Medicine at Mount Sinai*

*Emilia Bagiella, PhD*
*Professor of Biostatistics*
*Center for Biostatistics*
*Department of Population Health Science & Policy at Mount Sinai School of Medicine.*
*Icahn School of Medicine at Mount Sinai*

*Hun-Seng Chao, MD*
*Senior Associate Editor for Editorial Review and Layout for Neonatology Today*
*Neonatologist Emertus*
*Irvine, CA*

*Joy Browne, Ph.D., PCNS, IMH-E(IV)*
*Clinical Professor of Pediatrics and Psychiatry*
*University of Colorado School of Medicine*
*Aurora, Colorado*
*Telephone: 303-875-0585*
*Email:* Joy.browne@childrenscolorado.org

*Corresponding Author*

*Robert D. White, MD*
*Director, Regional Newborn Program*
*Beacon Children's Hospital*
*615 N. Michigan St.*
*South Bend, IN 46601*
*Phone: 574-647-7141*
*Fax: 574-647-3672*
*Email:* Robert_White@pediatrix.com

***Corresponding Author***

*Donald Null, MD*
*Professor of Pediatrics*
*Division of Neonatology*
*Department of Pediatrics*
*University of California, Davis*
*Davis, CA*
*'Email* dnull159@gmail.com

*Vincent C. Smith, M.D. M.P.H.*
*Boston Medical Center*
*801 Albany Street Room 2009*
*Boston, MA 02119*
*Email:* Vincent.smith@bmc.org

***Corresponding Author***

*Susan Hepworth*
*Director*
*National Coalition for Infant Health*
*2020 K Street NW, Suite 505*
*Washington, DC 20006*
*Email:* info@infanthealth.org

*Corresponding Author*

*Abby Clark*
*Comm. & Digital Design Coordinator, iCAN Website: www.ican.health*
*Website:* www.icanresearch.org
*Phone: (+1) 228-343-0961*
*Email:.*abbyclark@icanresearch.org

***Corresponding Author***

*Kelly Welton, BA, RRT-NPS*
*Academy of Neonatal Care*
*www.AcademyofNeonatalCare.org*
*877-884-4587*
https://www.linkedin.com/in/kelwel
*email:* kelwelrt@gmail.com

*Corresponding Author*

*Gabriel Espinoza, MD*
*Pediatrics Resident*
*Loma Linda University Medical Center*
*Loma Linda, CA*
*Email: GEspinoza@llu.edu*

***Corresponding Author:***

*Tiffany A Moore, PhD, RN, FAWHONN*
*Associate Professor, College of Nursing*
*University of Nebraska Medical Center*
*985330 Nebraska Medical Center*
*Omaha, NE 68198-5330*
*Email:* tamoore@unmc.edu

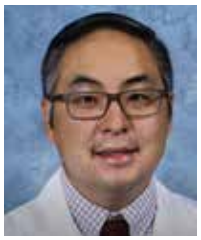
*Alyson E. Hanish, PhD, MSN, RN.*
*Assistant Professor, College of Nursing*
*University of Nebraska Medical Center*
*Omaha, NE 68198-5330*

*T.Allen Merritt, MD, MHA*
*Professor of Pediatrics*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics*
*email:* allenmerritt.md@gmail.com

*Elba Fayard, MD*
*Professor of Pediatrics*
*Loma Linda University School of Medicine*
*Division Chair, Emeritus*
*Division of Neonatology*
*Department of Pediatrics*
*Loma Linda University Children's Hospital*
*Loma Linda, CA*

*Chaitra Manjunath, MD*
*Neonatology Fellow, Post-Graduate Year 5*
*Department of Pediatrics*
*Loma Linda University Children's Hospital*
*Loma Linda, CA*

***Corresponding Author***



*Larry Ngo, MD*
*Assistant Professor of Pediatrics, Loma Linda University School of Medicine*
*Associate Program Director, Neonatal-Perinatal Fellowship Program*
*Division of Neonatology, Department of Pediatrics*
*Loma Linda University Children's Hospital*
*Loma Linda, CA*
*Email:* LANgo@llu.edu

*Luis Fernando Rivera Melara, MD*
*Neonatologist*
*Department of Pediatrics*
*Southern California Permanente Medical Group*

*Mark Baker, MD*
*Neonatology Fellow, Post-Graduate Year 6*
*Department of Pediatrics*
*Loma Linda University Children's Hospital*
*Loma Linda, CA*

*Corresponding Author*

*Lorraine Dillon, RGN, RM, RPHN, MSc Nursing*
*Primary Care Manager*
*Community Healthcare in South Dublin*
*Ireland*
*email:* dillonlorraine8@gmail.com

**Corresponding Author**

*Rakesh Sahni, MD*
*Professor of Pediatrics at CUMC*
*Course Director*
*Medical Director, NICU*
*Columbia University*
*New York, NY 10032*
*Email: rs62@cumc.columbia.edu*
*Tel: (212) 305-9743*

*Corresponding Author*

*Gil Wernovsky, MD, FAAP, FACC*
*Senior Consultant in Pediatric Cardiology and Cardiac Critical Care*
*Children's National Hospital*
*Professor of Pediatrics*
*George Washington School of Medicine and Health Sciences*
*Washington DC, USA*
*Email: gwernovsky@childrensnational.org*

*Carole Kenner, PhD, RN, FAAN*
*Dean and Professor*
*The College of New Jersey*
*2000 Pennington Road, Trenton Hall, Room 206, Ewing, New Jersey 08628*

*Manan Desai, MD*
*Director, VAD and Heart Transplant*
*Surgical Director, Advanced Cardiac Therapies and Heart Transplant Program*
*Children's National Hospital*

*Corresponding Author*

*Benjamin Hopkins, DO*
*Pediatric Resident*
*University of California, San Francisco*
*Community Regional Medical Center*
*Valley Children's Hospital*
*Email: Benjamin.hopkins@ucsf.edu*

**Corresponding Author**

*Joan Hebert Cook MSW, ACSW, LCSW*
*National Association of Perinatal Social Workers*
*NAPSW Award for Excellence 2019*
*Orlando, Florida*
*Email:*bearvanna55@gmail.com

*Corresponding Author*

*Noel D. Tan, MD*
*Neonatologist*
*Envision Healthcare*
*email:* noeldtan.md@gmail.com

*Corresponding Author*

*Munish Gupta MD, MMSc, FAAP*
*Chair, AAP Section on Neonatal-Perinatal Medicine*
*Assistant in Medicine, Division of Newborn Medicine*
*Assistant Professor of Pediatrics, Harvard Medical School*
*Department of Neonatology*
*330 Brookline Avenue, Rose Building, 3rd Floor*
*Boston, Massachusetts 02115*
*Phone: 617-667-3276*
*Email:* mgupta@bidmc.harvard.edu

**Corresponding Author**

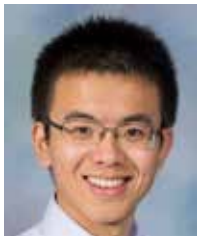
*Jim Pryde, M.A.*
*Instructional Design Specialist*
*University of Central Missouri*
*Warrensburg, MO*
*email:* jimpryde@gmail.com

*Corresponding Author*

*Gilbert I. Martin, MD*
*Professor of Pediatrics*
*Loma Linda Children's Hospital*
*Loma Linda, CA*
*Email:* gimartinmd@yahoo.com

*Hillary Pennell, Ph.D.*
*Associate Professor of Communication Studies*
*Department of Communication and Digital Media Production*
*University of Central Missouri*
*Warrensburg, MO*

*Sally Mutch, CPNP-AC*
*Division of Cardiology*
*Department of Pediatrics*
*Baylor College of Medicine at Texas Children's Hospital*
*Houston, Texas*



*Meng Li, PhD*
*Associate Professor*
*Department of Statistics*
*Rice University*
*Houston, TX*

*Duy Dinh, PhD*
*Division of Cardiology*
*Department of Pediatrics*
*Baylor College of Medicine at Texas Children's Hospital*
*Houston, Texas*

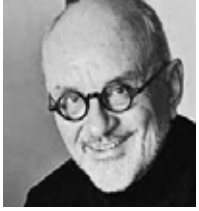
*Silvana Molossi, MD, PhD*
*Associate Professor*
*Department of Pediatrics*
*Division of Cardiology*
*Baylor College of Medicine at Texas Children's Hospital*
*Houston, Texas*

*Bingrui Chen, MS*
*Statistician*
*Rice University*
*Houston, Texas*

*David K. Stevenson, MD*
*Ann L. and Charles B. Johnson Director, Prematurity Research Center; Fmr. Vice Dean and Senior Associate Dean for Academic Affairs, Fmr. Senior Associate Dean for Maternal and Child Health, Fmr. Co-Director, Maternal and Child Health Research Institute*
*Stanford University School of Medicine*
*Stanford, CA*

*Corresponding Author*

*Kimberly Firestone, MS*
*Neonatal Respiratory Outreach Clinical Liaison at Akron Children's Hospital*
*Akron Children's Hospital · NICU*
*Akron, Ohio*
*Email:* kfirestone@akronchildrens.org



*Evan Richards*
*Advanced Practice Clinical Specialist*
*175 I Street*
*Salt Lake City, UT 84103*
*E-mail:* kerouac66@icloud.com

*Ann T. Ly, CGC*
*Genetic Counselor*
*Loma Linda University Health*

*Corresponding Author:*

*Scott D. Duncan, MD, MHA.*
*Professor and Chief*
*Division of Neonatal Medicine*
*University of Louisville*
*571 S. Floyd St.*
*Suite 342*
*Louisville, KY 40202*
*P:502-852-8470*
*F:502-852-8473*
*Email:*sddunc02@louisville.edu

***Corresponding Author***

*Subhadra Ramanathan MSc, MS, CGC*
*Assistant Professor*
*Loma Linda University School of Medicine*
*Division of Genetics*
*Department of Pediatrics*
*Email:* SRamanathan@llu.edu

***Corresponding Author***

*Michael Pitt, MD*
*Associate Chair for Faculty Development, Department of Pediatrics*
*Professor, Fellowship Program Director, Associate Residency Program Director, Division of Pediatric Hospital Medicine*
*University of Minnesota*
*Email:* mbpitt@umn.edu
*Office Phone: (612) 625-6678*

*Hua Wang, MD, PhD*
*Loma Linda University School of Medicine*
*Division of Genetics*
*Department of Pediatrics*

*Susana Rodríguez, MD*
*Adjunct Professor of Neonatology*

*Scientific Director*
*SIBEN, The Iberoamerican Society of Neonatology*
*email:* susana.rodriguez@siben.net

*Robin Clark, MD*
*Professor, Pediatrics*
*Loma Linda University School of Medicine*
*Division of Genetics*
*Department of Pediatrics*
*Email:*rclark@llu.edu

*María Teresa Montes Bueno, RN*
*Professor of Neonatology*
*Hospital Universitario*
*La Paz, Madrid, Spain*

*SIBEN, The Iberoamerican Society of Neonatology*
*Nursing Council, SIBEN,*
*email:* MariaTeresa.Montes.Bueno@siben.net

***Corresponding Author***

*Sergio G. Golombek, MD, MPH, FAAP*
*Professor of Pediatrics*
*Director, Neonatal-Perinatal Fellowship Program*
*SUNY Downstate Health Sciences University*
*Brooklyn, New York, USA*
*Professor of Neonatology & Chancellor*
*SIBEN, The Iberoamerican Society of Neonatology*
*email:* sergio.golombek@siben.net

*Marcelo Cardetti, MD*
*Adjunct Professor of Neonatology*
*Chief, Neonatology Service CERHU, San Luis, Argentina*

*Director of Programs and Projects*
*SIBEN, The Iberoamerican Society of Neonatology*
*email:* marcelo.cardetti@siben.net

*Lara Maksimovic*
*Director of Operations*
*SIBEN, The Iberoamerican Society of Neonatology*
*email:* lara.maksimovic@siben.net

*Maria Elena Venegas, MD*
*Neonatologist Pediatrician, Intensive Care Unit.*
*Postgraduate Professor, Universidad del Norte.*

*María de Lourdes Lemus Varela, MD*
*Professor of Neonatology*
*Hospital de Pediatría, IMSS*
*Guadalajara Jalisco, Mexico*

*SIBEN, The Iberoamerican Society of Neonatology*
*email:* lulalemus@gmail.com

***Corresponding Author***

*Joseph B. Philips, III, MD*
*Professor of Pediatrics*
*University of Alabama at Birmingham*
*Email:* jphilips@uabmc.edu

*Augusto Sola, MD*
*Emeritus Professor of Neonatology*

*General Director*
*SIBEN, The Iberoamerican Society of Neonatology*
*email:* augusto.sola@siben.net

*Corresponding Author*

*Juan Sebastian Pimienta Parra, MD.*
*Phone: (+57) 3215088333*
*Fax:(+57) 3215088333*
*Postal address: Barranquilla, Colombia. 080020*
*Email:* sjpimienta@uninorte.edu.co

*Kiran Depala*
*Department of Public Health*
*Saint Louis University*
*St. Louis, MO, United States*
*email:* kiran.depala@slu.edu

*Nesly Lorena Velandia, MD*
*Neonatologist Pediatrician, Intensive Care Unit.*
*Postgraduate Professor, Universidad del Norte.*

*Adriana Hernandez MD*
*Neonatology*
*John H. Stroger Jr. Hospital of Cook County*
*Chicago, IL, United States*
*email:* adria-na.portela@cookcountyhhs.org

*Corresponding Author*

*Janardhan Mydam, MD*
*Neonatology*
*John H. Stroger Jr. Hospital of Cook County*
*Chicago, IL, United States*
*email:* mydamj@gmail.com

*Rohan Parvathala*
*Department of Biostatistics*
*Saint Louis University, St. Louis, MO*
*United States*
*email:* rohanheat8@gmail.com

*Nihal Paidipelly*
*Chicago Medical School*
*North Chicago, IL*
*United States*
*email:* nihal.paidipelly@my.rfums.org

*Corresponding Author*

*Joseph B. Philips, III, MD*
*Professor of Pediatrics*
*University of Alabama at Birmingham*
*Email:* jphilips@uabmc.edu

*Sarah Ampalloor*
*New York Medical College*
*Valhalla, NY*
*United States;*
*email:* Sampalloor@gmail.com

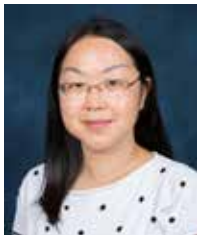
*Marilyn B. Escobedo, MD, FAAP*
*Professor and Reba McEntire Chair Emeritus*
*Neonatal Perinatal Medicine, Pediatrics*
*University of Oklahoma*
*Email* marilyn-escobedo@ouhsc.edu

*Sarah Bhagudas*
*St. George's University School of Medicine*
*Grenada, West Indies*
*email:* sarahdas8@gmail.com

*Corresponding Author*

*Monica V. Collins, RN, BSN, MaEd*
*Research Nurse Manager*
*University of Alabama at Birmingham*
*Birmingham, Alabama*

**Corresponding Author**



*Ting Wei, MD, PhD;*
*Neonatology*
*University of Alabama at Birmingham*
*Birmingham , Alabama*

*Corresponding Author*

*Carolina Michel Macías, MD*
*Neonatología, Pediatricares*
*Hospital Ángeles Centro Sur*
*Querétaro, México.*
*Email:* carolina.michelmacias@mcgill.ca

*Amelia Schuyler, MD,*
*Neonatology*
*University of Alabama at Birmingham*
*Birmingham , Alabama*

*Dr. Andrés Vázquez de la Isla*
*Pediatrician and Neonatologist at PEDIATRICARES*
*Hospital Ángeles Centro Sur,*
*Querétaro, México.*
*Email:* pediatricares@gmail.com

*Vivian Valcarce Luaces, MD;*
*Neonatology*
*University of Alabama at Birmingham*
*Birmingham , Alabama*

*Dr. Luis Chávez Talamantes*
*Pediatric Surgery*
*Pediatric Urologic Surgery*
*Hospital Star Médica*
*Querétaro, México.*

*Dr. Alberto Vázquez Salazar*
*Obstetrician and Gynecologist*
*Maternal-Fetal Medicine at IPRENATAL*
*Hospital Ángeles Centro Sur*
*Querétaro, México.*
*Email:* citasprenatal@gmail.com

*Laura Rose, MD*
*Post Graduate Year 6 Neonatal-Perinatal Fellow*
*University of California San Diego School of Medicine*
*Rady Children's Hospital San Diego*
*Email:* l2rose@health.ucsd.edu

***Corresponding Author***

*Christy Gliniak, PhD, OTR/L, CNT, CPXP, NTMTC*
*Associate Professor, Fielding Graduate University*
*Neonatal Therapist*
*Communications Manager/Conference Co-Chair*
*National Association of Neonatal Therapists® (NANT)*
*Email:* christyg@neonataltherapists.com

***Corresponding Author***

*Katherine Nyman, MD*
*Assistant Professor of Pediatrics*
*University of California San Diego School of Medicine*
*Rady Children's Hospital San Diego*
*Email:* Knyman@health.ucsd.edu

*Daniel Ault, MD*
*Post Graduate Year 2 OB/GYN Resident*
*Universal Health Services Health Education Consortium*
*Email:* daniel.ault@uhsinc.com

*Dr. Jaen Echavez Del Riego*
*Pediatric Surgery*
*Pediatric Oncologic Surgery*
*Hospital Star Médica*
*Querétaro, México.*
*Email:* drjechavezcirped@gmail.com

*Pamela C. Petersen, MD, FAAP*
*Assistant Professor of Pediatric Critical Care Medicine*
*Associate Medical Director of Mission Control*
*Division of Critical Care Medicine*
*Department of Pediatrics*
*Baylor College of Medicine at Texas Children's Hospital*
*6651 Main Street, MCE1420*
*Houston, Texas 77030*
*email:* Pamela.Petersen@bcm.edu

*Parag Jain, MD*
*Director of Clinical Research*
*Division of Critical Care Medicine;*
*Division of Cardiology*
*Associate Professor*
*Department of Pediatrics*
*UT Southwestern Medical Center*
*Dallas, TX*

*Maria Teresa Valenzuela, MD*
*Division of Critical Care Medicine*
*Department of Pediatrics*
*Baylor College of Medicine at Texas Children's Hospital*
*Houston, Texas*

*Rocky Tsang, MD*
*Assistant Professor of Pedaitrics*
*Medical Director of the Sungle Ventricle Program*
*Division of Critical Care Medicine*
*Department of Pediatrics*
*Baylor College of Medicine at Texas Children's Hospital*
*Houston, Texas*

*Mubbasheer Ahmed, MD*
*Associate Professor*
*Division of Critical Care Medicine*
*Department of Pediatrics*
*Baylor College of Medicine at Texas Children's Hospital*
*Houston, Texas*

*Meghan Anderson, CPNP-AC*
*Division of Cardiology*
*Department of Pediatrics*
*Baylor College of Medicine at Texas Children's Hospital*
*Houston, Texas*

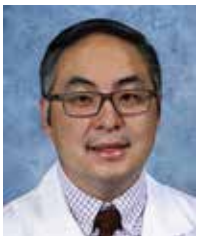

*Corresponding Author*

*Raouth R. Kostandy, PhD, MSN, RN, CKC*
*JoAnn Gay Dishman School of Nursing*
*Lamar University*
*Beaumont, TX*
*email:* rrkostandy@yahoo.com

*Susan M. Ludington-Hoe, PhD, RN, F-CNM, CKC, FAAN*
*Professor*
*Carl W. and Margaret Davis Walters Professor Emeritus of Pediatric Nursing*
*Frances Payne Bolton School of Nursing*
*Case Western Reserve University*
*Cleveland, OH*

*Abdus Sattar, PhD, MS.*
*Professor of Biostatistics in the Department of Population and Quantitative Health Sciences*
*Case Western Reserve University School of Medicine*
*Cleveland, OH*

**Corresponding Author**



*Larry Ngo, MD*
*Assistant Professor of Pediatrics*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics Loma Linda, CA*

*Email: LANgo@llu.edu*

*Nihaal Shah, DO*
*Valley Children's Hospital*
*Madera, CA*

**Corresponding Author**

*Erika Goyer*
*Family Advocate*
*Director of Communications,*
*National Perinatal Association*
*Co-Chair NPA 2019 conference*
*egoyer@nationalperinatal.org*

Corresponding Author

*Andrea M. Cevasco-Trotter, PhD, MT-BC*
*Fellow*
*Institute for Infant & Child Medical Music Therapy*
*The University of Alabama*
*Box 870366*
*Tuscaloosa, AL 35487-0366*
*Office: 205-348-7804*
*Email: amtrotter@ua.edu*

**Corresponding Author**

*Destiny Stokes, MPH*
*First Candle*
*New Canaan, CT*
*email: destiny@firstcandle.org*

*Amy M. Robertson, PhD, MT-BC*
*Fellow*
*Institute for Infant & Child Medical Music Therapy*
*University of Missouri-Kansas City*

*Ama Atiedu, MS, MSOD*
*A-Cubed Consulting, Atlanta, GA*
*email: ama.atiedu@a-cubedconsulting.com*

Corresponding Author

*Larry Ngo, MD*
*Assistant Professor of Pediatrics*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics Loma Linda, CA*
*Email: LANgo@llu.edu*

*Mattie F. Wolf, MD, MSc*
*Department of Pediatrics*
*Division of Neonatal-Perinatal Medicine*
*Emory University School of Medicine and Children's Healthcare of Atlanta*
*Atlanta, GA*

**Corresponding Author**

*Bibiana Chinea Jiménez, PNP, PhD.*
*Enfermera de Ensayos Clínicos, Instituto de Investigación Sanitaria Biobizkaia. Profesora Asociada de Neonatología y Miembro del Capítulo de Enfermería, Sociedad Iberoamericana de Neonatología (SIBEN®). Cruces Plaza, 48903 Barakaldo, Bizkaia. e-mail:* bibiana.chineajimenez@bio-bizkaia.eus
*teléfono: +34945236377.*
*ORCID: 0000-0003-3655-9423)*

*Corresponding Author*

*Dr Ross Sommers*
*CEO/ founder*
*Firstday Healthcare*
*Email:* ross.sommers@firstday.health

**Corresponding Author**

*Dr Robert Koppel-*
*Chief Medical Officer*
*Firstday Healthcare*

**Corresponding Author**

*Dr Carla Cangemi*
*St. Mary's Pediatric*

**Corresponding Author**

*Dennis T. Costakos, M.D.*
*Assistant Professor of Pediatrics (Neonatology)*
*Mayo Clinic Alix School of Medicine*
*Rochester, Minnesota*
*email:* costakos.dennis@mayo.edu

**Corresponding Author**

*Hima Bindu Bhaskar, MD*
*Independent Researcher(Usmle Aspirant);*
*Former Consultant Pediatrician, Asian Hospitals, Andhra Pradesh, India*
*Email:* himabindubhaskar9@gmail.com

*Corresponding Author:*

*Scott D. Duncan, MD, MHA*
*Professor and Chief*
*Division of Neonatal Medicine*
*University of Louisville*
*571 S. Floyd St.*
*Suite 342*
*Louisville, KY 40202*
*P:502-852-8470*
*F:502-852-8473*
*Email:sddunc02@louisville.edu*

*Augusto Sola, MD.*
*General Director and Professor of Neonatology, Ibero-American Society of Neonatology (SIBEN®).*
*E-mail: augusto.sola@siben.net,*
*Phone: +1-561-319-2351.*
*ORCID: 0000-0002-7608-3872*



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*Corresponding Author*

*Shetal Shah, MD, FAAP*
*Professor of Pediatrics/Neonatology*
*Division of Neonatology, Stem Cell Liaison*
*Maria Fareri Children's Hospital, New York Medical College*
*Division of Neonatology*
https://bchp.childrenshospital.org/practices/neonatology
*Boston Children's Health Physicians | New York & Connecticut*
*100 Woods Road NICU Rm#C2225A Valhalla, NY 10595*
*Email:* shahs2@wcmc.com

*Corresponding Author*

*Jenné Johns, MPH*
*Mother of a micropreemie, author, speaker, advocate, and national senior health equity leader*
*emaii:* info@onceuponapreemie.org

*Janene H. Fuerch, MD*
*Clinical Associate Professor of Pediatrics*
*Division of Neonatal and Developmental Medicine*
*Stanford University School of Medicine*
*Co-Director, Impact1 / Stanford Pediatric Device Consortium*
*Associate Director, Stanford Biodesign Innovation Fellowship*
*Medical Director,*
*Neonatal ECMO at Stanford Children's Hospital*
*Email:* jfuerch@stanford.edu

*Corresponding Author*

*Dr. R. Kishore Kumar, MBBS, DCH (London), MD (Paed), FRCPCH (UK), FRACP (Australia)*
*Consultant Neonatologist & Paediatrician, Cloudnine Hospitals, Bangalore, INDIA*
*& Adjunct Professor in Neonatology & Paediatrics, Notre Dame University, Perth, Australia*
*Consultant Neonatologist &Paediatrician, Cloudnine Hospital*
*1533, 3rd Block Jayanagar, 9th Main, Bangalore - 560011, INDIA.*
*Tel: +919900155001*
*E-mail:* drkishore@cloudninecare.com

*Corresponding Author*

*Brenda Takata, OTR/L, MHA, SWC, NLP*
*Occupational Therapist - Clinical Therapist on the NICU*
*Emanate Health - Queen of the Valley Hospital*
*West Covina, CA*
Email: brenda_takata@att.net

***Corresponding Author***

*Mahesh L. Sampat, BASc*
*Founder,*
*Metrology Services,*
*Lakewood, California*
*Email:* metrologys@aol.com

*Shaina Khan Lodhi, MD*
*Assistant Professor of Pediatrics*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics Loma Linda*, CA
*Email: SLodhi@llu.edu*

***Corresponding Author***

*Dr. R. Kishore Kumar, MBBS, DCH, MD, FRCPCH, FRACP*
*Consultant Neonatologist & Paediatrician*
*Cloudnine Hospitals*
*1533, 3rd Block Jayanagar, 9th Main*
*Bangalore - 560011, INDIA.*
*Tel: +919900155001*
*E-mail: kishkum@gmail.com*
*Adjunct Professor in Neonatology & Paediatrics*
*Notre Dame University*
*Perth, Australia*

*Dr Avantika Dhanawat, MBBS, MD*
*Fellow( Neonatology) IAP*
*Junior Consultant Neonatologist & Paediatrician*
*Cloudnine Hospital*
*Jayanagar Bangalore, India*

***Corresponding Author***

*Leslie Caldarelli, MD*
*Medical Director, Neonatal Intensive Care Unit, Northwestern Medicine's Prentice Women's Hospital*
*Associate Professor of Pediatrics (Neonatology), Northwestern University Feinberg School of Medicine*
*Ann & Robert H. Lurie Children's Hospital of Chicago*
*225 E. Chicago Ave.*
*Chicago, Illinois 60611*

*Matthew Pellerite, MD*
*Attending Neonatologist*
*Department of Pediatrics*
*Northshore University Medical Group*
*Evanston, IL 60201*
*Assistant Clinical Professor of Pediatrics*
*Pritzker School of Medicine, University of Chicago*
*Chicago, IL*
mpellerite@peds.bsd.uchicago.edu

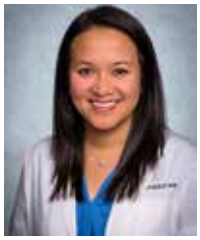
*Corresponding Author*

*Tomohisa Fujimoto, B.A.*
*Manager, First Rehabilitation Section, Japanese Red Cross Society Himeji Hospital;*
*Director, Japan National NIDCAP Training Center*
*Email: fusan.mail@gmail.com*

*Shohei Ohgi, RPT, MS, PhD*
*Professor, Seirei Christopher University;*
*President, Japan DC Research Association*
*Email: shohei-o@seirei.ac.jp*

*Lolita Alcocer Alkureishi, MD*
*Associate Professor of Pediatrics*
*Assistant Director,*
*Ambulatory Care Residency Program*
*Director, Pediatric Clerkship*
*The University of Chicago Medicine*
*5841 S. Maryland Avenue*
*Chicago, IL 60637*

***Corresponding Author***



*Thanh L. Summerlin, MD*
*Assistant Professor of Pediatrics*
*Division of Neonatology*
*University of Alabama at Birmingham & Children's of Alabama*
*Email:* tsummerlin@uabmc.edu

*Corresponding Author:*

*Kara Wong Ramsey, MD*
*Neonatologist and Assistant Professor of Pediatrics*
*University of Hawaii John A Burns School of Medicine*
*Division of Neonatology*
*Kapiolani Medical Center for Women and Children*
*Honolulu, HI*
*Email:* Kara.wongramsey@hphmg.org

*Corresponding Author:*

*Kate Peterson Stanley, MD, FAAP*
*Medical Director of Revenue Integrity*
*CS Mott Children's and Von Voigtlander Women's Hospitals*
*Clinical Associate Professor*
*Division of Neonatal-Perinatal Medicine Department of Pediatrics*
*University of Michigan Medical School Michigan Medicine*
*8-621 CS Mott 1540 E. Hospital Dr., SPC4254 Ann Arbor, MI*
*48109-4254 Phone: 734-763-4109*
*Email:* katest@med.umich.edu

***Corresponding Author:***

*Bianca Urness*
*Third Year Osteopathic Medical Student*
*College of Osteopathic Medicine of the Pacific*
*Western University of Health Sciences*
*303-520-2885*
*Email:* bianca.urness@westernu.edu

***Corresponding Author***

*Julia Giesen, M.Sc., R.SLP, S-LP (C)*
*Feeding and swallowing specialist in the Stollery Children's Hospital's Philip C. Etches Neonatal Intensive Care Unit (NICU)*
*Adjunct Professor in the Department of Communication Sciences and Disorders at the University of Alberta, Canada*
*Kangaroo Care Celebration facilitator*

*Anthony Shoo, MD*
*Assistant Professor*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics*
*Loma Linda University Childrens Hospital*
*Loma Linda, CA*
*Email:* ashoo@llu.edu

***Corresponding Author***

*Cassandra McLennan, R.N., I.B.C.L.C.*
*Philip C. Etches NICU, Edmonton, Alberta, Canada*
*Kangaroo Care Celebration facilitator*

***Corresponding Author***

*James Greenberg, MD*
*Co-Director, Perinatal Institute*
*Cincinnati Children's Research Foundation*
*Professor of Pediatrics*
*University of Cincinnati College of Medicine*
*Cincinnati, OH*
*email:* James.Greenberg@cchmc.org

*Christine Wade, BSN, RN*
*Arizona Neonatology/Pediatrix Medical Group*
*Neonatal Intensive Care Unit,*
*Banner – University Medical Center Phoenix*
*Phoenix, AZ*
*Email: Christine.Wade@pediatrix.com*

*Kartik Mody, MD*
*Arizona Neonatology/Pediatrix Medical Group*
*Neonatal Intensive Care Unit,*
*Banner – University Medical Center Phoenix*
*Phoenix, AZ*
*Email: Kartik.Mody@pediatrix.com*

*Julianna Diddle, MD*
*Phoenix Children's Pediatric Residency Program*
*Phoenix Children's Hospital*
*Phoenix, AZ*
*Email: jdiddle@phoenixchildrens.com*

*Corresponding Author*

*Destiny Stokes, MPH*
*Program Director*
*First Candle*
*21 Locust Avenue, Suite 2B*
*New Canaan, CT 06840*
*Email: destiny@firstcandle.org*

*Reese Clark, MD*
*The Pediatrix Center for Research, Education, Quality, and Safety,*
*Pediatrix Medical Group*
*Sunrise, FL 33323*
*Reese.Clark@pediatrix.com*

***Corresponding Author***

*Robert Cicco, MD*
*Retired Neonatologist*
*Pittsburgh, PA*

*Corresponding Author*

*Bridget Davern, BA*
*M Health Fairview Masonic Children's Hospital*
*Minneapolis, MN*
*667 Harriet Avenue*
*Shoreview, MN 55126*
*651-343-9333*
*Email: bridget@davern.org*

***Corresponding Author***

*Robert D. White, MD*
*Director, Regional Newborn Program*
*Beacon Children's Hospital*
*615 N. Michigan St.*
*South Bend, IN 46601*
*Phone: 574-647-7141*
*Fax: 574-647-3672*
*Email: Robert_White@pediatrix.com*

*James Gray, MD, MS*
*Geisel School of Medicine at Dartmouth*
*Hanover, NH*
*Children's Hospital at Dartmouth*

*Valerie Tran, MD*
*Resident, PGY2*
*Department of Pediatrics,*
*Loma Linda University School of Medicine*

***Corresponding Author***

*Gabrielle A. Pina, DO*
*Assistant Professor*
*School of Medicine*
*General Pediatrics Division*
*Loma Linda University Children's Hospital*
*OrcidID: https://orcid.org/0009-0009-1763-0096*
*Email: GAPina@llu.edu*

*Becky Micetic, BSN, RN*
*Arizona Neonatology/Pediatrix Medical Group*
*Neonatal Intensive Care Unit,*
*Banner – University Medical Center Phoenix*
*Phoenix, AZ*
*Email: Becky.Micetic@pediatrix.com*

**Corresponding Author**

*Samantha Butler, PhD*
*Department of Psychiatry and Behavioral Sciences*
*Boston Children's Hospital*
*1 Autumn Street, room 335 Boston, MA 02115.*
*Department of Psychiatry (Psychology) Harvard Medical School, Boston, MA, United States.*
*Email:* samantha.butler@childrens.harvard.edu

*Dorothy Vittner, PhD, RN, FAAN*
*Egan School of Nursing and Health Studies*
*Fairfeld University, Fairfeld, CT*
*Connecticut Children's Medical Center, Hartford, CT*
*Email:* dvitt8@gmail.com

*Corresponding Author*

*Christie Sander*
*Cofounder, President, COO*
*Kismet Health*
*Oakland, California 94608*
*+1.517.927.3358*
*email:* christie@kismethealth.com

*Kaitlyn Ludder, M.Sc.*
*Boston Children's Hospital*
*1 Autumn Street, Boston, MA 02115.*
*Department of Cardiology*
*Email:* kaitlyn.ludder@childrens.harvard.edu

*Cierra Gromoff*
*Cofounder, President, CEO*
*Kismet Health*
*Oakland, California 94608*
*+1 650-229-8270*

**Corresponding Author**

*Anvita Ambardekar*
*Woodbridge High School (Class of 2026)*
*Irvine, CA*
*International Children's Advisory Network (iCAN).*
*Email:* ambardekar.anvita@gmail.com

*Suzanne Staebler, DNP, NNP-BC*
*Professor*
*Director, Neonatal Nurse Practitioner*
*Nell Hodgson Woodruff School of Nursing*
*Emory University 1520 Clifton Road, NE*
*Atlanta, GA 30322-4027*
*Email: suzanne.staebler@emory.edu*

***Corresponding Author***

*Jennifer Shin, MS*
*Pediatric Genetics Counselor*
*Loma Linda University Medical Center*
*Loma Linda, CA*
*Email:* jennifershin@llu.edu

***Corresponding Author***

*Susan Hepworth*
*Director, Emeritus*
*National Coalition for Infant Health*
*2020 K Street NW, Suite 505*
*Washington, DC 20006*
*Email:* info@infanthealth.org

*Durga Cherukuri, Ph D*
*Chief of Clincal Genetics*
*Department of Pathology, Molecular Laboratory*
*Loma Linda University School of Medicine*

***Corresponding Author***

*Jessica Daigle, MD, FAAP*
*NICU Consultant| I help companies & organizations serving NICU families strengthen their services, support, and impact| Neonatal Hospitalist serving 10 states | NICU Grad Specialty Clinic | Life Coach| NICU Mom*
*Atlanta, GA*
*Email:* drjessdaiglemd@gmail.com

*Corresponding Author*

*Francis Chan, MD*
*Department Chair*
*Department of Pediatrics*
*Division of Medical Informatics*
*Loma Linda University School of Medicine*
*Email: FChan@llu.edu*

**Corresponding Author**

*Lindsay Cox, MPM*
*Director,*
*National Coalition for Infant Health*
*2020 K Street NW, Suite 505 | Washington, DC 20006*
*Email:* LCox@infanthealth.org
*Phone: (202) 951-7098*

*Jennifer Hofherr, MS, OTR/L, CNT*
*NIDCAP Trainer*
*Neonatal Therapy Program Manager*
*Nationwide Children's Hospital*
*Email:* jennifer.hofherr@nationwidechildrens.org

**Corresponding Author**

*Rosemarie Bigsby, ScD, OTR/L, FAOTA*
*Clinical Professor Emeritus of Pediatrics*
*The Warren Alpert Medical School of Brown University*
*Email:* rosemarie_bigsby@brown.edu

*Corresponding Author*

*Alejandra Valladolid, MD*
*Neonatalogist*
*Banner – University Medical Center Phoenix*
*Arizona Neonatology/Pediatrix Medical Group*
*4722 N. 24th St. Suite 100, Phoenix, AZ, 85016,*
*Phone: 602-839-7412*
*Fax: 602-839-7325*
*Email:* Alejandra.Valladolid@pediatrix.com

**Corresponding Author**

*Kimberly Hillyer, PhD, RN, DNP*
*Neonatal Nurse Practitioner*
*Neonatal Intensive Care Unit*
*Loma Linda University Health Advanced Care Practice Services*
*Email:* KHillyer @llu.edu

*Debra Paul, BS, OTR/L*
*Clinical Practice Specialist, Quality and Patient Safety*
*Division of Occupational and Physical Therapy, Rehabilitation and Therapy Services Line*
*NIDCAP Professional/Developmental Specialist*
*Children's Hospital Colorado*
*Email:* debra.paul@childrenscolorado.org

***Corresponding Author***

*Benjamin Hopkins, DO*
*Pediatric Resident*
*University of California, San Francisco*
*Community Regional Medical Center*
*Valley Children's Hospital*
*Email:* Benjamin.hopkins@ucsf.edu

*Corresponding Author*

*Renee Boss MD MHS*
*Rembrandt Foundation Professor of Pediatric Palliative Care*
*Professor, Division of Neonatology*
*Berman Institute of Bioethics*
*Johns Hopkins School of Medicine*
*200 N. Wolfe St., Rm. 2019*
*Baltimore, MD 21287*
*410-614-6444 (ph)*
*410-955-0298 (f)*
Email: rboss1@jhmi.edu

*Corresponding Author*

*Jay P. Goldsmith, M.D.*
*Clinical Professor of Pediatrics*
*Tulane University School of Medicine*
*4740 S I-10 Service Rd, West, Suite 120*
*Metairie, LA 70001*
*Email:* jgoldsmi@tulane.edu

*Emily Batton, MD*
*Assistant Professor of Pediatrics*
*Division of Neonatology, LLUCH*
*NICU Medical Director, RUHS*

*Nicholas P. Callahan, IV*
*MS3*
*University of Alabama*
*Birmingham, AL*

***Corresponding Author***

*Kimberly Hillyer, PhD, RN, DNP*
*Neonatal Nurse Practitioner*
*Neonatal Intensive Care Unit*
*Loma Linda University Health Advanced Care Practice Services*
*Email:* KHillyer @llu.edu

# The Gap Baby: An RSV Story


*Corresponding Author*

*Donald Null, MD*
*Professor of Pediatrics*
*Division of Neonatology*
*Department of Pediatrics*
*University of California, Davis*
*'Email* dnull159@gmail.com

*Mitchell Goldstein, MD, MBA, CML*
*Professor of Pediatrics*
*Division of Neonatology*
*Department of Pediatrics*
*Loma Linda University School of Medicine*
*Email:*mgoldstein@llu.edu

*Arun Pramanik, MD*
*Professor of Pediatrics*
*Division of Neonatology*
*Department of Pediatrics*
*Louisiana State University*

*Corresponding Author*

*Laura Farach, MD*
*Pediatrician*
*Email:* Dralaurif@gmail.com

*Corresponding Author*

*Erin Barnett, PhD*
*Associate Professor*
*Dartmouth University*
*Dartmouth Health and West Central Behavioral Health*
*Email:* Erin.r.barnett@dartmouth.edu

**Corresponding Author**

*Kelly Welton-Lewis, BA, RRT-NPS*
*Academy of Neonatal Care*
*www.AcademyofNeonatalCare.org*
*877-884-4587*
*https://www.linkedin.com/in/kelwel*
*email: kelwelrt@gmail.com*

**Corresponding Author**

*Jonathan K. Muraskas, M.D.*
*Professor of Pediatrics*
*Co-director, Neonatal ICU*
*Director, Neonatal-Perinatal Research*
*Loyola University Medical Center*
*2160 S First Ave*
*Maywood, Illinois 60153*
*email: JMURASK@lumc.edu*

**Corresponding Author**

*Jay P. Goldsmith, M.D.*
*Clinical Professor of Pediatrics*
*Tulane University School of Medicine*
*4740 S I-10 Service Rd, West, Suite 120*
*Metairie, LA 70001*
*Email: jgoldsmi@tulane.edu*

*Corresponding Author*

*Benjamin Hopkins, OSM IV*
*Fourth Year Medical Student*
*College of Osteopathic Medicine of the Pacific*
*Western University of Health Science*
*Pomona, CA*
*Email: benjamin.hopkins@westernu.edu*

**Corresponding Author**

*Keira Sorrells*
*Mom of 25-weeker triplets*
*Founder & Executive Director, NICU Parent Network*
*Family Partner Co-Chair, FCC Taskforce*
*Email: keira@nicuparentnetwork.org*

*Munaf Kadri, MD*
*Assistant Professor of Pediatrics*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics*
*Loma Linda University Children's Hospital*
*Loma Linda, CA*

*Elba Fayard, MD*
*Professor of Pediatrics*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics*
*Loma Linda University Children's Hospital*
*Loma Linda, CA*

*Melissa Scala, MD*
*Clinical Associate Professor*
*Lucile Packard Children's Hospital*
*Stanford University*
*725 Welch Road*
*Palo Alto, CA 94304*

*Nicole J Kraus, DO*
*Assistant Professor of Pediatrics*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics*
*Loma Linda University Children's Hospital*
*Loma Linda, CA*

*Kristy Love*
*Parent Advocate*
*National Perinatal Association*

*Angela Patterson, MD FAAP*
*Attending Neonatologist MedStar Montgomery Medical Center/*
*Georgetown University Hospital*
*Assistant Professor*
*Cura Personalis Fellow*
*Department of Pediatrics/Perinatal-Neonatal Medicine*
*Georgetown University School of Medicine*
*Email:* Angela.M.Patterson@medstar.net

*Cristal Grogan*
*Parent Advocate*
*National Perinatal Association*

*Colleen A. Kraft, MD, MBA, FAAP*
*Professor of Pediatrics*
*Keck School of Medicine at the University of Southern California*
*2018 President, American Academy of Pediatrics*
*Division of General Pediatrics*
*Children's Hospital Los Angeles*
*4650 Sunset Blvd., MS #76 | Los Angeles, CA 90027*

*Corresponding Author*

*Noel D. Tan, MD*
*Neonatologist*
*Envision Healthcare*
*email:* noeldtan.md@gmail.com

*Donald Null, MD*
*Professor Emeritus*
*Department of Pediatrics*
*University of Utah*
*Salt Lake City, UT*

*Lolita Alcocer Alkureishi, MD*
*Associate Professor of Pediatrics*
*Assistant Director,*
*Ambulatory Care Residency Program*
*Director, Pediatric Clerkship*
*The University of Chicago Medicine*
*5841 S. Maryland Avenue*
*Chicago, IL 60637*

*T.Allen Merritt, MD, MHA*
*Professor of Pediatrics*
*Loma Linda University School of Medicine*
*Division of Neonatology*
*Department of Pediatrics*
*email:* allenmerritt.md@gmail.com

***Corresponding Author***

*Howard Cohen, MD*
*Oregon City, OR*
*email:* howardcohen60@gmail.com

**Corresponding Author**

*Morgan Kowalski*
*Program Manager*
*Family Partner*
*Family Centered Care*
*Division of Neonatology*
*Department of Pediatrics*
*Stanford University*
*Palo Alta, CA*
*Email:* morgankw@stanford.edu

*Jessi Barnes, MSN, RN, RNC-NIC, NPD-BC, C-ELBW*
*Neonatal Outreach Coordinator,*
*Atlanta Perinatal Region*
*Emory University School of Medicine, Department of Pediatrics*
*NICU Clinical Nurse Educator*
*Grady Memorial Hospital*
*NICU Parent*

## Endnotes

*Mia Malcolm, BS, CDFT*
*Community Outreach & Programs Care Manager,*
*Ollie Hinkle Heart Foundation*
*Senior Research Coordinator,*
*Washington University School of Medicine*
*Clinical Research Coordinator,*
*Stanford University School of Medicine*

**Corresponding Author**

*Houchang D. Modanlou, MD*
*Professor of Pediatrics/Obstetrics and Gynecology*
*University of California Irvine*
*Irvine, CA*
*Professor of Pediatrics*
*Loma Linda University*
*Loma Linda, California*
*email:* modanlou@uci.edu

**Corresponding Author**

*Robert Cicco, MD*
*Retired Neonatologist*
*Pittsburgh, PA*
*Email:* tririver818@gmail.com

*Corresponding Author*

*Carolyn TenEyck, RN*
*Senior Director, Patient & Family Advocacy*
*AngelEye Health*
*Email:* cteneyck@angeleyehealth.com

**Corresponding Author**

*Benjamin Hopkins, DO*
*Pediatric Resident*
*University of California, San Francisco*
*Community Regional Medical Center*
*Valley Children's Hospital*
*Email:* Benjamin.hopkins@ucsf.edu

**Corresponding Author**

*Dr. R. Kishore Kumar*
*Founder-Chairman and Executive Director*
*MBBS , DCH (Mysore), MD (Paed, India), FNNF (India), FIAP, DCH (London), MRCP (Paed, U.K.), MRCP (Ireland), FRCPCH (U.K.), Sabbatical at Johns Hopkins (U.S.A.), FRCPI, FRACP (Australia), Management in Healthcare Delivery (Harvard Business School, U.S.A.),*
*Chief Neonatologist, Cloudnine Group of Hospitals, INDIA*
*Founder Chairman & Executive Director, Cloudnine Group of Hospitals, INDIA*
*Chairman, Cloudnine Foundation, INDIA*
*Adjunct Professor of Neonatology, Notre Dame University, PERTH, AUSTRALIA*
*Email:* drkishore@cloudninecare.com

**Corresponding Author**

*Jan M. Bult*
*President Emeritus,*
*Plasma Protein Therapeutics Association*
*Email:* janmbult@jmbconsultancy.nl

**Corresponding Author**

*Bernice Quesenberry |*
*Founder, CEO & President,*
*Chasing the Rainbows*
*Maternal & Mental Health Advocate*
*Supporting all in the U.S.*
*Phone (717) 801-1518*
*Email:* Bernice@chasingtherainbows.org
*Website:* chasingtherainbows.org

**Corresponding Author**

*Sandro Shubladze*
*Founder & CEO — Datamam*
*Sandro's Profile*
linkedin.com/in/sandroshubladze

**Corresponding Author**

*Houchang D. Modanlou, MD*
*Professor of Pediatrics/Obstetrics and Gynecology*
*University of California Irvine*
*Irvine, CA*
*Professor of Pediatrics*
*Loma Linda University*
*Loma Linda, California*
*email:* modanlou@uci.edu