

WOOD IN HOSPITAL INTERIORS: A SCOPING REVIEW

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ABSTRACT: *Background.* The construction sector must shift towards more sustainable solutions to meet global climate goals. Wood is seen as an environmental friendly material, a material that may also have positive health effects on users. To achieve the effects strived for, the use of wood must be done with relevant consideration. *Objective.* The purpose of this scoping review is to give an overview of research on the use of wooden material for interior purposes in hospital buildings. The study aimed for a knowledge base that may facilitate the design process and decision-making concerning the use of wood in hospital environments. *Design.* The search was conducted in online databases as a Boolean search, restricted to conference articles or articles from peer-reviewed scientific journals. *Results.* The literature search resulted in 13 sources, divided on three main themes. The sources vary in method, and both qualitative, quantitative and mixed-method studies are included. *Conclusions.* This scoping review have identified a growing number of studies and a development of a research theme. As the number of sources are few, the findings of this study is highly contextual, and the study as such offer no general conclusions to the use of wood in hospitals.

KEYWORDS: architecture, biophilic design, built environment, hospital design, wood

1 – INTRODUCTION

The design of hospitals are complex. The buildings must be functional, safe and highly efficient, as well as meeting sustainability requirements. They must facilitate a wide range of user groups with needs in constant development. Against this backdrop there are also discussions on materials and functions related to the design of hospitals. One material discussed is wood. It is a material that have specific qualities regarding fire, hygiene safety, acoustics and other indoor environmental parameters. The perception of the material is connected to context and culture, and it may have an effect on the psychological and physiological human responses. As with any material, the use of wood must be done with relevant consideration to achieve effects strived for, such as health related aspects, sustainability, circularity etc. As the topic of “wood in hospital interiors” is limited, a literature review was conducted with an aim of mapping the existing research on this field, identify gaps of missing research and locate areas where more research is

needed. The compiled knowledge from this study can facilitate both the design process and decision-making on the use of wood in hospital environments.

To examine the use of wood in hospital interiors, the following research questions were formed:

- I) *Where is wood applicable in the design of hospitals?*
- II) *Are there any documented studies on how wood affects user's health in hospitals?*
- III) *What is the potential and limitations for using wood material in hospital buildings?*

2 – BACKGROUND

2.1 EVIDENCE-BASED DESIGN

The quality of the built environment may influence our health, both positively or negatively. In a building, whose

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primary function is to support treatment and care of individuals with illness, the design of these environments for recovery may have great impact. The Evidence-Based Design approach is relevant to this topic.

From Hamilton et al.[1] we know that "Evidence-Based design is a process for the conscientious, explicit, and judicious use of current best evidence from research and practice in making critical decisions, together with an informed client, about the design of each individual and unique project".

In Evidence-Based Design, research is used as a tool in combination with best practices to make informed decisions about the built environment. In order to make research on health care environments more accessible, the EBD2020 Report[2] was created. This report focus on synthesizing research on different areas of health care environments, and has been a main source of inspiration for this literature review. The EBD2020 follows in the footsteps of Roger Ulrichs pioneering work in the field of Evidence-based design, and is to be seen as an update to the 2012 report[3]. As with both of these reports, this literature study aims to synthesize research to support the design of healthcare environments, and more specific to support design decisions on the use of wood material in healthcare environments.

2.2 LINKING WOOD AND HEALTH

In the last half-century a growing body of research strengthens the argument of the need for human connection with nature, and positive benefits from nature exposure[4, 5]. Different theories are used as arguments, mainly the Biophilia hypothesis, the attention restoration theory (ART) and the stress recovery theory (SRT).

The Biophilia hypothesis is developed from an evolutionary perspective, arguing that throughout time humans have developed an innate need to connect with nature[6]. According to SRT, non-threatening natural environments will support recovery from stress[7], while ART argues attention restoration from cognitive fatigue as an effect of nature exposure [8].

Wood is a biological material, designed by nature to ensure the survival of the living organism in its habitat. The texture of the material gives away details of the life of the organism, with characteristic features like grain pattern that follows the orientation of the wood cells, wood rays that shows the transportation ores for water and nutrition, and the color contrast of the growth rings, which is formed by the yearly growth of the tree. Studies on human perception show that wood's characteristic appearance is easily recognized as a natural material[9], [10], meaning that even though the material has gone through processing it is still regarded as natural. This enables us as recipients the possibility of an indirect connection with nature, and potential health benefits.

3 – METHOD OUTLINE

The execution of this literature review engaged four participants, including two reviewers and two controllers. In the review phase the reviewers had bi-weekly meetings to discuss screening and full-text readings, while dialogue in the writing phase was mainly by mail. The project duration lasted for six months approximately. There is no published protocol for this project.

4 – STUDY DESIGN

A scoping review based on the Arksey and O'Malley framework[11] with a process in five stages was applied. The five stages includes identifying the research question, identifying relevant studies, study selection, charting the data and finally collating, summarizing and reporting the results.

Two reviewers worked independently with the study selection and data extraction, and all contradicting interpretations were resolved by consensus. Zothero was used in the process of reviewing articles.

4.1 IDENTIFYING RELEVANT STUDIES

The limitations set in *Table 1* was used in order to identify relevant studies. To ensure the correct context, the search was designed as a boolean search with four blocks (see *Appendix 1*). The first three blocks are close to identical with the EBD2020[2] search blocks, with words describing 1) The built environment and its design, 2) Participants and 3) Hospital environments. Studies only indirectly involving participants is outside of the scope, meaning that studies on for example bacterial growth of wooden surfaces in healthcare environments, or emissions of volatile organic compounds from surfaces are excluded from the review.

The fourth block with search words is original for this scoping review and contain words linked to wood material. By using the boolean operator AND, the search was narrowed down, and ensured to contain at least one search word from all of the four blocks in the title, abstract or key words. OR was used to broaden the search regarding language, and make sure that all synonyms was captured. In addition to the typical wood material related words, *natural* and *biobased* was added as search words in the material block. The reason for this is that articles containing biophilic or natural materials very often speak of wood but may not mention it directly in the abstract. To maintain a clear and transparent methodology, the same search words was used in all of the chosen databases.

Regarding time of publication, there was no bakward time restriction. As the work with charting and analyzing data took time, only studies published by the end of november 2024 had the possibility of being included.

Table 1 Search limitations

Search limitations	
Article specification	Peer reviewed article or conference article in English from the following online databases: Web of Science, SCOPUS, CINAHL and PubMed.
Time restriction	Backwards: no limit Forwards: published within November 2024.
Context environment	Hospital environment
Context participant	Hospital users (patients, employees, next of kin)
Material	Wood specific

4.2 STUDY SELECTION

See *Figure 1* with flow diagram of the selection process. The selection included 84 articles after removal of duplicates, and was reduced to 25 articles through screening of title and abstract. Articles excluded during the screening were mostly articles where Wood was used as a proper name in the text. After full-text reading 13 articles met the eligibility criterias and was included in the final selection.

4.3 CHARTING AND ANALYZING THE DATA

A data extraction form was made and used in the process of charting and assessing the 25 articles that was included for full-text reading. To ensure agreement in the use of the form, a pilot was done where each reviewer charted two articles each before comparison. The data extraction process was done independently by the two reviewers, and discussed afterwards. The data extraction form included data as article title, year of publication, name of authors and peer-review status. It also included information about methodology and study design, in addition to aims and key findings.

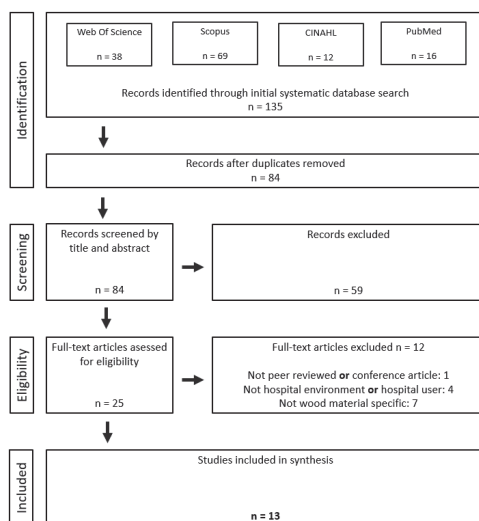


Figure 1 Flow diagram of the selection process

5 – RESULTS

5.1 DESCRIPTIVE RESULTS

The final study selection includes 13 articles divided into three categories by topic; Preference Studies, Restoration Studies and Design Frameworks. The distribution regarding article topic and location of author affiliation is shown in the timeline in *Figure 2*. The timeline span seventeen years, with the first study published in 2008, and the last ones in 2024. From 2019 there is an increase in the number of publications, and especially in the category of Design Frameworks. This category has the largest number of publications (6), followed up by preference studies (4) and lastly restoration studies (3).

When regarding the affiliation location of main authors, the number of publications varies from one to three publications per country. All continents, except South America is represented in the study selection, with Europe ranking on top with almost half of the articles in the selection. The two countries with most publications are Norway and the United States, with three articles each.

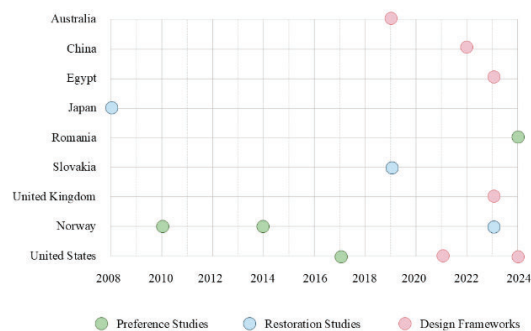


Figure 2 Article distribution by topic, country and publication year

5.2 RESULTS ORGANIZED BY CONTEXT

As mentioned in section 4.1, the context of each study was important when assessing study eligibility. Regarding the participant context, three different perspectives was present in the selection; patients, employees and studies combining both perspectives or the perspective of next of kin. How these studies are connected to specific hospital environments in the different studies is shown in *Figure 3*. Four studies focused solely on hospital environments for the benefit of the patient, including optimizing patient rooms for healing and environments especially for patients with cancer. The three articles focusing mainly on the employees included the same type of environments. In the mixed participant category, three studies focus on areas within the hospital in general, two studies focus on

waiting rooms and one study the meaning of place/setting in therapy rooms for children.

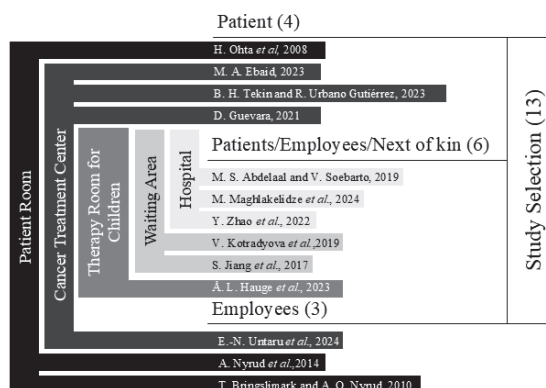


Figure 3 Article distribution by user group and hospital environment

5.3 RESULTS ORGANIZED BY CATEGORY

During full text assessment, the article selection was grouped into three categories: Preference studies, Restoration studies and Design Frameworks, see Figure 2.

Preference studies

The common feature of the Preference studies is the use of questionnaires as a method for accessing user opinions. Two of the Norwegian studies[12, 13] looked into employee preferences regarding wood surfaces in patient rooms. The results showed that out of ten computer renderings depicting rooms with different amounts of wood, an intermediate amount was preferred (one wall and wood flooring). Regular rooms without wood and rooms with extensive wood use was least preferred, showing that the preference for wooden surfaces in patient rooms has its limitations.

In another preference study from 2017[14], looking into preferences of transparency attributes in health care waiting areas, preferences for additional design attributes that affect the perception of waiting areas was identified by factor analysis. Natural materials were identified as a favorable attribute (natural materials in this study were described as being of stone, bricks and wood).

In a study from 2024[15] biophilic attributes in hospice environments was identified through semi-structured interviews with employees. One of the 5 main features identified was the presence of wooden furniture.

Restoration studies

The category of Restoration studies contains studies focusing on human responses to stress, both physiological and psychological.

A study from Japan[16] during the cold season describes an improvement in thermal comfort and a significantly

reduction of stress hormones (cortisol) for subjects in rooms with natural materials (wood panel and rice paper) compared to responses from patients in a control room with painted concrete surfaces.

In an article from Slovakia [17] multiple methods was used to assess the response from wooden material in a hospital waition room on human beings. Heart rate, heart rate variability, cortisol and blood pressure showed no significant differences when compared to measurements done in control room without wooden surfaces, while positive emotions measured from facial expressions showed an increase in positive emotions by 7.5 %.

Another example where wooden interiors is part of a “biophilic package”, and may influence patient care is the article of Hauge *et al.* [18]. In this study, the meaning of the physical environment in child and adolescent therapy was studied through interviews with parents of chronically ill children, therapists and their leaders. The quality of therapy in the Outdoor Care Retreat (a cabin in natural surroundings with wooden interior) was compared to therapy in conventional hospital environment. In the article the possible effect of natural surroundings and biophilic design is described:

“The place/setting influences the child’s and therapist’s body and emotions, which further affects their understanding of the situation and the way they see each other. These components influence the alliance between child and therapist, and the positive experiences create valuable expectations for therapy. The starting point of a positive circle like this may be natural surroundings and biophilic design.”

Design Frameworks

Six of the articles[19, 20, 21, 22, 23, 24] in the study selection propose improvements to biophilic design frameworks in hospital environments.

In an article from the USA [23], evidence on different biophilic design elements, including natural materials for use in the design of hospitals was synthesized. The practical results from the study, including an assessment matrix and graphical analysis of possibilities regarding material surfaces may facilitate the design process of incorporating natural materials in healthcare environments.

In this review three articles focused on the subject of biophilic frameworks for cancer treatment facilities. In the article of Tekin[21] the importance of context is discussed, and a framework for the typology on non-clinical environments in the UK is proposed, with specific recommendations for the different areas within the cancer treatment center. The use of natural materials and wood is regarded as an important biophilic parameter within the framework, and recommended in areas as common rooms and entrances.

In an article from the USA [22] focusing on treatment centers for breast cancer, one of the concluding

recommendations was to simulate nature in the interior by incorporating natural elements, such as wood, stone, and plants.

In an article from Egypt [20], a framework for implementing biophilic design in cancer healthcare spaces to enhance patient experiences is proposed. The framework was constructed based on both site visits and patient survey results. Among the 20 most important biophilic features identified in the survey, three of the features included natural materials as wood. This supports evidence on wood being part of biophilic design frameworks in health care facilities with special focus on cancer patient areas.

Another study[24] with a similar survey done in China, asked 240 hospital users from twelve different Chinese hospitals to rank the importance of biophilic patterns in healthcare spaces. In this study the use of natural materials (defined as wood, stone, wool, cotton, leather, bamboo and rattan) ranked third out of 27 biophilic patterns.

6 – CONCLUSION

This scoping review identified a research field in its early development. As the number of sources are few, the findings of this study is highly contextual, and the study offer no general conclusions to the use of wood in hospitals. The number of articles within each category is not enough to claim evidence. Thus, the research question are answered by summarizing the relevant findings from the different sources below.

I Where is wood applicable in the design of hospitals?

- Employees regard patient rooms with an intermediate amount of wood surfaces as suitable for patients, and prefer this interior compared to traditional patient interior.
- A large portion of the studies focus on Biophilic design in the special case of cancer treatment centers. This implies an interest and agreement in the design field that biophilic strategies, using natural materials is well suited in this type of health care areas. One of these studies recommends the use of natural materials especially in common areas and entrances.

II Are there any documented studies on how wood affects user's health in hospitals?

- Wood may affect stress levels, and in this manner influence restoration in hospital environments. One study showed a significantly decrease in stress hormones, while another showed no significant change of stress hormones.

III What is the potential and limitations for using wood material in hospital buildings?

- The amount of wood surface in patient rooms as its limitations in regards to employee preferences, where an intermediate amount of wood is preferred.

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APPENDIX 1

Search words			
BLOCK 1 The built environment and its design:	BLOCK 2 Participants	BLOCK 3 Healthcare environments	BLOCK 4 Material:
Architecture Architectural design Biophilic design Building design Building's design Built environment Construction of Hospitals Environment design Evidence-based Design Facility design Health Facility Environment Hospital construction Hospital Design Hospital Environment Indoor Environment Interior design Interior Environment Physical environment Redecoration Redesign	Caregiver Caregivers Client Clients Family Family member Family members Health Personnel Nurse Nurses Patient Patients Physician Physicians Relative Relatives Staff Subject Subjects User Users Visitor Visitors	Accident and emergency Acute care environment Acute care environments Ambulatory Care Facility Ambulatory Care Facilities Care unit Care units Critical Care Emergency department Emergency departments Emergency Service Healthcare building Healthcare buildings Healthcare facility Healthcare facilities Healthcare service Healthcare services Healthcare setting Healthcare settings Healthcare space Healthcare spaces Health facility Health facilities Hospital Hospitals Hospital Unit Hospital Units Intensive Care Intensive Care Units NICU Operating room Outpatient PICU Rehabilitation room Waiting room Ward Wards	Bio-based building material Bio-based building materials Biophilic Cross-laminated timber CLT Glulam Glued-laminated timber Natural material Natural materials Timber Wood