

Theoretical Integration for Designing Healing ICU Environments: An Interdisciplinary Framework

Health Environments Research & Design Journal
1–14

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DOI: 10.1177/19375867261440937

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Abstract

Purpose: This paper presents an integrated framework combining perspectives from nursing, environmental psychology, and critical space theory. The framework is intended to support the study of materiality in ICUs and to inform future research on stakeholders' needs and guiding design interventions for more supportive, healing care environments.

Background: Intensive care units (ICUs) are paradoxical spaces designed to save lives yet often experienced by patients as environments of dependency, disorientation, and loss of control. Materiality of the ICU environments can exacerbate stress and compromise recovery. While interventions addressing the material environment show promise in improving care experiences, existing approaches remain limited by single-theory perspectives that fail to capture the complexity of ICU materiality.

Methods: The integrated conceptual framework was developed through theory-informed synthesis guided by relevance to ICU settings and theoretical complementarity. Three established theories were synthesized—Roy's Adaptation Model, Ulrich's Theory of Supportive Design, and Lefebvre's Critical Theory on Space Production—using conceptual mapping across ontological, interactional, and interventional levels.

Results: The analysis revealed convergent points and complementary relationships across the three theories. The integrated framework synthesizes these perspectives across three interconnected dimensions: environmental stimuli and adaptive response, spatial production and power relations, and evidence-based supportive design.

Conclusions: The integrated framework demonstrates that healing ICU environments require interdisciplinary approaches addressing interconnected biological, psychological, social, and material dimensions simultaneously. Effective interventions must target adaptive physiological needs, reduce

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psychological stress through supportive design, and challenge spatial power relations that marginalize patients and families. This framework provides a foundation for research and practice that empowers all care-related stakeholders to actively shape healing ICU environments.

Keywords

ICU environments, healing spaces, theoretical framework, spatial theory, environmental psychology, nursing theory

Intensive Care Units (ICU) are paradoxical spaces, primarily designed to save lives, yet often experienced by patients as environments of dependency, disorientation, and loss of control (Tronstad et al., 2021a; Yang, 2016). Patients find themselves suddenly immersed in high technological and unfamiliar environments, where they often lose autonomy over their health, surroundings, decisions, and bodies (Tronstad et al., 2021a; Wilson et al., 2019). The material environment of the ICU, including constant noise, artificial lighting, and unfamiliar equipment, exacerbates stress, disrupts circadian rhythms, and impairs sleep (Kotfis et al., 2022; Oldham et al., 2016; Simons et al., 2018). These environmental stressors are strongly associated with physical, cognitive, and psychological complications that compromise recovery and overall well-being (Colbenson et al., 2019; Flaws et al., 2024; Kotfis et al., 2022; Tronstad et al., 2021a, 2021b; Tronstad et al., 2023; Wilson et al., 2019).

Despite these challenges, interventions addressing the material environment have shown promise in improving care experiences and fostering healing spaces (Tronstad et al., 2021a, 2021b; Tronstad et al., 2023). The concept of healing environment, first articulated by Florence Nightingale as “manipulating the environment to be therapeutic” (Nightingale, 1859), emphasizes optimizing the patient’s capacity to recover. Since 1960, this notion has evolved alongside evidence-based design, supported by a growing body of research demonstrating its benefits for patients, families, and staff (Dovjak & Kucek, 2019).

Extending this perspective, the notion of materiality offers a deeper lens for understanding how healing environments are configured in ICUs. Design culture transcends simple dichotomies of “good” or “bad” design, adopting a more nuanced, interdisciplinary approach that acknowledges the

complex social and cultural dimensions of designed environments (Attfeld, 2000). Within this perspective, materiality refers to the intrinsic properties and sensory capacities of objects and spaces: the walls that structure space, lighting systems that regulate circadian rhythms, acoustic materials that shape sound environments, and medical equipment whose presence defines spatial relationships (Woodward, 2020). Material culture, in turn, provides the theoretical and methodological tools to analyze how these material elements are woven into daily life, conditioning gestures, interactions, and habits in ICU settings (Csikszentmihalyi, 1991; Saito, 2001; Woodward, 2020).

Seen through this lens, ICU environments are not neutral backdrops but active participants in care, conditioning how patients, families, and healthcare providers experience and enact healing. Importantly, healing environments must be defined inclusively, integrating the perspectives of all care-related stakeholders—patients, families, and healthcare professionals—as well as hospital administrators, facility managers, and public health policy makers who shape the organizational and resource contexts in which ICU environments are created and maintained. ICUs are not only technologically intensive but also socially and relationally intensive settings where continuous interactions occur among individuals and with the material environment itself (Hupcey, 2000; Leong et al., 2023; Tronstad et al., 2021a; Wilkinson, 1995). Understanding these multifaceted dynamics requires an interdisciplinary approach capable of capturing the interplay between human actors and material surroundings. Such a perspective is essential to conceptualize, design, and implement more supportive, human-centered ICU spaces (Bazuin & Cardon, 2011; Tronstad et al., 2023; Wilson et al., 2019).

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Building on this need for an interdisciplinary and human-centered perspective, a conceptual framework that addresses both the material and experiential dimensions of ICU spaces becomes essential. Three theories are particularly relevant in this context: Roy's Adaptation Model (Roy, 2009), Ulrich's Theory of Supportive Design (Ulrich, 1991) and Lefebvre's Critical Theory on Space Production (Lefebvre, 1974). Each offers a distinct yet complementary lens. Roy's model explains how individuals physiologically and psychosocially adapt to environmental stressors (Roy, 2009). Ulrich's theory emphasizes the therapeutic potential of design elements in reducing stress and supporting recovery in healthcare settings (Dodeler, 2014; Ulrich, 1991), and Lefebvre's critical theory situates space as socially produced, shaped by experiences and embedded in power (Lefebvre, 1974; Shields, 2011).

The present paper presents the development of a conceptual framework that integrates these multidisciplinary and critical theories. The framework is intended to inform and guide future qualitative and quantitative research on ICU environmental materiality, in a perspective of a healing space. It was developed in the context of a master's thesis in nursing and will be applied to provide preliminary empirical exploration of how essential care-related stakeholders perceive a healing ICU environment, with attention to both materiality and design principles (Buse et al., 2018). By drawing on diverse yet complementary theoretical perspectives, this integrated framework aims to address the limitations of existing siloed approaches and offers a more nuanced analysis of how material environments impact care experiences in critical care settings.

Aim

This paper presents an integrated framework combining perspectives from nursing, environmental psychology, and critical space theory. The framework

is intended to support the study of materiality in ICUs and to inform future research on stakeholders' needs and guiding design interventions for more supportive, healing care environments.

Methodology

This is an integrated conceptual framework development through theory-informed synthesis guided by both relevance to ICU settings and theoretical complementarity. Unlike empirical qualitative studies that involve data collection from participants [and would follow SRQR reporting guidelines (O'Brien et al., 2014)], this work engages in conceptual analysis—systematically examining, comparing, and integrating existing theoretical perspectives to create a new analytical framework (Jabareen, 2009). The methodology follows established approaches for conceptual framework building in the health sciences.

The process involved identifying, analyzing, and integrating concepts from three established theories that address the concept of environment: Roy's Adaptation Mode (nursing science), Ulrich's Theory of Supportive Design (environmental psychology), and Lefebvre's Critical Theory on Space Production (social sciences and critical geography). These were selected based on three inclusion criteria: 1) their explicit focus on the interactions between individuals and their environments; 2) their applicability to healthcare or spatial ICU contexts; and 3) their capacity to inform material, perceptual, and experiential dimensions of healing environments (Figure 1).

Several alternative theories were considered during the selection process but were not included in the final framework. Antonovsky's Salutogenesis theory, while relevant to health promotion, lacks specific focus on spatial and material environments (Antonovsky, 1996). Actor-Network Theory, though potentially valuable for material analysis, presented complexity challenges and lacks healthcare-specific applications (Latour, 2005). Planetary Health frameworks focus on macro-environmental rather than micro-environmental (bedspace) scales. The three selected theories were determined to offer the most comprehensive and complementary coverage of the phenomena of interest.

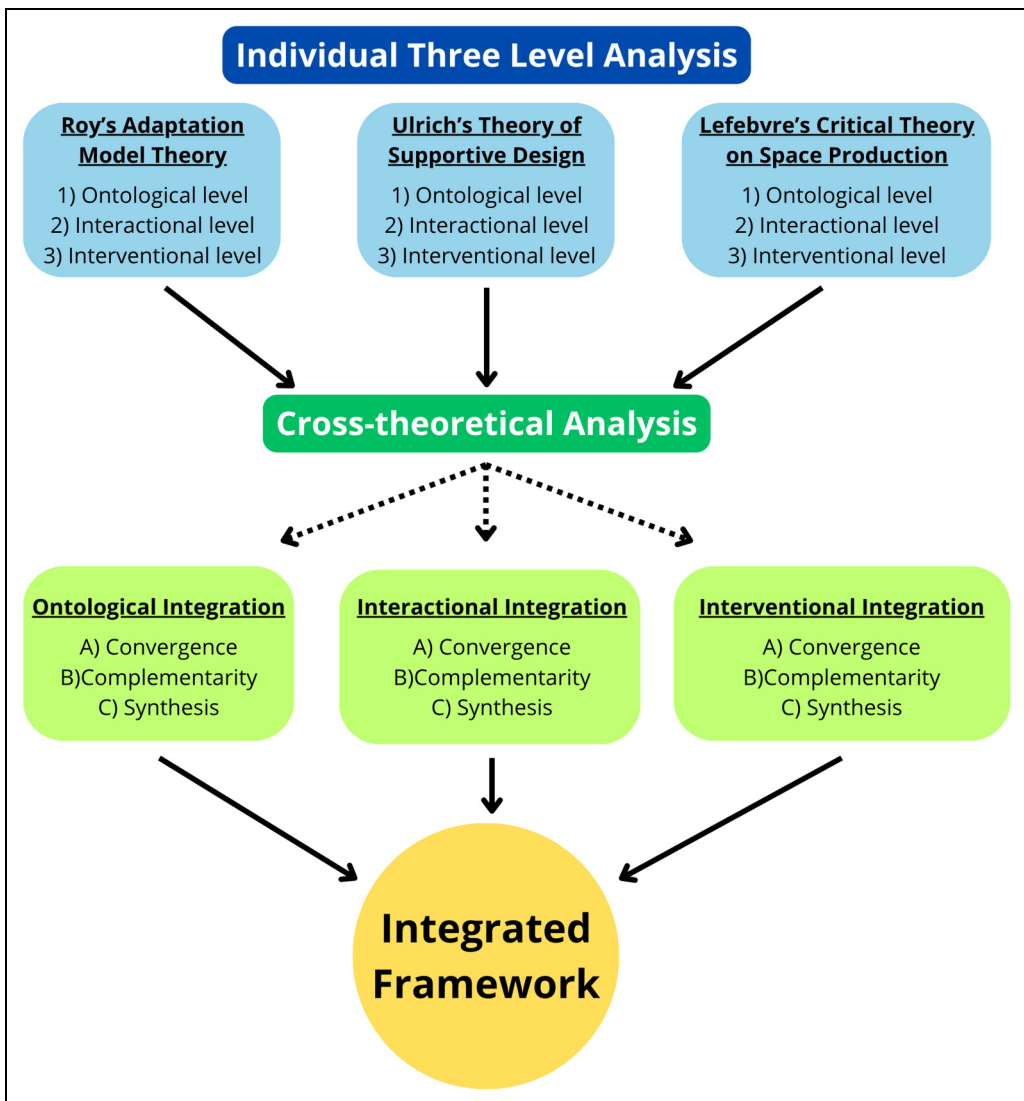


Figure 1. Graphical representation of the applied methodology for development of the integrated framework. *Note.* The figure illustrates the systematic three-step approach used for the building the integrated framework: 1) Individual three level analysis of Roy's Adaptation Model Theory, Ulrich's Theory of Supportive Design, and Lefebvre's Critical Theory on Space Production: analysis on ontological, interactional, and interventional levels; 2) Cross-theoretical analysis: triangulation of the individual analyses and synthesis from ontological, interactional and interventional integration perspectives; and 3) Integrated Framework: result of the integration of the three theories to create an integrated framework.

Addressing Epistemological Complementarity

The integration of these three theories requires acknowledgment of their different epistemological foundations. Ulrich's Theory of Supportive Design

operated from a positivist/post-positivist paradigm, emphasizing measurable outcomes, controlled studies, and evidence-based interventions (Ulrich, 1991). Lefebvre's Critical Theory of Space Production adopts a social constructionist and critical lens, emphasizing how spaces are produced through social

processes, power relations, and lived experiences (Lefebvre, 1974). Roy's Adaptation Model bridges these perspectives, as nursing science has historically integrated both empirical (physiological) and interpretive (psychosocial) approaches to holistic patient care (Roy, 2009).

We adopt a pragmatic approach to theoretical integration, similar to justifications used in mixed-methods research (Creswell & Plano Clark, 2018). While these theories emerge from different paradigmatic traditions, they address different dimensions of the same complex phenomenon—human experience in ICU environments. The integration occurs at the phenomenological level, seeking to understand the multifaceted nature of patient, family, and staff experiences, rather than attempting to reconcile fundamentally different truth claims. This theoretical pluralism enables the framework to capture both: (1) the measurable effects of design interventions; and (2) the socially constructed meaning of ICU spaces. Rather than viewing epistemological diversity as a limitation, we position it as a strength that reflects the irreducible complexity of human-environment interactions in healthcare settings.

Each theory contributed a distinct analytical lens. The perspectives of the three theories were synthesized using a conceptual mapping process, identifying shared and complementary concepts across three dimensions:

- Ontological level: how space and environment are conceptualized
- Interactional level: how humans engage with the environment
- Intervention level: how the material environment can be shaped to support healing

Results

Roy's Adaptation Model Theory

Ontological Level—Conceptualizing Environment and Space. Roy's model conceptualizes the environment as a dynamic, multi-layered stimulus field that encompasses all medical, social, and material conditions, circumstances, and influences that affect a person's development and behaviours (Fawcett & DeSanto-Madeya, 2013; Roy, 2009). Rather than viewing the space as a static container, the theory

presents the ICU environment as an active constellation of stimuli requiring constant adaptive responses (Roy, 2009). The environment is structured through three hierarchical stimulus types that can be internal or external to the person: focal stimuli (immediate critical health problems demanding primary attention), contextual stimuli (the broader social and material ICU environment that influences focal stimulus effects), and residual stimuli (background factors like past experiences and cultural influences with unclear effects) (Roy, 2009). This ontological framework positions ICU materiality as contextual stimuli that can either support or hinder adaptation processes, creating an environment that is inherently relational and responsive rather than fixed.

Interactional Level—Human-Environment Engagement. The theory describes human-environment engagement through continuous adaptation processes where individuals use both innate and learned coping mechanisms to achieve adaptation, leading to optimal health and well-being (Roy, 2009). This interaction occurs across four distinct adaptive modes: physiological (influenced by disease and stress levels), self-concept (psychological and spiritual integrity including self-esteem, body image, and personal beliefs), role function (ability to fulfill social roles and maintain social integrity), and interdependence (relationships and support systems emphasizing giving and receiving of love, respect, and value) (Roy, 2009).

Interventional Level—Shaping Material Environment. Roy's model positions environmental interventions as central to promoting positive adaptation across all four modes (Roy, 2009). Healthcare professionals serve as environmental managers who manipulate contextual stimuli—the material ICU environment—to optimize adaptive responses. This interventional approach targets reducing maladaptive stress while simultaneously supporting physiological healing, psychological integrity, social role function, and meaningful relationships within the ICU setting.

Ulrich's Theory of Supportive Design

Ontological Level—Conceptualizing Environment and Space. Ulrich's theory conceptualizes the built environment, as a measurable, objective reality with predictable psychological impacts on human well-being (Ulrich, 1991). Operating through

stress-reduction paradigm, the theory positions space as a collection of discrete, modifiable design elements that can systematically address stress as an obstacle to recovery (Andrade & Devlin, 2015; Fischer & Dodeler, 2009; Ulrich, 1991). ICU materiality is thus conceptualized as an assemblage of controllable features—lighting systems, privacy elements, art installations, nature views—that function as therapeutic tools with measurable effects on patient, family, and staff experiences.

Interactional Level—Human-Environment Engagement. The theory describes human-environment engagement through stress appraisal processes and three core mechanisms that mediate environmental perception and response. Individuals interact with the ICU environment through: sense of control (enabled by adjusting lighting and temperature systems, various privacy features to enhance autonomy and reduce the feeling of vulnerability, and accessible control systems), access to social support (facilitated through flexible visiting policies, virtual communication tools and spaces dedicated to families), and positive distractions (provided by views of nature, featuring art and entertainment systems, and implementing noise reduction strategies) (Andrade & Devlin, 2015; Dodeler, 2014; Fischer & Dodeler, 2009; Nin Vaeza et al., 2020; Tronstad et al., 2023; Verderber et al., 2021).

Interventional Level—Shaping Material Environment. Ulrich's theory provides a systematic, research-validated approach to environmental intervention based on these three core principles (Ulrich, 1991). The interventional approach emphasizes measurable stress indicators and empirically-demonstrated design guidelines, enabling healthcare facilities to implement targeted material interventions that address the psychological dimensions of ICU experiences while supporting physiological recovery processes (Andrade & Devlin, 2015; Ulrich, 1991).

Lefebvre's Critical Theory of Space Production

Ontological Level—Conceptualizing Environment and Space. Lefebvre's theory conceptualizes space as fundamentally a product of social relations rather than a neutral, pre-existing container (Lefebvre, 1974; Shields, 2011; Strus et al., 2024). This

ontological framework positions ICU materiality through a spatial triad where perceived, conceived, and lived spaces are intertwined within a dialectical relationship (Lefebvre, 1974; Strus et al., 2024). ICU environments thus embody contested terrains where institutional ideologies, power relations, and competing interests are embedded within material arrangements, challenging traditional notions of space as objective reality (Shields, 2011; Strus et al., 2024).

Interactional Level—Human-Environment Engagement. Human-environment engagement occurs through three simultaneous spatial dimension that reveal different modes of interaction. Perceived space—spatial practice—involves embodied experiences of individuals navigating the space, such as patients experiencing sensory deprivation due to monotonous designs and noise from machines and healthcare workers navigating tension between cure-focused tasks and care activities, which are hindered by environments prioritizing machinery over human interaction (Lefebvre, 1974; Strus et al., 2024). Conceived space—representations of space—operated through institutional design logic where standardized layouts of homogenized patient experiences neglect individualized needs, reproducing capitalist values of productivity over well-being through environments where clinical and medical equipment dominates, creating a non-homely feel (Lefebvre, 1974; Strus et al., 2024). Lived space—representational space—emerges through emotional and symbolic experiences where patients often associate ICUs with vulnerability and loss of autonomy, exacerbated by impersonal designs while healthcare professionals struggle to provide holistic care in environments that fragment emotional and clinical labour (Lefebvre, 1974; Strus et al., 2024).

Interventional Level—Shaping Material Environment. Lefebvre's theory advocates for transformative spatial interventions that challenge existing power structure and reclaim spaces through participatory approaches (Lefebvre, 1974). Environmental interventions must address all three spatial dimensions simultaneously: integrating perceived (sensory), conceived (design), and lived (emotional) dimensions while challenging inequities through participatory, place-based solutions (Strus et al., 2024). Specific interventions include family

zones, nature views, or personalized lighting—elements that reduce stress and improve well-being that counter institutional dominance by creating spaces for alternative practices and meanings (Lefebvre, 1974; Rubin et al., 1998; Verderber et al., 2021). The interventional approach emphasizes transforming ICUs from sterile clinical zones into healing environments that empower patients, family members and staff through critical examination of whose interests spaces serve and creating opportunities for marginalized voices to shape spatial design and use (Shields, 2011; Strus et al., 2024). This requires moving beyond technical modifications to address fundamental power relations embedded in spatial arrangements.

Cross-Theoretical Analysis: Building the Integrated Framework

A comparative analysis across the three theoretical perspectives revealed convergent points and complementary relationships between them. Building on the three-level analysis of each theory presented in the previous section, the following table demonstrates the convergence and complementarity of these theories at the ontological, interactional, and interventional levels of analysis (Table 1).

Integrated Framework

The integrated framework synthesizes elements from three complementary theoretical perspectives to understand how ICU material environments can support rather than hinder healing and well-being: Roy's Adaptation Model, Ulrich's Theory of Supportive Design, and Lefebvre's Critical Theory of Space Production (Figure 2). The framework operates across three interconnected dimensions through which materiality transcends: Environmental stimuli and adaptive response, spatial production and power relations, and evidence-based supportive design.

By mobilizing this integrated perspective, the individuals immersed in the ICU are seen as individuals confronted with a continually changing material environment, loaded with stimuli to which they must adapt. The material environment thus becomes a lever for adaptation when it fosters

elements that procure a sense of control, support social interactions and incorporate elements that act as pleasant, comforting distractions (Andrade & Devlin, 2015; Dodeler, 2014; Roy, 2009; Ulrich, 1991). These conditions foster a more favorable adaptive response and can reduce the stress associated with ICU hospitalization. To intervene appropriately on this material environment, it is essential to understand that spaces are simultaneously perceived through embodied navigation experiences, conceived through institutional design logic prioritizing clinical efficiency, and lived through emotional and symbolic meanings. Recognizing this spatial triad reveals how power structures are embedded in and can be challenged through material arrangements thus empowering individuals to challenge inequities and sculpt their material environments (Lefebvre, 1974).

The integration of the multiples perspectives resulted in identifying three common fundamental principles on which the framework is built. Firstly, emphasizing the centrality of human-environment relationships in health and well-being outcomes, the framework rejects passive conceptualizations of environmental influence in favor of dynamic, reciprocal interactions. Secondly, acknowledging the importance of human agency, whether through adaptive coping mechanisms, stress appraisal, control and social support seeking or spatial practices and meaning-making. Thus, referring to the capacity of individuals to act independently, make choices, and exert influence on their circumstances and environment. Thirdly, recognizing that environmental experiences are mediated by individual characteristics, contextual factors, and ongoing processes rather than deterministic cause-effect relationships.

Discussion

Framework Applications

The integrated model provides practical guidance for ICU design research and practice across multiple domains. For environmental assessment, the framework suggests evaluating ICU spaces simultaneously as adaptive stimulus fields (identifying focal, contextual, and residual stimuli), supportive design environments (measuring

Table 1. Convergences and Complementarities of Roy's Adaptation Model (Roy, 2009), Ulrich's Theory of Supportive Design (Ulrich, 1991), and Lefebvre's Critical Theory on Space Production (Lefebvre, 1974) on Ontological, Interactional, and Interventional Levels.

Ontological Level—Conceptualizing Environment and Space

| | Convergences | Complementarities |
|-------------------|---|---|
| Roy's Theory | The environment is a dynamic stimulus field requiring adaptive responses. | Adaptive stimulus field that captures the physiological and psychological responsiveness of environments. |
| Ulrich's Theory | The environment is a measurable reality with predictable psychological impacts. | Evidence-based objectivity providing measurable parameters for environmental effects. |
| Lefebvre's Theory | Space is socially produced through power relations. | Social constructivism reveals power structures embedded in spatial arrangements. |

Interactional Level—Human-Environment Engagement

| | Convergences | Complementarities |
|-------------------|--|---|
| Roy's Theory | Emphasizes adaptive coping mechanisms across four modes. | Adaptive responses: physiological adjustment, self-concept maintenance, role function preservation, interdependence facilitation. |
| Ulrich's Theory | Focuses on stress appraisal and control mechanisms | Stress appraisal mechanisms: control seeking, social support access, positive distraction. |
| Lefebvre's Theory | Highlights spatial practices and meaning-making processes. | Spatial practices: perceived navigation, conceived reproduction, lived resistance. |

Interventional Level—Shaping Material Environment

| | Convergences | Complementarities |
|-------------------|---|--|
| Roy's Theory | Clinical optimization through environmental manipulation to support adaptive responses across four modes. | Roy's adaptive agency: Individuals are active agents in responding to environmental stimuli. Addresses adaptive bio-psycho-sociological needs. |
| Ulrich's Theory | Evidence-based design interventions targeting measurable stress reduction through control, social support, and positive distraction elements. | Ulrich's informed Agency: Individuals are active agents in processing and seeking environmental elements that reduce stress and promote well-being. |
| Lefebvre's Theory | Advocates for critical space transformation that challenges power structures through participatory, place-based solutions that empower marginalized voices. | Lefebvre's transformative agency: Individuals are active agents in producing and transforming space itself through their spatial practices. Individuals don't just adapt to or utilize space, they actively create, contest, and reshape spatial arrangements through their lived experiences and practices. |

stress-reduction elements), and socially produced spaces (analyzing whose interests current designs serve). In intervention design, the model guides the development of comprehensive environmental modifications that optimize adaptive responses, implement evidence-based stress reduction strategies, and create opportunities for spatial reclamation. For hospital administrators and facility

managers, the framework provides multi-dimensional justification for design investments by demonstrating how environmental interventions simultaneously address clinical outcomes (adaptation), patient/staff experience (supportive design), and equity considerations (critical spatial analysis). For public health policy makers, the framework illustrated how ICU design intersects with health system priorities

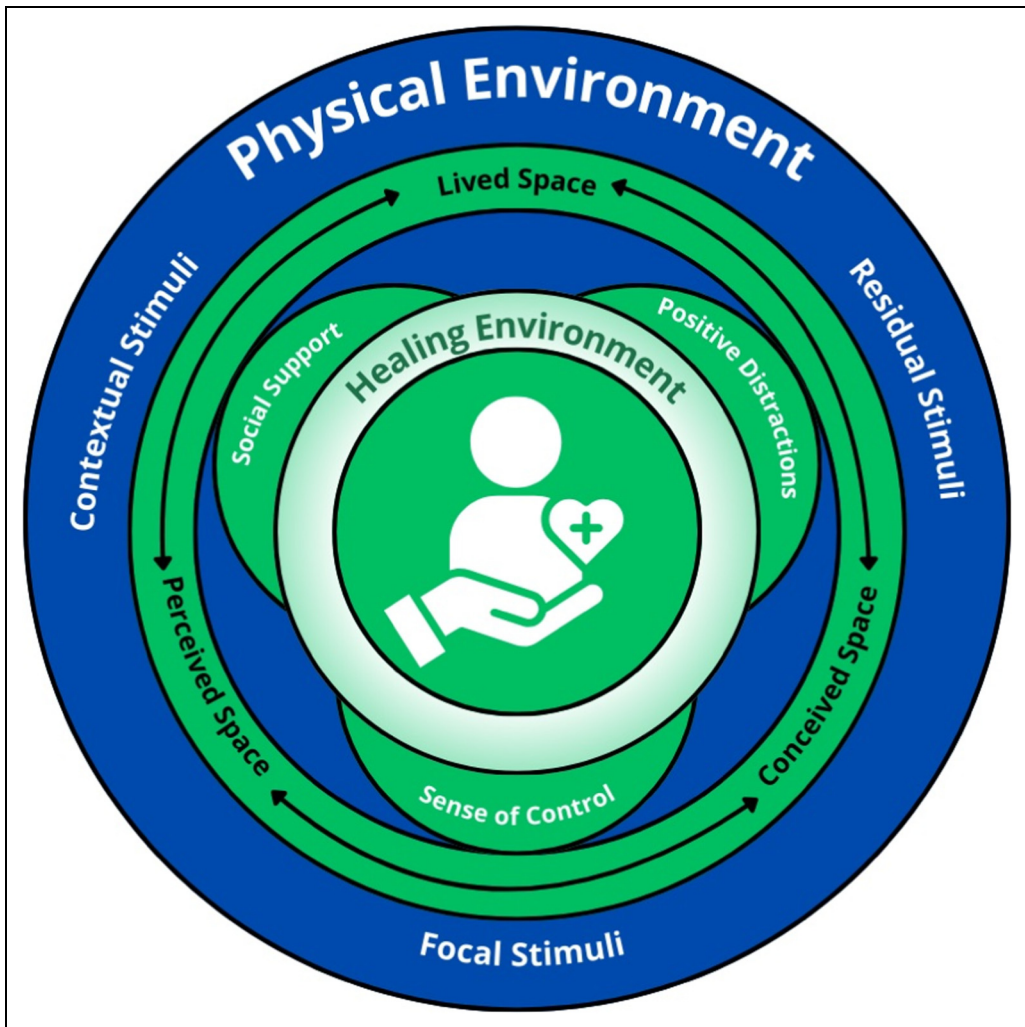


Figure 2. Integrated Framework for Healing Environments in the Intensive Care Unit (ICU).

Note. The Integrated Theoretical Framework for Healing ICU Environments. This diagram presents the synthesized framework showing: (Center) The ICU healing environment as the goal of the analysis; (Three outer circles) Each theory's contribution— Ulrich's supportive design principles, Lefebvre's spatial triad, and Roy's Adaptation processes, (Connecting circles) The multidimensional and conceptual relationships between theories; (Inner ring) The framework should be read as a dynamic system where interventions at any point affect all other dimensions, requiring simultaneous considerations of adaptive, supportive, and critical perspectives.

including patient safety, workforce well-being, and healthcare quality improvement.

Illustrative Application: ICU Bedspace Redesign

To demonstrate the framework's practical utility, we present a detailed application to a common ICU design challenge: redesigning the patient

bedspace. This example illustrates how the integrated framework produces more comprehensive analysis and intervention than any single-theory approach.

Problem Identification: A typical ICU bedspace presents challenges from each theoretical perspective. From Roy's adaptation lens, patients face overwhelming focal stimuli, contextual stimuli that hinder adaptation, and residual stimuli

that affect coping. From Ulrich's supportive design lens, many bedspaces lack patient control over environmental features, provide inadequate accommodation for family presence, and offer few positive distractions from the clinical environment. From Lefebvre's critical lens, the typical bedspace prioritizes clinical surveillance and efficiency over patient dignity, with design decisions reflecting institutional needs rather than patient/family preferences.

Framework-Guided Analysis: Applying Roy's model, the assessment identifies specific stimuli affecting each adaptive mode: physiological (noise disrupting sleep, temperature variations), self-concept (loss of privacy, inability to maintain personal appearance), role function (difficulty communicating with family, inability to participate in care decisions), and interdependence (physical barriers separating patient from family, limiting visiting hours). Applying Ulrich's theory, the assessment evaluates: sense of control (can patients adjust lighting? Temperature? Bed position?), social support (is there comfortable seating for family? Privacy for conversations?), and positive distractions (are there windows? Nature views? Art? Entertainment options?). Applying Lefebvre's theory, the assessment examines: whose interests does the current design serve? (efficiency-focused layouts suggest institutional priorities); how do spatial arrangements structure power relationships? (patient bed as object of clinical gaze); what alternative spatial practices do patients and families attempt? (personalizing space with photos, adjusting furniture).

Integrated Intervention Design

The framework guides the development of interventions addressing multiple dimensions simultaneously. Example intervention: A "Family Zone" within the bedspace that includes comfortable convertible seating (Addressing interdependence adaptation AND social support), a small personal storage area for family belongings and patient's personal items (supporting self-concept adaptation AND challenging clinical dominance of space), adjustable lighting separate from clinical lighting (enhance sense of control AND supporting physiological adaptation to circadian rhythms AND enabling

spatial reclamation for rest periods). This single intervention addresses Roy's four adaptive modes, Ulrich's three supportive design principles, and Lefebvre's call for challenging institutional spatial dominance—demonstrating the integrative power of the framework.

Framework Adaptability Across Contexts

Resource-Level Considerations. The framework's core principles remain applicable across resource levels. However, specific interventions will differ. Low-resource settings might prioritize low-cost, high-impact modifications: maximizing natural lighting through strategic bed placement, implementing noise reduction protocols, establishing family presence policies, and using existing materials creatively. High-resource settings can implement more technologically sophisticated solutions: circadian lighting systems, acoustic monitoring and management, and integrated family accommodation. Importantly, Lefebvre's critical lens remains essential in all contexts, ensuring that resource constraints do not become excuses for perpetuating designs that serve institutional rather than patient/family needs.

Population-Specific Adaptations. The current framework was developed with adult ICUs as the primary focus. Adaptation is required for different ICU populations (pediatric and neonatal ICUs) and empirical validation across the different contexts is recommended as a priority for future research.

Novel Insights for Healing ICU Environments

The framework demonstrates that healing environments cannot be achieved through single-theory approaches, as biological, psychological, social, and material dimensions of environmental experience are fundamentally interconnected. Environmental interventions may have contradictory effects across analytical levels—for example, technologically advanced adaptive features may support physiological needs while simultaneously reinforcing institutional power structures that marginalize patients. Sustainable environmental improvements require addressing not only immediate adaptive needs and stress reduction

but also the underlying spatial practices and power relations that reproduce problematic environmental conditions over time. Effective healing environments emerge when interventions simultaneously address adaptive physiological needs, reduce psychological stress through supportive design elements, and challenge spatial power relations that marginalize patients and families.

Effective healing environments emerge when interventions simultaneously address adaptive physiological needs, reduce psychological stress through supportive design elements, and challenge spatial power relations that marginalize patients and families.

Limits

This theoretical integration has several limitations that should be acknowledged. First, as a conceptual framework synthesis, this work does not include empirical validation of the proposed integrated model in actual ICU settings. The framework was developed within the context of a master's thesis employing a qualitative approach to explore the materiality of adult ICU environments, with the aim to conceptualize the creation of healing ICU spaces. As such, future empirical research is needed to validate its practical applicability and effectiveness in guiding environmental interventions. Second, the selection of three specific theories, while justified by the inclusion criteria, may have excluded other relevant perspectives. Third, the interpretive synthesis may reflect the authors' theoretical positioning in the way concepts were integrated across disciplines. Fourth, the framework's complexity, encompassing biological, psychological, and social dimensions, may pose challenges for implementation in practice settings where single-theory approaches are more familiar to healthcare teams. Fifth, although the framework addresses power relations and social justice through Lefebvre's theory, it may not fully account for specific cultural, ethnic, or socioeconomic factors influencing how different populations experience ICU environments. Sixth, the framework focuses primarily on the care experience and would benefit from fuller integration of organizational and

economic perspectives relevant to administrative decision-making. Finally, while guidance has been provided on adapting the framework for different resource levels and populations, empirical validation in these varied contexts remains necessary.

Conclusions and Recommendations

The integrated framework developed in this study offers a novel, multi-dimensional, and interdisciplinary approach to examining the perceptions of key stakeholders regarding healing environments in ICUs. It underlines the limits of a single theory approach for capturing the complexity of ICU materiality and demonstrates how the integration of disciplinary and critical perspectives provides a more comprehensive foundation for research and practice encompassing biological, psychological, social, and material dimensions of healing environments simultaneously. By bridging theory and practice, this framework offers a structured lens to explore materiality in the ICU environment although its future validation through applied research is needed.

To support its application, several recommendations can be proposed: (1) Use the framework as a boundary object to facilitate interdisciplinary dialogue among stakeholders from clinical, design, administrative, and patient/family perspectives. (2) Adapt the framework to local resource contexts while maintaining attention to all three theoretical dimensions. (3) Validate the framework through empirical research across diverse ICU settings. (4) Consider its potential to inform policy development for ICU design standards that address not only clinical functionality but also patient experience and equity.

This framework holds significant implications for ICU practice by informing design and organizational interventions aimed at enhancing the overall care experience. By emphasising person-centred care and the humanization of ICUs, it contributes to advance knowledge on healing environments and supporting improved patient experiences and outcomes. The framework thus provides a foundation for future research aimed at better conceptualizing, understanding and operationalizing the healing environment across varied ICU contexts.


Implications for Practice

- It provides the first systematic integration of nursing, environmental psychology, and critical spatial theories specifically addressing ICU materiality
- It offers practical guidance for ICU design research and practice across multiple domains, from environmental assessment to comprehensive intervention design
- It empowers all care-related stakeholders—patients, families, and healthcare professionals—to actively shape healing ICU environments
- It bridges theory and practice, providing structure for both researchers and practitioners working to create more supportive critical care spaces.

Acknowledgements

The authors would like to thank the Canadian Institutes of Health Research (CIHR), the Ministry of Higher Education (MES), the Bureau de coopération interuniversitaire (BCI), the Faculty of Graduate and Postdoctoral Studies (FESP) at Laval University, and the Canadian Nurses Foundation (CNF) for the various grants that EP obtained for this project.

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Ethical Considerations

Ethical approval was not required for this theoretical research paper.

Consent to Participate

Not applicable.

Consent for Publication

Not applicable.

Author Contributions

Edouard Paquet: Conceptualization, methodology, formal analysis, visualization, writing—original draft, writing—review & editing; **Caroline Gagnon:** Conceptualization, supervision, writing—review & editing; **Maria Cecilia Gallani:** Conceptualization, formal analysis, methodology, supervision, visualization, writing—review & editing.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: EP received funding support from the Canadian Institutes for Health Research (CIHR), the Bureau de coopération interuniversitaire (BCI), Quebec's Ministry of Higher Education, the Laval University Faculty of Higher Education and Postdoctoral Studies (FESP) and holds a Canadian Nurses Foundation (CNF) Scholarship. This funding supported his master's degree in nursing research, of which this publication forms part of his thesis work.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data Availability

Not applicable.

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