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Lessons Learnt from Testing Three Spatial Observation Tools in a Hospital Ward

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Abstract. Observation tools are increasingly important in healthcare building design research. They enable us to understand how the design of healthcare buildings affects users' health and organisational outcomes. Observations are used in case studies and pre- and post-occupancy evaluations. However, these case studies often struggle to pinpoint the specific design features responsible for observed outcomes. Additionally, harnessing collective knowledge from multiple cases can be challenging. This underscores the need for structured observations. The paper describes the lessons learnt from using three spatial observation tools as part of a study to assess a hospital ward design. Its goal is to reflect on the purpose, usability, advantages, disadvantages, and future improvements of these tools and to offer insights into their potential to support research on hospital ward design. The first tool, by the Centre for Health Design, utilizes a checklist-style matrix to evaluate the design of patient rooms, assessing 17 Evidence Based Design goals, including patient safety, worker safety and effectiveness, quality of care, patient experience, and organizational performance. The second tool is a one-time observation tool, a structured spatial inventory aimed at documenting design features throughout the entire hospital ward, covering elements such as room size, access to daylight, natural elements, furniture, safety measures, and more. It can be combined with the third tool; the recurring observation tool, which focuses on monitoring usage, users, their activities, and behaviour across various types of environments, including patient, staff, care, and supportive spaces. The last two observation tools were developed for the research project, adapting the Smart Sustainable Offices method for healthcare environments. This paper emphasizes the importance of selecting suitable observation tools for specific research objectives, providing guidance for working with observations and conducting pre-and post-studies. While not aimed at validating observation tools, it offers reflections to aid in development and use of observation tools. Finally, documenting spatial contexts enhances understanding of study findings, and reusing observation tools enables cross-study comparisons, with future potential for leveraging artificial intelligence.

Keywords. healthcare building design, observation tool, evaluation tool, indoor environmental quality (IEQ), post occupancy evaluation (POE)

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1. Introduction

1.1. Healthcare building design research

The design quality of healthcare buildings can have a positive effect on users' health [1-6], planetary health [7, 8], and organizational outcomes [2]. The current situation with an interlinked crisis of human and planetary health, requires a reorientation of healthcare to include all disciplines [9, 10]. Healthcare organizations are therefore encouraged to incorporate building design approaches into their organizational goals and strategies [10-13]. And people who are involved in the design of healthcare environments (i.e., healthcare designers or property developers) are urged to pay attention to human and planetary health outcomes in the planning and (re)design of healthcare buildings [9, 14].

A historical perspective on healthcare building design research traces back to Ulrich's study on the impact of views on nature in 1984 [15]. Since then, a substantial body of research has expanded, with various literature reviews offering comprehensive insights into the growing evidence base [1, 3, 6, 16]. Numerous papers provide directions to categorizing different dimensions of healthcare building design concerning health-related outcomes. For instance, Ulrich and colleagues [2] developed the supportive design framework to comprehend the relationship between the design of the healthcare environment (design features) and health-related outcomes. Within this framework, they categorize several space types present in hospital wards, including the patient room, physician support spaces, care support spaces, and other staff and family support spaces. They also list design features; the audio, visual, and safety environment as well as wayfinding.

Elf and colleagues [6] have made contributions through their recent systematic review, providing insights into design research in different inpatient healthcare settings. They distinguish between general wards, medical wards, as well as psychiatric, paediatric, and geriatric wards. Their comprehensive work explores a spectrum of health-related outcomes, covering activity and behaviour, clinical outcomes, emotional well-being, person-centered care, and safe care. In an adapted version of the grouping proposed by Harris [16], Elf et al. thoroughly examine design features, categorizing them into ambient, architectural, interior, social, and nature components. Moreover, their research encompasses a broad range of populations, studying the impact on patients, staff, and visitors. The knowledge gained from the reviews and its included papers should support healthcare designers and properties developers to make evidence-based design-decisions to support health by applying/transferring these to their specific practices and conditions [9, 14].

1.2. Observation studies for healthcare building design research

Observation studies play a crucial role in healthcare research [17]. Observation methods serve various purposes, and the choice of a specific method depends on the researcher's focus, disciplines, resources, and study settings. One crucial distinction lies in the choice between quantitative and qualitative observation methods, which can also be combined. Quantitative methods are focused on numerical measurements whereas qualitative observation methods interpret phenomena through descriptions and thematic analysis. Another distinction in the observation methods involves whether the method is use(r)-focused or space-focused. Use(r)-focused methods entail observing individuals or groups in specific healthcare settings, involving techniques such as shadowing or using devices to track behaviours [18]. Space-focused methods involve researchers stationed or doing rounds in designated spaces [30]. This can involve collecting data on occupancy and activities in different spaces on the ward as well as using building sensor data such as occupancy, or indoor environmental quality (IEQ) measures such as air quality or sound. Distinctions also exist between continuous and snapshot observations [17]. For instance, continuous observation involves uninterrupted monitoring, while snapshot observation involves periodic assessments.

The advantage of observations, is that it reveals what is there and happening rather than what is perceived (such as is the case in interviews and focus groups) [17].

However, observation studies have several disadvantages. One of the problems is that observations can be quite resource intensive [17], intrusive (specially in environments with vulnerable populations such as patients) or distracting (mainly for healthcare staff). These are the reasons why researchers often aim to minimize the number of observations while maintaining the quality of the results. Another disadvantage of observation studies is that the findings are often case-specific which results in difficulties in generalizability or cross-case comparison [18].

1.3. Research gap, research question and aim of the study

While existing research supports the link between healthcare building design and health outcomes, there is a noted deficiency in holistic, interdisciplinary research that integrates various observation methods and data types [17, 18]. Additionally, there is a lack of standardized documentation methods that would facilitate cross-case analysis and comparisons across different healthcare settings [19]. As we enter an era of artificial intelligence (AI) capable of analysing large datasets in various formats, this documentation would allow for comparing results across different teams and projects. Studies are needed to evaluate the anticipated outcomes of implementing 'evidence' in design decision-making through pre-post comparisons [15]. This could provide insights into whether prior research can be transferred to different conditions or settings [19]. This gap underscores the need for a comprehensive approach that merges qualitative and quantitative data, along with space-focused observations and recurrent user outcomes, to better understand and optimize healthcare environments.

The research question explored in this paper is: How can the integration of multiple observational tools in healthcare building design enhance the understanding and implementation of design decisions that positively influence health-related outcomes?

Hence the aim of this work is to describe the lessons learnt from using three spatial observation tools as part of a study to assess a hospital ward design all focusing on its relation to health and user behaviour outcomes. Its goal is to reflect on the purpose, usability, advantages, disadvantages and future improvements of these tools and to offer insights into their potential to improve research on hospital ward design.

2. Research methods

This paper is a part of the research project Medical Hospital Hanover (MHH) focused on redesigning environmentally friendly hospitals [20]. The MHH-project explores a combination of methods to study the (re)design of hospital wards with attention to smart, sustainable, user-oriented, energy-efficient, and low-carbon buildings. The multidisciplinary research team of the MHH-project conducted a post occupancy evaluation of a surgical-medical ward. The research project consisted of four parts: 1) measuring IEQ; 2) observations tools; 3) patient and staff perspectives; and 4) benchmarking of best practices. For this paper we focused on the second part of the project, which targets observation tools.

2.1. Ethical considerations

The ethical approval was provided by Ethikkommission der Medizinischen Hochschule Hannover (OE 9515) on February, 20th in 2020. This was based on the agreement that the observations did not include any personal data. Rather, the observations collected data on activities, which was related to the room number and type of user group (patient, staff, relative, students). Although it would have been possible to get personal data from the healthcare directories, connected to the rooms, these data sources have not been connected in this paper that rather focuses on experiences using observation methods. The authors declare no conflicts of interest.

2.2. Data collection and analysis

The data was collected on-site by two research assistants, with support from the main author (EM) via video conferencing. This took place from November to December 2020, amidst the COVID-19 pandemic, in a cardiac surgical ward at a university hospital in Germany. There were three different observation tools used for data collection.

The first one was the CHD-tool Medical-Surgical Patient Room Post-Occupancy Evaluation developed by The Centre for Health Design [21]. This tool is implemented in Excel (attachment A1).

The second and third tools were adapted from a previous tool (SSO-method) developed to inform the re-design of office environments, with attention to user outcomes, and sustainability [20, 22]. This was in the form of a digital database with digital input pages and a database to collect all data (Attachment A2 and A3). Data was organized in an Excel file by observation type, area type, room number, time, and day of data collection, along with information on the design features and usage. Data analysis done by the author (EM) included grouping according to type of environment (i.e., patient area, staff area, support area, care area, common area, and outdoor area) and predeveloped themes (i.e., visual environment, use, activities & occupancy, socio-spatial environments, indoor environmental quality (IEQ) and health protection). The quantitative data were color-coded to ease analysis. For example, green for positive, yellow for neutral, and red for negative ratings). For example a positive rating would be: *'clean, tidy, sterile'*. Negative rating could be: *'chaotic, a lot of garbage bags (...) in the shelves'*. The qualitative data was read and re-read to familiarise ourselves with the content. All data was then described per area type and theme. Figure 1 visualizes the layout configuration of the studied ward with information regarding the area category, space type, and technique used.

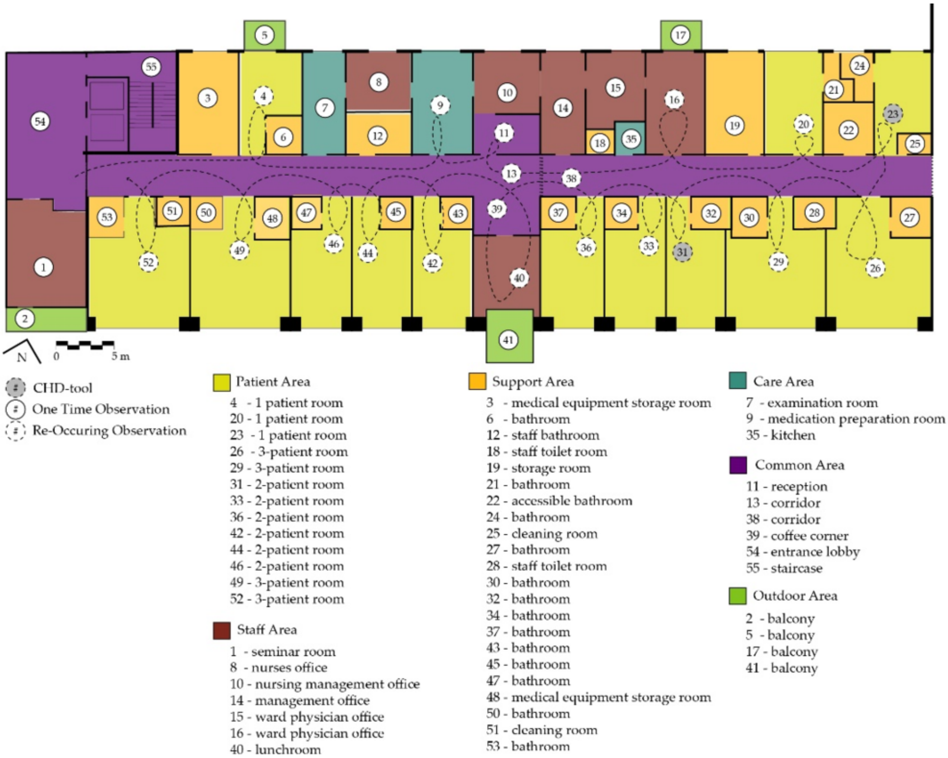


Figure 1. Layout arrangement of the evaluated ward win types of observation tools, areas and rooms.

3. Findings

The findings of this study are grouped per observation tool and for each tool we explain its purpose, applicability, advantages, disadvantages and future improvements. Table 1 shows the relation between the different observation tools tested.

Table 1 Relation of tools tested in the surgical ward.

	CHD	Furbish© SSO-method	
Tool	Medical-Surgical Patient Room Post-Occupancy Evaluation tool	One-time observation tool	Re-occurring observation tool
Content	Worker safety & effectiveness Quality of care & patient experience Organizational performance Patient safety	Visual environment Use, activities & occupancy Socio-spatial environments IEQ Health protection	Visual environment Use, activities & occupancy Socio-spatial environments IEQ Health protection
Area types	Patient area	Staff area, support area, care area, common area, and outdoor area	Patient area, staff area, care area, and common area

Room number	23, 31	1-53	4, 9, 11, 13, 16, 20, 26, 29, 33, 36, 38, 39, 40, 42, 44, 46, 49, 52

3.1. Medical-Surgical Patient Room Post-Occupancy Evaluation tool (CHD-tool)

CHD-tool purpose - The tool was developed by The Center for Health Design (CHD) [21] in 2015 with the purpose to serve as an independent auditor to evaluate a medical surgical patient room. The tool is freely available on the website of the CHD. The CHD-tool identifies design features that already have been shown to contribute to healthcare outcomes of an existing medical surgical patient room [21]. The tool content is organised in a checklist style with four categories (patient safety; worker safety and effectiveness; quality of care and patient experience; and organizational performance) and 23 evidence-based design (EBD) goals (refer to Table 1 and attachment A1). Each goal has various assessment items (ranging from 1 to 11). These assessment items are rated by the observer on a five-point Likert scale, from 1 (low performance) to 5 (high performance). Additionally, each assessment item is accompanied by an assessment aid, offering a brief description of design features that contribute to the desired performance of the patient room. For example, under the organizational performance category and the EBD goal #17 'Improve privacy', there are two assessment items. One of them, 'design supports auditory privacy,' includes a description of available technologies for noise filtering, single-bed patient rooms, and sound absorption measures to minimize sound transmission between rooms and corridors. A comment box is provided for each assessment item, allowing for the addition of narratives or the inclusion of design features not covered in the assessment aid. In addition to the rating of each assessment item, the overall rating system of the tool can be personalised for each individual case, as the importance of EBD goals varies depending on the project.

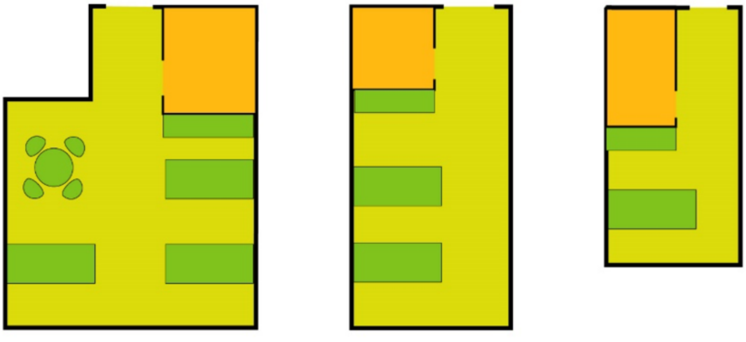


Figure 2. Diagram of floorplans patient rooms

CHD-tool usability - For this research project, the CHD-tool was tested in only two of the 13 patient rooms of the surgical ward (Figure 1, Figure 2), representing the main types: the single patient room (room 23) and the multi-patient room (room 31). Expanding the assessment to all the other rooms did not seem relevant, as they did not differ from the representative rooms in aspects documented through the CHD-tool. As seen in Table 1, the differences between the single and multi-patient rooms were already minimal.

The main author (EM) and two research assistants started with the observation of the single patient room. This allowed for the team to address any questions or unclarities. Further communication with one staff member from facility management, was led by the main author (EM) to addressed specific questions that could not be answered by the observers. For instance, regarding the types of ventilation systems and types of flooring. The thorough observation and documentation of both patient room types collectively required a full day of investigation.

The scores for each goal and room are summarised in Table 1, Table 2 provides specific findings for each tool category and Table 3 highlights relevant aspects for each category. The scores are calculated (in the excel) based upon the ratings of the assessment items. For example, under EBD Goal #2 'reduce risk of injury,' there are three assessment items that need be rated by the observer (Figure 3). The observers are aided in their room rating by 'assessment aids' (located to the right of the rating). These assessment aids assist in combining the scores to calculate the overall score (Figure 3).

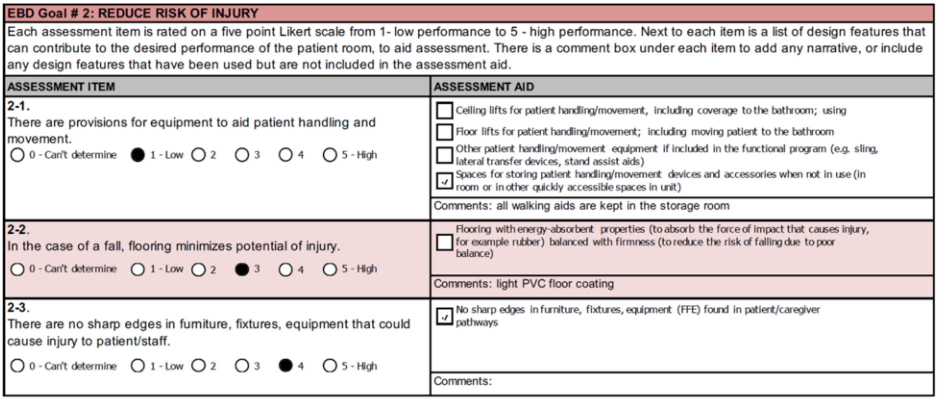
Table 2: Scores per goal and surgical ward room.

Categories	EBD Goals	single (r=23)	multi (r=31)
Patient safety	01. Improve mobility and reduce falls	4,00	3,80
	02. Reduce risk of injury	2,67	2,67
	03. Reduce risk of contamination	3,44	3,44
	04. Improve hand sanitization	5,00	5,00
	05. Provide safe delivery of care	2,50	2,50
Worker safety & effectiveness	06. Provide efficient delivery of care	3,36	3,18
	07. Improve communication	4,00	4,00
	08. Improve staff health	4,00	4,00
	09. Improve job satisfaction	3,33	2,33
Quality of care & patient experience	10. Reduce patient stress and anxiety	3,25	3,00
	11. Enable & enhance patient sense of control	2,50	2,50
	12. Improve patient engagement	1,00	1,00
	13. Improve patient satisfaction	2,00	1,50
	14. Improve family presence & engagement in patient care	1,00	1,00
	15. Improve comfort	1,67	1,67
	16. Reduce noise	2,50	2,00
	17. Respect privacy	4,50	1,00
Organizational performance	18. Ensure durability	n.a.	n.a.
	19. Improve air quality	n.a.	n.a.
	20. Provide a secure environment	3,00	3,00
	21. Enable change readiness/ future-proofing	2,00	2,00
	22. Enhance sustainability	n.a.	n.a.
	23. Provide return on investment	1,00	1,00

Table 3. Summary of findings per CHD-tool category.

Patient Safety	**Both room layouts (single and multiple occupancy) improved mobility and reduced falls.** **Hand sanitization scored maximum, but no sink in the patient rooms.** **The room designs enabled patient monitoring and easy access from the corridor.** **Limited provisions for equipment aiding handling and movement.** **Private bathroom in the single-patient room; shared bathroom in the two-patient room.** **Lack of facilities for bariatric patients, scored medium in reducing the risk of injury.** **Low rating for supporting error-free medication activities.**

Worker Safety & Effectiveness:	Positive ratings for features supporting efficient delivery of care. Supportive of communication between patients, family, and care providers. Negative observations included the lack of measures to reduce alarm fatigue and limited lighting. Job satisfaction negatively influenced by exposure to noise.
Quality of Care & Patient Experience:	'Respect for privacy' scored low for the multi-patient room, and high for the single patient room. Limited regard for improving patient engagement, satisfaction, family presence, and comfort. Enabling and enhancing the patient's sense of control scored medium. 'Reduce noise' scored lower for multi-patient than for the single patient room. Medium scores for 'reduce patient stress and anxiety.'
Organizational Performance:	Scored low on change readiness, considering difficulty in crisis adding beds. Limited provisions for securely storing personal items or medical equipment. Unclear if fixtures and equipment were energy-efficient, water-saving, or had sustainable standards.



EBD Goal # 2: REDUCE RISK OF INJURY	
Each assessment item is rated on a five point Likert scale from 1- low performance to 5 - high performance. Next to each item is a list of design features that can contribute to the desired perfomance of the patient room, to aid assessment. There is a comment box under each item to add any narrative, or include any design features that have been used but are not included in the assessment aid.	
ASSESSMENT ITEM	**ASSESSMENT AID**
2-1. There are provisions for equipment to aid patient handling and movement. ○ 0 - Can't determine ● 1 - Low ○ 2 ○ 3 ○ 4 ○ 5 - High	☐ Ceiling lifts for patient handling/movement, including coverage to the bathroom; using ☐ Floor lifts for patient handling/movement; including moving patient to the bathroom ☐ Other patient handling/movement equipment if included in the functional program (e.g. sling, lateral transfer devices, stand assist aids) ☑ Spaces for storing patient handling/movement devices and accessories when not in use (in room or in other quickly accessible spaces in unit) Comments: all walking aids are kept in the storage room
2-2. In the case of a fall, flooring minimizes potential of injury. ○ 0 - Can't determine ○ 1 - Low ○ 2 ● 3 ○ 4 ○ 5 - High	☐ Flooring with energy-absorbent properties (to absorb the force of impact that causes injury, for example rubber) balanced with firmness (to reduce the risk of falling due to poor balance) Comments: light PVC floor coating
2-3. There are no sharp edges in furniture, fixtures, equipment that could cause injury to patient/staff. ○ 0 - Can't determine ○ 1 - Low ○ 2 ○ 3 ● 4 ○ 5 - High	☑ No sharp edges in furniture, fixtures, equipment (FFE) found in patient/caregiver pathways Comments:

Figure 3. Example of CHD-tool assessment items per EBD-goal

CHD-tool advantages - The CHD-tool has certain advantages. It is positive that the tool is free and provides support such as the assessment aids with each assessment item. This makes it suitable for use even by inexperienced (healthcare design) researchers. It also becomes a comprehensive starting point for investigating the relationship between the patient room environment and EBD goals. Since it concerns a rating system it also involved valuing rather than just checking. This is helpful to make distinctions between levels of compliance to EBD goals, which makes it better suited to comparisons between different rooms.

CHD-tool disadvantages -However, the tool presents some limitations. Firstly, its focus on the patient room neglects the broader relationship with the rest of the room types in the whole ward. Moreover, certain data is challenging to ascertain even for individuals familiar with installations and IEQ, as the information remains hidden from view within the room and must be inferred from visible components such as ventilation ducts or lighting fixtures. Even though, the tool prompts questions regarding valuation, some assessment aids featuring numerous checkboxes while others have only one. Hence, determining when something rates a 1 or a 5 becomes ambiguous when not explicitly mentioned in the assessment aid, and as a consequence there may be more influence of the researchers bias. In addition to this, observing the section on organizational performance became challenging, requiring requests through organization and facilitation management rather than direct observation. Determining the durability of furniture, fixtures, equipment, or finishing, crucial for preventing mildew and mould growth and minimizing wear, posed difficulties.

CHD-tool future improvements - After testing the tool in the surgical ward, several ideas of tool improvement were developed. For example, the section on health protection, particularly the scoring systems, appears outdated, especially given increased sanitation requirements due to the COVID-19 pandemic. Although both rooms scored 5 out of 5, current recommendations suggest having sanitation stations at the entrance, near the sink, and close to the bed. Additionally, considering the current emphasis on environmental sustainability, healthy behaviours, and equity, the tool could benefit from incorporating themes like supporting sustainable behaviours (recycling, resource use), equity (cultural and information access), and family and community support spaces. The main issue, could be that it heavily relies on expected health outcomes and lacks insights into actual use behaviours. This requires triangulation with other methods, as part of a more holistic POE.

3.2. Furbish© SSO-method

The main author (EM) contextualised and developed the observation technique used in the Furbish© SSO-method [22] from the office to the hospital ward environment. The adjustments of the SSO observations technique encompassed several aspects, such as the incorporation of additional types of environments (including circulation spaces, supportive spaces, sanitary spaces, patient environment, care environment, and both nurses and physician environments), the ability to distinguish between different types of users (patients, nurses, physicians, students, and visitors), and the introduction of new observation items related to design features linked to health-related outcomes drawing from sources like the literature reviews conducted by Ulrich [2] and Elf et al [6]. The two resulting observation tools consisted of a one-time spatial observation tool and a recurring observation tool. Further details are elaborated in the subsequent sections.

3.2.1. One-time observation tool

One-time observation-tool purpose - The purpose of the one-time observation tool is to document a spatial inventory, of all the ward rooms, structured in different categories: visual environment (furniture, finishing, art, nature); use, activities and occupancy (intended users); IEQ (acoustics, light, air); and health protection (safety, sustainability).

One-time observation-tool usability - In this study, the data was collected over several days in two proceeding weeks. The observation team included the main author (EM) via video call and two assistants on-site. Additionally, photos were taken (Figure 4-9), and notes were made in the digital data collection tool (attachment A2). The tool was tested in all the rooms shown in Figure 1. However, for the interest of this paper, only results from the patient area are displayed in Table 4.

The scoring of the items was mainly quantitative, yes/no, or numerical questions, such as how many people were in the room or whether the door was open. An additional open description section was available to add comments during the observation.

Figure 4 Photo patient room

Figure 5 Photo patient room

Figure 6 Photo double patent room.

Figure 7 Photo patient room

Figure 8 Photo double patient room.

Figure 9 Photo patient room.

Table 4 Results of the patient area with the one-time observation tool.

Visual environment
All patient rooms had a bathroom that could be accessed from the room; a (movable) nightstand, a TV, a chair, and a seating area with a table and at least one chair. The furniture was perceived as 'old-fashioned'.

Generally, the patient rooms were characterized as clean and sterile. Some rooms were also characterized as cold, grey, dark, or bright.
Use, activities & occupancy
The patients' rooms were used by patients, nursing and medical staff, and visitors. There were three types of patient rooms: one patient, two patients, and three patients.
Socio-spatial environments
Few items indicate personalization. There was one room with patient names printed on the bottom side of the bed. Some patients in the single-patient rooms had left personal belongings on their bedside tables or desk. Some multi-patient rooms had decorated the walls while other walls were empty. All patient rooms accommodated relatives with an extra chair and desk, but there were no accommodations for sleeping or extra (locked) storage. Privacy in the single-patient rooms was rated good, while the multi-patient rooms were rated average or poor. Some rooms had a privacy screen or curtains. The bathrooms were considered to have excellent visual privacy. All multi-patient rooms had poor speech privacy, while in the single-patient rooms speech privacy was perceived as good. The patient rooms provided control over bed lights, blinds, ceiling lighting, and desk light. They could also open the windows, while only slightly. Some of the rooms had a personal display. One room did not have any personal storage space, others had personal storage without a lock, and one room provided a lock on the personal storage.
IEQ
The light quality was perceived as poor in one room and average in the rest. All thirteen rooms had access to daylight. Almost all patient rooms had a ceiling light, most also had a bedside light, a few had a desk light and one had floor lighting. There were no acoustic panels in any of the rooms.
Health protection
All patient rooms had a hand sanitation station at the entrance door, and only one room also had a sink in the room. All patient rooms had a safety alarm, but few beds had a bedrail. There was no ergonomic furniture, nor were there any recycling options, only one garbage bin per room.

One-time observation-tool advantages - The advantages of the tool are that it gathers useful information for individuals who cannot physically visit the ward (as it was the case for some researchers due to COVID-19 restrictions). The idea is that these insights into variables facilitate cross-case comparisons, thereby contributing to a more robust evidence base. Through the one-time observation tool, it becomes possible to link rooms and their design features to patients and their specific healthcare experience, treatment, and healing progress.

One-time observation-tool disadvantages - However, several challenges emerged when using the one-time observation tool. Some questions related to building engineering or architecture, like the availability of acoustic panels (ceilings, walls) were difficult to reply. Moreover, due to the broad focus of the tool (both in themes, types of environments, and amounts), it was really difficult to relate all the data together, and to address the interrelation between the data.

One-time observation-tool future improvements - Considering these limitations, further tool development could consider using photogrammetry to create 3D photos of rooms. These 3D images could verify collected data or guide the data collection process. Documenting these images could facilitate future follow-up studies and offer a better understanding of the room and its design features.

3.2.2. Reoccurring observation tool

Reoccurring observation-tool purpose - The reoccurring observation tool aims to track various users and activities within the spaces over time. The purpose of the tools is to provide a repeated snapshot observation, where the researcher moves between spaces, periodically observing people's behaviours, activities, and traces of use over a defined period of time. It focuses on user outcomes (occupancy, diverse user activities, the social-spatial environment, as well as IEQ and health protection). Expanding beyond the original (office) focus on occupancy and perceived IEQ, the hospital ward version incorporated diverse activities (play/leisure, eating/drinking, self-care, and sleeping), user body positions (laydown, sit, stand, walk), and types of social interactions (between staff, patients or relatives) (see attachment A3 for template). The content of the reoccurring observation tool is organised according to a predetermined set of design features, based on the Supportive Environment framework by Ulrich [2].

Reoccurring observation-tool usability - The observation team on-site did two observation rounds per day: between 8.00-9.00 and 16.00-17.00 during the period of two weeks (n=26 rounds). Some patient rooms had to be excluded in some of the reoccurring observation rounds due to sudden COVID-19 infections. All data collected was automatically saved on the online database. Data was collected from various types of environments including patient, staff, care, and supportive spaces. Yet, for the purpose of this paper, solely findings from the patient area are showcased (Table 5).

Table 5. Results of the patient environment with the reoccurring observation tool.

Visual environment
Some multi-patient rooms were untidy on occasion. For instance, paper towels were left on the sink, and food or drink leftovers were found on the bedside table.
Use, activities & occupancy
The single-patient rooms never had an empty bed during the 26 rounds. The patient beds in the multi-patient rooms were sometimes empty. The tables in the patient rooms were not used during any of the observation rounds. Multiple activities and body positions were observed in the patient rooms. Most often patients were in bed, awake or asleep. They also moved to the chair next to the table for eating and drinking, talking to a visitor, to a staff member, or another patient or with the phone. Patients were observed taking part in different social interactions, play/leisure, eating/drinking, self-care, and sleeping. One time a patient was observed helping another patient to the bathroom. The nurses were mainly observed standing or walking in the patient rooms while performing care tasks. Physicians were observed seated, standing, or walking while performing (medical) care tasks. There were very few conversations observed between patients. Most conversations were between nursing staff and patients, patients and visitors, and nursing staff together. Patients and nursing staff were also the most observed in conversations.
IEQ
Different lighting options were used, including bed light, ceiling, and desk light. The doors were almost always closed, sometimes open or ajar. The windows were observed; mainly ajar or closed and in very few times open; the position of the windows would change per room. The curtains were mostly open, and a few times closed. Headphones were observed twice, both in a multi-patient room. The air quality was mostly rated average, otherwise good, and in a few occasions excellent or poor (in rooms with the door and window closed). The perceived background noise was mainly average, sometimes good, and in a few occasions poor or excellent (in the single patient room). Examples of background noise included an alarm in the adjacent kitchen, and talking in the corridors.

Reoccurring observation-tool advantages - In terms of advantages, the reoccurring observation tool was particularly good to capture dynamic behaviours in the ward. This information is useful to combine with the other two tools that focused more on the permanent features.

Reoccurring observation-tool disadvantages - Compared to the original SSO-method it was difficult to assess occupation; for example, in offices, you have chairs and desks, while in the ward you additionally have beds, and it was not always clear which ones were supposed to be used and by how many. This assessment of occupancy was further complicated due to the frequency of observation rounds.

Reoccurring observation-tool future improvements - As mentioned, the tool should not be used independently, but rather combined with qualitative data (from interviews, focus groups, diaries, or photovoice studies) to better understand the complexity of the ward and its impact to users. For ease of use, the tool should be accessible on mobile phones. Most importantly, recurring observations are crucial for indicating the intended outcomes of spatial interventions and should align the items of the observation tool with those outcomes. This approach can make it more manageable to use the tool in multiple rooms or expand the study's timeframe. For example, if the focus is on promoting healthy behaviour, there is no need to assess windows, doors, or air quality. However, in comprehensive studies like MHH, where multiple disciplines and focuses are combined, collecting observational data on a range of themes was necessary, which meant longer rounds and therefore less rounds.

4. Discussion

This paper describes lessons learnt from using three observation tools developed for researching hospital ward design, aiming to assess their effectiveness and potential contributions to enhancing user health and the quality of hospital ward design. The description and reflections prompts discussions on various themes, including a comparison of the data collection methods (the role of the observer in evaluating features of the physical environment (one-time and CHD-tool); the role of the observer in evaluating the ways of using the spaces (re-occurring), as well as a discussion on the validity of the results in each three methods, is of interest. Then a reflection on adjusting methods used in office design research for healthcare design research. Lastly we reflect on ward (re)design recommendations, and list study limitations.

4.1. Comparing observation methods

Each observation tool serves a distinct purpose. While the CHD-tool and the one-time observation focus on the permanent design features, the recurring observation concentrates on the flexible and dynamic aspects of the space (such as opening or closing windows and doors, turning lights on or off), indicating the use of the space. Hence, the CHD-tool and the one-time observation are most appropriate for documenting the spatial intervention and comparing the pre-and post-spatial conditions that have been changed. Instead, the recurring observation is better suited for evaluating the effects of the change, such as observing alterations in behaviours and usage patterns.

The CHD-tool is developed for a specific healthcare setting: the surgical patient room. In contrast, the other two tools allow for data collection across various types of environments within the hospital ward and possibly adaptable to other healthcare settings. However, all three tools overlook the broader context, lacking information about the relationships between rooms, wards, and their environment. It may also be mapped combining with spatial analysis tools such as space-syntax [23]. Nevertheless, the SSO-tools also gather case-specific data on the ward, such as orientation and floor location, opening up opportunities for cross-case comparisons.

4.1.1. The role of the observer

It's important to note that the research outcomes as found using the observations, are linked to the frequency and timing of rounds conducted. Initially, we scheduled multiple rounds per day, but this proved too time intensive. Consequently, we had to select a time that was representative of the day and compatible with the working hours of the assistants. The timing was decided in collaboration with the ward manager, assistants, and the main researcher. Planning reoccurring observations thus requires reflecting on the goals and rigor of the research, as well as the daily practices on the ward and the restrictions in resources. As others have also mentioned, observers can influence the results as it is difficult to maintain objectivity [19]. This influence may stem from what they observe, focus on, value, or perceive as good, medium, or poor.

In the case of the CHD-tool, the aim is to have an independent auditor of the patient room . While the tool offers EBD goals, assessment items, and assessment aids, questions persist regarding the interpretation of "independent." Does it imply that the assessment could be conducted by an outsider or that it should be free from bias, ensuring consistency among different observers' responses? The latter seems difficult, as there is no indications from the assessment aids on how many checked boxes would warrant each rating. This makes it difficult to distinguish between good and excellent. Although that was maybe never the purpose of the CHD-tool. Still, it could be beneficial to specify what criteria determine each rating for every item.

The one-time observation tool comprises both objectively quantitative data and some subjective measures (such as air quality and sound quality). Conducting the initial assessments with both assistants and the main researcher helped calibrate the more subjective measures. However, this underscores that, depending on the observation type and level of subjective measures, the need for training or some form of calibration for observers when comparing multiple cases.

The recurring observations primarily involved quantitative data, where the researcher's perception had less influence. For example, counting the number of people in the room is not subject to interpretation. However, the presence of researchers in the room may have influenced the behaviors observed, as others have suggested that users' behaviours can be influenced by the presence of people, especially researchers. This approach is less invasive than shadowing users; instead of focusing on the space and its activities, it concentrates on the behaviours of specific users of the ward.

4.2. Transition from office to healthcare design research

It has been argued that knowledge derived from studies on relation between design features and health-related outcomes, situated in healthcare buildings, should also be used in another context [24]. For instance, studies on the importance of view on nature in healthcare wards may also be relevant in other settings such as offices. Enhancing the quality of knowledge on healthcare building design requires assessing the transferability of research and knowledge to other contexts. Thus, there is a need for adapting to the specific context and in that case reflection on the context itself is even more relevant.

Refocusing on the hospital ward, the three observation tools tested offered different possibilities. While the CHD-tool was only prepared for the patient room, both the one-time and the reoccurring observation tools allowed for the assessment of the whole ward. This fact also resulted in the question about which rooms should be evaluated within the observation; should the focus be on the patient, staff, or other areas, or all? We argue that it would be good to have a spatial inventory (one-time observation tool) for all the rooms in the ward, and then focus the re-occurring observations on a specific type of environment, such as the patient, care, staff, or public spaces. This would allow us to do more observations per day and focus on specific user needs. Moreover, a recent literature review on healthcare architecture research [6] emphasizes the need to specify ward-design features in the methods section of research on healthcare building design. This process serves a dual purpose: (1) enhancing the understanding of the specific case through data triangulation, and (2) facilitating future cross-case analyses with other studies using a similar spatial inventory.

4.3. Ward redesign recommendations

Planned design interventions, including those for the ward where the observation tools were tested, should be informed by research [9, 14]. The three observation tools tested in this study combine project research (assessing the current state of the environment and identifying opportunities for improvement) with the ability to conduct pre-post comparisons, thus collecting baseline data. Table 6 presents the redesign recommendations based on the main findings. It is important to note that these findings are influenced by the focus and setup of the data collection tools. For example, the CHD-tool, developed before the COVID-19 pandemic, assigns the highest score to hand sanitation, resulting in no design recommendations regarding this aspect. However, more recent research suggests that other factors could enhance sanitation further. The recommendation of single room policies, based on these observations, may appear straightforward. Nevertheless, single-room policies are increasingly debated due to their impact on people's social interaction and feelings of isolation, despite offering more privacy.

Table 6 Redesign recommendations based on the three observation tools tested for the patient area.

Transforming all patient rooms into single-patient rooms.
Standardizing the layout for the patient rooms and reducing the difference between the rooms.
Adding locked storage to the patient rooms.
Possibilities for personalization such as pinboards, a small shelf, or a place for personal photos, plants, flowers, or decoration.
Installing localized lighting, as well as dimmers that would allow changing the intensity of the lighting.
Improving privacy in multi-patient rooms with privacy curtains or acoustic panels.
Improving control in patient rooms; bedside control for all lighting (including ceiling lighting), control over ventilation and temperature, being able to open a window, being able to change the temperature/strength of the lighting.
Having as many TV screens as beds and adding headphones that work with the TV.
A sink in the room that allows handwashing but also increases access to drinking water.
Installing wall handrails, add sanitation stations in the room near the patient beds, and adding night lighting on the floors.
Being able to engage in patient recovery (electronic media, education, interaction between patient and staff).
Furniture for bariatric patients to facilitate their needs and reduce injury for both staff and patients.
Provisions for equipment to aid patients handling and movement (ceiling lift; floor lifts, slings, stand assists aids).
An easy path moving the patient (in bed) out of the room.
A visible sanitation station when walking into the room that could be used hands-free and adjusted to the ergonomics of staff.
Dedicated medication preparation zone in the patient room with sound absorption.
Introduction of recycling bins.
Reducing alarm fatigue equipment.

Having a place for the family to stayover (desk, chair, sleeper); lighting/tv for visitors that does not disturb patients, Wi-Fi. Sufficient illumination for care providers around the bed.

4.4. Limitations of the study

Conducted in November 2020 during the COVID-19 pandemic, this study faced challenges such as excluding certain rooms and expanding on-site teams due to travel restrictions. Team calibration, necessitated by these circumstances, offered the advantage of creating a more objective observation tool. Data collection and analysis by different teams ensured objectivity but potentially limited a holistic understanding of the site context.

The study did not differentiate between patient populations and excluded equity questions, while the CHD tool addressed aspects like wheelchair access and fall risks.

Finally, the purpose of this study is not to create a validated observation tool, rather to offer an example and reflect on lessons learnt to support others in their effort working with observations, developing observation tools or conducting pre-and post-studies.

5. Conclusion

This study explores three observation tools designed to evaluate the design features of a hospital ward, focusing on factors influencing users' health and organisational outcomes. By testing the three tools in the same surgical-medical hospital ward, we can compare the purpose, content, usability, advantages, disadvantages and future improvements of each tool. Our results, emphasize the importance of selecting the appropriate tool or combination of them based on specific research objectives. A crucial aspect for future studies in healthcare building design is documenting the design features which may increase research validity, offering context to the studied case and potentially mitigating tool limitations. Moreover, the reuse of observation tools in multiple case studies enables valuable cross-study comparisons.

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