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PATIENT-POPULATION BASED DESIGN:
A Wellness Approach for Designing Healthcare Environments

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ABSTRACT
This is a practice-based research investigation, not a scientific enquiry, intended to consider how wellness can be first and foremost in the design of our healthcare environments. In this investigation, designing with wellness means going beyond hospitality design meant to soften institutional care, aiming instead on designs that acknowledge illness with the intent of uncovering the support needed to maximize well-being.

The result of this investigation is a process and a tool that acknowledges health as a fluctuating continuum between wellness and illness, and as such, what an individual may need to maintain wellness anywhere on this spectrum.

The process is referred to as Patient-Population Based Design, and the tool is a practical application known as a "needs assessment" matrix. This article highlights how the process and tool resulted in a re-designed clinic floor plan for a specific patient population, thus increasing their chance of independence from their disease.

KEYWORDS: health, wellness, needs assessment, clinical diagnosis, clinical presentation, competence-press model, cognitive maps, neuro-psych continuum, patient-population based design

1.0 INTRODUCTION
The design of modern healthcare facilities is dominated by code and equipment criteria, where codes are categorized by medical intervention, and equipment classified by diagnostic or treatment capability; consequently, our healthcare facilities focus on illness.

> *Can wellness flourish when the built environment begins with an illness perspective? Can we craft healthcare facilities that signal wellness, while also meeting the requirements to diagnose and treat disease?*

It is important that the design of our healthcare environments begin with these questions in mind in order to address how we can promote health, beyond suppressing disease, by designing from a perspective of wellness rather than illness.

1.1 Health Continuum
This is a practice-based research investigation, not a scientific enquiry, intended to consider how wellness can be first and foremost in the design of our healthcare environments. In this investigation, designing with wellness means going beyond hospitality design meant to soften institutional care, aiming instead on designs that acknowledge illness with the intent of uncovering the support needed to maximize well-being. To achieve this, two questions are pertinent. Where on the continuum does health end and disease begin? And, how can our environment leverage what little health a diseased individual may have?

The result of this investigation is a process and a tool that acknowledges health as a fluctuating continuum between wellness and illness, and as such, what an individual may need to maintain wellness anywhere on this spectrum.

1.2 Patient-Centric Process

The context of health-as-a-continuum is patient-centric rather than disease-centric; with the focus on the patient, we are able to see what the patient needs from the environment, as opposed to what the disease demands of the environment. In other words, the focus is on spatial impacts or environmental supports needed to maximize wellness for a patient with a particular ailment, as opposed to the environment supporting function for the treatment or diagnostic modalities for that disease.

This patient-centric process is referred to as Patient-Population Based Design, and the tool is a practical application known as a "needs assessment" matrix. The four-step process focuses on the particular patient illness being cared for in order to determine the fundamental needs that foster wellness for that patient population. The tool outlines each step in the process by creating a matrix of four fields: clinical diagnosis, clinical presentation, environmental goals, and environmental features. Completing this needs-assessment matrix helps the designer translate what wellness would look like for a specific patient population; the end objective is an environment that fosters patient independence from their disease or aliment.

2.0 HYPOTHESIS

The line of inquiry for this research began with the question: where on the continuum does health end and disease begin? The World Health Organization defines health as the complete physical, mental, and social well-being, not merely the absence of disease[1]. Therefore, we can hypothesize that disease "begins" when any one of the physical-mental-social triad is "incomplete" or is lessened in any way.

This theory presents an opportunity to seek what in the environment "makes complete" or supports the physical-mental-social triad. The assumption is that seeking and finding these supportive elements will guide designers toward creating spaces that foster wellness. Furthermore, note we must first understand how the disease presents itself in the environment, to then know how the environment might counter the disease impacts in order to best support patients with a particular ailment.

2.1 Methodology

The approach for researching this issue began with the question: how can our environment leverage what little health a diseased individual may have? A disease-specific example might be: how can a neurology clinic serving M.S. patients support individuals who may be comfortable only walking short distances? The answer to this question can be discovered in a matrix outlining the "needs" that must be addressed for this specific disease.

The methodology used in this research begins with a needs-assessment matrix, detailing the four fields of: clinical diagnosis, clinical presentation, environmental goals, and environmental features, which are then cross referenced with the specific patient illness being served by the institution or healthcare provider. A sample needs-assessment matrix is shown in Table 1 with the four fields noted on the left and the patient populations across the top; the three populations exhibited here, dementia, psychosocial, and complex medical, are three of six distinct patient populations from a specific long-term care institution serving residents in an inpatient setting.

Table 1: Sample needs-assessment matrix.

	Dementia	Psychological	Complex Medical
Clinical Diagnosis	• Alzheimer's Disease • Multi-Infarc Dementia (MID) • Short-term memory impairment • Judgment impairment due to perception problems (such as left/right neglect) • Impulse control due to an unmet need or anxiety (such as wandering)	• Spinal cord injury • Multiple sclerosis • Substance abuse • Delusional presentations • Depression • Judgment impairment or impulse control due to behavioral problems (such as acting out)	• Mild retardation • Spinal cord injury • Cerebral vascular accident (CVA) • Continuous Dialysis (CAPD) • Diabetes • Wound care • Huntington's
Clinical Presentation	Unable to manage self-care at home or in community settings due to progressive dementia or non-progressive cognitive impairments. Indefinite length of stay	Complex psychosocial problems often due to a medical diagnosis. Rehabilitation is the ultimate goal for this population. Goals of treatment include lessening of symptom severity, improvement in ability to relate to others, improvement in ability to perform activities of daily living, and reduction of specific target behaviors that impact the resident's ability to interact safely and socially in another environment. Varied length of stay	Multiple medical problems with concomitant psychosocial issues. Most residents are alert, oriented and able to communicate. However, despite being cognitively intact, many have significant social or behavioral issues. Unlike the Psychosocial population whose therapeutic goal is rehabilitation back into the community, the Complex Medical residents' behavioral goal is to restore social interactions for maximum independence in a group setting Indefinite length of stay
Environmental Goals	Dependent upon environment for a therapeutic setting with the goal of safety and security.	Like Dementia residents, Psychosocial residents are also dependent upon their environment as a therapeutic setting, but the goal is clarification of the environment as opposed to comfort and predictability of the environment.	Due to the psychosocial component of Complex residents' care, their environmental needs are similar to the Psychosocial residents' needs with an additional requirement to accommodate medical care.
Environmental Features	Cueing opportunities (such as which room is their bedroom, where is the toilet room, etc.) provide important visual "clues". • Personalization of rooms (such as "memory cabinets", picture rails, etc.) helps reclaim a sense of self-identity, maximizes attention span, and reinforces directional cueing. • Stimulation control (such as private bedrooms, small-group dining rooms, etc.) help minimize intake overload. • Stimulation outlets (such as indoor/outdoor wandering paths, come-and-go activities, etc.) allow release of anxiety and agitation. • Security issues (such as protection from aggressive residents, non-axial entries and exits, etc.) increases feelings of security and improves emotional well-being. • Creative resolution of paradoxes (such as need for stimulation but problems of over stimulation, need for predictability versus value of prompting curiosity, etc.). • High spatial/storage needs to accommodate bulky assistive devices unique to the declining dementia resident (such as "ultimate walkers".)	Orientation to place (such as wayfinding) helps the resident adjust to the environment. • Personalization of rooms (such as private rooms) helps reclaim a sense of self-identity as well as reduce territorial issues. • Behavior control (such as small-group dining rooms, time-out rooms, etc.) helps modify inappropriate actions. • Behavior outlets (such as access to the outdoors, vigorous activities, etc.) • Range of security issues (such as protecting frail residents from psychosocial residents, observation of the residents for behavior control, etc.) • Rehabilitation opportunities (such as cooking &/or housekeeping, self-medication, group therapy, egalitarian rooms, etc.) • Average spatial/storage needs associated with skilled care residents.	• Orientation to place (such as wayfinding) helps the resident adjust to the environment. • Personalization of rooms (such as private rooms) helps reclaim a sense of self-identity as well as reduce territorial issues. • Behavior control (such as small-group dining rooms, time-out rooms, etc.) helps modify inappropriate actions. • Behavior outlets (such as access to the outdoors, varied activities, etc.) • Range of security issues (such as protecting the frail from psycho-social residents, observation of residents for behavior control, etc.) • High spatial/storage needs to accommodate numerous assistive devices unique to the medicallydependent Complex Medical resident, which are often bulky and high maintenance (such as Vail beds, Broda chairs, PVC toilet frames, power wheelchairs that need re-charging, etc.)

The genesis of the needs-assessment matrix as a tool began with a client's report re-assigning patients to care units based on their clinical diagnosis rather than on a random assignment. This report outlined two fields, clinical diagnosis and clinical presentation, from which the author later added two environmental design fields; from this original report, the four-field matrix was fully developed.

2.2 Application

For clinical validity, applying the tool requires that the clinical diagnosis and clinical presentation fields in the needs-assessment matrix be developed by clinicians specializing in the patient populations being served; the environmental goals and environmental features are then developed by the architectural team through a review of the literature, evidence-based documentation, and anecdotal but established experience.

The matrix has been designed as a flexible tool capable of generating specific results for any patient population; having a tool that can be applied to a variety of settings ensures that a consistent process can be realized. Prior to this process, healthcare environments did not have a standard design process; for example, healthcare design specific to age-based populations (such as pediatrics or senior care) were subconsciously or intuitively modified to be child or elderly "friendly" designs, but the formal, conscious tool proposed here creates a reliable process for determining what will maximize well-being for any patient population.

It is important to note that this process is not prescriptive, which differs from "accessibility" design where high standards are set but unintentionally restrict options (and lessens accessibility) for some patient populations. By accommodating individuals with varying abilities, the needs-assessment tool is inherently flexible, addressing any patient-population need.

The objective of a patient-population based tool that can be generalized to a variety of patients in a variety of settings is to ensure that healthcare environments will be designed to foster health rather than emphasize illness. The overarching process has been labeled as Patient-Population Based Design.

3.0 RESEARCH

Research theories from various classic and current studies have been influential for the concept of Patient-Population Based Design. In particular, the value of a matrix format led to the discovery of counter-intuitive but interrelated features, such as the balance between stress and ease built into the environment. The first use of Patient-Population Based Design was for a long-term care facility in need of a residential (as opposed to institutional) ambiance with a rehabilitation focus, therefore the Competence-Press Model by Lawton and Nahemow helped shape the concept of the need for stress (press) in the environment as a positive challenge contributing to an individual's rehabilitation (competence); remarkably, adaptive behavior and personal satisfaction are the products of a balance between competence and press[2]. Another early study by Carpman et al. provided the classic perspective on the significance of easy way-finding, in particular: "The close proximity of common destinations, availability of visual clues that provide landmarks (such as windows, plants, artwork, changes in floor covering), easily understood terminology, clear floor and room numbering systems, availability of well-trained staff for giving directions, and the signage system should all work together as an integrated system"[3]. Had this latter study been reviewed in isolation, the value of "un-ease" or stress as noted in the initial study by Lawton would have been missed.

As different healthcare settings and different patient populations emerged as candidates for this research, further readings influenced the concept of Patient-Population Based Design. In addition to the predecessor theories above, two theories were highly informative: Cognitive Maps theory and Sense of Coherence (SOC) by Antonovsky[4]. The concept of cognitive maps originated in the 1940s based on the research of Tolman (1948), Golledge (1998) and others, from which Alan Dilani later applied to healthcare settings[5,6]. Cognitive maps are key to the neurological and psychiatric patient population for this article's case study, and this concept is discussed in detail in the section below.

For the reader's further interest, one of the most challenging patient populations to design for are patients with a psychiatric condition; for this population, Dr. Jan Golembiewski, on the faculty of Built Environment at the University of New South Wales, is developing a wealth of new material that spans both neuroscience and architecture for this demanding patient population[7].

3.1 Case Studies

To date, Patient-Population Based Design has been employed in a range of facilities, as diverse as acute to long-term care. An example in acute care concerns a major medical center serving two million people as the designated trauma center, burn center, and spinal cord injury center. This facility is currently under construction and was designed based on the unique population needs for traumatic brain injury (TBI) and spinal cord

injury (SCI) patients; Patient-Population Based Design was used to support the decision to convert all 280 beds to meet the same criteria as the 64-licensed rehab beds for TBI and SCI patients. An example in long-term care concerns a 1,200-bed inpatient facility designed for the unique population needs that spanned acute, skilled, rehab, dementia, and hospice patients. This new facility, with patient rooms customized to meet these specific needs yet flexible enough to meet other patients' needs, has been in operation for four years, and in 2014, more patients were rehabilitated and discharged back into the community for the first time in its 150-year history, where previously they were expected to live the remainder of their life in this institution. This paper details the use of Patient-Population Based Design in an outpatient setting, further reinforcing the validity of this universal process for a wellness-based approach to healthcare design regardless of occupancy type.

The case presented is a newly constructed translational medicine facility, combining research labs with patient clinics dedicated to serving severe neurological and psychiatric diseases. The Centre for Brain Health at the University of British Columbia in Vancouver, is a 135,000-square-foot clinical research facility containing wet and dry labs in addition to patient clinics, all of which are dedicated to serving the full range of neuro-psychiatric diseases from Lou Gehrig's disease, Multiple Sclerosis, Parkinson's, and Alzheimer's to resistive Psychosis. Designing environments for the treatment and cure of chronic neurological and psychiatric disorders is one of the greatest challenges in healthcare architecture, made even more so when the driving vision for this institution was to maximize patient research.

The success of Patient-Population Based Design was crucial in this case study because the client's objective was to strive for 100 percent patient participation in clinical research. As a benchmark for this high expectation, patient participation in research is known to range from as low as 2 percent based on a 2007 study of US cancer clinical trials, to as high as 67 percent according to a 2007 study of Canadians volunteering for randomized, controlled trials[8,9]. Notably, even if research funds are unlimited, little research will be done if there are no patients upon which studies can be conducted; therefore, patient participation is critical. Research participation is always a patient dilemma and especially so for the neurological patient, as he or she may feel "untreated" in a controlled study and donating brain tissue post-mortem requires sensitive ethical considerations; clinical trials for cancer patients carry similar risks as there is always a chance a new treatment may be ineffective or worse than their current treatment. For patients of any clinical diagnosis, before they can commit to clinical research they must first have felt cared for—and that means the architectural environment must meet their physical and emotional needs. This is an issue of more than patient comfort—this is about patient trust.

While it may seem obvious that the built environment is important for patients' sense of confidence with their care, little research exists to corroborate how the physical environment may be essential to facilitating patient commitment in research. Carpman et al. highlighted a seemingly unrelated article concerning Boston City Hall that noted visitors' disorientation with wayfinding may surface as generalized hostility toward the organization, alluding to the relationship between environmental discomfort and distrust[3] Lawton and colleagues in a later study found that residential well-being has considerable bearing on psychological well-being, alluding to how an elderly person's sense of comfort in their environment leads to their ease of mind—comfort equals confidence[10].

The Centre for Brain Health case study is ideal for exhibiting the universal potential for Patient-Population Based Design, because the needs of neuro-psychiatric patients are frequently contradictory. For example, patients with neurological diseases most often have opposing movement disorders, such as the simple need to stop and rest, while others have difficulty starting and stopping altogether. Patients with psychiatric disorders need shielding from overstimulation, but simultaneously need to visually scan all that the environment may pose for them; lack of spatial clarity stresses both patient populations for different reasons, such as neurological patients distracted by the physical effort navigating even simple environments, while psychiatric patients become easily confused due to the mental effort navigating unfamiliar settings. Developing a matrix of environmental needs for this range of patients highlights features that support both populations, while calling attention to features that exacerbate either patient's condition. While Patient-Population Based Design hones in on specific patient needs, the objective is a facility design that is not narrowly customized to one single patient population, but instead is flexible enough to support a variety of patient needs.

"Before" and "after" floor plans illustrate how Patient-Population Based Design thinking was utilized to support the neuro-psychiatric patient population, while remaining functional for the general patient population.

The pre-design diagram (Figure 1) shows the preliminary clinic layout as a loop corridor with doors at both ends of the loop and a single waiting zone. The final design diagram (Figure 2) shows the patient-based clinic layout with a single primary corridor, only one option for both entry and exit, and internal clinic sub-waiting in addition to the main waiting zone.

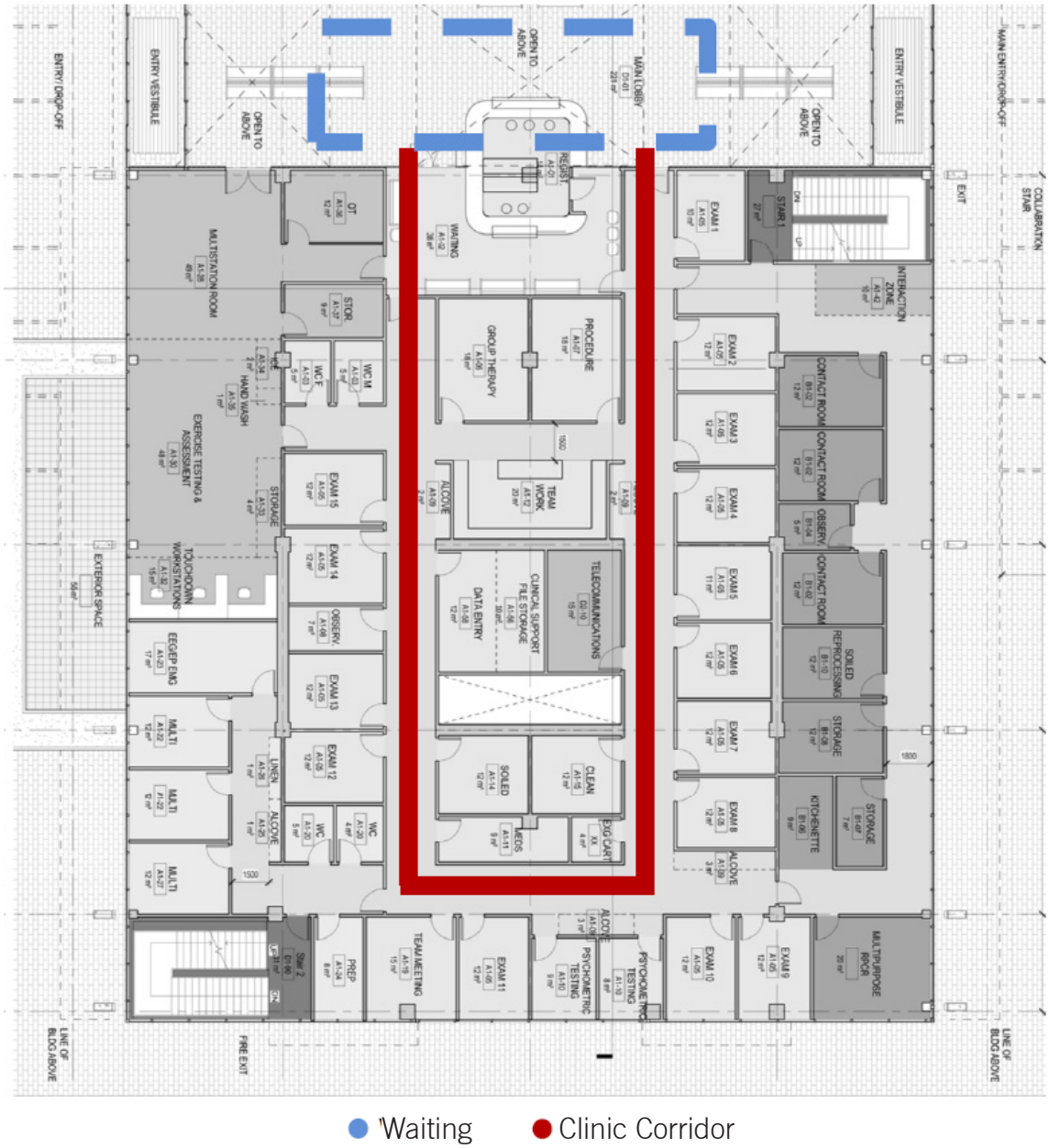

Figure 1: Pre-design clinic plan.

Figure 6: Pulling angles of polycaprolactone stretched beams. *Courtesy of: AADRL.*

The final clinic floor plan represents an entirely different building footprint; the building was completely reconfigured to efficiently maximize the research labs above without inefficiently penetrating the clinic spaces below with stairwells and duct shafts. In the final clinic layout, three critical design parameters were established:

- Single clinic entry and exit
- Redundant pathway
- Break points.

How these three design elements maximize the environment for both neurologically impaired patients as well as patients with psychiatric conditions is summarized in Table 2.

Table 2: Neuro-psych case study needs.

Centre For Brain Health	Population	
	Neurological	**Psychiatric**
Single Clinic Entry Exit	Same way in and out is physically more manageable with less seek-and-find wasted movement due to its predictability;	Same way in and out is emotionally more manageable with less unknowns and requires less thought due to its predictability;
Redundant Pathway	Single shorter corridor is physically more manageable with less seek-and-find wasted movement due to its predictability; Single decision point (one turn off corridor) is physically more manageable with less seek-and-find wasted movement due to its simplicity;	Single corridor is emotionally more manageable with less unknowns and requires less thought due to its predictability and visibility; Single decision point (one turn off corridor) is emotionally more manageable with less thought due to its memorability;
Break Points	Sub-waiting alcoves offer stopping points for rest of physical movement; Sub-waiting alcoves offer landmarks from which to mark physical progress.	Sub-waiting alcoves offer escape points to pull away from corridor traffic; Sub-waiting alcoves offer landmarks from which to gauge mental effort.

These three design parameters for the Centre for Brain Health each address the unique day-long clinic visits experienced by both patient populations, who typically cycle in and out of waiting and clinic exam rooms between various procedures or consultations. For the reader's interest, general environmental needs not specific to this case study but to be anticipated for any facility serving neurologic and/or psychiatric patients are summarized in Table 3.

Table 3: General environmental needs for the neuro-psych continuum.

Movement	Cognition	Psychosis
• Pacing is key to theirmovement through the environment; • Focus on features thatallow stopping & starting, such as: - Corridor 'pull outs' or niches; - Deeper elevator / entry vestibules; • Create a 'new normal'environment by acknowledging / celebrating differences / imbalance through asymmetry such as: - Corridors lit from one side; - Parallel planes treated differently; • Predominately seatedpopulation, therefore: - Assume low view angle with focus on floor more than ceiling (typical 60-degree cone of vision is from about 8 feet, 6 inches down to the floor); - Consider wheelchair 'rear view mirrors' for backing out of elevators, exam rooms, etc.; - Assume reach is limited regardless of front or side approach; - Push plates needed throughout patient pathway.	• Guide their (limited)thinking; • Focus on features that aretouched more so than seen and offer simple decisions, such as: - Bathroom stall swivel latches; - Sliding doors where ever possible (5# limit). • Therapeutic way finding,such as: - Strong differentiation between left versus right; - Shortest distance to meaningful space; - Previewing of adjacent spaces through transparency will create visually open plans for orientation; - Details that differentiate (asymmetrical color coding, staggered doors, etc.) will trigger individual cueing.	• Limit choice & decision-making; • Focus on features that areseen more so than touched and offer predictable cues, such as: - Hand rail different color than wall; - Small alcoves with 1 or 2 seats; • Avoid creating paradoxesthrough predictable spaces that progress from small to large (alcove, sub-waiting, full waiting to lobby); each space will act as transition space and enhance their sense of control; • Stimulating spaces willover stimulate; smaller groups & waiting rooms help minimize intake overload/over stimulation and reduce territoriality; • Simple decision points atmeaningful spaces (a space they will use) reduces anxiety; • Behavior outlets (accessto the outdoors, quite rooms, time-out rooms, etc.) help dissipate or modify inappropriate actions.

3.2 Neuro-Psych Patient Population

Broadly speaking, the environment for the neuro-psych patient-population continuum should support physical (movement) and mental (cognitive) needs, and some evidence supports this. Patterson and Zangwill's article focuses on brain lesions[11]. Cooney and Gazzaniga's research focused on neurological disorders[12]. And most recently, Davidson and Straus investigated psychiatric conditions and sense of self[13]. From these studies, we might assume that patients with neurological ailments have a weakened sense of space with safety as a primary concern, therefore design parameters should focus on things they touch; patients with psychiatric conditions have a vulnerable sense of self with composure as a primary concern, therefore design parameters should focus on things they see. Combined, the above three references form a cohesive relationship between the neurological disorders ranging from brain lesions and space to psychiatric conditions and the sense of self.

A review of the literature reinforced and influenced the environmental parameters that would be ideal for neuro-psychiatric patients. One concept put forward by Antonovsky states that individuals with numerous emotional resources, referred to as a high SOC, were more confident and therefore better able to adapt to stressful situations[14]. Patient-Population Based Design assumes that patients may have a high SOC, and offers them an environment with choices to meet their physical and mental needs when in a stressful situation; more importantly, for patients who do not have a high SOC, the patient-population designed environment offers supportive features appropriate for several levels of coping ability.

The concept of cognitive maps put forward by Dilani stresses that landmarks in buildings are closely related to the perception of stress, and can serve as reference points for easier orientation[15,16]. In the Centre for Brain Health, the sub-waiting alcoves are distinct elements creating a cognitive map that fosters the neurological patient's need for rest and reassures the psychiatric patient's need for escape, thereby reinforcing the well-being of both populations.

3.3 Clinic Efficiency

Beyond the concern for Patient-Population Based Design, two concepts in the final clinic layout were specific to maximizing overall clinic efficiency for the Centre for Brain Health: clinic pods and dual-purpose exam rooms. First, the total 18-exam room clinic was re-configured into three, self-contained pods, each comprising six exam rooms, two support rooms, and a touch-down space for staff and sub-waiting alcove for patients. This clinic pod concept simplified the patients' experience by reducing their exposure down to a smaller number of rooms, while increasing the staff's efficiency through in-the-pod access to support rooms and work space. Second, the exam room functions either for an exam-table neurological assessment or for a group-seating psychiatric consultation. This dual-purpose exam room concept was achieved by fixing only the door and sink location with all other items being movable, allowing the clinic to flex from neuro to psychiatric services as needed.

These design concepts are efficient not only for this patient population but can be applicable to a variety of patient populations if the institution's staffing model supports a pod-like model of care and/or an exam room conversion concept.

4.0 CONCLUSION

The facility in this case study was open for only a few months at the time of this research, therefore, the effects of the Patient-Population Based Design process have yet to be proven or disproven. While the outcome of this process is not known at this time, the process did inform the design and ideally, a post-occupancy evaluation conducted a full year or more after opening would greatly inform the validity of this process.

Specific to the case study presented in this paper, there is a clear need for studies that examine patient participation in clinical research, but the objective of a wellness-based setting is to allow less-well patients to consider research dilemmas and prepare them for time sacrificed, tissue or organs donated, and risk missing a miracle drug or treatment. For translational medicine research facilities, a wellness-based setting should reinforce patients' trust that researchers and clinicians are committed to the patient's care regardless of the outcome.

The primary intervention described in this paper focused solely on the spatial relationships without considering the other physical elements that were modified, such as access to daylight, sensitivity to color, and asymmetrical interior design elements, all of which were undertaken in order to have a significant, positive impact specific to this neuro-psychiatric patient population. The research for this paper focused on the case study patient population, but in the hope that Patient-Population Based Design gains acceptance, future research for broader populations is highly recommended.

The objective of Patient-Population Based Design is to create a standardized process for wellness-based design in healthcare settings to increase the likelihood that healthcare environments will be designed to foster health rather than emphasize illness. This process is currently being taught to healthcare executives in a graduate program for healthcare design so that they may influence the architecture before design begins, and set the stage for a wellness-based environment.

Future steps in research should begin with identifying valid and reliable metrics to measure the intended outcomes, followed by testing conceptual design options to predict the desired outcomes. Initially this may require selecting a specific patient population to confirm the process and the intent of patient-population based design.

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