

Gravens By Design: Common Questions for Designing Today's State-of-the-Art NICU

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Abstract:

This article guides NICU stakeholders and others planning new construction, renovation, or evaluation of NICU design. The author poses six common questions related to the strategic and facility planning of a NICU. Responses to these questions are provided within the context of current thinking, best practices, and emerging trends. Keeping up with information about planning state-of-the-art NICUs helps achieve more informed decisions and better designs.

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The annual Gravens Conference includes a design track where NICU participants, families, researchers, planners, architects, and others share evidence-based design, experience, and new ideas. Stories abound about NICU stakeholders who arrived at the conference with design plans in hand and then went home with changed plans when rich discussions and research illuminated their perspectives.

Over the years, the conference has framed common questions for planning today's NICU design. While questions and objectives may not have changed significantly, the responses have evolved with research and experience.

Well-informed decisions help achieve the best possible NICU design. This article elaborates on a few typical topics that arise early in planning a NICU project. This information might also help dispel myths about NICU design that could surface during design plan-

ning exercises.

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What NICU design models prevail?

NICUs continue to include more single-family room designs, the prevailing model for new construction in the United States (US). The movement to better control the high-risk infant's environment, such as lighting, noise, temperature, infection prevention, and privacy, began many decades ago. In the spirit of “form following function,” more NICUs continue to explore physical designs that better support practices related to developmental and family-centered care.

Many of today's newly constructed NICUs have all single or single and twin/triplet rooms exclusively. However, several hybrid models have emerged with a mix of multi-bed/multi-function rooms to address couplet care, babies without parents' presence, capacity surges, and other flexible uses. These multi-function rooms tend to be a smaller portion of the total beds in their NICUs than the percentage of single bedrooms.

While still prevalent, NICUs with mostly open ward designs are rare for recent new construction or major renovation in the US. According to a Vermont Oxford Network (VON) study of member NICUs, a large NICU group in North America, the number of NICUs that cared for 90+% of very low birth weight infants in single-family rooms climbed from 13% in 2009 to 27% by 2020. (1) Based on my knowledge of current projects in the planning phase, this proportion will increase as more facilities are refreshed or replaced.

1. What NICU design models prevail?
2. What sizes are today's NICU rooms and units?
3. What is the status of neonatal couplet care?
4. What factors are NICUs considering to decide on highly specialized versus universal design for patient care areas?
5. How are NICUs addressing the senses and neuroprotective best practices?
6. What's on the horizon for future NICU design?

When might NICUs need more square feet?	When might NICUs need less square feet?
<ul style="list-style-type: none"> • Couplet care rooms • Individual bathrooms • Universally sized for PICU/other patient care • Satellite pharmacy, large milk lab, MRI, simulation suite, OR, and other dedicated support services within NICU • Academic teaching center • Significant structural/circulation space 	<ul style="list-style-type: none"> <input type="checkbox"/> Centralized off-unit equipment and bed storage <input type="checkbox"/> Off-unit equipment cleaning <input type="checkbox"/> Off unit other spaces such as NICU offices and on-call rooms <input type="checkbox"/> Configured to share support space in ideally-sized clusters (e.g., groupings of 12 bed vs. small #s) <input type="checkbox"/> A significant amount of multi-bed rooms <input type="checkbox"/> Minimum room sizes are used - NICU is not providing high level III or Level IV capability

What sizes are today's NICU rooms and units?

Hot off the press, the Facilities Guidelines Institute (FGI) has released their 2022 publication that includes NICU design standards. (2) These standards are used or referenced as minimum codes for approximately 43 US states. These guidelines and their rationale were proposed by the consensus committee that develops *Recommended Standards for Newborn ICU Design (2019)*, (3) evaluated by FGI's Health Guidelines Revisions Committee, submitted for public comment, and accepted after thorough vetting.

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Minimum Size - NICU Patient Care

- 180 square feet clear floor area for single infant room - not room size
- 150 square feet clear each, if multiple infants are in the room

These sizes are minimum clear areas and not room sizes. Hospitals should size patient care areas based on how they function. Most large, newly-constructed units that I have been involved in planning include an average of 180-220 square feet in a single infant room. The highest risk, academic teaching hospital NICUs usually need more than the minimum square feet around the infant. Additional space is needed for more bedside procedures, learners, advanced equipment and therapies, parents, and other staff. Better sizing of NICUs can be accomplished by staff testing the proposed size and configuration by simulating activities in a “mocked up” space. Examples of simulated activities usually include patient transfers to resuscitation, parent participation in care, material/medication delivery, and bedside procedures.

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Another metric commonly reviewed during planning is departmental gross square feet (DGSF). Based on my experience with dozens of recent NICU projects, NICUs are built with 650-1,000 DGSF per bed. DGSF includes NICU “department” support spaces for clinical care, operation, and families. This space can vary widely. Below are examples that impact NICU department size.

What is the status of neonatal couplet care?

Neonatal couplet care rooms reduce the separation between hospitalized mothers and NICU babies compared to the traditional approach of moving mothers to a postpartum unit and their babies

Minimum Size - NICU Bed Area	Minimum Size - Postpartum Bed Area
<ul style="list-style-type: none"> • 180 square feet clear floor area for single infant room - not room size • 150 square feet clear each, if multiple infants in a room 	<ul style="list-style-type: none"> • 150 square feet clear floor area • Excludes bathroom, vestibule, wardrobe/closet, alcove, etc. • Bathroom required • Exterior window required

to a NICU after birth. The status for neonatal couplet care appears to be in an early adoption stage. As of early 2022, I have been able to identify the concept at hospitals in 15 US states, several European countries, and Canada. Iterations are emerging with different nomenclature and approaches. A few Swedish and US hospitals have operated neonatal couplet care in their facilities for two decades. The selection criteria and staffing model for using these rooms vary by NICU, as does the percentage of total patient beds that are designed for this model.

While operating standards are not widely standardized, the aforementioned FGI Guidelines (2022) provide design standards for the minimum size of a neonatal couplet care room.

“These rooms usually require 360-460 square feet each, which includes a minimum of 300 square feet clear for patient care and the remaining 60-160 square feet for the bathroom, fixed spaces such as columns, floor-based fixtures, family area, and staff workspace.”

These rooms usually require 360-460 square feet each, which includes a minimum of 300 square feet clear for patient care and the remaining 60-160 square feet for the bathroom, fixed spaces such as columns, floor-based fixtures, family area, and staff workspace. If the neonatal couplet care concept combines a labor/delivery/recovery/postpartum room (LDRP) and a NICU room, the minimum size increases significantly to accommodate labor and birth in addition to postpartum/NICU baby care. This combination model exists, but it is less common at this time. Most, but not all, stakeholders prioritized the adjacency between the neonatal couplet care rooms and the NICU rather than with the labor and delivery area or postpartum unit. Many of the latter areas had already offered mother/baby recovery and postpartum care for babies not requiring intensive care before adding neonatal couplet care.

What factors are NICUs considering to decide on highly specialized versus universal design for patient care areas?

The practice of building NICUs with multiple, differently-designed units based on acuity seems to have waned. Although it is still a practice, graduating and moving babies three or more times is less common now. New NICUs are often planned with more acuity-adaptable spaces that reduce the restrictions on where a baby

can be accommodated. Here are some of the reasons provided when a NICU has moved away from the more customized design by acuity:

- Desire for flexibility of patient care spaces when the mix of patients by acuity changes over time
- Standardized patient care spaces for medical safety/ease of practice for staff
 - ⑥ Fewer staff handoffs for safety considerations
 - ⑥ Consistent, familiar set-ups for staff to provide infant care from room to room
- Supports minimal patient movement for family satisfaction
- Balanced staffing, although patients can still be cohorted
- Perception of facility equity by families

Some NICUs include patient care spaces that are specialized by type of care. Several reasons provided for this practice have included:

- Customized for functions and sized/configured differently (e.g., ECMO, palliative care)
- Dedicated, separate space for sub-units or different levels of care
- Supports patient movement – desire to continue graduation approach
 - ⑥ Clear criteria for patient placement by area help parents understand facility differences
- Specialized staffing assigned to a subset of the NICU (intermediate care nurses who do not provide neonatal intensive care; staff specializing in cardiac, neuro, or small baby care)

Some NICUs provide a blend of mostly acuity adaptable with some specialized patient care spaces. With limited comparative research, the individual hospital usually relies on their research and circumstances regarding this question.

How are NICUs addressing the senses and neuroprotective best practices?

What are some of the state-of-the-art design topics that are common considerations related to protecting the fragile newborn’s brain and supporting sensory development? Planning teams should review the evidence through literature searches, studies, conferences, and expert panel discussions by medical professionals, scientists, NICU staff, and families. This high-level list of ideas are a few of the considerations that should be researched when designing a NICU.

- Lighting Innovations

- Programmable system – circadian rhythm considerations
- Indirect lights – not in the baby’s face
- Flicker/Spectrum/Lumen Metrics
- Auditory Exposure
 - Remove noxious sound and test noise using published threshold guidelines
 - Consistent parent/other voices – live and virtual
 - Music – distinguishing best practices for different uses of music: targeted music therapy, therapeutic music, and music exposure
- Touch
 - Skin-to-skin parent furniture/space
 - Making parent space comfortable
- Smell
 - Mom/parent scent
 - Aromatherapy
- Stimulation
 - Appropriate rather than disruptive
 - Sleep research
- Taste
 - Taste exposure during tube feeding
- NeuroProtection
 - Consultation with Brain Sensitive Care Committees and design to support Brain Protection Bundles
 - All of the above ideas and much more

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What is on the horizon for future NICU design?

Strategies are always subject to the context of the times and issues the hospital faces. Predicting the future is very difficult at best, but we have the wisdom of research and experience to guide decisions about future design. Here are a handful of emerging design ideas that are likely to become more mainstream in near-future NICUs.

- Changes in power and outlet requirements as energy solutions and devices evolve
 - ⑥ Virtual/wearables for notification and tracking
 - ⑥ Extinction of beeping monitors
 - ⑥ Voice-activated/biological communication

- Holographic wayfinding, welcoming, and education
- Scent cameras
- Parent-designed family space in the NICU, from layout and furniture to colors that better reflect the diversity and equity of NICU families
- Special delivery units aligned with NICUs and located in freestanding children’s hospitals

We must be on the lookout for emerging trends to make informed decisions. I believe that, similar to a statement known as Amara’s Law,(4) we can overestimate the impact of phenomena like neonatal couplet care in the short run but underestimate its long-term impact that could potentially transform neonatal care. While the chance for rapid, widespread success may be minimized due to the challenges of such a radical shift, it does not mean that this type of care might not take hold and transform practices in the future.

“More recent VON surveys show that the percentage of hospitals with mostly single room NICUs is closer to 30%, and signs indicate it will continue to evolve and grow in the long run, at least in industrialized countries. It may take a few more decades, but eventually, the noisy, open warehouse-type facilities for hospitalized premature and ill infants could become only history.”

A 2002 poll of the audience at the Graven’s Conference exemplifies this “law.” The participants were asked to predict the percentage of US hospitals likely to embrace single room NICUs in 15 years (by 2017). Approximately 41% of participants predicted that less than 20% of NICUs would go for the model. This percentage was the most frequent response. They were close in their prediction if you consider that VON research showed that 21% of NICUs reported single-room care for their smallest patients in 2016. In the short run, people estimated the barriers were too much for most hospitals. More recent VON surveys show that the percentage of hospitals with mostly single room NICUs is closer to 30%, and signs indicate it will continue to evolve and grow in the long run, at least in industrialized countries. It may take a few more decades, but eventually, the noisy, open warehouse-type facilities for hospitalized premature and ill infants could become only history.

References:

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Disclosure: The author has no conflicts of interest

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Judy Smith has devoted her career and significant personal time to improving the health environment with a great passion for women and children's health. Her consulting experience includes successfully completing hundreds of birth service, NICU, women's and children's healthcare planning projects. She served for several decades on the Facility Guidelines Committee as a women and children's specialist to help shape facility standards for US hospitals. Judy is a founding member of the Consensus Committee that develops and updates *Recommended Standards for Newborn ICU Design*. She is also a facilitator for the newly formed Pediatric Environment Network for the Center for Health Design and a frequent author and lecturer.