DOI: 10.1097/JPN.0000000000000376

J Perinat Neonat Nurs • Volume 33 Number 1, 26–34 • Copyright © 2018 Wolters Kluwer Health, Inc. All rights reserved.

Facility Design

Reimagining Approaches to Childbirth in Hospital and Birth Center Settings

Ginger Breedlove, PhD, CNM, FACNM, FAAN; Lesley Rathbun, MSN, FNP, CNM, FACNM

ABSTRACT

Few maternity care clinicians are aware of the current regulations that guide design standards for childbirth facilities in the United States or the regulatory history. There is considerable variance among state regulations as well as oversight of facility standards for healthcare settings. Understanding evidence-based recommendations on how facility design affects health outcomes is critical to reversing the rise in maternal mortality and morbidity. A variety of measures can be implemented that promise to improve user satisfaction, quality of care, and efficiency for all who engage in the childbirth environment. Recommendations for change include broader assessment to better understand how clinicians and consumers simultaneously maneuver within a complex system. Key metrics include evaluation of workflow within available space, patient acuity and census patterns, integration of evidence-based recommendations, and options that promote physiologic birth. For the changes to succeed, human centered design must be implemented and diverse clinicians and consumers engaged in all phases of planning and implementation. Exploring characteristics and outcomes of low-risk women who receive care in a freestanding birth center or the European alongside maternity unit provides opportunity to reimagine and address improvements for inpatient, hospital birth.

Author Affiliation: Grow Midwives, LLC, Shawnee, Kansas.

Disclosure: The authors have disclosed that they have no significant relationships with, or financial interest in, any commercial companies pertaining to this article.

Each author has indicated that he or she has met the journal's requirements for Authorship.

Corresponding Author: Ginger Breedlove, PhD, CNM, FACNM, FAAN, Grow Midwives, LLC, 13608 W 54th St, Shawnee, KS 66216 (ginger@growmidwives.com).

Submitted for publication: July 28, 2018; accepted for publication: September 30, 2018.

Key Words: alongside birth unit, birth center, childbirth setting, design influence on childbirth, evidence-based design of childbirth setting, facility design

In the United States (US), the healthcare setting (HCS) is constructed by balancing architectural recommendations with federal standards, state regulations, city codes, and operating budget. Design considerations include structural and environmental safety, infection control, staff function and efficiency, organizational philosophy, operational workflow of the unit, and federal requirements for individuals with physical accessibility needs.[1–3] Equally important is an environment that provides spiritual comfort, hospitality-based service, and homelike privacy for patients. For childbirth settings, physical surroundings can affect the performance of staff as well as the mother's perception of how easy or difficult it is to give birth.[4–6]

The Centers for Disease Control and Prevention final data for 2016 indicate that 98% of all births occurred in-hospital with a physician in attendance.[7] Safe care requires that trained staff are ready to manage inductions, spontaneous labor admissions, peak admission times, variance in patient acuity level, emergency cases, and obstetric triage. Safe and satisfying care includes staff who promote physiologic birth for women who desire low intervention offering an array of options, care not universally provided in all obstetric units. To reimagine childbirth settings for the majority, those who are at low risk, clinicians must increase knowledge about how facility design influences maternity outcomes and embrace approaches that promote a human-centered experience. For this to happen, clinicians and consumers must be engaged in all phases of design planning and implementation. The primary aim of this review is to increase awareness of US guidelines and standards that

influence facility design including implications related to childbirth outcomes.

RESEARCH

Research demonstrates that implementing evidence-based design in HCS improves health outcomes.[1,8] Florence Nightingale is credited as one of the first to formally investigate how design correlated with rate of infection, level of stress, and influence on healing.[9] Nightingale discovered factors that led to the adoption of smaller wards, improved ventilation, and therapeutic use of natural light. Her research of the single room concept led to the findings that privacy improved sleep and reduced stress. Contemporary research based on Nightingale's premises provides evidence on design and environmental influence. A robust open source library focusing on design related to general health outcomes can be found in *The Center for Health Design Knowledge Repository*.[10]

Investigating design influence around birth is expanding beyond the labor room to how the entire obstetric unit workflow may contribute to outcomes. Concepts include environmental, structural, and staff characteristics that can help or hinder the delivery of maternity care. A multidisciplinary team examined unit blueprints and interviewed staff from 12 diverse childbirth settings (inpatient and freestanding birth centers [FSBCs]). Analysis confirmed that high patient volume and acuity, coupled with clinician's work load and design layout, negatively influenced maternal outcomes.[11] Preliminary work suggests that facility capacity, design, and staffing all play a large role in outcomes, indicating the busier the unit, the greater risk for cesarean section. Findings also highlighted that end users are not always engaged in design, nor were evidence-based care practices uniformly implemented.

Another emerging field of study is human-centered design. Emphasis is on determining why design problems exist in care settings, starting with the consumer. This evaluative 7-step framework *begins* by asking patients to describe experiences. Implementation is accomplished only by testing stakeholders (both staff and consumers) and then continuously refining design options until ready to deploy.[12] Of particular interest is how increasing technology can interfere with operational workflow, staff-to-patient relationships, the patient care experience, and health outcomes.[13]

Does the birth room design matter? The US hospital birth room, where most women give birth, places the bed in the center. The labor room looks like every other hospital room with similar furnishings and also includes an electronic fetal monitor and infant warmer. Mothers in the United States enter the labor unit spending hours lying in the hospital bed. Nonambulation is often due to hospital or provider policies related to ambulation with ruptured membranes, use of Pitocin, requirement for continuous fetal monitoring, or use of epidural anesthesia. Unless there are policies that promote physiologic birth, including freedom of movement, most women in the United States experience prolonged hours in the hospital labor bed.

Contrast the US birth room to a childbirth setting currently being investigated in a Denmark hospital.[14] A randomized trial, still underway, is being conducted by architects and midwives. Hypothesis testing includes whether a nontraditional labor setting can reduce stress, can increase natural oxytocin production, and can evoke a sense of calmness. The experimental design includes family options to select lighting, sound, choice of imagery (ceiling-to-floor projections of nature scenes), large space, comfortable furniture, and a moveable tub. A nontraditional birth bed is alongside one wall, out of the center of the room. Findings of more than 600 births will be published in 2019.

Growing research demonstrates that unit and room design influences the clinician's capacity to carry out work, which in turn correlates to patient experience.[13] In 2011, The Center for Health Design published findings from a comprehensive literature review examining environmental variables on staff and patient outcomes.[15] Measurement outcomes included frequency of healthcare-associated infections, medical errors, patient falls, patient satisfaction, patient waiting, staff efficiency, and staff satisfaction. Findings that positively influence satisfaction included layout, noise control, acuity-adaptable rooms, lighting options, visual view of nature, cleanliness, and privacy.

In addition to environmental influences, staffing challenges that limit nurse/patient interactions are swayed by the unit census and patient acuity level. Is there an impact on care delivery when census ratios shift from predominantly low risk to high risk? Two recent studies found correlations between labor and delivery census and patient management. One examined nurse managers' response to variation in patient census and resource decision making over the course of a simulated shift, finding that increasing census was associated with delayed patient care.[16] Another study found that while labor and delivery unit management varied widely in the United States, variances of models could be correlated with increased risk of cesarean section and maternal morbidity.[17]

Of great concern in obstetric nurse staffing is stress and burnout. Inpatient obstetric unit staffing is more than determining the number and ratio of nurses to patients and also skill level of staff available to ensure patient safety. This requires a cadre of trained, prepared, on unit and on-call nurses capable of managing

a flexing volume and acuity level.[18] In addition to electronic charting, administering medication, and performing frequent maternal/fetal assessments, it is no wonder that nurses have little time to provide continuous emotional beside support. Even with implementation of the Association of Women's Health, Obstetric and Neonatal Nurses Staffing for Perinatal Units in 2011[19] and the Association of Women's Health, Obstetric and Neonatal Nurses 2018 Position Statement on Continuous Labor Support for Every Woman,[20] many units are challenged by staff shortages, contributing to an inability to provide continuous support for low-risk women in labor.

In 2017, the American College of Obstetricians and Gynecologists (ACOG) released a new Committee Opinion on Approaches to Limit Intervention During Labor and Birth.[21] Decades of rigorous evidence suggest that *continuous* emotional presence and support during labor increase the likelihood of improved outcomes and increase satisfaction in experience.[22] Implementing the recent ACOG recommendation requires adequate nurse staffing. Other solutions to be considered include midwifery-led units for low-risk women and/or the use of a doula. A recent publication by ACOG describes a doula as one of the most effective tools to improve labor and delivery outcomes.[21]

High-grade evidence suggests that therapeutic use of water in labor can be an effective method to help relax and reduce pain.[23] This option requires structural capacity of full immersion tubs, implemented policies and procedures, and staff oversight for temperature monitoring. Facility design considerations for water immersion in labor or water birth include location of electrical equipment, flooring, plumbing, sufficient structural support to accommodate surface weight, temperature observance, sanitation, and size.[24]

Patient-administered nitrous oxide in labor is another option increasing in use across the United States.[25] Although nitrous oxide has been utilized in European countries in childbirth for decades, it moved out of favor in the United States in the early 1970s with the introduction of spinal and regional anesthesia. Facility design implications include equipment functionality, staff monitoring of ambient nitrous levels, and scavenging systems designed to allow outside ventilation.

Additional nonpharmacologic methods to promote physiologic birth traditionally found in birth centers include intermittent auscultation, Pilates bar, peanut and birth balls, birth stools, squat bars, and an above head sling.[26–28] Many of these options require design consideration for functional use of space in the labor room, safety, cleaning, and storage.

To help address challenges around continuity of care, staffing models, and women's satisfaction of care, alternative models under investigation include collaborative team-based care between physicians and midwives, midwifery-led care units, the obstetrician/midwife laborist in-house team, and alongside hospital birthing centers.[29–32]

Regulation and guidelines for design

The history of facility design standards and regulations for childbirth parallel the dramatic shift from home to hospital birth, dating to 1947 when regulations were written into the Federal Register to build hospitals.[33] However, it was not until the Hill-Burton Act passed by Congress in 1946 that funding for construction and modernization of hospitals was provided, in part due to the rapid rise of women giving birth in-hospital. In return for funding, hospitals agreed to provide services for all persons residing in the community.[34] Most clinicians and consumers today are unaware how the 72-year-old law set in motion significant financing to create hospital infrastructure, particularly due to the influx of childbearing women. The General Standards remained in place, rarely modified, until the early 1970s.

In 1974, the General Standards for hospitals and healthcare facilities became the first iteration to allow public comment. In 1987, as a response to decentralized federal regulations, the American Institute of Architects formed a steering committee to provide a venue for formal revision cycles. This action removed oversight by the federal government.

In 2001, the Facility Guidelines Institute (FGI), an independent, nonprofit association, acquired oversight to establish and promote consensus-based guidelines advised by evidence-based research. Central to FGI goals and objectives is engaging with diverse stakeholders, seeking public input, and use of a consensus process in the standards revision process (see Figure 1).[35]

Despite the longevity and history of facility standards, the United States is far from adopting uniform state regulations. States choose whether or not to implement FGI *Guidelines*. Further complicating matters, states that adopt recommendations may promulgate, via law and regulation, any edition of the *Guidelines*. The FGI Web site indicates that 36 states have adopted 1 of 7 editions dating back to 1992 and 14 states do not use any edition.[36]

The lack of uniformity in national standards for facility design of childbirth settings may be a significant contributor to challenges in delivery of optimal care. These authors posit that requirement of national, uniform, minimum standards for childbirth settings would promote public confidence in facilities, provide a basis for approval and licensing of healthcare facilities (inpatient and birth center), protect the wellbeing and safety of patients and staff, and promote inclusion of evidence-based practices.

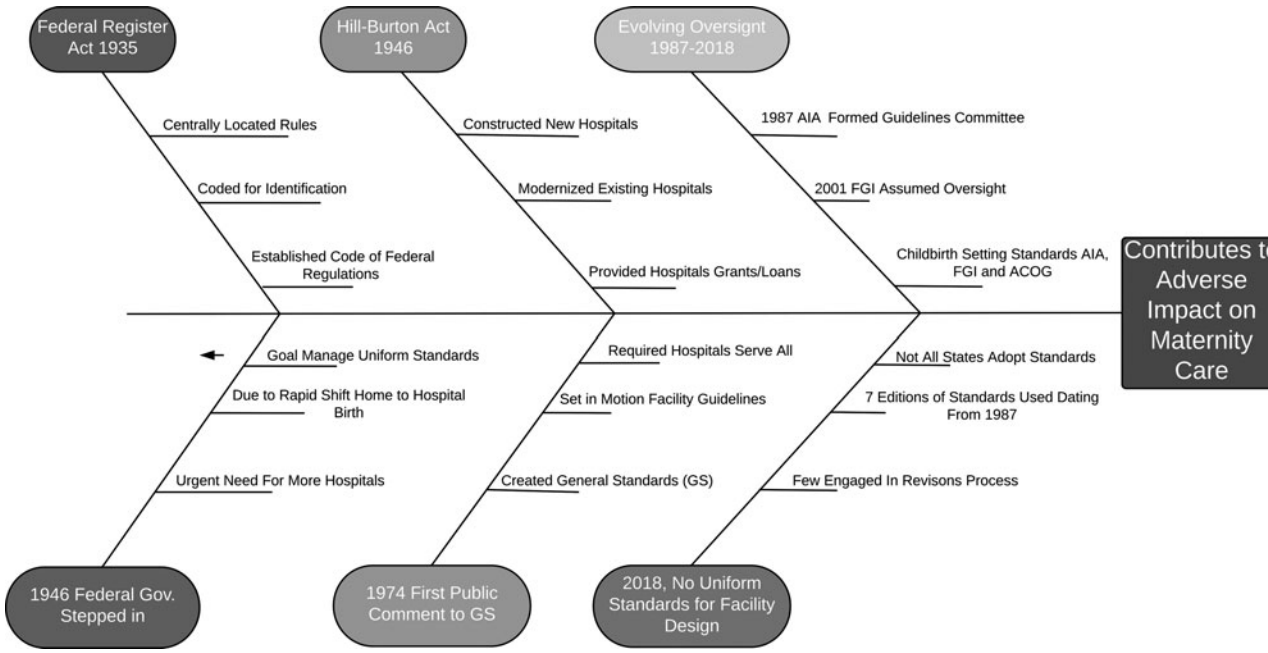

Figure 1. History of healthcare setting facility guidelines. ACOG indicates American College of Obstetricians and Gynecologists; AIA, American Institute of Architects; FGI, Facility Guidelines Institute.

The FGI Standards are periodically updated in collaboration with the American Institute of Architects and the ACOG. The most recent FGI publications were released in 2018. Two texts provide content related to childbirth facilities. The *Guidelines for Design and Construction of Hospitals* is written for the inpatient setting, and the *Guidelines for Design and Construction of Outpatient Facilities* for FSBC settings.[37]

In-hospital standards specific to childbirth include Guidelines 2.2-2.9 describing design of rooms including the antepartum and postpartum unit, labor, delivery, recovery (LDR), labor, delivery, recover, postpartum (LDRP), special care, support areas for staff, families and patients, cesarean delivery suite, recovery, nursery, and neonatal intensive care unit. Details include space of room by type, equipment in room, clearances, windows, privacy, handwashing stations, and elements of the nurses' station.

The 2018 FGI revisions separated description of in-hospital and FSBC requirements by moving the birth center standards to the *Design of Outpatient Facilities* book. Now in the *Outpatient Facilities* book, Guideline 2.4 provides birth center recommendations on space describing the general site, examination and birth rooms, support areas, building support facilities, public and administrative areas, design and construction requirements, and building systems.

Although FGI does not require single room care for childbirth settings, research on improved safety of single room care combined with higher patient satisfaction is noted in the literature.[38–40] The acuity-adaptable patient room implemented in obstetric units has gone in and out of favor. Acuity-adaptable patient rooms (AAPRs) are designed so that the patient remains in the same room from admission to discharge.[41] The maternity room type equivalent to an AAPR is the LDRP, designed for mother and infant to remain together from labor admission to couplet discharge. The LDRP must be designed in such a way that the mother, infant, and family can function with adequate space to move and be conducive to healing. Design must also allow the clinician to function and perform duties of couplet care within the shared space.

The most common inpatient maternity care blueprint includes a distinct area for labor using a single room concept for labor and short recovery, the LDR room. After labor and birth, a healthy postpartum mother is transferred to a second room until discharge. Postpartum rooms may be on a separate floor or wing. Both LDRP and LDR models must include a newborn nursery. With LDR models, continuity of care is interrupted impacting maternal/infant bonding, as families are required to change rooms and adapt to new staff soon after birth.

Administrative decisions on selecting the LDRP versus LDR include factors such as number of births per year, square footage allowance of available space, staff model, amenability of staff to cross-train, and organizational philosophy. Why is this important? There is significant evidence that use of LDRP rooms in

maternity care settings is optimal. However, the cost of these rooms for hospitals is more expensive, fueling an ongoing debate that the LDRP improves patient outcomes and satisfaction.[42] Hospitals have limited operating budgets for managing capital improvements in a rapidly changing marketplace. Yet, it is critical to note that the new market change from volume to value-based care places importance on linking reimbursement to outcomes, quality indicators, and satisfaction of childbearing women.[43]

The hospital women's service line is the largest allocation of hospital space with the majority of space devoted to services around childbearing. At least 12 types of patient rooms are typically designed to serve as functional women's health areas.[8] Reported in 2017 and for years prior, admission to hospital for labor-/birth-related indications (coded as maternal and neonatal) represented the top 2 categories of inpatient stays by hospitalization type.[44]

Concurrently, maternal mortality and morbidity related to childbirth in America has been rising the last 20 years.[45] Multiple workplace and clinician characteristics contribute to challenges for optimal care in hospital settings including room demand, capacity, operating room access, delivery volume, clinician workload, and more.[46] With increasing rates of morbidity, mortality, and near-miss events associated with childbirth, consideration for standardizing optimal design of hospital childbirth settings must become a national priority.

Freestanding birth centers

Freestanding birth centers are growing in numbers across the United States. Interest is being driven by the consumer looking for a calm, familiar environment that is an alternative to the high-tech birth experience in US hospitals today.[47] Physicians, midwives, third-party payers, and hospital administrators are all increasing their interest in the FSBC concept. When the term is used appropriately, a "birth center" is a healthcare facility where care is provided in the midwifery and wellness model. The birth center is freestanding and is not a hospital.[48] Because of risk criteria that provide service only for low-risk birth, birth centers do not require design space for intensive equipment or surgical procedures. It is vital to consult with birth center experts when constructing childbirth inpatient units to benefit from their unique perspective on variables that improve care of low-risk mothers and infants.[49,50]

In 2015, there were 270 FSBCs reported in the United States, and of these, 71 accredited.[49] A recent large-scale study investigating mothers who have Medicaid maternity care coverage and are cared for in an FSBC demonstrated safe, satisfying, and reduced cost care for those experiencing normal pregnancy and labor.[51] Although the number of FSBC has increased nationwide during the last 10 years, not all states provide regulatory oversight. The American Association of Birth Centers Position Statement on Birth Center Licensure and Regulations includes definitions and recommendations related to facility design.[52] The American Association of Birth Centers endorses the regulation, licensure, and accreditation of all birth centers and is committed to ensuring safe options for family-centered care.

Key resources for childbirth settings

In addition to FGI Guidelines, the *Guidelines for Perinatal Care*, eighth edition,[53] the ACOG/Society for Maternal Medicine (SMFM) Obstetric Care Consensus Statement,[54] and the Commission for the Accreditation of Birth Centers Standards[55] influence the design of childbirth settings. These documents serve as guidelines and not state regulations.

The eighth edition of Perinatal Care Guidelines serves as recommendations from both ACOG and the American Academy of Pediatrics (AAP), not strict operating rules. Physical facility recommendations[53(p60)] describe environmental design that mirrors FGI guidelines such as illumination, windows, wall surfaces, acoustic characteristics, obstetric functional units, and combined units.

In 2014, both ACOG and SMFM published the first document to designate levels of care, services, and provider types by setting. Characteristics of childbirth facilities are described by type of licensed provider, as well as capabilities of the facility to perform increasing levels of high-acuity services. It is important to note that this consensus document recognizes and defines the birth center capabilities, types of healthcare providers by title, and examples of appropriate patients.

The Commission for the Accreditation of Birth Centers is the only accrediting organization dedicated exclusively to overseeing operation and services of birth centers regardless of ownership, primary care provider, location, or population served. The Commission for the Accreditation of Birth Centers is an independent, nonprofit organization that accredits developing and existing birth centers in the United States using established standards, a self-evaluation report mechanism, and on-site visits. Birth center accreditation is voluntary. In addition, wide variance exists in state regulations of birth center based on state adoption of FGI guidelines (see Table 1).

An international perspective

International facility design guidelines of childbirth settings provide a robust cache of information to explore. Ireland launched the *National Standards for Safer Better Healthcare* in 2012 with a new focus on maternal

Table 1. **Key Resources for childbirth setting guidelines**

FGI Guidelines for Hospitals and Outpatient Facilities	https://www.fgiguidelines.org/guidelines/2018-fgi-guidelines/
ACOG/SMFM Obstetric Care Consensus Statement	https://www.acog.org/Clinical-Guidance-and-Publications/Obstetric-Care-Consensus-Series/Levels-of-Maternal-Care
Commission for the Accreditation of Birth Centers, Standards	https://www.birthcenteraccreditation.org/go/get-cabc-indicators/
Guidelines for Perinatal Care, 8th Ed.	http://ebooks.aappublications.org/content/guidelines-for-perinatal-care-8th-edition

health in 2017.[56] The standard setting document provides guidance on safe, high-quality maternity services, highlights a mother-centric model, describes implementation of evidence-based care, and promotes alongside unit design recommendations for freestanding maternity homes.

A second resource is the *International Health Facility Guidelines* 2017 edition, detailing international recommendations for the birthing unit. A side-by-side comparison of *International Health Facility Guidelines* and FGI publications shed light on widely divergent values in concept and design of the childbirth setting. The *International Health Facility Guidelines* delineates evidence-based recommendations for childbirth settings based on shared care models and family choice, outlining mechanisms for access to seamless care for women in-hospital or stand-alone birth center.[57] It is important to reemphasize that the United States has the worst maternal mortality rate of all high-income countries.[58] Hospital systems may find value in learning more about mandatory design standards for maternity care units from countries that fare better with outcome indicators than the United States.

Researchers of innovative childbirth facilities in low-income countries are examining how regions with limited maternity resources can reduce maternal and infant mortality by building maternity waiting homes.[59] For example, in Malawi, women travel great distance in late pregnancy to reside in group settings akin to their home village. The aim is to provide services that would otherwise not have been accessible. The setting includes an alongside maternity ward with trained staff and full range of maternity services.

And finally, in 2018, the World Health Organization published evidence-based guidelines on intrapartum maternity care, prioritizing need for a human-centered approach in all labor and birth settings throughout the world.[60] The 56 recommendations (26 newly developed) are intended to guide implementation of action steps known to promote a positive childbirth experience. The World Health Organization intrapartum care model places the mother at the center, emphasizing need for families to have the type of care they want and need.[61]

DISCUSSION

Beyond FGI Guidelines, the HCS must consider balancing efficiency of clinician tasks with prioritizing the individual's experience. For childbearing women, labor and birth is an experience anticipated with great fear juxtaposed with anticipatory joy. Families expect their experience to be supported, safe, and satisfying.

Promising concepts in design and care models are emerging to improve maternal outcomes and increase satisfaction. In 2014, *The Lancet* series on midwifery coined a phrase describing essential needs for childbearing women around the world as 1 of 2 extremes, "too much too soon, or, too little too late."[62] Both unavailability and overuse of technology contribute to poor outcomes for mothers. What can moderate these extremes?

In response to the notion of too much too soon in hospital settings, one concept is to defer admission of women who are not in active labor. Evidence shows that women admitted too early are at increased risk for unnecessary interventions.[21] One method to delay admission is by providing an early labor lounge[63–65] designed for those who may be anxious and want to stay at the facility, given their home may not be conducive to relaxation or they have no supportive partner to assist them. The early labor lounge serves as outpatient space providing intermittent assessment and comfort measures. Design concepts could include a walking area (in and outdoors), rocking chairs, nutritional options, private space, and immediate call access to labor and delivery staff. A doula could serve as nonclinical team member to provide oversight and coordinate access to nursing care.

In facilities with increasing levels of care, specialty clinicians and staff must be in house at all times to manage critically ill women. This includes women with conditions that may complicate labor, birth, and postpartum such as, high body mass index, hypertensive

disorders of pregnancy, infectious disease, drug addiction, and maternal trauma.

With increased complexity of care, hospitals must have 24/7 skilled staff, rooms, and surgical space to accommodate flexing needs. To balance settings that have high numbers of high-risk women, an emerging approach is designing space that distances the proximity of the low- and high-risk units from one another. Continuity of care, LDRP-designed rooms are staffed by nurses ready to facilitate and promote options using a wide variety of evidence-based recommendations. This model embraces key characteristics of the FSBC.

There is growing interest in evaluating models outside the United States, including benefits associated with alongside or midwifery-led units.[31,40,66,67] These settings are staffed by licensed midwives who provide continuous supportive care for healthy women desiring physiologic birth. A Cochrane review from 2015 investigated 15 trials involving 17 674 women and concluded that women who had alongside or midwifery-led units care were less likely to experience regional anesthesia, instrumental vaginal birth, preterm birth less than 37 weeks, and less overall fetal/neonatal death. Women were also more likely to experience normal spontaneous vaginal birth and were satisfied with their care.[29] The alongside or midwifery-led unit combined with space dedicated as a low-risk unit merges 2 successful models of evidence-based maternity care.

A safe and satisfying birth depends on the amount of stress a woman experiences during her labor and birth. In the United States, the typical birth room is a clinical environment similar to high-risk intensive care units. Hospitals were designed to facilitate use of necessary interventions. Labor/birth rooms are characteristically the same across the country whether women are experiencing a normal or complicated labor. For many women, the hospital environment is impersonal, frightening, and provokes anxiety that something is wrong. This feeling is amplified as more and more equipment is hooked up and placed on her from the time of admission. Required use of invasive technology coupled with images of a sterile environment is a reason why low-risk families seek care in FSBCs.

Until recently, these authors were unfamiliar with state regulatory options for healthcare facilities, variance in state regulations, and preferential adoption of 7 editions of the FGI Guidelines. As invited attendees of the April 2018 Reimagining Childbirth Facilities Workshop convened by FGI, American Institute of Architects, and ACOG, in-depth information about design, prototyping, and processes to improve care were explored. Discussion included collegial review of current facility guidelines for inpatient childbirth and FSBC settings. However, there is confusion and inconsistency among state regulatory bodies in what is required compared with recommended in structural design features. Typically, when hospitals seek consultants for maternity setting design projects, conversations rarely involve a wide diversity of clinicians or consumers.

CONCLUSION

What would a childbirth setting of the future look like if designed with an eye to the family first? Authentic leadership in organizations with continuous quality improvement will help to implement change. A first step to improving maternity care in the United States includes birth settings examining their maternity care design, staffing, and policies. A second step is engaging others in purposeful collaboration to explore and understand best practice for HCS design standards. Actions to improve outcomes for childbearing women include implementing evidence-based recommendations, promoting shared care models for low- and high-risk women, supporting family choice, and improving access to appropriate levels of care for women in or out of hospital.

References

1. Reiling J, Hughes R, Murphy MR. Chapter 28. The impact of facility design on patient safety. *Patient Safety and Quality: An Evidence-Based Handbook for Nurses*. Vol 2. Rockville, MD: Agency for Healthcare Research and Quality; 2008. No.: 08-0043. https://www.ncbi.nlm.nih.gov/books/NBK2651/. Accessed July 28, 2018.
2. Singer RF, Dickman I, Rosenfeld A. *Increasing the Physical Accessibility of Health Care Facilities. CMS OMH Issue Brief*. Baltimore, MD: CMS Office of Minority Health; 2017.
3. Centers for Medicare & Medicaid Services. Quality, safety and oversight: certification and compliance. https://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/CertificationandComplianc/index.html. Published 2018. Accessed July 28, 2018.
4. Holder M, Berndt A. The effect of changes in servicescape and service quality perceptions in a maternity unit. *Int J Health Care Quality*. 2011;24(5):389–405.
5. Shin JH. Hospital birthing room design: a study of mother's perception of hominess. *J Interior Design*. 2008;30(2):23–36.
6. Hammond A, Foureur M, Homer CS. The hardware and software implications of hospital birth room design: a midwifery perspective. *Midwifery*. 2014;30(7):825–830.
7. Martin JA, Hamilton BE, Osterman MJK, Driscoll AK, Drake P. Births: final data for 2016. *Natl Vital Stat Rep*. 2018;67(1), Tables 1–4. https://www.cdc.gov/nchs/data/nvsr/nvsr67/nvsr67_01_tables.pdf. Accessed September 4, 2018.
8. Smith J. Obstetrics/women's care. Health Architecture Blog. https://www.google.com/search?q=Smith+Health+Architecture+Obstetrics%2FWomen%27s+care&rlz=1C5CHFA_enUS790US791&oq=Smith+Health+Architecture+Obstetrics%2FWomen%27s+care&aqs=chrome..69i57.18528j0j7&sourceid=chrome&ie=UTF-8. Published 2016. Accessed July 28, 2018.
9. Aravind M, Chung KC. Evidence-based medicine and hospital reform: tracing origins back to Florence Nightingale. *Plast Reconstr Surg*. 2010;125(1):403–409.

10. The Center for Health Design. Knowledge repository. https://www.healthdesign.org/knowledge-repository. Accessed July 28, 2018.
11. Ariadne Lab. The impact of design on clinical care in childbirth. https://massdesigngroup.org/sites/default/files/file/2017/170223_Ariadne%20Report_Final.pdf. Accessed July 28, 2018.
12. Harte R, Glynn L, Rodriguez-Molinero A, et al. A human-centered design methodology to enhance the usability, human factors, and user experience of connected health systems: a three-phase methodology. *J Med Internet Res*. 2017;4(1):e8.
13. Reay S, Collier G, Kennedy-Good J, Old A, Douglas R, Bill A. Designing the future of healthcare together: prototyping a hospital co-design space. *CoDesign*. 2017;13(4):227–244.
14. Hernig Hospital Case Study. https://modos.dk/delivery-room Accessed July 28, 2018.
15. Quan X, Joseph A, Malone E, Pati D. *Phase I Report: Healthcare Environmental Terms and Outcome Measures: An Evidence-Based Design Glossary*. Concord, CA: The Center for Health Design Research. https://www.healthdesign.org/system/files/chd408_researchreportglossary_v6_final_0.pdf Accessed July 28, 2018.
16. Molina RL, Gombolay M, Jonas J, et al J. Association between labor and delivery unit census and delays in patient management: findings from a computer simulation model. *Obstet Gynecol*. 2018;131(3):545–552.
17. Plough AC, Galvin G, Li Z, et al. Relationship between labor and delivery unit management practices and maternal outcomes. *Obstet Gynecol*. 2017;130(2):358–365.
18. Simpson KR. Safe nurse staffing is more than numbers and ratios. *Am J Matern Child Nurs*. 2017;42(5):304.
19. Association of Women's Health, Obstetric and Neonatal Nurses. *Guidelines for Professional Registered Nurse Staffing for Perinatal Units*. Washington, DC: Association of Women's Health, Obstetric and Neonatal Nurses; 2010.
20. Association of Women's Health, Obstetric and Neonatal Nurses Position Statement. Continuous labor support for every woman. *J Obstet Gynecol Neonatal Nurs*. 2018;47(1):73–74.
21. The American Congress of Obstetricians and Gynecologists. Committee opinion, number 687. Approaches to limit intervention during labor and birth. *Obstet Gynecol*. 2017;129(2):e20–e28.
22. Bohren MA, Hofmeyr GJ, Sakala C, Fukuzawa RK, Cuthbert A. Continuous support for women during childbirth. *Cochrane Database Syst Rev*. 2017;7:CD003766.
23. Cluett ER, Burns E, Cuthbert A. Immersion in water during labour and birth. *Cochrane Database Syst Rev*. 2018;5:CD000111.
24. Weaver M. Water birth in the hospital setting. *Nurs Women's Health*. 2014;18(5):365–369.
25. Collins M. Use of nitrous oxide in maternity care: AWHONN Practice Brief Number 6. *J Obstet Gynecol Neonatal Nurs*. 2018;47(2):239–242.
26. Maude RM, Skinner JP, Foureur M. Putting intelligent structured intermittent auscultation (ISIA) into practice. *Women Birth*. 2016;29(3):285–292.
27. Makvandi S, Roudsari RL, Sadeghi R, Karimi L. Effect of birth ball on labor pain relief: a systematic review and meta-analysis. *J Obstet Gynaecol Res*. 2015;41(11):1679–1686.
28. Howard ED. Optimizing the birth environment with evidence-based design. *J Perinat Neonatal Nurs*. 2017;31(4):290–293.
29. Sandall J, Soltani H, Gates S, Shennan A, Devane D. Midwife-led continuity models versus other models of care for childbearing women. *Cochrane Database Syst Rev*. 2015;9:CD004667.
30. van der Kooy J, de Graaf JP, Birnie E, Denktas S, Steegers E, Bonsel GJ. Different settings of place of midwife-led birth: evaluation of a midwife-led birth centre. *Springerplus*. 2016;5(1):786.
31. Maillefer F, de Labrusse C, Cardia-Voneche L, Hohfeld P, Stoll B. Women and healthcare providers' perceptions of a midwife-led unit in a Swiss university hospital: a qualitative study. *BMC Pregnancy Childbirth*. 2015;15(56). https://bmcpregnancychildbirth.biomedcentral.com/articles/10.1186/s12884-015-0477-4. Accessed July 28, 2018.
32. Rosenstein MG, Nijagal M, Nakagawa S, Gregorich SE, Kuppermann M. The association of expanded access to a collaborative midwifery and laborist model with cesarean delivery rates. *Obstet Gynecol*. 2015;126(4):716–723.
33. McKinney R. A research guide to the Federal Register and the Code of Federal Regulations. *Law Library Lights*. 2002;46(1):9–15.
34. Schumann JH. A bygone era: when bipartisanship led to health care transformation. NPR Health News. https://www.npr.org/sections/health-shots/2016/10/02/495775518/a-bygone-era-when-bipartisanship-led-to-health-care-transformation. Published 2016. Accessed July 28, 2018.
35. Facility Guidelines Institute. History of the guidelines. https://www.fgiguidelines.org/about-fgi/history-of-the-guidelines/ Accessed July 28, 2018.
36. American Society for Health Care Engineering of the American Hospital Association. FGI guidelines adoption map. http://www.ashe.org/advocacy/orgs/fgi-adoption-map.shtml. Published 2017. Accessed July 28, 2018.
37. Facility Guidelines Institute. Guidelines for design and construction of hospitals and guidelines for design and construction of outpatient facilities. https://www.fgiguidelines.org/guidelines/2018-fgi-guidelines/. Published 2018. Accessed July 28, 2018.
38. Devlin AS, Andrade CC, Lima ML. Hospital rooms and patients' well-being: exploring modeling variables. Report to the Academy of Architecture for Health Foundation. https://aahfoundation.org/wp-content/uploads/2016/02/2012_Report_DevlinAndradeLima.pdf. Published 2014. Accessed July 28, 2018.
39. Foureur MJ, Davis D, Fenwick J, et al. The relationship between birth unit design and safe, satisfying birth: developing a hypothetical model. *Midwifery*. 2010;26:520–525.
40. Jenkinson B, Josey N, Kruske S. *BirthSpace: An evidence-based guide to birth environment design*. Queensland, Australia: Queensland Centre for Mothers & Babies, The University of Queensland; 2013. https://espace.library.uq.edu.au/view/UQ:339451. Accessed July 28, 2018.
41. Bonuel N. Acuity-adaptable patient room from the patient's perspective. *J Nurs Educ Pract*. 2017;8(5):38–43.
42. Lacanna G. Commentary on Jeffrey Voigt et al.'s article, "Private rooms in low acuity settings: a systematic review of literature." *Health Environments Res Design J*. 2018;11(1):78–81.
43. Fleishon HB, Itri JN, Boland GW, Duszak R. Academic medical centers and community hospitals integration: trends and strategies. *J Am Coll Radiol*. 2017;14:45–51.
44. McDermott KW, Elixhauser A, Sun R. *Trends in Hospital Inpatient Stays in the United States, 2005–2014*. HCUP Stat Brief #225. Rockville, MD: Agency for Healthcare Research and Quality; 2017.
45. MacDorman MF, Declercq E, Thoma M. Trends in maternal mortality by socio-demographic characteristics and cause of death in 27 states and the District of Columbia. *Obstet Gynecol*. 2017;129(5):811–818.
46. Ariadne Labs, MASS. Designing capacity for high value healthcare: the impact of design on clinical care in childbirth.

Final report. https://massdesigngroup.org/sites/default/files/file/2017/170223_Ariadne%20Report_Final.pdf. Published 2017. Accessed July 28, 2018.
47. Declercq ER, Sakala C, Corry MP, Applebaum S, Herrlich A. Major survey findings of listening to mothers (SM) III: Pregnancy and Birth: Report of the Third National U.S. Survey of Women's Childbearing Experiences. *J Perinat Educ*. 2014;23(1):9–16.
48. American Association of Birth Centers. Definition of birth center clarified. Published May 2017. Accessed July 28, 2018.
49. Illuzzi J, Stapleton S, Rathbun L. Early and total neonatal mortality in relation to birth setting in the United States, 2006–2009. *Am J Obstet Gynecol*. 2015;212(2):250.
50. Stapleton S, Osborne C, Illuzzi J. Outcomes of care in birth centers: demonstration of a durable model. *J Midwifery Womens Health*. 2013;58(1):3–14.
51. Jolles DR, Langford R, Stapleton S, Cesario S, Koci A, Alliman J. Outcomes of childbearing Medicaid beneficiaries engaged in care at Strong Start birth center sites between 2012 and 2014. *Birth*. 2017;44(4):298–305.
52. American Association of Birth Centers. Position statement on birth center licensure and regulations. https://cdn.ymaws.com/www.birthcenters.org/resource/collection/46992E86-D0A4-476E-8B09-F5ECE203B16E/AABC_Position_Statement_-_BC_Licensure_and_Regulations.pdf. Accessed July 28, 2018.
53. Kilpatrick SJ, Papile LA, Macones GA. *Guidelines for Perinatal Care*. 8th ed. Itasca, IL: American Academy of Pediatrics; 2017.
54. The American Congress of Obstetricians and Gynecologists and the Society of Maternal-Fetal Medicine Obstetric Care Consensus. Levels of maternal care. *Am J Obstet Gynecol*. 2015;212(3): 259–271.
55. Commission for the Accreditation of Birth Centers, Inc. CABC indicators. https://www.birthcenteraccreditation.org/go/get-cabc-indicators/. Published 2016. Accessed July 28, 2018.
56. Health Information and Quality Authority. National standards for safer better maternity services. https://www.hiqa.ie/sites/default/files/2017-02/national-standards-maternity-services.pdf. Published 2017. Accessed July 28, 2018.
57. International Health Facility Guidelines. Part B—health facility briefing and design, 20 birthing unit. Version 5. http://healthfacilityguidelines.com/Guidelines/ViewPDF/iHFG/iHFG_part_b_complete. Published 2017. Accessed July 28, 2018.
58. Molina RL, Pace LE. A renewed focus on maternal health in the United States. *N Engl J Med*. 2017;377(18):1705–1707.
59. Seda E. Kasungu maternity waiting village/mass design group. ArchiDATUM, Architecture in Africa. http://www.archidatum.com/projects/kasungu-maternity-waiting-village-mass-design-group/. Published 2016. Accessed July 28, 2018.
60. World Health Organization. *World Health Organization Recommendations: Intrapartum Care for a Positive Childbirth Experience*. Geneva, Switzerland: World Health Organization; 2018. http://www.who.int/reproductivehealth/publications/intrapartum-care-guidelines/en/. Accessed July 28, 2018.
61. Oladapo OT, Tuncalp O, Bonet M, et al. WHO model of intrapartum care for a positive childbirth experience: transforming care of women and babies for improved health and wellbeing. *Br J Obstet Gynaecol*. 2018;125(8):918–922.
62. Miller S, Abalos E, Chamillard M, et al. Beyond too little, too late and too much, too soon: a pathway towards evidence-based, respectful maternity care worldwide. *Lancet*. 2016;388(10056):2176–2192.
63. Swain L. Understanding and identifying opportunities for improvement in the latent labor OB triage process. Scholar Archive. 3931. https://digitalcommons.ohsu.edu/etd/3931. Published 2017. Accessed July 28, 2018.
64. Paul JA, Yount SM, Blankstein Breman R, et al. Use of an early labor lounge to promote admission in active labor. *J Midwifery Womens Health*. 2017;62:204–209.
65. Kobayashi S, Hanada N, Matsuzaki M, et al. Assessment and support during early labour for improving birth outcomes. *Cochrane Database Syst Rev*. 2017;4:CD011516.
66. Rayment J, McCourt C, Rance S, Sandall J. What makes alongside midwifery-led units work? Lessons from a national research project. *Pract Midwife*. 2015;18(6):31–33.
67. Hauck Y, Rivers C, Doherty K. Women's experiences of using a Snoezelen room during labor in Western Australia. *Midwifery*. 2008;24(4):460–470.