Academy Journal

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Academy of Architecture for Health

AIA Knowledge Community

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Mission of the *Academy Journal*

As the official journal of the AIA Academy of Architecture for Health (AAH), this publication explores subjects of interest to AAH members and others involved in the fields of health care architecture, planning, design, and construction. The goal is to promote awareness, educational exchange, and advancement of the overall project delivery process, building products, and medical progress that affect all involved in those fields.

About AAH

AAH is one of 21 knowledge communities of The American Institute of Architects (AIA). AAH is unique in the depth of its collaboration with professionals from all sectors of the health care community, including physicians, nurses, hospital administrators, facility planners, engineers, managers, health care educators, industry and government representatives, product manufacturers, health care contractors, specialty subcontractors, allied design professionals, and health care consultants.

AAH currently consists of approximately 7,000 members. Its mission is to provide knowledge which supports the design of healthy environments by creating education and networking opportunities for members of – and those touched by – the health care architectural profession.

Please visit our website at aia.org/aah for more about our activities. Please direct any inquiries to aah@aia.org.

Contents

About the journal

As we start the 25th year of the Academy Journal, published by the AAH Knowledge Community, this edition includes articles that support the enhancement of the built environment for health care.

As the official publication of the Academy, the Journal publishes articles of particular interest to AIA members and the public involved in the fields of health care architecture, planning, design, research, and construction. The goal has always been to expand and promote awareness, educational exchange, and advancement of the overall project delivery process, building products, and medical progress that affects all involved in those fields.

Articles are submitted to, and reviewed by, an experienced, nationally diverse editorial review committee (ERC) of medical and architectural professionals. Over the years, the committee has reviewed hundreds of submissions, responded to writers' inquiries, and encouraged and assisted writers in achieving publication. In its 25-year history, the Journal has provided valuable opportunities for new and seasoned authors from the architecture and health care professions including architects, physicians, nurses, other health care providers, academics, research scientists, and students from the US and foreign countries.

Published articles have explored a broad range of medical topics and research trends. Some topics addressed in the past include the future of health care architecture, cardiac care, future and evolving technology, patient rooms and patient safety, lighting design for health care, psychology, workplace design, cancer care environments, emergency care, women's and children's care, and various health care project delivery methods.

We encourage graduates who have received health care research scholarships and others involved with research within the health care architecture field to submit their research to the Journal for publication consideration. We will continue to develop a cross-referenced article index and a broader base of writers and readers.

Since the late 1990s, this free publication has expanded to include worldwide distribution. We are proud to report that as our readership continues to grow, it also expands internationally. Readers have viewed the Journal online from the US, Canada, Europe, the Caribbean, Asia, Africa, India, and Saudi Arabia, just to name a few. The Journal is available to the over 96,000 AIA members and the public on the AIA website.

Special thanks to AIA for its continued support and hard-working staff and to the many volunteers who have contributed to our growing and continued success including Isabella Rosse, Doug Paul, and Southern Ellis, AIA for their leadership on behalf of the AIA and AAH. I would especially like to thank the other members of the 2022 ERC: Donald L. Myers, AIA, NCARB; Angela Mazzi, FAIA, FACHA, EDAC; Sharon Woodworth, FAIA, FACHA; Dale A. Anderson, AIA, NCARB, LEED AP BD+C, CSBA, EDAC, MBA, GGP, ACHA; and Erin McNamara, EDAC. As always, we appreciate your feedback, comments, and suggestions by emailing aah@aia.org.

Letter from the editor

Health care architecture is getting better

The articles in this year's journal focus on both new modalities of health care delivery and new methods to research health care design. Newness, not for the sake of being in vogue, but in the pursuit of improvement, growth, and betterment.

It strikes me how so many health care focused architects are driven to improve the built environment through their work. We read articles, sponsor research, attend conferences, and join professional development groups to explore new ideas, understand new findings, and implement new design strategies – better design strategies.

Perhaps our daily interactions with physicians, practitioners, and researchers have energized our drive for continual practice improvement; We have absorbed their passion for the scientific method. Or perhaps we see the cause of sheltering and caring for the sick as a noble and tireless pursuit on behalf of humanity. Whatever the reason, it is inspiring to witness the passion and dedication the authors, editors, and readers of this journal have for improving the environments of healthcare and, in a small way, improving the care provided within our communities.

Thank you for your involvement with the journal and the AAH Knowledge Community. It is through embracing the ever-changing pursuit of knowledge and striving for process improvement that we may continue to get better together.

In praise of the scientific method,

Regan Henry, RA, PhD, LEED AP, LSSBB, WELL AP
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Co-Diagnosis: An Interdisciplinary Design Study of Inpatient Units for Mental and Physical Health

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ABSTRACT

The contemporary crisis in mental health underscores a need in the healthcare industry to design healing environments for patients who suffer from mental as well as physical illnesses. There is a gap in the literature and little precedent in the industry for designing inpatient units to meet the needs of patients who require hospitalization for medical conditions, and who also suffer from mental and behavioral health conditions. To explore this design problem, we organized an interdisciplinary workshop that engaged healthcare providers, administrators, and architects with undergraduate and graduate students in art, architecture, communications, and urban design. The goal was to examine barriers and opportunities to create a new type of hybridized medical-behavioral health unit to address the needs of co-diagnosed patients as well as their healthcare providers. Lived experiences of doctors, nurses, and healthcare designers were integral to forming an understanding of the design problem and creating concepts for this largely unprecedented space type. The workshop took place at Barnes-Jewish Hospital, an urban academic medical campus, where an existing inpatient unit was identified for renovation to pilot a 'safe unit' that cares for medical patients with mental and behavioral health co-diagnoses. Insights from this interdisciplinary collaboration create pathways for future exploration in design research and industry application.

Introduction

"At the root of this dilemma is the way we address mental health in this country. When it comes to mental health conditions, we often treat them differently from other diseases like cancer, diabetes, or asthma. And that makes no sense. Whether an illness affects your heart, your leg, your brain, it is still an illness, and there should be no distinction."

– ***Michelle Obama***

Prior to the COVID-19 pandemic, nearly 20% of US adults were known to live with a mental illness that ranged from mild to moderate to severe (National Institute for Health, 2020). Following the onset of the pandemic, that percentage of people doubled as the National Institute of Mental Health (NIMH) found 40% of US adults reported mental health issues in 2021 (Panchal, Kamal et al., 2021). Among the recent alarming trends is the drastic rise in suicide and self-harm (John, A., Eyles, E. et al, 2021). The American Academy of Pediatrics declared a National Emergency in Child and Adolescent Mental Health, noting the impact of COVID-19 and the influx of pediatric and adolescent mental and behavioral health cases that have been further exacerbated by the racial inequalities seen in communities of color (AAP-AACAP-CHA, 2021). Literature points to the disproportionate toll the pandemic has placed on the mental health of healthcare providers (Feinstein, R.E., Kotara, S., 2020). The connection between mental and physical health, factors into the dynamics of the public health crisis; people with severe mental illness are more likely to experience chronic physical conditions, and people with chronic physical health conditions are more likely to experience depression and anxiety (CMHA, 2008). The lasting impacts of the COVID-19 Pandemic paired with the initiative to destigmatize behavioral and mental health resources have highlighted the built environment's role in helping meet the needs of patients and staff. Public concern for mental health brings attention to major gaps in mental health services (World Health Organization, n.d.), and the need for spaces to be designed to support patients who struggle with both mental health and medical conditions. Vulnerabilities we see in today's infrastructure for care highlight a long history of disinvestment and marginalization around the treatment and support of mental health needs.

The origins of organized care for mental health in the US date back to 1752 when Quakers in Philadelphia opened the Pennsylvania Hospital with rooms in the basement dedicated to mentally ill patients. Social isolation was a common spatial strategy in the design of early hospitals to "cure" mental illnesses. Early US-based champions of the mental health movement include Dorothea Dix, who documented the brutal treatment and living conditions of mentally ill patients and forged a more positive, human-centric approach to behavioral health. By 1890, every state had one or more publicly funded mental hospitals even though the American Medical Association did not recognize mental health as an illness when it was

founded in 1847. The 1920s saw a shift of interest in US psychiatry to consider ways that social environments contributed to mental disorders (Horwitz, A.V. & Grob, G., 2011). State-funded hospitals built after World Wars I and II commonly had psychiatric wards that reverted to isolation strategies with patients sequestered in contained, discrete sections of hospitals. The Community Mental Health Act of 1963 aimed to deinstitutionalize state-run care for mental health and help catalyze the growth of community-based care. Only half the proposed centers were built, and none were fully funded, leaving many communities ill-equipped to cope with the later surge in mental health needs, particularly following the Vietnam War.

This framework is integral to contextualizing the landscape of care we see today where physical and mental health are typically regarded in isolation from each other. There is a gap in the literature and few precedents in the healthcare industry for designing to meet the needs of patients who are admitted for medical conditions and who have mental health needs that make hospitalization in a medical inpatient unit unsafe. The term co-occurring disorder (COD) emerged in the 1980s in reference to patients with concurrent mental health and substance abuse disorders as clinicians increasingly recognized the need to identify patient populations with complex, intertwined needs (Hryb, Kirkhart & Talbert, 2007). Today, a co-diagnosed patient—also identified as a dually diagnosed or medically enhanced psychiatric patient—might be hospitalized in an acute care unit after suffering a heart attack, for instance, but has a mental health condition that contributes to delusions and self-harming behaviors. Patient room layouts, equipment, and furnishings in medical units are designed to entirely different standards than in psychiatric units, as are care levels and observation capacities. This poses major risks to safety and security for both patients and providers. It also raises questions about the future capacity of health environments to help patients with intertwined mental and physical health needs. Currently, there are no measures in psychiatric units to meet the medical needs of patients. Stopgap measures in medical units currently include hiring 'sitters' to provide 24/7 observation of high-risk inpatients in acute care units and putting 'mitts' on patients in order to prevent them from misusing equipment for self-harm. These are often expensive and ineffective uses of time and resources. Temporary fixes belie larger, systemic vulnerabilities.

To address the problem of designing for co-morbidities, we organized a workshop that was a collaboration between Barnes-Jewish Hospital (BJH) and the Sam Fox School of Design & Visual Arts at Washington University in St. Louis. The conceptual framework of the workshop was grounded in exploring the psychology of space and the impacts of architectural design on human health and wellbeing (Kopec, 2018; Richie, 2020; Robinson & Pallasmaa, 2015; Sternberg, 2010). Investigating connections between architecture and psychological states created a focus for investigating ways that spaces affect behavior and healing in the integrated realm of mental and physical health (Neutra, 1954; Pallasmaa, 2012; Sternberg & Wilson, 2006). This article reports the methods, results, and findings of the design investigation, and discusses the need for future design research into environments that holistically address physical and mental health needs. We additionally discuss the potential for design education and interprofessional initiatives to catalyze innovation around complex health issues, and we advocate for the benefits of examining design problems in the healthcare industry through interdisciplinary lenses.

Methods

This design investigation began with an unmet need identified by BJH in late 2019 to care for co-diagnosed patients. The administrative leadership of BJH began exploring the potential to renovate an existing unit of acute care patient rooms at BJH, an urban academic medical hospital, to test design concepts and strategies for a 'safe unit' that would be dedicated to caring for co-diagnosed patients, only to discover there were no precedents for this type of unit to benchmark. The need for this type of space is described by the Vice President of Patient Care and Services, Chief Nursing Officer and Chief Operations Officer: "*BJH is very committed to serving the most vulnerable in the community, many of whom have a psychiatric diagnosis. In order to honor this commitment, it is essential to have a therapeutic environment that supports the safety of the patient, the clinical team, as well as other patients. Typical medical-surgical units are not designed to be therapeutic or to meet the needs of psychiatric patients and as a result create increased risks for the patients, other patients, and their families, as well as the clinical teams.*"

A relationship between BJH and the Sam Fox School of Design & Visual Arts at Washington University in St. Louis prompted the proposal for a Masters Class workshop which was held in Spring 2020, just weeks before the state of emergency was declared because of the COVID-19 pandemic. The curriculum for the three-

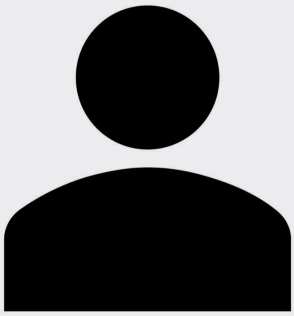
day workshop was designed by architects and educators at BJH and the Sam Fox School of Design & Visual Arts. A Curriculum Collaboration Project Proposal was formalized to identify roles and responsibilities in the partnership. Enrollment was limited to 16 undergraduate and graduate students in art, architecture, visual communications, and urban design. Workshop instruction was supported by practicing healthcare architects with industry leadership and research backgrounds in behavioral health.

Students were required to read and watch materials prior to the start of the workshop, including the documentary "Let There Be Light" (Huston, 1980), the film "One Flew over the Cuckoo's Nest" (Forman, 1975), and the short story "The Yellow Wallpaper" (Gilman, 1892). Confidentiality waivers were additionally required from students, and protocols were observed to protect the privacy of patients and providers.

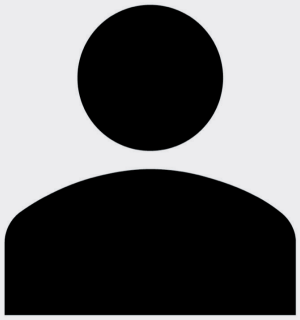
Tours and lectures were organized on-site at BJH's urban academic medical campus, where workshop participants talked with physicians, nurses, executive administrators, and staff. Design work was hosted at the school where students had access to pin-up space, digital fabrication resources, and the photo lab. The group of 16 students were organized into four groups of four students, who each had different disciplinary backgrounds in art, design, architecture, and visual communications, as well as various levels of training in drawing and modeling. Architectural floor plans of the existing unit were provided by BJH, along with a functional program and patient profiles written by clinicians. Figure 1 provides patient profiles; Figure 2 shows the floor plan of the existing 15-bed inpatient unit identified for renovation into a 'safe unit.'

The workshop focused on the following brief:

" Develop a unit to serve a patient population that presents with acute medical and behavioral health needs. The unit requires patients to have an active medical issue that needs acute inpatient medical care but who have behavioral issues that cannot be safely accommodated on a regular medical unit."



Patient number one is a 42-year-old male with a known history of opiate use disorder was admitted to the medicine service for chest pain and shortness of breath. He was found to have endocarditis from IV drug abuse which required 6 weeks of IV antibiotic treatment. Psychiatry consult recommended treating the opiate use disorder with Suboxone. They also determined he was not depressed, manic or psychotic but he admitted to using cocaine and MJ. After initiation of replacement therapy, the patient had no craving for narcotics. Since patient was homeless and penniless there was no ability to arrange credible outpatient support to continue his life saving IV antibiotics. The medicine hospitalist recommended he stay in the hospital for the duration of his antibiotic treatment. He frequently leaves the unit for hours at a time and has been seen by nursing staff loitering in the garage with his IV pole in tow.



Patient number two is a 21-year-old male with moderate intellectual disability who was brought to the ED after he beat his mom into a coma. The family did not want to press criminal charges since they believed this behavior was unusual for him. However, they could not identify a provocation for the attack. A Psychiatry consult was performed in the ED where it was determined that the patient was nonverbal and expressed his need for food by simple gestures. He could not follow simple directions and would preoccupy himself with adjusting his diaper. Psychiatry refused to admit the patient to the inpatient psychiatry unit since he was not psychotic, depressed or manic and had no treatable psychiatric illness. They recommended that he be admitted to a State sponsored facility for developmentally delayed patients, of which, there are none available in Missouri. The ED attending physician decided to admit the patient to the medicine service for "placement." He is now indefinitely on 1:1 supervision confined to his room.

Figure 1. Hypothetical patient profiles written for use in the design workshop.

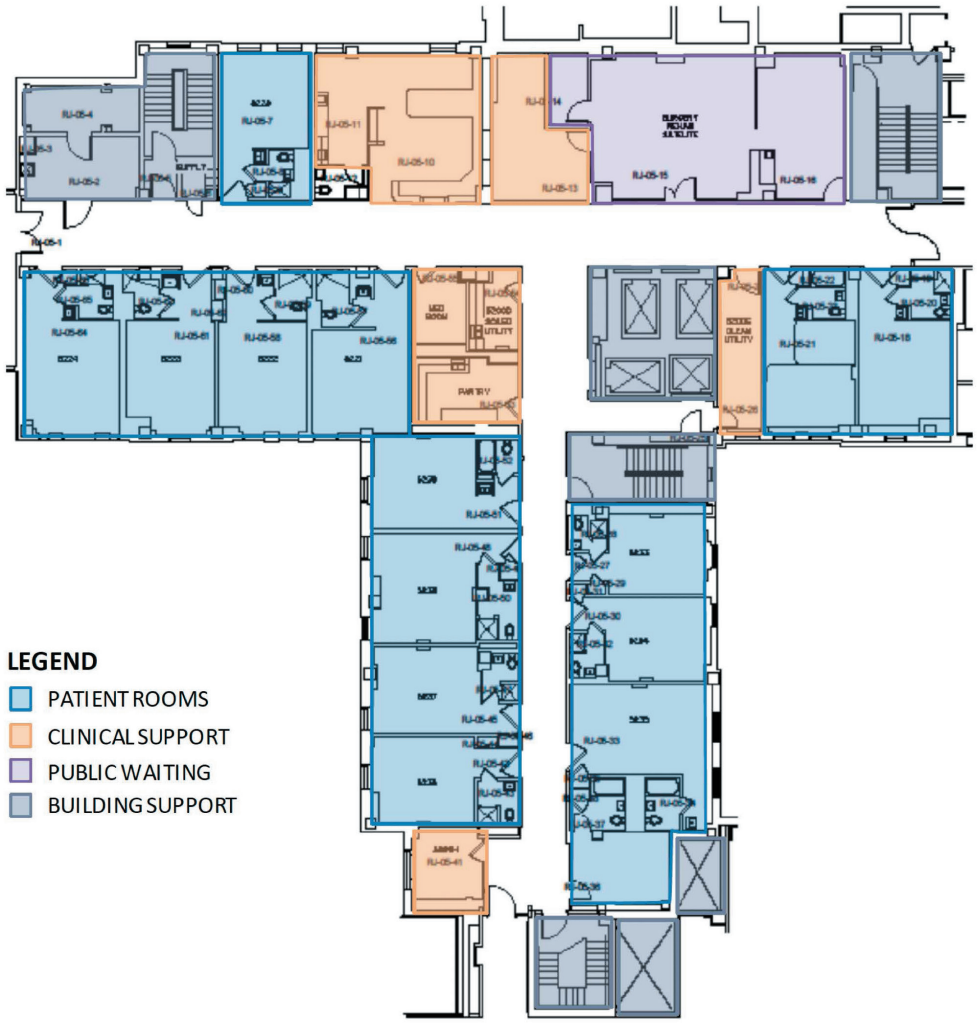


Figure 2. Existing floor plans of a 15-bed inpatient unit studied for conversion into a 'safe unit.'

The workshop concluded with design presentations of four distinct concepts for the renovation of the existing inpatient unit into a 'safe unit' for co-diagnosed inpatients. Students made 1/8" = 1'-0" models of their design proposals and created drawings and diagrams to support their ideas. A jury of architects, design studio faculty, practitioners, and stakeholders from BJH and the Sam Fox School of Design & Visual Arts provided feedback on the schemes. Discussions contributed to insight and evaluation of the design concepts and strategies.

Results

The workshop contributed to fact-finding and problem-definition phases which created frameworks for design speculation. A tour of three different levels of psychiatric care inpatient units at the academic medical campus (severe, geriatric, and step-down) provided insight into various spatial and design strategies that accommodate diverse patient populations. This complemented a tour of an acute care inpatient unit, and a tour of the unit slated for renovation. Overarching themes that emerged from tours and conversations with clinical staff included:

- Concerns for the physical and personal safety of frontline staff
- Space constraints limit the needs of staff to care for patients with best practices
- Lack of resources and space to manage multiple crises occurring at once
- Needing space for staff to decompress and maintain their personal wellness

Clinical staff shared personal and practical insights into the challenges they experience when caring for

co-diagnosed patients in medical surgical units which are not designed to support the needs of psychiatric patients. A nurse reflects on her own experience, saying “working on a primary medicine floor caring for patients with both medical and psychiatric diagnosis creates compassion fatigue due to lack of resources and untrained staff. Medical units lack the daily activities provided on psych units. Patients are often confined to their room on medical units instead of being able to socialize in a common area with others. Patients feel a lack of privacy if sitters are appropriate on a medical floor. Many times, medical units have unsafe features for patients and staff members in a psychiatric crisis.”

Teams prioritized and articulated the challenges they understood in ways that supported the design concepts they generated. Design themes addressed an understanding of needs for the following spatial and environmental qualities in both medical and behavioral health units:

- Daylight and access to nature
- Social support
- Safety and security
- Diverse sensory environments
- Choice and individuality

Shared common spaces designed to support mental health in psychiatric care units, such as art rooms and therapy areas, were an integral component to concepts proposed for an inpatient unit dedicated to a co-diagnosed patient population. Concerns around visibility and sight lines were a predominant factor to enhance safety and connectivity. Spaces designed to provide respite and support for staff were created in all the schemes. Finally, strategies to recognize and honor the individuality of patients were strongly emphasized. The design concepts, which originated from distinct understandings of the design problem, are summarized here. Figure 3 illustrates floor plans for the proposed schemes.

Figure 3. Floor plans for proposed schemes.

Design Concept A: Interzone

Design Concept B: Coterie

Design Concept C: Belonging

Design Concept D: Breathe

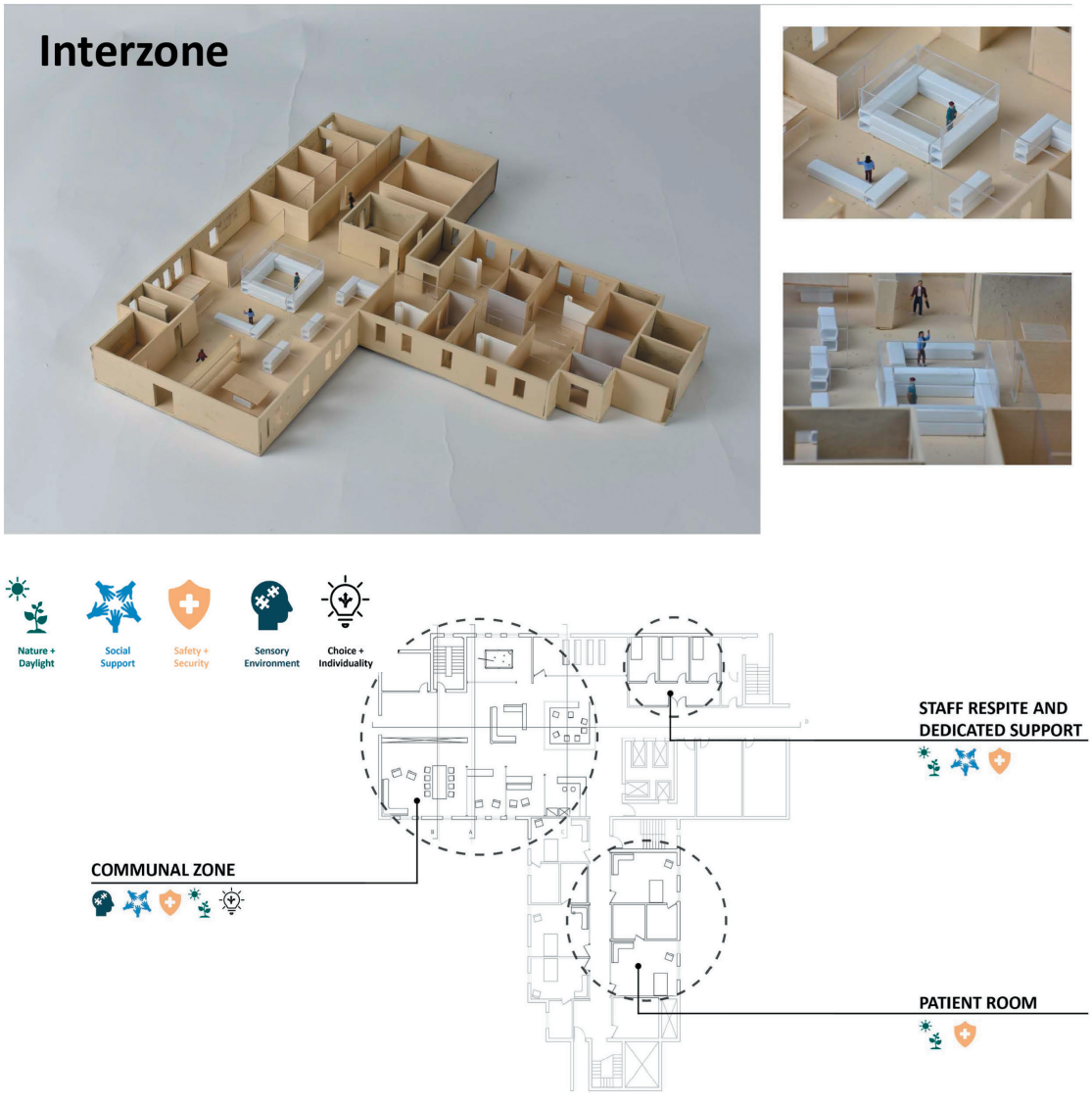
Design Concept A: Interzone

This team began with a spatial analysis of the existing inpatient unit where three categories of space were identified: double-loaded corridors created public circulation space; the elevator lobby and entry areas into rooms created threshold spaces between public and semi-public space; and walls enclosed discrete rooms and semi-private spaces such as patient rooms, bathrooms, clinical work areas, and supply/support spaces. The team was concerned over the lack of intermediate-scaled space which limited the visibility and potential interaction between patients and staff in public and semi-public spaces.

In response, the team proposed a central common area for the unit where a nursing station, a conversation alcove, a library/resource center, and an arts/recreation space would be located. Rather than using full-height walls, thick half-walls that accommodate built-in seating and perching were proposed to divide zones within the central common space. A full height plexiglass enclosure was designed around portions of the nurse station to add an element of acoustical privacy and protection for staff.

Figure 4 illustrates this design proposal and provides model shots of the visual connections made possible through the centralized common zone of layered spaces. Private patient rooms and clinical support spaces flank the common area, and views across and through the common area promote greater connectivity between patients and providers.

Figure 4. Design concept for Interzone.

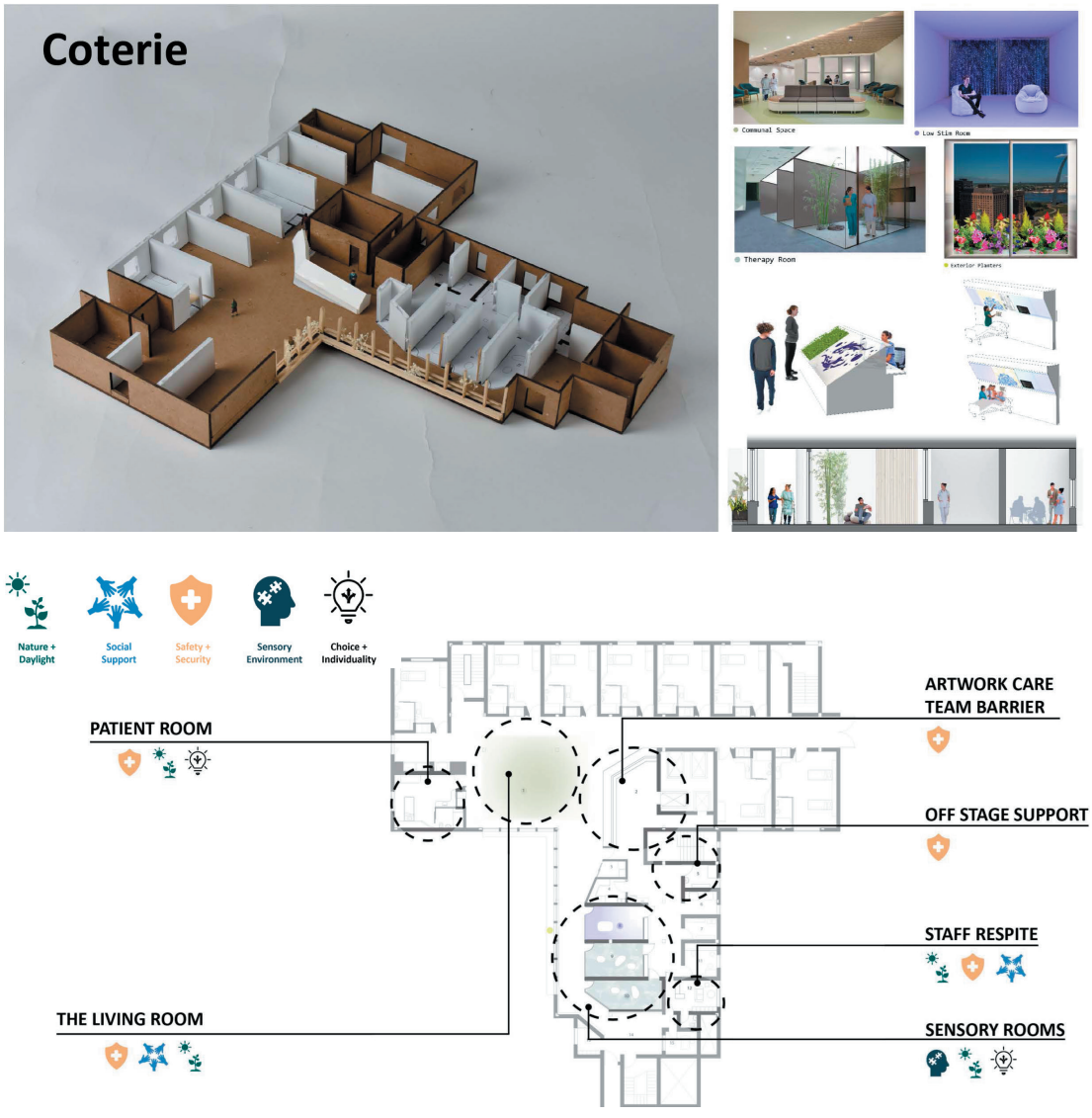


Design Concept B: Coterie

The concept of celebrating the individuality of patients and providers drove the scheme titled Coterie, named to recognize the community of people inhabiting the unit with shared interests and needs. This design approach, illustrated in Figure 5, centered around an open common space and featured a set of distinct sensory destinations, including a low-stimulation room, a therapy room, and a meditation lounge. These were envisioned to be retreat areas that provided relief for patients who needed to get outside of their individual patient rooms. Staff retreat areas were organized alongside, but separated from, patient areas; staff areas included a mother's room, a break area, a small conference room, and a huddle room—all of which were privileged with daylight and views.

Visual display was a critical component of the scheme. An extended front to the nurse station was proposed to both display artwork and to provide a spatial buffer of protection for staff. A canted headboard in patient rooms was designed to contain medical equipment and supply outlets without posing concerns for ligature and self-harm. Restrictions to incorporating live plants in the unit itself were addressed by proposing a ledge for plants that would be housed in the exterior façade system. The team, which was comprised of two students in art and two in architecture, additionally proposed a way for patients to personalize their attire with logos, in lieu of the green and blue hospital scrubs that are common issue.

Figure 5. Design concept for Coterie.

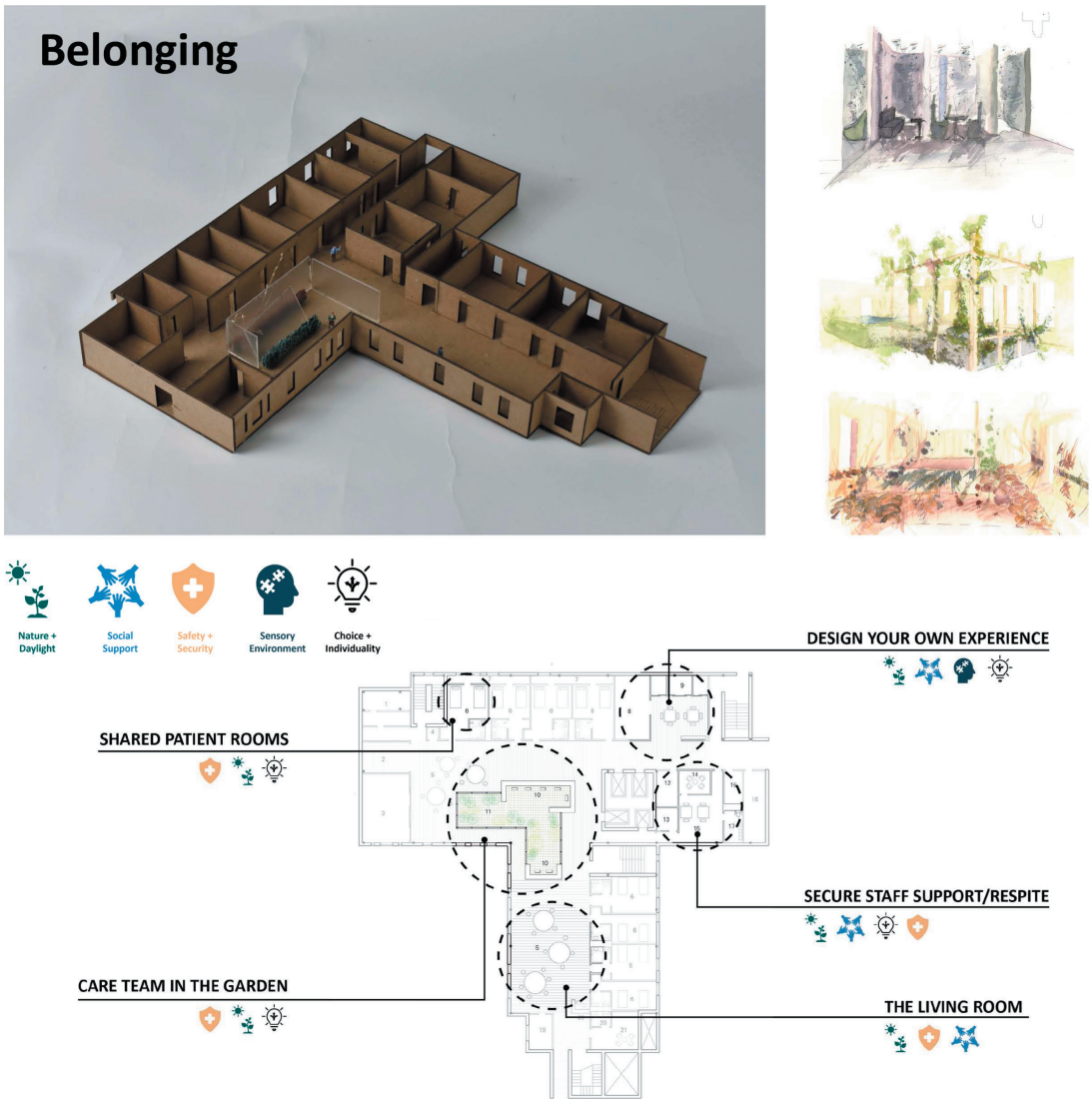


Design Concept C: Belonging

Interest in aggression reduction strategies prompted this team to think about proactive design measures that could engage primary senses such as sound, sight, touch, smell, and taste. Team members were struck by the number of damage-resistant components they saw on tours including locks, observation windows, security cameras, and metal detectors; while acknowledging the need for safety and the incorporation of these features, they were inspired to rethink the 'safe unit' as a source of revitalization for the senses.

The team interpreted the program therapy areas to include a sound room, a cool room, an art exhibition area, and a smell zone. Restrictions to having greenery within the unit were addressed by conceiving of the central nursing station as a kind of greenhouse—filling it with plants and enclosing it with glazing—which creates visibility to greenery and brings plant life into the work zone of healthcare providers. A subtle use of color was also intentionally deployed in the scheme, Belonging, as the team envisioned how daylight or lack of daylight can work with color to create different emotive qualities in semi-public, common spaces. Figure 6 depicts the model and illustrations generated for the scheme Belonging.

Figure 6. Design concept for Belonging.

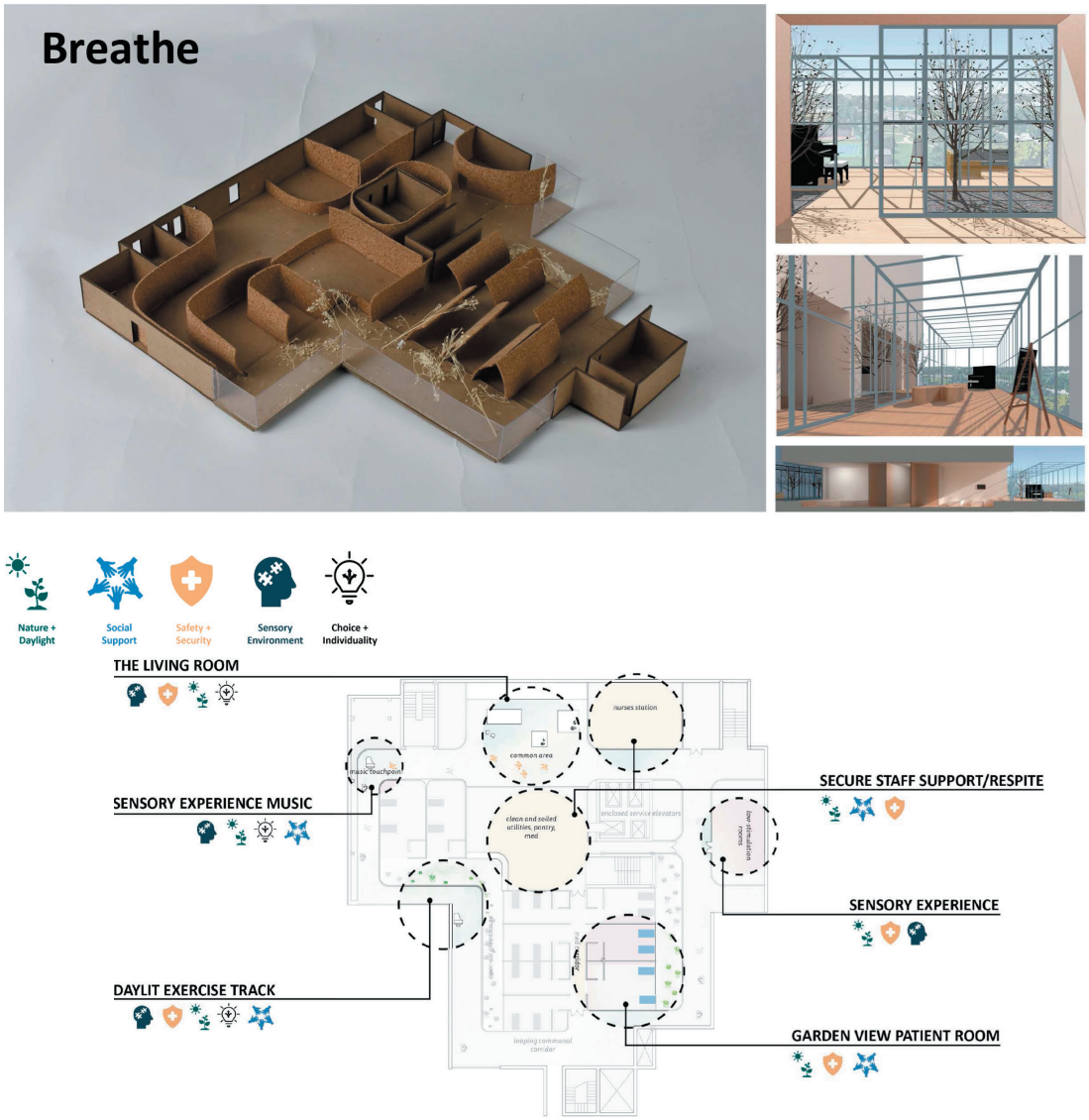


Design Concept D: Breathe

One of the primary concerns that resonated with this team was the sense of confinement and disconnect from the outside world that they experienced in both acute care units and psychiatric care units. Inspired by the need for physical activity and connection to the outdoors, this team proposed a continuous loop of a walking track around the perimeter of the unit, made possible by a cantilevered extension of space off the T-shaped tower. Figure 7 illustrates ideas for the concept Breathe.

Conceived as a hybrid between a conservatory for music and art, and a walking track, the team envisioned this cantilevered space as a linear refuge akin to the linear patio at Aalto's Paimio Sanatorium. The daylight and privileged views of the city would be brought into the heart of the unit through gently curving walls that enclosed patient rooms and staff work areas. A visual connection to the surrounding city and environment would provide a positive distraction for both patients and providers and be a space where family and friends would be attracted to spend time with their loved ones outside of the context of patient rooms. This space would encourage social interaction, exercise, and creative activities, which team members regarded as critical to supporting mental and physical health. Symbolically, the space would also serve as a beacon at night and celebrate the presence of space on the academic medical campus that cares for co-diagnosed patients.

Figure 7. Design concept for Breathe.



Discussion

The diversity of ideas offers a glimpse into the potential to rethink the model of care for co-diagnosed patients who are admitted for primary medical conditions but who have behavioral and mental health issues and cannot be safely accommodated on a regular inpatient medical unit. This is largely an unprecedented space type with the same challenges and requirements related to infection control in medical surgical units. Rather than focusing on precedents and case studies, this workshop took the approach of investigating design issues from interdisciplinary and collaborative perspectives within a charette format.

Further design research is needed to address this pressing need, and to respond to issues of safety and security that are posed for patients and healthcare providers. While there is currently a lack of precedent for this type of 'safe unit' envisioned in the workshop, the premise of caring for health needs that are both physical and mental is fundamental to the charge of healing environments. Strategies presented here reflect visions of how inpatient units of the future might be designed to dually support mental and physical health. The projected rise in behavioral health crises because of the COVID-19 pandemic underscores the warranted attention.

This design study also calls attention to opportunities for experiential learning and interdisciplinary exchange which are critical to the education of the next generation of designers. The ability to form an understanding of novel problems and issues through the lived experiences of patients and providers is core to mobilizing education around unmet social and health needs. Meaningful experiences and collaborative processes of working with practitioners, providers, and fellow students in other fields of study create formative portals for entry into the profession. Projects and learning opportunities which build on 'real world problems' engage students with their local communities and tie curriculum and learning objectives into tangible contexts.

Increasingly, the design problems we face are ones without precedent. The relationship between the healthcare organization and the university presented a unique opportunity for interdisciplinary and interprofessional collaboration in this workshop and offers a model for design investigation that pairs the next generation of designers with healthcare providers, administrators, and architects. The authors hope that these types of collaborative endeavors continue to shape and contribute to the realm of education, the field of practice, and the larger healthcare design industry.

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Medicine in Minutes: A New Paradigm in Healthcare New York Hotel and Motel Trades Council's (NYHTC) Brooklyn Health Center

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Medicine in Minutes

New York Hotel Trades Council (NYHTC) endeavored to relocate and expand its Brooklyn Health Center location and selected a new parcel of land in the BAM cultural district. This new center would utilize a health and wellness model that was designed to keep patients out of hospitals and would be set up for patient care by disease type with a multispecialty model comprised of a diverse clinical care team versus separate primary care and specialty practices.

NYHTC's goal of "Medicine in minutes" rather than hours was a key element. Through careful planning, design, and the use of key technological elements, FCA was able to deliver a center to realize the vision of providing an efficient member-centered experience.

"We had two major goals for this building," said Dr. Robert Greenspan, former chief executive officer of the Fund and executive director of the Health Center, in a statement. "First, we wanted to create a strong image for [the Health Center] in Brooklyn that supports our brand and welcomes our members. Second, we insisted on a vigorously member-centered environment with top-of-the-line care that exceeds the efficiency, comfort, and quality of commercial health care institutions. Above all, we want our members to enjoy an unmatched health care experience."

To realize these goals, the design team—along with the clinical leadership from NYHTC—developed different focus groups to interview patients and staff using a P3 process and SWOT analysis where the group could identify where improvements and opportunities existed and changes to the operation and design should be made. As a result of the focus groups, many issues came to light:

- Patients were being scheduled too far out and waited too long to see specialists;
- Once they arrived at the centers, the door-to-physician time was very long;
- Patients were asked to travel around within the center and between the centers for treatment and imaging;
- Patients also did not feel as though their medical issues were truly being shared among their clinicians in a multidisciplinary way.

An Innovative Approach to Health

The design team including the clinicians, specialists, phlebotomists, and support team came together to review these issues. Together, they identified and created a new paradigm for delivering care that utilized operational, technological, and design concepts to eliminate redundant steps. Dr. Greenspan led the operational concept wherein, rather than using the traditional Ambulatory Care model of individual physician

practices, the center would be organized around disease type and provide preventative care spaces that would encourage its members to not only get healthy but learn to stay healthy. Why around disease type? Their visionary leadership knew that if you could treat patients for the major disease that they came to the health center with, for example a diabetic patient, you could also layer in all of the specialists and services that a diabetic patient would typically need to see all in one pod. This was a more efficient model, as it turned out, because diabetic patients, had in the past, needed to make multiple appointments per week with different specialists. At the Brooklyn Health center, they could come in for 1 visit and see all those specialists in one place. The patients didn't even have to move throughout the building as the specialists all came to the patient.

Rather than making several appointments each week with key specialists, patients are seen by multiple clinicians in a single visit. The Health Center design utilized interdisciplinary workplaces and technology to better reduce redundant steps and wait times. Additionally, the building is designed to engage with the local Brooklyn community and invite them to attend health sessions and activities.

Image 1. Concierge lobby.

One of the most revolutionary aspects of the design was the concept of self-rooming. Patients enter the building lobby and are greeted by concierge team members that translate instructions into 43 languages that are spoken at this center. Once checked in, they are given a small clipboard with an RFID badge attached to it; the concierge then prints the directions for them to self-room, including the floor and room that the patients will go to in the language of their choice.

As patients arrive in their Exam room, a welcome message is instantly displayed on the monitor within the room, identifying the patient's name and letting them know they are in the right room and that the clinical team will arrive shortly. The Health Center doesn't have physicians' offices or even waiting rooms; all appointments are handled electronically through online scheduling and registration programs that link patient records and medical history with the appropriate treatment programs.

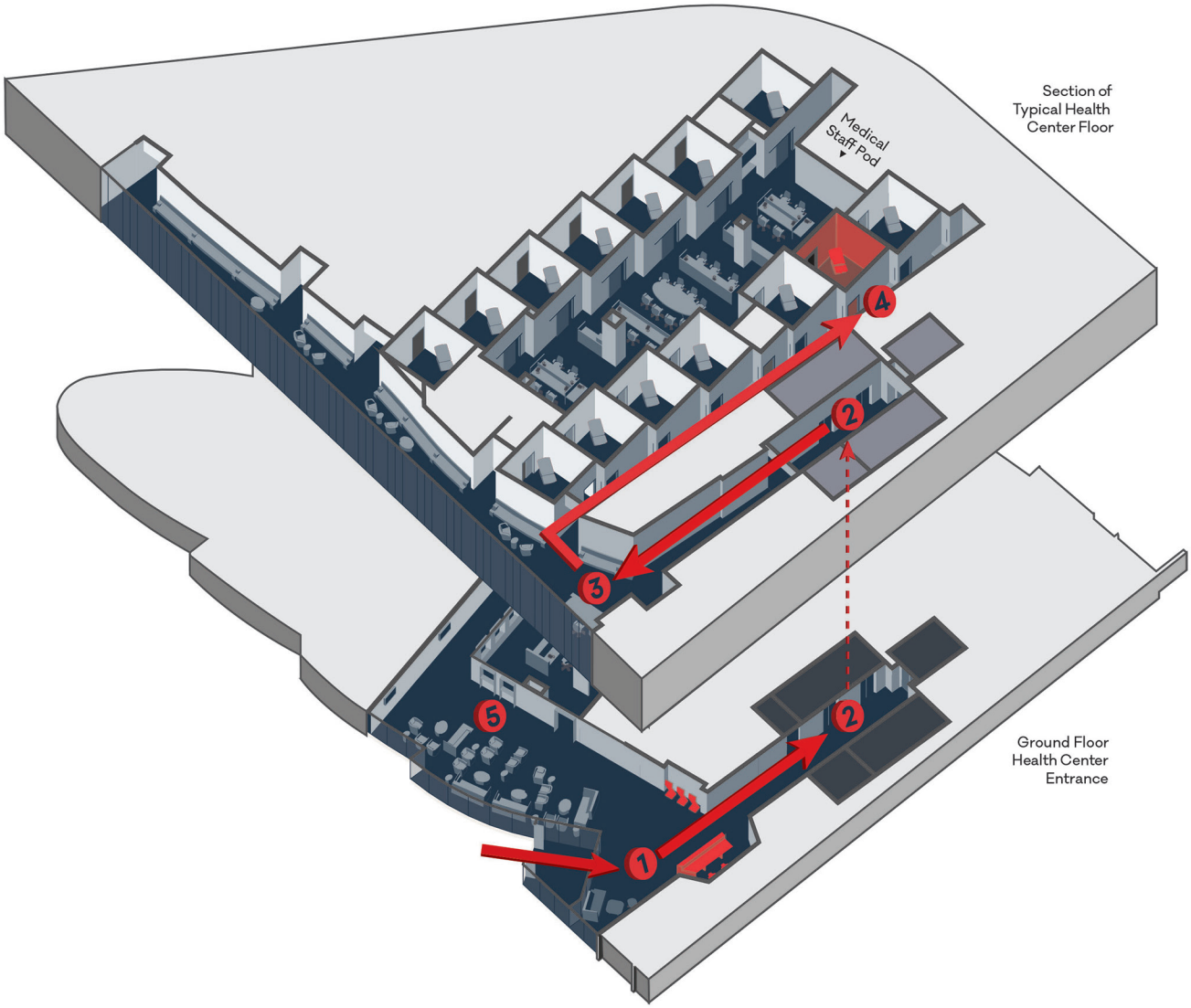

Image 2. Self-rooming path from lobby to exam room.

Image 3. Exam room with clinical touchdown visible.

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Image 4. Seating outside exams.

Patients simply walk into the building and right into their treatment spaces. And while waiting areas weren't necessary for patients, we provided them so that family members could have a comfortable, eye-pleasing place to wait and relax, with outstanding views of the surrounding neighborhood.

Image 5. Off-stage (staff) access route.

We also included seating just outside of the Exam rooms to accommodate family members who may need to step out for a moment during the exam process so that they don't have to travel out to the Family waiting areas.

While this is not a new concept, the group investigated several models for accessing the spaces and ultimately landed on an on-stage/off-stage approach for Public and Staff flow. It was felt that this model provided the clinicians and supplies to flow quite seamlessly to their spaces in a cleaner way that would not be seen by the public accessing the Exam suites.

After arriving at their floor, patients then travel up through public-only access routes, as the center is organized using an on-stage/off-stage concept so that their members can access the treatment spaces from one side and the staff from the other. Union members and materials/supplies travel on separate paths throughout the building both vertically and horizontally.

Image 6. Second floor with public and staff flow.

Image 7. Floor plans and circulation plan.

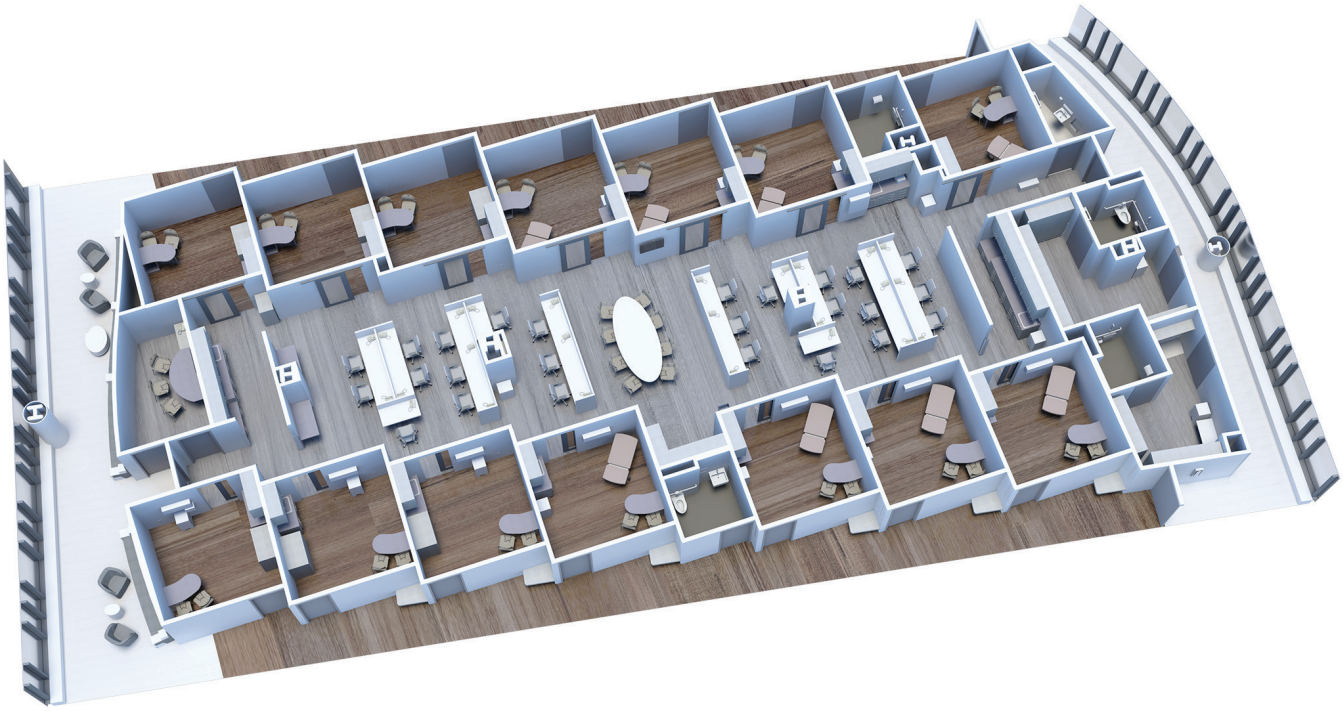

Image 8. Treatment pod diagram.

Accessing the left-hand side of the plan, members circulate up the spine and flow into the exam corridors from the left. Each of the Exam rooms within the pods is angled, which not only allows for easier wayfinding but also creates a small area where family members can wait outside the room. Staff and materials flow from the right side of the plan up a staff-only spine to the top of the plan where each floor has a staff respite space.

The treatment pods are grouped by disease type: Musculoskeletal, Diabetes & Endocrine, Cardiovascular, Peds, Family, Womens, Ophthalmology, Dental, and Procedural. There are also preventative care spaces, such as a teaching & training Kitchen, a multi-purpose/fitness space, an imaging suite, and a blood draw center.

The centralized nature of the staff workspaces fosters a collaborative environment where physicians can speak with each other about complex cases. This multidisciplinary collaboration allows for multiple team members to review patient cases and be prepared ahead for direction on care. The patient Exam rooms are directly connected to the Care Team workspace via double-sided Exam rooms allowing quick access to centralized areas.

The Health Center's clinical core/exam room model pod was built in a live mock-up at the Queens Health Center location to test this model's efficiency; the model proved to be wildly efficient. This mock-up of a pod of 3 Exam rooms, a Consult room and a Care team workspace was a wonderful test case. Physicians, Specialists, Behavioral Health team members along with Phlebotomists and Clerical team members came to realize how inefficient they had been by sitting apart from one another in their current offices and workspaces that isolated each other. They stated how they appreciated being together in the Care team space as it eased many simple things that they found were causing additional time to be added to a patient's visit. No longer were they running to find the Clinician to get clarity on a prescription order. They also utilized the team conference table to break down the following day's patients, reviewing them together as a group. The mock-up revealed a few things that didn't work, and they were incorporated into the final Health Center. The exam rooms did not initially have printers in the rooms, and they were ultimately added to the Exam rooms to retrieve printouts. The desk shape was modified in the mock-up to ensure that the desk could have 2 chairs for pull-up access to review x-rays or other pertinent materials with patients. Another issue that was brought out in the mockups was patients arriving at an Exam room but not quite being sure they arrived at the right one. RF technology was utilized using a patient tracker to have the patient's name come up on

Image 9. Clinical touchdown showing exam room.

the large monitor in the patient room. This was perceived as a much better assurance that patients had indeed arrived at the proper Exam room. We utilized this for self-rooming as much as was possible since the Queens Health Center, where the mock-up was constructed, was a fully functioning Health center that continued to operate. “Welcome Mr. Jones – we will be right with you” was a much easier way for patients to be greeted and assured they found their way to the correct location. This was done in the language that they registered in as 43 languages are spoken in the health center.

Upon occupation of the Brooklyn Health Center, the performance metric was quantitatively calculated and 85% of members were treated in less than an hour. The data also showed that the physicians were able to see an additional 1,200 patients per year. This is a huge improvement that allowed the center to see many more patients than they had anticipated.

While the clinical care teams vary, they are usually comprised of a family practitioner, behavioral health specialists, clinical specialists, medical assistants, nurse practitioners, a clerical team, floating phlebotomists, and care managers.

During the design process, the clinical team wondered about such a large open space in which many people would be working. The design team mitigated this by utilizing high-performance sound absorption ceiling tiles in the Care Team work area as well as Pink Noise for sound reduction. The space has a very calming atmosphere due to these elements.

While it was vital to the Fund to ensure that its members would receive care at the same level in a similar environment as the guests in the world-class Hotels they worked in every day, it was equally vital to them that the staff of the Brooklyn Health Center be treated with equal

importance. To that end, we placed the Staff Lounges within the building, not in dark basements but in areas of prominence, strategically placed at the apex of the building on each floor, allowing the staff to enjoy natural light from all sides of the space as well as tremendous views of the cultural district. Materials here were also chosen to emphasize a hospitality feel. These lounge spaces also allow for patient tracking and efficiency on the monitors visible in these rooms.

Leveraging Technology

The Brooklyn Health Center was designed to incorporate the best in state-of-the-art technology. Even before patients come for visits, the scheduling team leverages EMR to book multiple visits. Upon arrival, technology is engaged in language translation software, RFID badges and tracking software are used to aid in patient self-rooming and navigation. Fingerprint touch technology allows Clinicians to log out from Exam rooms and log back in instantly into -charts within the Care Team areas. In the live mock-up, the technology showed where all the glitches were in the timing of the appointments and shined a light on patient waiting times for things like time to doctor, blood draw, and overall wait times. These could not have been accounted previously, without the aid of the patient tracking systems.

All these technological interventions aid the Center to operate in a more effective way streamlining care.

Image 10. Lounge space with patient tracking on monitor.

The Health Center's Beating Heart

The Fund wanted to ensure that the Brooklyn Health Center wouldn't become lost inside the high-rise building, and they wanted it to be as distinctive and vibrant as the community around it. They wanted their 4-floor Health Center to be as distinctive as their 11-story building itself.

While reflecting on this design challenge, the project's Senior Designer had a breakthrough— she crumpled a red piece of paper into a glass and realized a design vision for the center. The Health Center would be a distinct element within a glass building. The red walls of the Health Center stand out at different times of the day identifying the Health Center as it is encased in the glass envelope of the building. It is highly visible from the exterior so that at any vantage point around the site, you would always see the Health Center, the beating heart of the building.

By centering the beating heart of the Health Center within the glass object of the building, we allowed for the large windows to provide enormous amounts of natural light, along with a connection to the surrounding community, and breathtaking views of the surrounding cultural district.

Inside, the building's circulation corridors run alongside its perimeter and around the clinical spaces, inverting what is traditionally the planned layout of healthcare

Image 11. The Health Center at night.

interiors. To reinforce the pathways for patients, each floor is assigned a color that is repeated throughout, via the furniture, wall colors, and artwork.

The layout, along with the intuitive wayfinding, provokes movement, while the curtain wall highlights the circulation throughout the building.

Realizing potential

Another tie to the community happened by maximizing the site. Initially, the client was looking to develop a five-story building to house their Health Center on a proposed site in Downtown Brooklyn. When the FCA design team reviewed the site, we saw the potential for so much more. If we could develop a public space, we could maximize the building envelope, which would allow for the inclusion of leasable space that would, over time, help pay for the project entirely. Our team showed the client that they could increase the projects size, if they developed a Privately Owned Public Space (POPS), which are outdoor/indoor spaces/parks built for public use and maintained by the owner of the building. POPS are created in exchange for greater square footage and allow for greater interaction and activate the streetscape within a dense urban fabric. In this situation, the inclusion of a 2,000 SF park on the building's east side, increased the allowable square footage of the site while opening it up to the neighborhood residents.

The increased square footage granted to us by the POPS allowed us to build additional floors. These additional floors required a building setback on the 6th floor. This gave us the opportunity to build a terrace. The terrace adds comfort with its easy access to the outside, which promotes wellness. All the outdoor spaces were constructed to promote wellness and were designed to complement the building's shape and design, as well as highlight the entrances. While the park creates a visual relief and connects the Brooklyn Health Center with the surrounding BAM cultural district, the terrace provides extended views of downtown Brooklyn and lower Manhattan while also acting as a buffer in an urban environment.

A New Paradigm for Care

The new Brooklyn Health Center truly embodies new and innovative ambulatory care design. From the operational model, to technology, to the design approach, each element that has been added supports the goals that the health center was attempting to achieve. The new model will influence their new center in Queens and their other existing centers will now be designed with these elements in mind so that future generations of patients can receive care in a thoughtful and state-of-the-art environment.

Image 12. The park is an added benefit that the residents will enjoy.

Co-Designing with Children: Innovating Patient Engagement and Participation in Pediatric Healthcare Design Research with Immersive Technology and Affective Interactions

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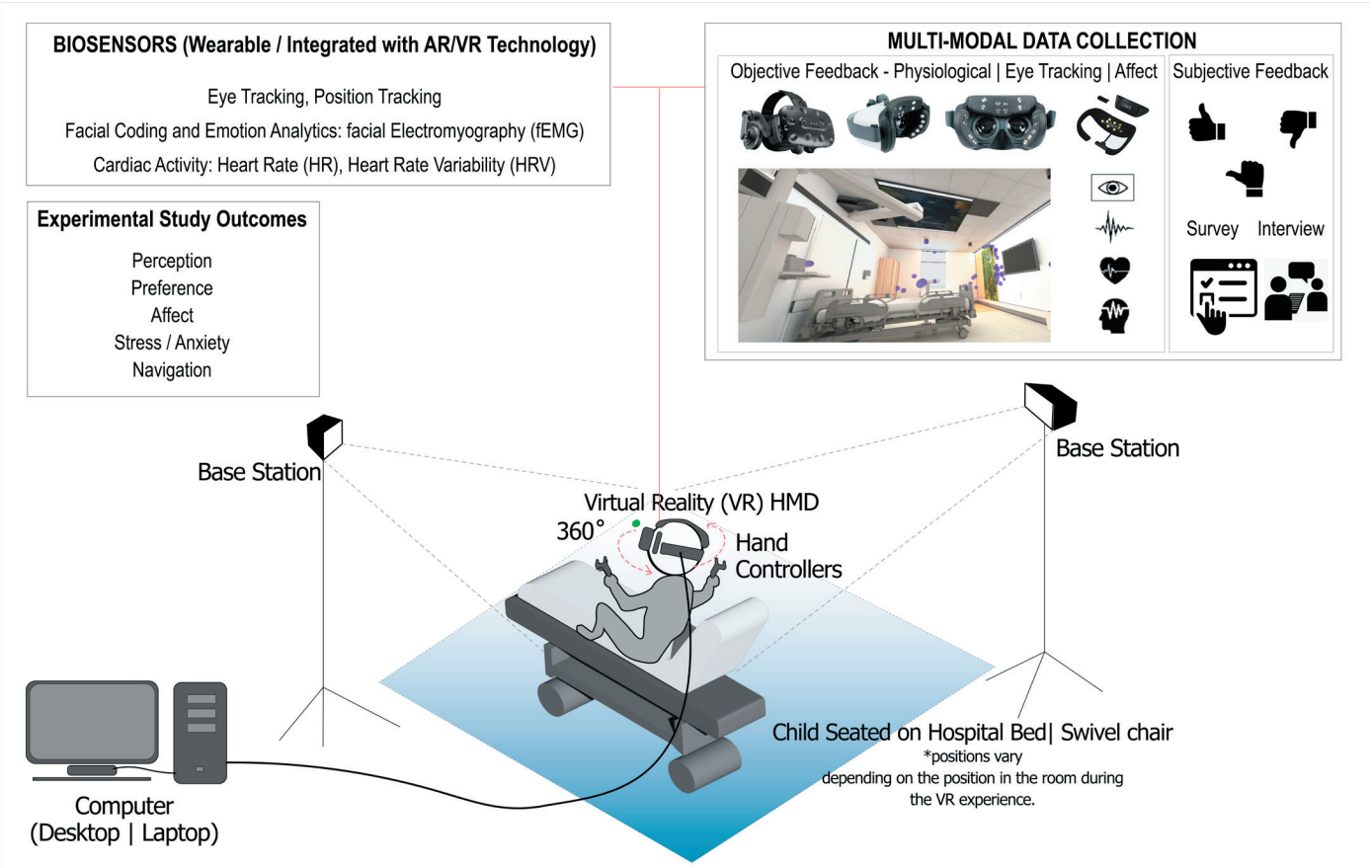
ABSTRACT

About 1.3 million children and adolescents are hospitalized yearly with a mean length of stay ranging from 4.2 to 5.3 days. Designing healthcare environments for young patients from different backgrounds is challenging due to the complex technology-intensive environments, interactions between people, and the diverse needs of hospitalized children from neonates to 21 years of age for supportive age-appropriate environments. Pediatric healthcare facilities have a crucial role in offering supportive healing environments to this vulnerable population. Considering the significant impact of the built environment on patient experience and health outcomes, partnership is important between hospital owners, doctors, nurses, administrators, architects, designers. It is particularly important for patients and family to include their unique and collective perspectives in the design of the healthcare environment. Evidence shows there is currently limited use of participatory research in pediatric health care built environments. This article outlines patient engagement methods in pediatric healthcare design research, along with unique challenges faced by researchers engaging with children in these settings. There is a need for innovation in the way children are meaningfully engaged and involved in research for patient-centered design. Our research explores innovative patient engagement methods and tools such as immersive technology and biometrics towards achieving a supportive pediatric built environment design.



Graphical Abstract 1. Innovating Patient Engagement and Participation in Pediatric Healthcare Design Research with Immersive Technology and Affective Interactions.

1.3 million children and adolescents spend 4.2 to 5.3 days annually at hospitals. The pediatric world and children's hospitals, in particular, are special places hosting particularly vulnerable patients. The physical environment of these places has an enhanced role in addressing the pediatric patient experience by offering a welcoming and supportive environment. Hospitalizations cause specific difficulties for this vulnerable young population and adults, as they can involve short or long-term separation from peers, school, and family, leading to the perception of a loss of status within the peer group because of the physical absence (Hutton et al., 2021). Studies show racial disparities and equity issues in health outcomes for pediatric patients (KIDs Inpatient Database (KID), HCUP AHRQ, 2012). Pediatric healthcare facilities have a critical role in offering a supportive healing environment with age-appropriate environments that can address the unique needs and concerns of the diverse population group, while also addressing the unique needs of the parents and caregivers (Carrie Hill et al., 2018).

In pediatric healthcare research, there is a growing focus on special population groups with studies addressing adolescents and young adults (AYA), neurodivergent, ADA (Fekete & Lucero, 2019; Peditto et al., 2020; Poltronieri .L, & Freeman .K, 2021), care settings — mental and behavioral health (Shepley et al., 2017), study design — mixed methods and experimental studies (Creswell & Clark, 2017; Wingler et al., 2021) including innovative methods in environmental design research using immersive technology such as virtual reality (VR) (Jafarifiroozabadi et al., 2022; Joseph et al., 2020), and outcomes such as experience and human emotion (Bower et al., 2019). With recent studies addressing differences in the neurocognitive functioning of diverse groups, the need for inclusive design, and the benefits of codesigning with and for children to capture their unique needs, we understand that innovating the pediatric space to improve the patient experience requires a deeper understanding of multiple factors. Some of these factors include spatial and environmental design of the physical environment, to be able to accommodate operational and user-specific needs that can in turn adapt to the affordances (Choi & Bosch, 2013) of space.

Whilst studies indicate that children and young people are competent to talk about, and document their environment and experiences within it, in a capacity that is useful to designers, planners, and policymakers (Taylor et al., 2006), the use of participatory research with the general public and even more so with children is limited within healthcare research. We see a need for increased involvement of children as participants and co-researchers in various settings (Bishop & Corkery, 2017), and for targeted research to inform evidence-based design guidelines with an interdisciplinary approach through the use of novel methods for engagement with this vulnerable population. With the patients' voice required in design mock-ups, simulation, and feedback to address diversity and equity, and to meet functional and emotional affordances, meaningful engagement and collaboration will enable useful feedback for architects to design supportive environments, by improving the basic understanding of how design affects this group physiologically and psychologically across the breadth of the population. Immersive technology is showing promise as a tool for environmental design research and for its ability to elicit different emotional states as measured by neural and cardiac dynamics through integrated sensors (Higuera-Trujillo et al., 2020; Marín-Morales et al., 2018). This could have a significant impact with novel applications in fields as diverse as architecture, health, and education, as well as in design practice. In architecture, immersive technology ,such as VR in Evidence-Based Design (EBD), processes may improve participatory design strategies in the context of pediatric design projects.

This article takes the approach of a review paper to provide a brief overview of various themes related to pediatric healthcare design research.

1. Patient-and-family-centered-design and impact of the built environment on the Patient-and-Family-Experience in pediatric healthcare settings
2. A review of methods used for patient engagement and participation in pediatric healthcare design research
3. Immersive technology and affect studies in design research and application in healthcare design research
4. Challenges in participatory research with children in healthcare design research

In addition, we propose a methodology using immersive virtual environments integrated with biometrics to study affective interactions. The goal is to improve participatory design in the context of pediatric healthcare design projects for engagement with patients and families offering deeper insights and feedback loops for architects designing supportive environments in healthcare.

1. Patient-and-family-centered design and impact of the built environment on the patient-and-family-experience in pediatric healthcare settings

Growing evidence demonstrates the impact of the built environment linking favorable room design elements to patient satisfaction, stress, health, and outcomes (Gaminiesfahani et al., 2020; Jiang, 2020; Ulrich et al., 2008). Healthcare facilities and designers have a fundamental role in designing supportive environments for the health and well-being of their users. Designing healthcare environments for young patients is particularly challenging due to the complex technology-intensive environments, interactions between people from different backgrounds, and the diverse needs of hospitalized children from neonates to 21 years of age in terms of supportive age-appropriate environments. Pediatric hospitals lead the way in patient-and-family-centered care with families being involved in the care design process, but we can do more via innovative methods of patient engagement to improve the pediatric built environment design and the patient-and-family-experience with deeper engagement and insights. With the significant impact of built environment design on patient experience and health outcomes, more research is required in pediatric research through partnerships between children's hospitals, healthcare planners, and architects, and for methodological and technological innovation around patient engagement (Elf et al., 2020).

Pediatric facility design 'needs' include providing a positive, supportive healing environment that can offer cognitive stimulation, access to recreational and learning activities, social engagement, personal space, privacy, and control. While several theories have been applied to hospital settings for supportive design for patient care and delivery through human-centered design from the perspective of adult patients experiencing their hospital stay, there is a lack of studies with children. More research is required to address gaps with studies on affordances provided by the environment and perceptions that support an individual's actions e.g., a physical environment designed to offer better affordances for family presence and activities will increase family presence, and the extent a patient room provides affordances contributes to patient-and-family-centered care through design. Studies show some application of supportive design in palliative and end-of-care environments (Ghirotto et al., 2019) and a dearth of application in acute pediatric healthcare facilities. With findings that suggest correlations between social support and well-being, including the need for psychosocially supportive design within pediatric settings, there is a need for targeted research to inform evidence-based design guidelines that use a broad disciplinary approach, with age-appropriate support and empathy (Lambert et al., 2013, 2014; McLaughlan, 2018; Wiener et al., 2015). There is little high-quality quantitative research including randomized controlled trials (RCT) that include diverse groups and clinical settings. Evidence demonstrates the positive impact of the physical environment on family behavior along with interactions with hospitalized children and staff (Bosch & Lorusso, 2019), however, there are few empirical studies that show the effectiveness of patient-and-family-centered design on health outcomes.

2. Current methods used for Patient Engagement and Participation in Pediatric Healthcare Design Research

A review of studies on patient engagement methods in acute healthcare settings was conducted from 2000-2020 with the objective of understanding the methods used for patient engagement in acute care settings on spatial and environmental variables, related patient outcomes, methods, metrics, and tools for engagement. The search was conducted using the online database Google Scholar. Post-screening and evaluation of twenty-two publications, that included ten studies in pediatric settings, were selected to be studied. Only a summary of the studies with a focus on pediatric settings is presented in this article on trends.

There is a growing trend in research with 55% of the total studies conducted in the past five years focused on the built environments within healthcare. Figure 1 presents the distribution of the studies on the pediatric healthcare built environment comparing it to the total number of studies identified. Figure 2 presents the methods, tools, and measured outcomes in ten pediatric healthcare studies between 2000-2020. In pediatric settings, studies on the perceptions and needs of patients and families predominantly use qualitative methods (Lambert et al., 2013; Water et al., 2017) and theories were explicitly used in 42% of studies. The findings show a weak theoretical nature with 20% failing to apply any theory to justify findings. Ulrich's Theory of Supportive Design (Stress Reduction Theory) is the most popular theory followed by Psychosocially Supportive Design and Participatory Research. Most of the studies adopt quantitative or mixed methods design using an exploratory qualitative phase to inform survey questionnaire development or a preference study using

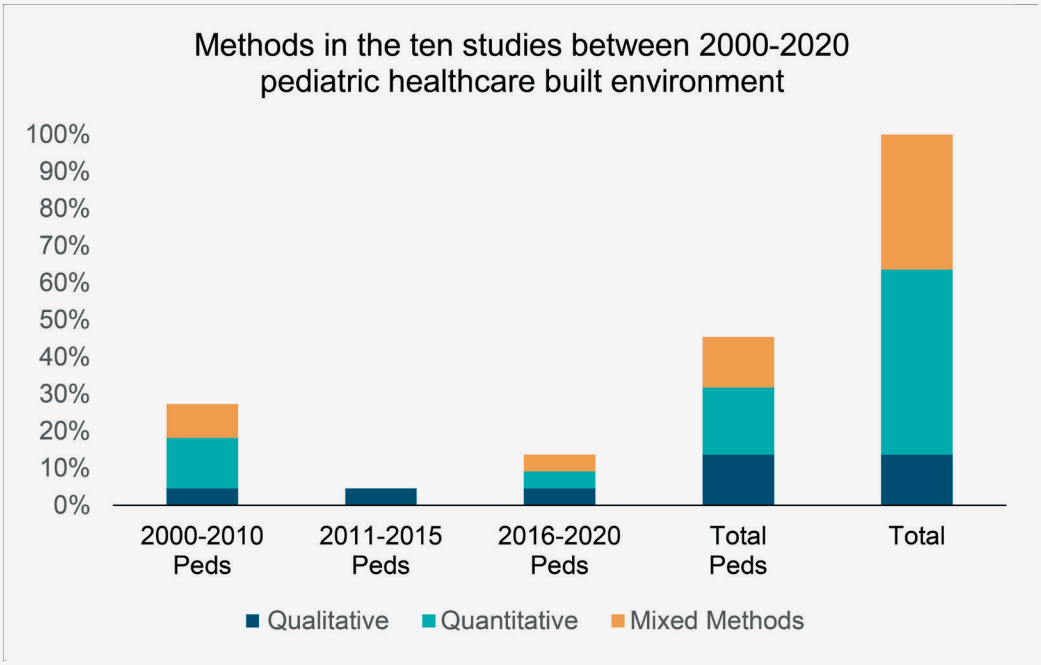


Figure 1. Summary of ten studies on the pediatric health care built environment conducted between 2000-2020 to the twenty-two studies identified in the review.

RCT. Interviews, focus groups, photo-elicitation, Delphi approach, art-based methods, observations, and surveys were the tools most widely used (Coad & Coad, 2008; Eisen et al., 2008; Felippe et al., 2017; Trzpuc et al., 2016; Ullán et al., 2012), with a couple of studies using physical or digital mock-ups using VR (McLaughlan, 2019). About 50% of the studies used validated tools to measure health-related quality of life (Mardelle McCuskey Shepley et al., 2012; Sherman et al., 2005), and 30% of the studies used qualitative findings to inform the development of the surveys. Two of the recent studies adopted a discrete choice experimental design (DCE) that is common in healthcare policy for a preference study. Both studies were not ranked high in terms of empirical evidence as they do not address rigor or share information on assumptions. Qualitative and quantitative methods of analysis include thematic analysis, descriptive statistics, t-tests, correlation, ANOVA, chi-square test, Fisher's exact test, and Mann-Whitney U test with two studies using structural equation modeling (SEM) with the exploratory and confirmatory factor analysis to study the latent built environment variables and the effect of mediators (perception). In pediatric settings, the sample size varies from n=37 to n=175, and includes children, adolescents, young adults, and parents responding as a proxy for children.

We present a summary of the built environment variables and the measured outcomes from the studies in Figure 3. Variables – Spatial, Positive Distraction, Social Support, Perceived Control and Comfort, and Outcomes – Perception, Satisfaction, Preference, Stress/Emotion, and Restorative/Healing. Some of the variables are not strictly as those presented in the paper, for example, "care for relationships" was included under social support and 'nature' was included in 'view'. Overall, we see that 'Positive Distraction' variables (window, view, nature) have received a lot of attention recently compared to perceived safety that is not directly addressed although it is seen in literature as a critical need for the pediatric population. Perception and Preference outcomes constitute 60% of all studies with 50% in peds- focused studies. Preference (42%) and Stress/Emotion (33%) are the common outcomes in pediatric studies. There is a lack of studies on healing environments within the pediatric group.

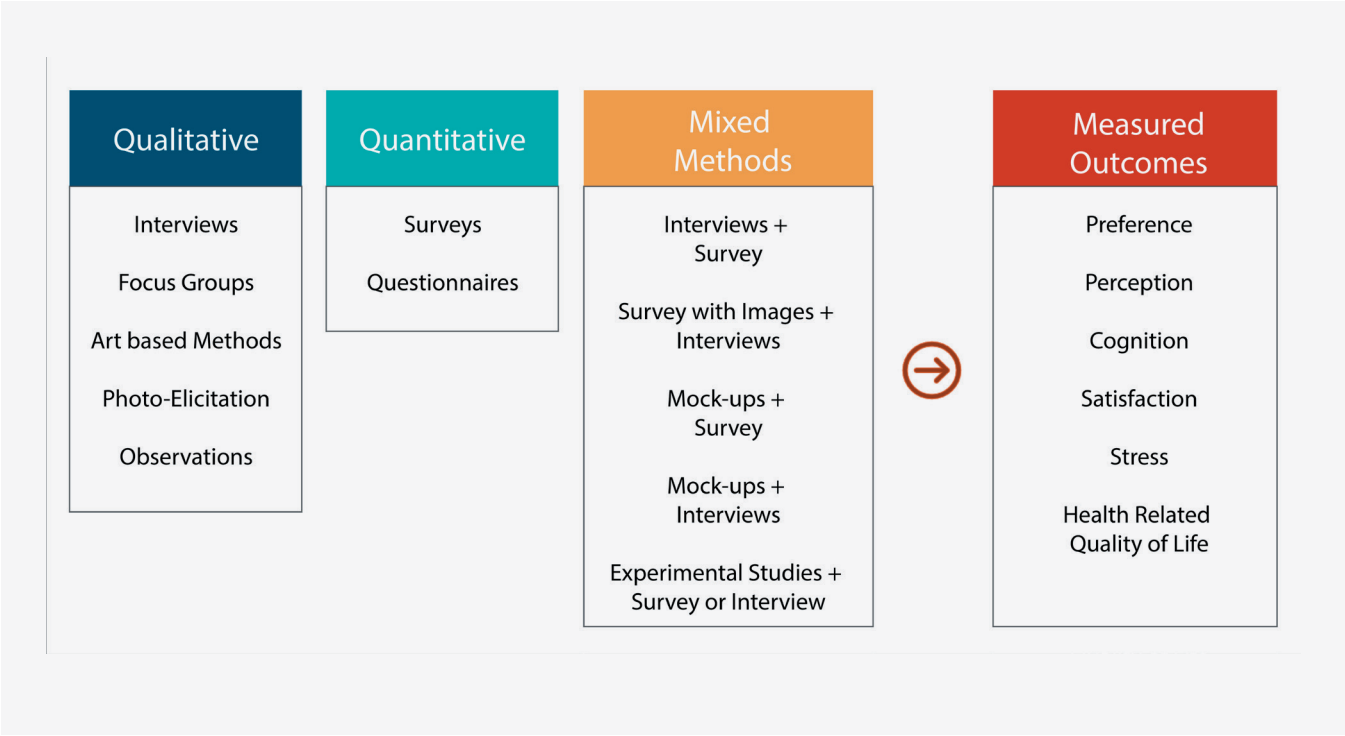


Figure 2. Methods, tools, and measured outcomes in ten pediatric healthcare studies between 2000-2020.

The studies reviewed present the need for objective measurements such as physiological and psychological responses rather than self-reports. Key challenges are in addressing covariates and confounders, and how to control for them. Existing research also highlights the need to include mediators and moderators for a holistic understanding of the impact. In the pediatric setting, early studies have focused on the ambient design features such as the color of the hospital environment and thematic design preferences such as nature and water using qualitative methods. Recent studies have focused on theoretical models such as supportive design with a new interest in addressing the age groups such as adolescent and young adults (AYA) population.

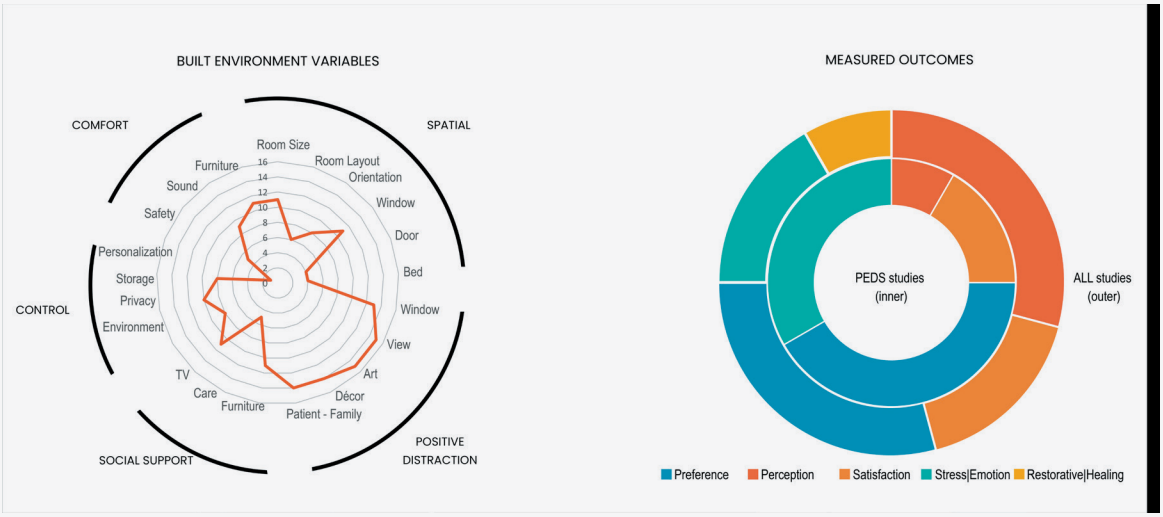


Figure 3. Summary of built environment variables and measured outcomes.

Recent research also questions the role that the physical environment's ambient features have on patient satisfaction (used as a proxy for patient experience), the increased role of spatial layouts and design features on health outcomes, and the need to include methods that can adequately measure objective qualities of the built environment that directly impact the patient experience for operationalization of the metric (Beattie et al., 2015). Study methods and metrics focus on the ambient environment and patient satisfaction while not adequately measuring the complex interactions within the physical environment for operationalization. There is a focus on single design features, lacking environmental sampling, and ignoring physiological mechanisms through which environments affect stress. Concepts are used interchangeably, with evidence showing patients tend to overrate satisfaction due to gratitude bias, and the need for measurement to focus on the experience in real-time (LaVela & Gallan, 2014). Patient experience, a multidimensional construct, needs to be re-conceptualized by identifying the constructs and variables for specific definitions and precise measurements, such as the independent room-level categories and variables, individual-level variables, mediators and moderators, and dependent variables. Strategies effective for operationalization of a multi-dimensional construct like patient experience include the following, all of which pose challenges described in a later section (1) involving the patient/end-users – here the hospitalized child and their parent (2) during active treatment (3) in a healthcare setting (4) using multi-methods of data collection for triangulation and validation of findings.

3. Immersive technology and Affect Studies in design research and applicability in healthcare design

Immersive virtual environments in head-mounted displays (HMDs) are having a significant impact on architecture and research, including opportunities for environmental design studies in-vivo rather than in-situ (Stals & Caldas, 2022). These advancements have given researchers opportunities to increase stakeholder involvement and efficiency of the work processes. Immersive technology allows the creation of realistic virtual environments where users can be fully immersed and feel a similar sense of presence as physical environments (Chirico & Gaggioli, 2019), blurring the boundaries between the physical and virtual worlds by creating a sense of immersion and enhancing the realism of virtual experiences (Slater et al., 2009). Immersive environments provide the opportunity for designers to create virtual mock-ups of buildings where the stakeholders and users can be immersed in and interact with a variety of design features to evaluate alternatives and provide feedback during the design phase, but it has not matured or been integrated fully in AEC projects currently. (Caldas & Keshavarzi, 2019) discuss design immersion and virtual presence in AEC and the possibilities with VR to address both the individual and social presence for collaborative design processes.

Immersive Technology such as Virtual Reality (VR) has emerged as a well-established methodology in different domains and as an empirical research tool for training, simulation, medical simulation in healthcare, therapy, spatial cognition, and navigation. In architecture, it has seen applications in building evaluation, prototyping, environmental design, and pre- and post-occupancy building evaluation. Virtual reality offers the advantage of testing out incremental changes through simulation in VR of several design alternatives in the pre-design phase without disrupting the usage of a building. Virtual environments are being used to support pre-design and pre-occupancy evaluation from a user's perspective on environmental design and evaluation. With the rapid development of immersive technology in the past decade, we are seeing more use of immersive technology as an empirical research tool as studies use theoretical frameworks and experimental design to study responses to different environments comparing the response to stimuli with the real environments in the built environment. We also see the need to test the creative power of designing immersive virtual environments. Some of the key challenges in empirical research include methodological difficulties that require controlled settings, reproducibility, and inflexible stimuli that are lacking in real work settings, which can be addressed by virtual environments. With advancements in wearables and biosensor technology, we are seeing an uptick in research that include bio-analytic metrics and interpretation that include physiological and psychological responses to real and simulated (virtual) environments. These allow for feedback and evaluation of human behavior offering a layer of unbiased data, real-time feedback, and point-in-time analysis of design and impact mitigating actual problems in data collection and participatory design methods that focus more on subjective feedback. Some problems in traditional methods of data collection and participatory design methods can be mitigated through immersive technology such as virtual reality and bio-sensors that allow for replication of healthcare environments in a virtual medium and facilitate data collection from patients after their discharge. This allows researchers to

circumvent hospitals and restrictions including patients in environmental and healthcare design research.

A study on the state of the art of research in the built environment using immersive virtual environments (IVE) was conducted from review papers published between 2000-2020, with the objective of understanding the major focus areas and trends where immersive virtual environments were used, methods, research context, sample size and factors in terms of stimuli, reactions, and outcomes. The search was conducted using the online database Google Scholar. A summary of the 13 review papers includes 4 papers on the state of IVE research in the built environment (Ayoung Suh & Jane Prophet, 2018; Kalantari & Neo, 2020; Kim et al., 2013; Zhang et al., 2020), 2 papers on education, 6 papers on presence/perception/emotion, and 1 paper on occupant behavior, with 70% of the reviews conducted since 2015, demonstrating the rapid growth of research in this area. Studies conducted in 2015 and later show use of tracking data such as head tracking, eye-tracking, and the use of biosensors for physiological data on heart rate (HR), heart rate variability (HRV), electrodermal activity (EDA), skin conductance, electrocochleography (EEG), Electroencephalography (ECG) and Facial Electromyography (fEMG).

Most of the studies use convenience sampling of students, predominantly university students, mixed samples with age groups 20-50 years, and fewer studies with the pediatric and elderly population. IVE is becoming popular for the elderly population with both VR and AR being used in diverse applications such as mental health, well-being in older adults, pediatrics, physical activity, and psychological outcomes. The sample size has high variance from very small samples of 7 subjects to large samples of 120 subjects and an average sample size of 10 for healthcare-related studies. There is more diversity in healthcare with the inclusion of different stakeholders – clinicians, nurses, and patients – while other domains mainly used students. There are few empirical studies with the pediatric population using a fully immersive experience using a HMD and even fewer studies with children under the age of seven probably due to the cost, weight, and fit of the headset (Bailey & Bailenson, 2017, p. 9) that we address in the next section.

4. Challenges in participatory research with children in healthcare design research

Participatory research is predominantly conceived from an adult perspective, adult-designed, and adult-led. According to Kellett (2005), involving children in research raises methodological and theoretical issues, on the rationale of involving them, acknowledging their perspective, valuing their contribution, giving them a voice, and empowering them. I present some unique challenges faced by researchers involved in participatory human subject studies with hospitalized children. Figure 4 presents the broad categories of the challenges and Table 1 presents the details of specific challenges in the identified categories. The list is not exhaustive and is based on personal experiences with ongoing mixed methods PhD research.

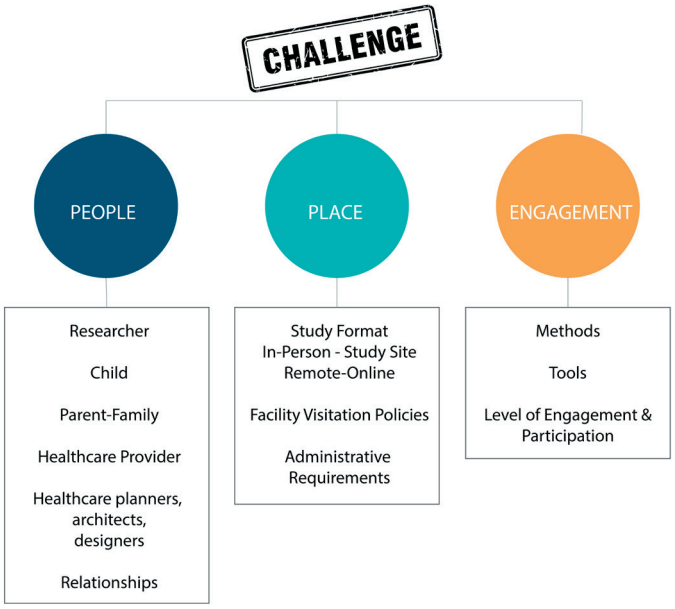


Figure 4. Challenges faced by researchers in pediatric healthcare research involving patient engagement.

Table 1 – Specific challenges in the identified categories in pediatric healthcare research

CATEGORY	CHALLENGES
People Access and Ethical Considerations	Access to the child – Navigating gate-keepers and healthcare mediators
	IRB and ethical approvals – Permissions/Consent/Assent for recruitment – Data privacy, confidentiality, and management in studies involving children – Strategies for approaching end-users responsibly, particularly in sensitive situations involving vulnerable populations (e.g., pediatrics, aged, mental and behavioral health)
	Logistical and child protection issues: Ensuring the presence of a trusted adult with the child
	Ensuring diversity in enrollment
	Child Health Status limiting participation during hospitalization – Challenges with proxy respondents and potential biases in self-reporting studies – Addressing biases in retrospective studies conducted during active hospitalization
Challenges for Researchers	Communication and articulation of ideas and opinions across different age groups and developmental factors
	Domain knowledge and skills for meaningful engagement, including patient education
	Parent-Family hesitancy and time commitment
	Perception of research as an unnecessary or unwanted disruption in a stressful period
	Time and commitment required for research
Challenges for Healthcare Planners, Architects, and Designers	Skepticism regarding children's engagement in research considering age and developmental factors
	Assessing children's competence and ability to engage in design
	Understanding complex visualizations and representations
	Allocation of personnel, time, resources, and cost
	Hesitancy to share project design and details for publications
	Empowering the child through co-design and addressing power dynamics
	Building trust and rapport with the research team
	Research agreements and approvals from hospitals – Navigating policies, permissions, IRB, and ethical approvals
	Commitment from the organization and healthcare providers to mediate between the researcher and the child/family
	Communicating the impact of design on care and patient outcomes
	Adapting research design during pandemics like COVID-19 – Addressing challenges posed by hospital visitation policies and finding creative solutions within pandemic constraints
Challenges in Relationships	Empowering the child in the research process
	Participation and engagement in ways that are meaningful to them
	Giving the child agency and control in the engagement process
	Providing the child with a safe inclusive environment, agency, and control
	Addressing power relations during engagement
	Building trust and rapport with the research team takes time, effort, and training
Place Field Research	Establishing expectations, possibilities, and agreements prior to research that impact time, resources, and cost
	Securing research agreements and approvals from hospitals
	Commitment from the organization and healthcare providers to act as mediators between the researcher and the child/family
	Communicating the impact of design on care and value to the experience and patient outcomes
	Hospital visitation policies and research during a pandemic like COVID-19 affecting the study design
Engagement Relationships	Challenges in Relationships (included under 'People'
Engagement Methods and Tools	Patient health status impacting active engagement, including physical and cognitive factors
	Frequency and duration of engagement depending on study design and tools
	Designing tools that value the child's worldview
	Need for simple, play-based, or art-based activities that children can trust and enjoy, keeping them motivated and interested

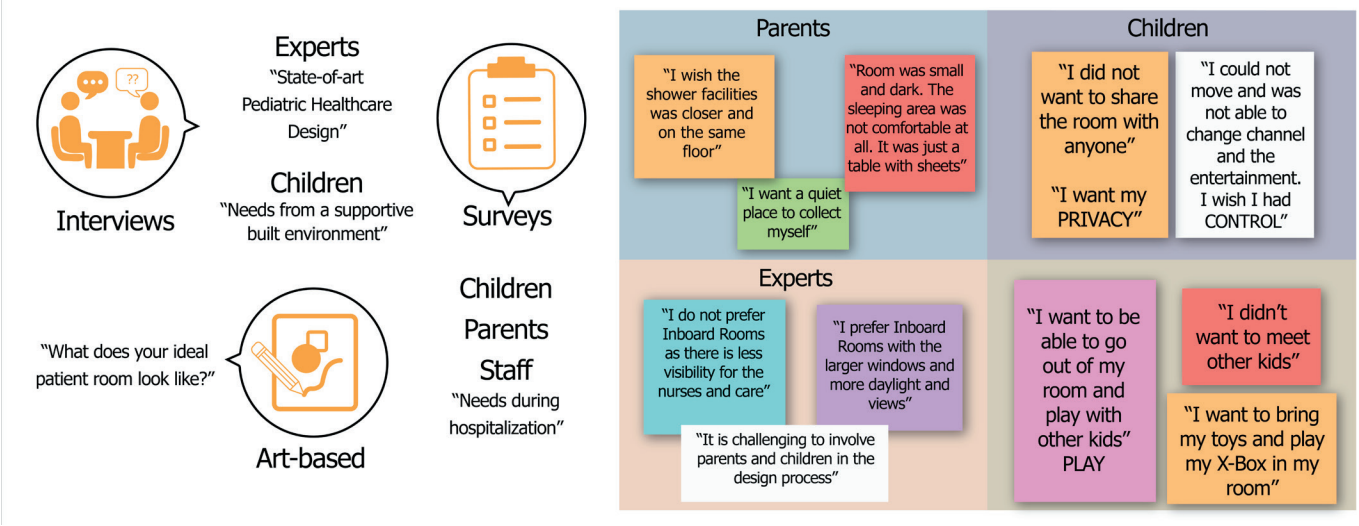


Figure 5. Preliminary Findings from Ongoing Exploratory Study using Art-Based Interviews and Surveys on the Needs of Child and Parent from the Pediatric Inpatient Room.

Improving Patient Engagement and Participation in Pediatric Healthcare Design Research through Immersive Technology and Affective Interactions

While there are numerous opportunities for using innovative digital technology in our research domain, there are also certain limitations that need to be addressed. These limitations include:

1. Limited focus on specific aspects of immersive technology in most studies.
2. Different conceptualizations of the concept of immersion.
3. Lack of empirical research explaining how and why technologies can improve or impair user performance.
4. Overreliance on student samples for data collection, potentially limiting generalizability.
5. Challenges in creating a sense of perceived realism and immersion.
6. Insufficient provision of sensory feedback in immersive experiences.
7. Time constraints impacting the depth of research.
8. Need for effective experimental design to ensure robust findings.
9. Selection and implementation of appropriate measurement techniques.
10. Development of comprehensive evaluation methods.
11. Importance of establishing feedback loops between end users and designers for design evaluation.

Considering both the opportunities and challenges, immersive environments show promise for research involving collaboration and engagement, providing valuable insights into human behavior to inform better design, particularly with the adult population.

Preliminary findings from our ongoing exploratory study reveal differences in the needs of children and parents regarding patient room design during hospitalization (Figure 5). Our study adopts a mixed methods approach, combining interviews with hospitalized children using art-based methods and an online survey to gather insights into their needs regarding the built environment of patient rooms. We are actively working on immersive experience studies to test incremental changes in patient room design (Figure 6), taking tangible steps to collect data from the child's perspective. These studies aim to evaluate the feasibility and effectiveness of the methodology with the pediatric population in healthcare settings.

Human experience within the built environment is closely tied to our physiological, psychological, and emotional responses, ultimately influencing our physical and cognitive states. Investigating emotions and physiological states can provide valuable insights into human behavior, serving as an unbiased layer of data for real-time feedback and analysis of design impact.

By addressing these challenges and leveraging the potential of immersive technology, we can enhance patient engagement and participation in pediatric healthcare design research, ultimately improving the overall well-being and experiences of patients in healthcare settings.

Figure 6. Testing incremental changes through simulation in VR of several room design alternatives in the pre-design phase.

Conclusion

Research on supportive design explores the impact of the healthcare physical-social environment on patients' well-being, including stress reduction. To gain a comprehensive understanding, more research is required in pediatric settings, considering the unique perspectives and preferences of children. Children are increasingly involved as study participants and active contributors in participatory research, highlighting the need for innovative approaches to meaningfully engage and involve them.

While it is widely accepted that the built environment significantly influences patient experience and health outcomes, there is a lack of validated data on children's emotional responses to pediatric healthcare environments. obtaining such data is essential to inform future design decisions. It is important to define key terms related to patient experience and satisfaction for a better understanding. Patient experience (PX) refers to the sum of all interactions that influence patient perceptions throughout the continuum of care, emphasizing the move toward patient-centered care (The Beryl Institute, 2010). Patient satisfaction, on the other hand, measures the extent to which a patient is content with the healthcare received and addresses whether their expectations were met (AHRQ, 2016).

As the use of immersive technologies is expected to increase, empirical studies are needed to examine their effects on user experience and performance, specifically in pediatric research settings. These studies should focus on measuring human responses and interactions in different environments and settings, taking into account the impact of immersive technology. By conducting further research and gathering empirical evidence, we can enhance our understanding of the impact of design on pediatric healthcare, ultimately improving the well-being and outcomes of young patients.

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