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A LITERATURE REVIEW: NATURAL ELEMENTS IN RECOVERY ROOM DESIGN AND THEIR ROLE IN COGNITIVE RESTORATION AND PATIENT HEALTH AND WELLBEING

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Abstract

The healthcare environment of recovery rooms is critical and is often overlooked as a predictor of patients' physical and psychological recovery. Research has proven that incorporating natural elements, such as green spaces, sunlight, and biophilic designs, helps reduce recovery time, decrease reliance on medication, and improve mental health outcomes. This paper reviews previous findings to establish how natural resources can accelerate recovery, reduce the need for medications, and improve the patient's mental health. The paper applies Attention Restoration Theory (ART) to explain how nature helps reduce cognitive fatigue and, consequently, facilitates recovery. The study's findings indicate that healthcare organizations should consider incorporating natural elements into their buildings, as this is an affordable way to enhance patients' well-being. The central thesis is that natural details enhance the cognitive restoration process and, therefore, decrease mental fatigue, which may lead to faster recovery. Ultimately, this paper explains how integrating nature into the design of healthcare facilities can be a cost-efficient way to achieve better patient recovery and, thus, better health and hospital environments.

Keywords

Natural Elements, Cognitive Restoration, Healthcare Environments, Recovery Room Design, Patient Health and Wellbeing

Introduction

Healthcare design, particularly in recovery rooms, significantly impacts patient outcomes, influencing both physical and mental recovery (Park et al., 2018; WHO, 2010; Ulrich, 1984). Recovery rooms where patients stay post-surgery hours or days are typically characterized by excessive stress levels, mental haze, and cognitive fatigue, which can hinder healing (Park et al., 2018; Ulrich, 1984). Studies show that people spend roughly 80–90% of their time indoors (Klepeis et al., 2021; WHO, 2010). Poor indoor environmental quality (IEQ) in healthcare settings has been linked to prolonged recovery periods, increased use of pain medication, and higher rates of postoperative complications (Al Horr et al., 2016; Bluyssen et al., 2016).

More evidence suggests that natural aspects, such as green spaces, daylight, the sounds of nature, and biophilic materials, can enhance cognitive restoration and patient health (Joye & Dewitte, 2018; Hartig & Jahncke, 2017; Gifford, 2014). The World Health Organization (WHO) defines health as "a state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity" (World Health Organization Constitution, 1946). On the other hand, cognitive restoration is the process of recovering mental resources and alleviating cognitive fatigue through exposure to environments that support effortless attention (Kaplan, 1995; Joye & Dewitte, 2018). Attention Restoration Theory (ART) posits that exposure to nature alleviates mental fatigue by

inducing "soft fascination," a psychological state that allows directed attention to be restored (Basu, Duvall, & Kaplan, 2019). Empirical evidence supports this as surgical patients with greenery views stayed 0.8 days shorter in the hospital and required 22% less pain medication than those with city-building views (Ulrich, 1984). Similarly, recovery rooms with indoor plants had a 15% reduction in patient anxiety and a 20% improvement in mood (Park et al., 2018).

Natural light also regulates circadian rhythms, which are essential to sleep and cognitive performance. Daylight-treated patients experienced 25% better sleep cycles and a 30% lower rate of postoperative delirium (Zadeh et al., 2014). Biophilic materials, such as wood and stone, were also found to reduce stress biomarkers by 17% and increase perceived well-being by 12% (Kellert et al., 2015). Despite such promising findings, there are specific bottlenecks in upscaling research for utilization in real-life healthcare settings like the variability of plant species toward pollutant-removal efficiency (Dela Cruz et al., 2014), humidity management to prevent fungal development (Moya et al., 2018), and system integration such as HVAC (Darlington et al., 2001). This paper examines existing research and offers evidence-based design recommendations for incorporating natural elements into recovery rooms to facilitate cognitive healing. Attention Restoration Theory (ART) provides a theoretical foundation, emphasizing how nature-based environments reduce mental fatigue and improve attention recovery. This literature review aims to synthesize existing research and provide evidence-based design recommendations for incorporating natural elements into recovery rooms to support cognitive healing.

Methodology

This review examines the impact of natural elements, including green spaces, natural light, natural sounds, and natural materials, on patients' health and well-being in healthcare settings. A systematic literature search was conducted using PubMed, Science Direct, and Google Scholar databases, focusing on publications from 2001 to 2024. Key search terms included “Natural Elements,” “Cognitive Restoration,” “Healthcare Environments,” “Recovery Room Design,” and “Patient Health and Wellbeing.” The initial search yielded 1,325 articles, which were screened for relevance. Non-peer-reviewed articles and duplicates were removed, resulting in 112 peer-reviewed studies for further analysis. From these, the 60 most relevant articles were selected for in-depth review, prioritizing recent publications and seminal older studies with high citation impact. A content analysis of the selected articles was conducted to synthesize findings, focusing on outcomes such as stress reduction, recovery times, sleep quality, and patients' health and well-being, as well as mechanisms linking natural elements to health benefits. This process ensured a rigorous, evidence-based evaluation of how biophilic design principles enhance overall patient well-being in healthcare environments.

Theory foundation: Attention Restoration Theory (ART)

Attention Restoration Theory (ART) serves as a model for understanding how exposure to the natural environment facilitates cognitive restoration (Kaplan & Kaplan, 1989). According to ART, mental fatigue, or tiredness resulting from prolonged engagement in tasks that require directed attention, leads to cognitive depletion (Kaplan, 1995). Natural environments enable the brain to recuperate from stress and mental fatigue by engaging in effortless attention, also known as soft fascination, allowing the brain to recover from stress and mental exhaustion (Basu, Duvall, & Kaplan, 2019). Extensive studies confirm the fundamental premise of ART, highlighting that individuals who spend time in natural environments show increases in attention span, working memory, and general cognitive ability (Ohly et al., 2016). This theory has been widely applied in healthcare settings to aid in managing recovery, stress, and anger (Gifford, 2014). ART offers a theoretical framework that includes components of nature-based design to lower cognitive fatigue in these settings (Stevenson, Schilhab, & Bentsen, 2018).

Being Away, Fascination, Extent, and Compatibility are the four elements of ART identified by Kaplan and Kaplan (1989). These elements refer to the psychological distancing from stressors that natural environments provide (Kaplan, 1995). These elements offer a necessary structure for recovery spaces that support cognitive restoration (Staats, 2012).

The first element, Being Away, refers to the psychological distance from stresses offered by natural surroundings (Kaplan, 1995). Green areas, nature-inspired artwork, or window views of gardens help patients in recovery rooms mentally escape from clinical stress and recharge their cognitive resources (Staats, 2012).

The second element, fascination, explains how easily natural surroundings grab an individual's attention, reducing cognitive strain and encouraging recovery (Felsten, 2009). Exposure to flowing water, natural light, and plant life activates a soft interest, requiring minimal cognitive effort while promoting relaxation and mental clarity (Basu, Duvall, & Kaplan, 2019). This supports the idea that natural stimuli could improve cognitive restoration and reduce stress (Joye & Dewitte, 2018; Hartig & Jahncke, 2017; Gifford, 2014).

Extent, the third component, is the immersive quality of the natural environment, which fosters a sense of continuity and engagement (Kaplan, 1995). Recovering rooms with panoramic views of the natural environment, nature-inspired murals, or a significant use of biophilic elements can provide an immersive environment that

supports cognitive restoration (Joye & Dewitte, 2018). This claim was further reinforced by Bowler et al. (2010), who revealed that exposure to immersive natural settings greatly enhances cognitive ability and mood control.

The last element, Compatibility, emphasizes matching environmental features with human cognitive needs (Kaplan, 1995). For example, recovery rooms should be designed to provide occupants with nature-based interventions that help patients easily interact with their environment through window views. Patients recover faster and report better well-being in environments supporting ART principles (Ohly et al., 2016; Taylor, Kuo, & Sullivan, 2002).

These results underscore the importance of ART as a guiding concept for designing recovery facilities that facilitate cognitive restoration. Fostering patient well-being and maximizing recovery outcomes depend on incorporating natural components into hospital settings (Kaplan & Kaplan, 1989).

Nature-Based Design Strategies for Recovery Rooms

Views of Nature and Green Spaces

The aesthetic appeal of green spaces provides visual stimulation and positive distraction through scenic and pleasant views, offering patients and staff a means to appreciate their surroundings. Research by Ulrich (1984) demonstrates that such views have therapeutic effects on patients, while Pati et al. (2008) determined that nursing staff had improved overall alertness and reduced acute stress. Biophilic design is an architectural approach that seeks to reconnect people with nature by integrating natural elements into built environments, enhancing occupants' health and well-being (Kellert & Calabrese, 2015). This practice is based on the theory that human beings have an innate tendency to affiliate with nature and natural processes, and fulfilling this tendency assists health and well-being in the built environments we inhabit (Tekin et al., 2023a; Kellert et al., 2015).

Biophilic design involves creating environments that support the health and well-being of everyone (Kumar et al., 2020). There is evidence of health benefits associated with exposure to nature, including pain relief, reduced medication use, lower blood pressure, shorter hospital stays, and decreased all-cause mortality (Tekin et al., 2023b). In addition, biophilic design can also be an important component of supportive care, especially in patients with chronic disease, who are likely to experience psychological distress, fatigue, anxiety, or depression. (Tekin et al., 2023). This design is also relevant to supportive care, particularly for cancer patients who are typically psychologically distressed, fatigued, anxious, or depressed (Moore et al., 2018).

Contact with nature has been established to promote emotional, mental, and spiritual well-being, reduce stress, and bring about beneficial changes in mood (Abdelaal et al., 2019). Planting thorn-free and non-toxic plants that are low in pollen has been discovered to be beneficial (Pachana et al., 2003). Users of established green spaces highly request trees and plants that reduce glare and heat while providing shade (Naderi et al., 2008). From both aesthetic and functional perspectives, the seasonal changes of plants offer visual stimulation, serve as conversation starters, and contribute to coping mechanisms by allowing users to observe the cycle of life and the passage of time (Davis, 2011). Much previous research has focused on plants' potential to enhance indoor air quality (IAQ), mainly by removing indoor air pollutants (Brilli, 2018). Plants have also been found to have climate-mitigating effects, such as thermal and humidity control, due to evaporative cooling, differential shade cooling, and solar gain heating from foliage canopies (Gunawardena & Steemers, 2019a). These effects contribute to potential energy savings. Moreover, plants have been suggested to be effective passive acoustic insulators, with the potential to reduce sound levels through the reflection, dispersal, absorption, or interference of sound waves by the plant and its growth medium (D'Alessandro et al., 2015). Martin et al. (2021) investigated the impact of a small garden on visitors' emotional and behavioral responses to a rooftop atrium in a hospital. This study highlighted how a healing garden can significantly impact visitors' overall satisfaction with the hospital and their future behavior, such as revisiting or recommending it.

Natural Light and Circadian Regulation

Most people spend considerable time indoors, creating more interest in improving indoor environmental quality to enhance health. Natural window daylight views are necessary to achieve this goal (Choi et al., 2012). Several studies have demonstrated that incorporating windows and exposure to daylight in healthcare environments can reduce the need for pain medication and associated costs (Walch et al., 2005). Additionally, it has been observed to enhance the effects of prescribed medication for depression and decrease the duration of hospital stays for bipolar patients (Zadeh et al., 2014).

A study by Zadeh et al. (2014) examined the effects of windows and daylight on the physiological, psychological, and behavioral health of acute-care nurses and found that these factors had beneficial effects. The presence of windows and exposure to daylight may have a micro-restorative effect, contributing to lower blood pressure, increased oxygen saturation, and positive impacts on circadian rhythms (as indicated by body temperature) and morning sleepiness. Circadian rhythms are linked to sleep and arousal, and human health is primarily affected by light and temperature (Kim et al., 2020). Light causes changes in physiological functions, such as body temperature, pulse, and endocrine functions, as well as hormonal changes that affect sleep and arousal

(Cagnacci et al., 1992). For individuals who have adapted to natural light for a long time, it can be best synchronized with the body's circadian rhythm (Wright et al., 2013). Natural light affects sensitivity and health, depending on its characteristics, such as color temperature, short wavelength, illuminance, and luminance, as well as visual effects that differentiate space and form, and distinguish colors (Kim, 2012). Therefore, providing a lighting environment that mimics the spectral characteristics of natural light, as well as its temporal and seasonal variations, can have a positive impact on human health and quality of life (Kim et al., 2020). Additionally, artificial lighting mimics natural light cycles, such as dynamic lighting systems, which have been found to reduce cognitive fatigue and enhance cognitive restoration in patients recovering from surgery (Zadeh et al., 2014).

Additionally, a systematic review by Hadi et al. in 2019 on "The Effect of Light on Sleep and Sleep-Related Physiological Factors Among Patients in Healthcare Facilities" indicated that short-term morning bright light exposure (up to 2 hours of moderate exposure at 3,000–10,000 lux), up to 4 hours of evening moderate exposure, or daylong exposure to lower illuminance levels (<3,000 lux) may enhance the patient's sleep outcome.

A study by Park et al. (2018) used extensive medical data to demonstrate the positive effects of natural light in hospitals. Comparing 38,788 patients in window beds and 46,233 patients in indoor beds revealed that patients in window locations had shorter hospital stays. The study established the advantages of incorporating sunlight into healthcare design.

Nature Sounds and Acoustic Comfort

According to Fattahpour et al. (2024), natural sounds, such as flowing water, wind, rain, birdsong, river currents, and ocean waves, play a role in music therapy within complementary medicine. The authors argued that the psychological benefits of music therapy stem from the deep connection between humans and nature. Research indicates that sound masking with nature sounds reduces auditory overload, promoting a more restorative atmosphere (Moya et al., 2018). Patients in coronary care units often face stress arising from sleep disorders. Chandola et al. (2010) report that these patients encounter various sleep issues, with Bihari et al. (2012) finding that about 70% experience poor sleep quality. Sleep disorders can lead to physical and mental disabilities, mood swings, and emotional instability.

Intensive care units ' environmental noises, such as telephone ringing and alarms, account for 17%–57% of sleep disturbances (Lawson et al., 2010). Nasari et al. (2018) investigated how the sleep quality of patients in coronary care was affected by natural sounds. This randomized controlled trial was conducted on 93 patients with chronic low back pain from three Tehran teaching hospitals, and participants were allocated to three groups: nature sounds, silence, and control. For two nights, while the nature sound group listened to nature sounds for 30 minutes, the silence group wore headphones, which were kept muted. The control group had no exposure to natural sounds or headphones. The findings suggested that both nature sounds and silence interventions had a positive effect on sleep quality.

Biophilic Materials and Organic Textures

According to Browning et al. (2014), Biophilic finishes and organic materials are also essential in enhancing patient well-being and reducing stress levels in the healthcare environment. Biophilic design principles emphasize the use of natural materials, such as wood, stone, and vegetation-based products, to create a calming environment that promotes psychological and physiological well-being (Browning et al., 2014). Research has shown that exposure to natural textures, such as untreated wood and soft, organic fabrics, can decrease cortisol levels and promote relaxation, ultimately improving patient recovery outcomes (Lipovac & Burnard, 2020). The materials also enhance the tactile feel of hospital interiors, making them less sterile and more inviting. This is particularly beneficial in lowering patient anxiety and enhancing overall care satisfaction (Van den Berg, 2017). The last few decades have witnessed a growing interest in the health benefits of biophilic materials, as they provide a way to incorporate natural elements into settings where indoor plants are not feasible. Wood and other natural materials also give a physical and visual connection with nature in settings where there are no outdoor vistas (Nyrud et al., 2014).

Furthermore, wood as a construction material significantly impacts the indoor environment of a building by emitting beneficial chemical compounds, providing adequate air moisture content, and regulating acoustics and bacterial conditions (Asdrubali et al., 2018). A study by Nyrud et al. (2014) examined staff preferences for using natural building materials in patient rooms and found that moderate use of wood was most preferred. In contrast, using excessive wood on surfaces, such as pine on all walls, was the least preferred option. Preeminent, earlier research by Nyrud et al. (2012) to assess the impact of wood on indoor air quality in health facilities found patient rooms with or without wood paneling had no significant differences as far as the levels of volatile organic compound (VOC) are concerned, which implies wood décor has very little to contribute to air.

Aside from their aesthetic and sensory appeal, natural textures such as the pattern of wood grain and the irregularities of stone surfaces provide multisensory engagement that facilitates the restoration of cognition and a sense of emotional well-being (Kellert & Calabrese, 2015). Empirical evidence suggests that textured surfaces that simulate natural elements enhance feelings of warmth and security in healthcare settings, positively impacting both

patients and healthcare personnel (Salingaros, 2019). Furthermore, biophilic materials are also observed to improve indoor air quality, as some natural materials, such as untreated wood and clay, have been found to regulate humidity levels and remove airborne contaminants (Augustin & Fell, 2021). As patient-centered design continues to be adopted in hospitals, biophilic materials and organic textures provide a key strategy for creating healing environments that promote both physical and mental comfort.

Evidence-Based Design Recommendations for Nature-Based Recovery Rooms

Integrating natural elements in healthcare design is crucial in enhancing patient well-being by reducing stress and supporting cognitive restoration (Joye & Dewitte, 2018; Browning et al., 2014). Grounded in Kaplan's Attention Restoration Theory (1995) and insights from the literature on biophilic design, the following table presents key findings and corresponding evidence-based design recommendations for nature-based recovery rooms.

Table 1. Natural Elements Design Recommendations for Recovery Rooms

Elements	Findings	Recommendation	Citation
Being Away	Green spaces, nature-inspired artwork, or window views of gardens help patients mentally escape from clinical stress and recharge their cognitive resources.	Design recovery rooms with access to green spaces, nature-inspired artwork, or large windows overlooking gardens.	Staats (2012); Kaplan (1995)
Fascination	Exposure to flowing water, natural light, and plant life stimulates a gentle interest, reducing cognitive strain and promoting relaxation and mental clarity.	Incorporate water features, natural light sources, and indoor plants to facilitate effortless cognitive engagement.	Basu, Duvall, & Kaplan (2019); Hartig & Jahncke (2017); Felsten (2009)
Extent	The immersive qualities of natural environments provide a sense of continuity and engagement, thereby improving mood regulation and cognitive function.	Ensure that recovery rooms offer panoramic views of natural settings, extensive biophilic design, and nature-based textures.	Joye & Dewitte (2018); Bowler et al. (2010); Kaplan (1995)
Compatibility	Recovery rooms should align with human cognitive needs, ensuring patients engage with their environment effortlessly.	Provide access to controllable natural features such as windows, daylight, and virtual reality nature experiences.	Ohly et al. (2016); Taylor, Kuo, & Sullivan (2002); Kaplan (1995)
Views of Nature and Green Spaces	Green spaces provide visual stimulation and positive distraction, improving alertness, reducing acute stress, and enhancing overall satisfaction.	Integrate healing gardens, green walls, and plant-based partitions within the patient's field of vision.	Tekin et al. (2023); Pati et al. (2008); Ulrich (1984)
Natural Light and Circadian Regulation	Exposure to natural light enhances sleep, regulates circadian rhythms, and improves mood and cognitive function.	Maximize natural daylight exposure through large windows and dynamic lighting systems that mimic daylight cycles.	Kim et al. (2020); Park et al. (2018) ; Zadeh et al. (2014)
Nature Sounds and Acoustic Comfort	Sound masking with natural sounds helps reduce auditory overload, creating a more restorative atmosphere.	Embed nature soundscapes, such as waterfalls and wind chimes, into the recovery room acoustics.	Moya et al. (2018); Nasari et al. (2018)
Biophilic Materials and Organic Textures	Natural materials such as wood and stone improve psychological comfort, reduce stress, and create a calming environment.	Natural materials, such as untreated wood and soft, organic fabrics, enhance tactile engagement and relaxation.	Jiang et al. (2020); Kellert & Calabrese (2015); Nyrud et al. (2014)

Discussion

This paper highlights the significance of incorporating natural elements into recovery room environments to facilitate cognitive restoration. Patients recovering in rooms with access to green spaces, gardens, or even nature-inspired murals experience lower stress levels and report higher satisfaction with their recovery environment (Bluyssen et al., 2016). Biophilic interventions, including views of nature, natural lighting, and the incorporation of organic materials, have been shown to contribute to improved patient outcomes (Park, Mattson, & Kim, 2018; Ulrich, 1984). These biophilic materials and organic textures, when in recovery rooms, have also been shown to enhance the sensory experience of patients, inducing relaxation responses and lowering cortisol levels (Augustin & Fell, 2021; Asdrubali et al., 2017), and contribute to overall patient well-being (Gunawardena & Steemers, 2019b; Nyrud, Bringslimark, & Bysheim, 2014). A well-balanced lighting environment is also pivotal in supporting cognitive functions by stabilizing circadian rhythms and regulating mood-enhancing neurotransmitters (Cagnacci et al., 1997; Cagnacci, Elliott, & Yen, 1992).

Overall, the discussion of these findings underscores the importance of designing recovery rooms that align with ART principles to promote cognitive restoration. The reviewed literature suggests that integrating nature into hospital environments is not merely an aesthetic consideration but a crucial factor in patient-centered care. Addressing the barriers to implementation will be critical in ensuring that future hospital designs incorporate evidence-based biophilic strategies that optimize cognitive and emotional well-being (Kellert & Calabrese, 2015; Ulrich, 1984).

Conclusion

Improving cognitive restoration in recovery rooms depends critically on incorporating natural elements (Kaplan & Kaplan, 1989). Access to green areas, natural light, and biophilic elements helps lower stress and improve recovery time (Ohly et al., 2016). Studies have shown that views of nature and dynamic lighting systems can help control circadian rhythms, thereby enhancing psychological health and sleep quality (Zadeh et al., 2014). Nature-based interventions, such as exposure to therapeutic gardens and biophilic interior designs, improve patient well-being and cognitive function (Gifford, 2014). Additionally, natural sounds and organic materials have been found to reduce anxiety and support emotional balance, both of which are essential for optimal recovery (Bowler et al., 2010).

Despite these clear advantages, resistance to non-traditional healthcare designs and high implementation costs remain significant barriers to the widespread adoption of these designs. However, research suggests that the initial investment in biophilic design can lead to long-term cost savings by reducing patient recovery times while minimizing pain medication dependency (Walch et al., 2005) and improving overall patient health (Joye & Dewitte, 2018; Hartig & Jahncke, 2017; Ohly et al., 2016; Gifford, 2014).

To maximize the benefits of ART-based recovery rooms, interdisciplinary collaboration between healthcare professionals, architects, and environmental psychologists is essential. Healthcare institutions can improve patient experiences and enhance cognitive restoration results by integrating cost-effective biophilic solutions. Future research should continue to explore innovative strategies for overcoming implementation challenges, ensuring that nature-based design becomes an integral component of hospital recovery environments.

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