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ARCHITECTURE FOR THE HUMAN BODY

ARCHITEKTURA DLA CIAŁA

Abstract

This article analyses methods of rehabilitation supported by the design of healthcare facilities, taking into account the integration of visual, tactile and auditory stimuli, as well as – in selected cases – olfactory stimuli. Taking sensory perception into account can significantly support regenerative processes. The article emphasises the need to move away from a purely technical design model towards a holistic and evidence-based approach, in which architecture becomes an active element of the therapeutic process and represents an attempt to systematise knowledge regarding the influence of sensory perception on the experience and effectiveness of rehabilitation facilities.

Keywords: *evidence-based design, healthcare architecture, rehabilitation*

Streszczenie

Przedmiotem artykułu jest analiza metod wspierających rehabilitację poprzez projektowanie obiektów ochrony zdrowia z uwzględnieniem integracji bodźców wzrokowych, dotykowych, słuchowych, a także – w wybranych przypadkach – węchowych. Uwzględnienie aspektów percepcji sensorycznej może istotnie wspierać procesy regeneracyjne. Artykuł podkreśla konieczność odejścia od czysto technicznego modelu projektowania na rzecz podejścia holistycznego i opartego na dowodach, w którym architektura staje się aktywnym elementem procesu terapeutycznego, oraz stanowi próbę uporządkowania wiedzy na temat wpływu percepcji zmysłowej na odbiór i skuteczność obiektów rehabilitacyjnych.

Słowa kluczowe: *architektura zdrowia, evidence-based design, rehabilitacja*

1. INTRODUCTION. DESIGNING FOR HEALTH

Modern standards for the design of healthcare facilities represent an integration of advanced medical technology, a coherent functional layout, and the humanisation of architecture. Buildings are ceasing to be merely “healing machines” and are becoming patient-oriented spaces. The concept of Patient-centred Design focuses on the physical,

psychological, and emotional needs of patients, involving them in the design process in line with the principles of participatory design. Based on the concept of Designing Healing Environments, a healthcare facility can serve as a therapeutic tool that supports patients' treatment and rehabilitation processes. The foundation of this model is the methodology of Evidence-based Design (EBD).

The Center for Health Design defines Evidence-based Design as "process of basing decisions about the built environment on credible research to achieve the best possible outcomes"[1]. The idea of EBD was developed based on the methodology of Evidence-based Medicine. Although the term Evidence-based Design was first used in 2004 by architect Kirk Hamilton, the origins of research into EBD methodology can be traced back to the 1960s in the United States. Since the 1970s, architectural researchers Clipson, Johnson, and Wehrer conducted studies on the influence of the functional layout of a hospital on staff efficiency. A pivotal moment for the popularisation of EBD was the publication of Roger S. Ulrich's seminal 1984 research on the impact of a window view on patient recovery. The study demonstrated that patients staying in rooms with a view of natural scenery received fewer doses of potent analgesics, and their post-operative hospital stay was shorter[2]. Undoubtedly, Ulrich's publication had a fundamental impact on the approach to architecture, which began to be perceived as an active factor in the healthcare process.

In 1993, the Center for Health Design was founded – one of the most important research groups focused on the design of healthcare facilities. The organisation lists eight steps to be included in the EBD process:

1. Define evidence-based goals and objectives.
2. Find sources for relevant evidence.
3. Critically interpret relevant evidence.
4. Create and innovate evidence-based design concepts.
5. Develop a hypothesis.
6. Collect baseline performance measures.
7. Monitor implementation of design and construction.
8. Measure post-occupancy performance results.[3]

A significant step in the EBD process is post-occupancy performance measurement, which is based on the Post-Occupancy Evaluation (POE) method. POE enables the verification of design assumptions and serves as a basis for creating better buildings in the future[4]. It is particularly significant that EBD enables the creation of an active healing environment, which can contribute to improving the quality of services and achieving the best possible outcomes for patients, staff, and operations.

Contemporary scientific studies clearly indicate the therapeutic properties of nature, which has the capacity to influence human health and well-being. Research on exposure to green spaces shows statistical associations with reductions in diastolic blood pressure, heart rate, and salivary cortisol levels, as well as a decreased incidence of type II diabetes, stroke,

[1] Center for Health Design, *About EBD*, "Health Design", https://www.healthdesign.org/certification-outreach/edac/about-ebd (access: 01.06.2026).

[2] J.S. Bil, *Współczesne projektowanie obiektów służby zdrowia oparte na dowodach naukowych*, "Przestrzeń i Forma" 2014, no. 22(1), pp. 70–72.

[3] Center for Health Design, *op.cit.*

[4] J.S. Bil, *op.cit*.

all-cause mortality, and cardiovascular mortality[5]. In the context of the impact of nature exposure on the human body, it is also essential to refer to two complementary theories: Attention Restoration Theory (ART) by Rachel and Stephen Kaplan, and Stress Reduction Theory (SRT) developed by Roger Ulrich. According to ART, spending time in a natural environment can restore the capacity to concentrate by regenerating the directed attention system. Furthermore, based on SRT, the natural environment contributes to a reduction in physiological stress, and viewing nature can reduce stressful thoughts and support psycho-physiological recovery[6].



Ill. 1. New North Zealand Hospital. Hospital in Hillerød, Denmark, designed by Herzog & de Meuron, competition project. Source: https://www.dezeen.com/2014/04/09/herzog-de-meuron-new-north-zealand-hospital-denmark/ (access: 09.06.2026)

The term "biophilia" was popularised by biologist Edward O. Wilson as an innate human connection with nature, which is deeply rooted in human biology and psychology. In an architectural context, it is worth noting the concept of biophilic design, which represents an innovative design approach that integrates natural elements into the built environment to enhance human connection with nature. Systematic reviews indicate that biophilic design in healthcare facilities can influence: a reduction in hospitalisation time and patient mortality,

[5] C. Twohig-Bennett, A. Jones, *The health benefits of the great outdoors: A systematic review and meta-analysis of greenspace exposure and health outcome*s, "Environmental Research" 2018, no. 166, p. 636.

[6] R. Berto, *The Role of Nature in Coping with Psycho-Physiological Stress: A Literature Review on Restorativeness*, "Behavioral Sciences" 2014, no. 4(4), pp. 396–398.

a reduction in pain levels and stress among medical staff, the alleviation of anxiety in patients, families, and staff, and support for faster patient recovery[7].

From a contemporary perspective, biophilia theory correlates significantly with neuro-architecture. Human perception of the built environment is multi-sensory and constitutes an integrated sensory experience based on visual, auditory, haptic, thermal, and olfactory factors. A visual connection with nature can influence psychological recovery and improve cognitive performance. A natural soundscape supports recovery from stress and memory performance. Positive olfactory stimuli can contribute to improving mood and well-being, as well as reducing stress. It is also worth noting that the effects of multi-sensory factors are not merely the sum of reactions to individual stimuli, as they are coupled with the interactions occurring between them[8].



Ill. 2. La Saleggina. Hospital in Bellinzona, Switzerland, by Herzog & de Meuron, competition project. Source: https://www.herzogdemeuron.com/projects/609-la-saleggina/ (access: 09.06.2026)

Greenery within the structure of a healthcare facility and therapeutic gardens serve a complementary function to the institution's programme, passively and actively supporting patients in therapy. Therapeutic gardens offer a range of clinical benefits related to improving patient well-being, shortening the length of stay in the facility, and increasing staff satisfaction. It is essential to integrate gardens into the programme of the healthcare facility, locate them in an easily accessible place, and consider the diverse perspectives and needs of the users[9]. Furthermore, the passive form of therapy in a therapeutic garden can include senso-

[7] I. Al khatib, F. Samara, M. Ndiaye, *A systematic review of the impact of therapeutical biophilic design on health and wellbeing of patients and care providers in healthcare services settings*, "Frontiers in Built Environment" 2024, no. 10, art. 1467692, pp. 1–3.

[8] J. Yin, H. Zhu, J. Yuan, *Health Impacts of Biophilic Design from a Multisensory Interaction Perspective: Empirical Evidence, Research Designs, and Future Directions*, "Land" 2024, no. 13(9), pp. 1–2.

[9] K. Nieberler-Walker et al., *Sustainable Health and Well-Being: Guidelines for Integrating Therapeutic Gardens for Holistic Hospital Care*, "Sustainability" 2024, no. 16(23), art. 10288, p. 2.

ry stimulation using biodiverse vegetation. The gardens can also incorporate horticultural therapy, which involves the use of plants and gardening activities for therapeutic and rehabilitative purposes.

Undoubtedly important in the context of healthcare facility design is the theory of salutogenesis developed by medical sociologist Aaron Antonovsky, which focuses on the origins of health and factors promoting health, rather than on the causes of disease. The theory defines the factors determining the level of health: stressors, generalised resistance resources, and a sense of coherence. The sense of coherence, considered by Antonovsky to be crucial for health, refers to a person's global orientation and an individual's perception of their life as comprehensible, manageable and meaningful[10]. Incorporating the three components of the sense of coherence into the architectural design of a healthcare facility can lead to the creation of a therapeutic environment. Providing patients with a sense of comprehensibility, manageability, and meaningfulness can serve as a tool supporting patients in therapy.

2. CURRENT TRENDS IN REHABILITATION AND THERAPEUTIC SPACE DESIGN

In the context of therapeutic space design, it is important to define how contemporary rehabilitation is understood and what objectives it establishes for the environment in which the rehabilitation process takes place. The earliest forms of rehabilitation-related activities date back to antiquity, when movement, message and the stimulating effects of physical agents were used in medical practice. Rehabilitation as a field of science and clinical practice, however, developed rapidly only in the twentieth century, in response to the growing health and social needs associated primarily with the consequences of wars, industrialisation and civilisational progress. The development of this field led to a broader understanding of rehabilitation as a combination of physical, psychological and social interventions[11].

Today, rehabilitation is regarded as an integral part of treatment aimed at restoring lost bodily functions, accelerating recovery and reducing the physical and psychological consequences of illness. According to the World Health Organization (WHO), rehabilitation comprises "a set of interventions designed to optimise functioning and reduce disability in individuals with health conditions in interaction with their environment"[12]. This definition extends beyond medical procedures alone and also refers to the patient's functioning within a specific environment.

The development of rehabilitation in Poland is closely associated with the work of Professor Wiktor Dega, whose contribution helped establish the principles of the Polish model of comprehensive rehabilitation. According to his concept, rehabilitation should begin as early as possible, concurrently with surgical treatment, and should include measures aimed at restoring the maximum possible level of musculoskeletal function. Rehabilitation was understood comprehensively as a combination of medical treatment with vocational, social and psychological

[10] M. Piotrowicz, D. Cianciara, *Teoria salutogenezy – nowe podejście do zdrowia i choroby*, "Przegląd Epidemiologiczny" 2011, no. 65(3), pp. 521–522.

[11] B. Przeździak, *Historia rehabilitacji na świecie i w Polsce*, [in:] A. Kwolek (ed.), *Rehabilitacja medyczna*, Elsevier Urban & Partner, Wrocław 2012, p. 4.

[12] World Health Organization, World Bank, *World Report on Disability*, Geneva 2011, p. 96.

rehabilitation. Its purpose was not only to restore the patient's ability to work, but also to enable independent functioning in everyday life[13]. The model assumed that rehabilitation constituted an integral part of treatment and was based on four principles: early initiation, universality, comprehensiveness and continuity of care[14]. From the perspective of therapeutic space design, the principles of comprehensiveness and continuity are particularly important, as they indicate the need to create an environment in which various forms of therapy can be delivered in a coordinated manner and adapted to successive stages of rehabilitation.

Rehabilitation patients represent all age groups, and their profiles reflect a wide range of health conditions, from injuries affecting children and adolescents to the consequences of chronic diseases among adults and older people. In Poland, the largest group consists of patients with musculoskeletal disorders, although neurological and cardiac rehabilitation services are also becoming increasingly important. The diversity of patients' needs requires facilities with different profiles and scopes of operation, including rehabilitation hospitals, rehabilitation wards in general hospitals, day rehabilitation centres and outpatient rehabilitation clinics. The variety of organisational models of rehabilitation directly translates into different functional and spatial requirements for individual facilities. The predominance of outpatient services and the slower development of inpatient care indicate the need for infrastructure that responds not only to the number of patients, but also to their diverse therapeutic, functional and environmental needs[15].

The rapid development of digital technologies and artificial intelligence is introducing new tools into rehabilitation practice, ranging from systems that reduce the physical workload of physiotherapists to solutions that enable precise progress monitoring and the development of personalised therapeutic programmes. One of the key directions in contemporary rehabilitation is robotics, which makes it possible to conduct repetitive and controlled exercises adapted to the individual needs of the patient. Exoskeletons form a particularly important group of devices. These external structures support and reproduce the user's natural movement patterns. The application of robots and exoskeletons in rehabilitation is referred to as cyber-rehabilitation, which combines conventional therapeutic methods with advanced technological solutions supporting the recovery process[16].

Virtual reality technologies complement conventional therapeutic methods. They are used for cognitive stimulation, the improvement of balance and motor function, as well as spatial orientation training. Owing to the immersive nature of virtual environments, patients can perform recreational or functional tasks, which increases their motivation and level of engagement. When combined with motion sensors, VR makes it possible to monitor progress and adapt therapeutic scenarios to the user's needs. One of the advantages of this technology is the possibility of creating controlled exercise conditions that can be safely modified according to the stage of rehabilitation and the patient's response.

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[13] M. Lubecki, *Rola ośrodków rehabilitacyjno-ortopedycznych w polskim modelu rehabilitacji medycznej w drugiej połowie XX wieku*, "Hygeia Public Health" 2011, no. 46(2), p. 253

[14] B. Przeździak, *op. cit.*, p. 9.

[15] *Czym jest rehabilitacja medyczna?*, "Baza Analiz Systemowych i Wdrożeń", https://basiw.mz.gov.pl/mapy-informacje/mapa-2022-2026/analizy/rehabilitacja/rehabilitacja-mapy-potrzeb-zdrowotnych/ (access: 4.06.2026).

[16] T. Sachaj, *Cyfryzacja, robotyzacja i wirtualizacja w procesie aktywizacji, integracji i socjalizacji osób z niepełnosprawnościami*, "Acta Universitatis Lodziensis. Folia Sociologica" 2025, no. 92, p. 25.



Ill. 3. The CUREO system based on VR technology. Source: https://cdn.prod.website-files.com/6548c6e5ab9a929dbb64e897/6901d804e529b1fc381ba849_HandFingerBlob_TabletPatient.jpg (access: 9.06.2026)



Ill. 4. The NIRVANA system using virtual reality. Source: https://www.btsbioengineering.com/wp-content/uploads/2022/05/link_what.png (access: 9.06.2026)

The importance of visual stimuli in the rehabilitation process is also demonstrated by solutions based on feedback and visual stimulation. Patients receive enhanced feedback, which supports more effective motor learning and increases their motivation to participate in therapy. A similar mechanism is used in mirror therapy, in which observing the movement of the unaffected limb activates areas of the brain responsible for controlling the limb affected by paresis[17].

Another rapidly developing area of technological innovation is artificial intelligence, which is used to analyse data obtained from diagnostic and therapeutic devices. The integration of artificial intelligence into rehabilitation programmes improves the effectiveness, personalisation and efficiency of treatment. Mobile applications and wearable devices allow patients to exercise at any time and in any location, while enabling therapists to monitor outcomes on an ongoing basis. The development of these technologies has led to the emergence of telerehabilitation models in which video communication and automated movement analysis make it possible to maintain regular therapeutic contact and continuity of treatment while patients exercise at home[18]. From an architectural and organisational perspective, the development of such technologies generates new requirements for therapeutic space design, ranging from the integration of diagnostic workstations to the creation of safe and ergonomic areas suitable for remote or hybrid rehabilitation.

An equally important direction in the development of contemporary rehabilitation is the adaptation of the physical therapeutic environment to the needs of patients. Modern rehabilitation centres combine technological solutions with environmental elements that recreate everyday situations, thereby preparing patients comprehensively for independent living. From this perspective, space does not merely provide a background for treatment, but actively contributes to the conditions in which patients gradually regain physical ability, independence and confidence in performing everyday activities.

Examples of such solutions include driving simulators, which enable the safe training of reaction time, visual-motor coordination and spatial orientation, as well as simulation apartments, also referred to as training or demonstration apartments, which support patients in adapting to life after the completion of treatment. These spaces recreate real domestic conditions and allow patients to practise everyday activities. Among the solutions supporting the rehabilitation of patients with limited mobility, overhead support systems installed in exercise rooms and corridors occupy a particularly important place. They enable safe movement, gait training and balance exercises while minimising the risk of falling. Such solutions demonstrate that circulation routes may also serve a therapeutic function when designed as spaces that support the gradual recovery of mobility.

3. CONCLUSION

The analysis of current trends in rehabilitation demonstrates a clear shift towards technologies supporting treatment and functional recovery. Robotics, virtual reality and artificial

[17] A. Stasieńko, I. Sarzyńska-Długosz, *Zastosowanie rzeczywistości wirtualnej w rehabilitacji neurologicznej*, "Postępy Rehabilitacji" 2016, no. 30(4), pp. 67–75.

[18] P. Kiper et al., *The Application of Virtual Reality in Neurorehabilitation: Motor Re-learning Supported by Innovative Technologies*, "Medical Rehabilitation" 2013, no. 17, pp. 33–34.

intelligence make it possible to adapt therapy precisely to the individual needs of the patient, improve its effectiveness and enable rehabilitation to continue in the home environment. The integration of these technologies with an appropriately designed therapeutic environment defines the direction of development for modern rehabilitation centres, in which space, technology and the treatment process form a coherent whole.

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