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Spatial experience of cancer inpatients in the oncology wards: A qualitative study in visual design aspects

Carmela Cucuzzella [a], Mohsen Rasoulivalajoozi [b,*], Golriz Farzamfar [c]

[a] Faculty of Environmental Design, University of Montreal, Montreal, Canada
[b] Department of Individualized Program (INDI), Concordia University, Montreal, Canada
[c] Department of Design and Computation Arts, Concordia University. Montreal, Canada

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ABSTRACT

Purpose: This paper aims to explore how the visual characteristics of cancer wards' interior spaces can be improved based on the combined visual design themes to help cancer inpatients' spatial experience and relieved state of mind. Accordingly, we present a visual design framework that can be applied in oncology wards.
Method: This study adopts the Ulrich-supportive design theory as a theoretical framework using two main methodological phases: observation of cancer wards and interviews with professional caregivers. The first phase critically explores hospital cancer wards' interactive aesthetical and visual interior characteristics. Next, we adjusted the visual criteria based on the Post Occupation Evaluation (POE) method to develop the interview questions. Interviews were conducted with experienced nurses, oncologists, and a general physician, all from a cancer ward at McGill University Health Center (MUHC) in Montreal, Canada.
Results: We presented 11 main themes in the categories of color and light, natural/artistic images, way-finding, and visual clutter. To present and justify our visual design framework, these main themes were then classified based on the common goals, resulting in four combined themes: applying simplicity and usability; developing naturality; creating homeyness and respecting patients' agency; and promoting trustworthiness.
Conclusion: Our findings suggest that—apart from the last theme, promoting trustworthiness, the rest are in line with Ulrich's supportive design theory. Therefore, further research is needed to investigate "promoting trustworthiness" in the context of cancer wards. In addition, each aspect of the visual design framework can offer practical design recommendations for future studies.

1. Introduction

The impact of the hospital environment on both patients and staff has been increasingly debated over the past 50 years (Karlin and Zeiss, 2006). Studies have supported the notion that physical intervention in the health environment can affect patient safety both directly and indirectly (Gurses and Pronovost, 2011; Smith et al., 2009; Ulrich et al., 2008). Today, however, the design of the hospital environment no longer serves as mere protection for patients (MacAllister et al., 2016). Health managers and designers have noticed that even a slight change in spatial environments can alter patients' spatial experiences and create more positive feelings rather than eliciting phobias and/or stigmas (Vaes, 2014). Of note, spatial experience encompasses the subjective, multimodal perception tied to the body and senses within a given context (Kwon and Iedema, 2022). To this end, interior designers can significantly impact patient spatial experiences, behavior, and treatment outcomes by addressing psychological and aesthetic factors to counter negative moods like depression and anxiety, benefitting both patients and staff (Karlin and Zeiss, 2006; Nanda et al., 2009). Studying the impact of these factors on the spatial experience of patients, particularly within critical groups like cancer patients, yields essential design considerations applicable to various clinical interior spaces.

Cancer patients experience frequent mood changes and/or depression after being diagnosed with cancer (Mystakidou et al., 2006). According to Patrick et al. up to 25% of cancer patients develop depression, and doctors only identify about 35% of these patients, which is why they remain untreated (Patrick et al., 2003). Studies suggest that if depression is not successfully treated, it negatively impacts other aspects of health

* Corresponding author.
E-mail addresses: carmela.cucuzzella@umontreal.ca (C. Cucuzzella), mohsen.rasoulivalajoozi@mail.concordia.ca (M. Rasoulivalajoozi), golriz.farzamfar@concordia.ca (G. Farzamfar).

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(Bruce, 2021; Farmer Teh et al., 2010). In this context, cancer inpatients have more interactions with the hospital environment than outpatients (Laursen et al., 2014). An analysis focusing on the amount of time cancer patients spend in hospitals reveals an average of 29 days of hospitalization per inpatient, with lung cancer having the longest duration at 35 days (Schneider et al., 2007). Therefore, it's common for inpatients to be more vulnerable to stress and trauma when facing a cancer diagnosis (Skalla and McCoy, 2006) and they may need more spiritual support (Hatamipour et al., 2015). In such circumstances, while medical factors such as reactions to chemotherapy and diet deficiencies may negatively impact patients' moods (Smith, 2015; Anand et al., 2023), the aesthetic and design aspects of inpatient rooms have the potential to positively influence patients' emotional states, contributing to a relieved state of mind (referring to a feeling of comfort and calmness following the alleviation of stress, anxiety, or tension). (Skalla and McCoy, 2006). According to Ulrich's theory of *supportive design* (1991), all challenges and considerations for the improvement of the health environment can be classed into three main branches. Essentially, the hospital environment reduces stress if it fosters *perceptions of control (PC)*, *social* support *(SS)*, and *positive distraction* (PD) (Andrade and Devlin, 2015). Within this framework, *perceptions of control* encompass studies that highlight the importance of mapping, wayfinding (Pukszta and Petzoldt, 2011), and other elements like observing natural surroundings (Berry et al., 2020), aiding patients in navigating independently (Devlin, 2014), and fostering a sense of control over their environment. *Social* support relates to patients' access to social assistance, where high levels of social support can reduce distress in the treatment center (Rasoulivalajoozi and Farzamfar, 2022). For example, rearranging the furniture is suggested to foster intimacy and as well as afford privacy, enhancing patients' moods (Salonen et al., 2013). *Positive distraction* mainly concerns factors such as viewing nature, listening to nature sounds (Berry et al., 2020; Lechtzin et al., 2010), or using indoor plants and images depicting realistic nature scenes (Berto, 2014), keeping patients away from negative emotions, (Bradt et al., 2016) and nudging them toward positive and psychological changes (Andrade and Devlin, 2015). These three categories are often used to enhance inpatients' well-being and to reduce stress in treatment centers.

Although in the design realm, other factors like window size (Cesari et al., 2020), material safety, cleanliness (Elliott et al., 2012), and noise (Hagerman et al., 2005) can affect patients' spatial experience, in this study, we focus on the visual design aspects. We employ Ulrich's supportive design theory to develop a visual design framework. According to the literature in this field, most research has focused on access to care and physical facilities, and few on psychological aspects, such as the visual analysis of the interior space. In addition, even though visual elements were considered in some studies as a part of the design strategy list, the weight attributed to them was insignificant. Furthermore, much of the research on visual elements has focused solely on individual aspects such as wayfinding, lighting, or color, (Dijkstra et al., 2008; Schweitzer et al., 2004), overlooking a comprehensive understanding of inpatients' perceptions of the overall visual aspects of cancer wards and rooms. Therefore, we aim to take a comprehensive approach to consider the visual interconnected effects on the patient's spatial experiences. To this end, we seek to answer our research question: what combined visual characteristics, as a framework, can help cancer inpatients' state of mind? For this, we try to realize the discrepancy between the existing spatial environments and patients' and medical experts' expectations of these environments. We expect that our findings illustrate the visual priorities and considerations for cancer departments and contribute to nurses, future researchers, hospital managers, and interior designers in presenting practical design interventions aligned with our framework. The contributions of this study are as follows:

Analysis of spatial experience outputs in the cancer ward can enable nurses and designers to understand the desired spaces for the other patients in other wards (e.g., Cardiology or Orthopedic), leading to tension-free experiences for cancer inpatients. This understanding can assist health managers in offering preventive solutions to decrease psychological-related costs for patients and enhance the productivity of professional caregivers.

2. Materials and methods

2.1. Establishment of the study procedure

Given that our research is focused on understanding the opinions and experiences of various people in cancer wards, our approach is founded on qualitative methodologies. To achieve deeper insights into the subjects' perspectives, we utilized semi-structured interviews. For developing the interview questions, a two-phased method was adopted. In the first phase, the theory of criticism of interface aesthetics (CIA) is used. Here, all possible interconnected visual items are analyzed, and the most important visual factors are extracted. These items are chosen based on their direct impact on inpatient cancer wards' overall appearance and characteristics. Next, the extracted visual factors are developed based on the Clinic Design Post-Occupation Evaluation Toolkit (CDPOE). Utilizing the CDPOE toolkit's questions on visual elements, we integrated it with our CIA-reference style analysis to formulate interview questions regarding visual characteristics (refer to Appendix A at the end of the paper). By employing these two steps to identify existing and desired spatial experiences, we provide a visual design framework in hospitals in addition to the main themes for the cancer ward space. Fig. 1 illustrates the procedure and steps of the study.

2.2. Development of interview questions and guide

2.2.1. Employing the criticism of interface aesthetics (CIA)

The theories related to the 'criticism of interface aesthetics' (CIA), introduced by Bertelsen and Pold, explore how human-computer interaction (HCI) can be viewed as an aesthetic discipline with the capability to transform conceptual thinking into tools for practical design (Bertelsen and Pold, 2004). Therefore, basic knowledge in the field of visual aesthetics is required for those who intend to use this method (Bertelsen and Pold, 2004). Given the authors' backgrounds in design and visual communication, the eligibility to employ this method was confirmed.

The CIA model consists of the following eight items: stylistic references (analyze stylistic references in the interface), standards (identify the use of standards and the conformity to tradition), materiality and remediation (consider the materiality of the interface), genre (Identify and consider various genres in the interface), hybridity (discuss the interface as a hybrid between the functional and the cultural interface), representations (identify representational techniques and analyze how they work), challenges to expectations (identify challenges to users expectations) and developmental potential (consider the developmental possibilities; How is development in use supported?) (Bertelsen and Pold, 2004). Although CIA has mainly been applied in the HCI, its first item (i.e., stylistic references) can also find application in other fields such as graphic and industrial design (Faraji and Valajoozi, 2014; Rasouli Valajoozi and Zangi, 2016), architecture, and interior design (Bertelsen and Pold, 2004; Coyne, 2001). Therefore, we use a 'stylistic reference' at this stage since this component provides valuable insights into aesthetic interactions with the environment. Employing the 'stylistic reference' for the analysis of space can address the entire interactive aesthetic of the environment at once or focus on individual elements while considering their interrelations (Bertelsen and Pold, 2004). Notably, while spatial experiences can be influenced by complex interfaces, our focus is on the visual and stylistic aspects of interior design in cancer inpatient spaces.

2.2.2. Photography documentation

To provide a common understanding to professional caregivers, we chose to conduct photo documentation of the MUHC hospital interior spaces, including oncology, hematology, and palliative care wards.

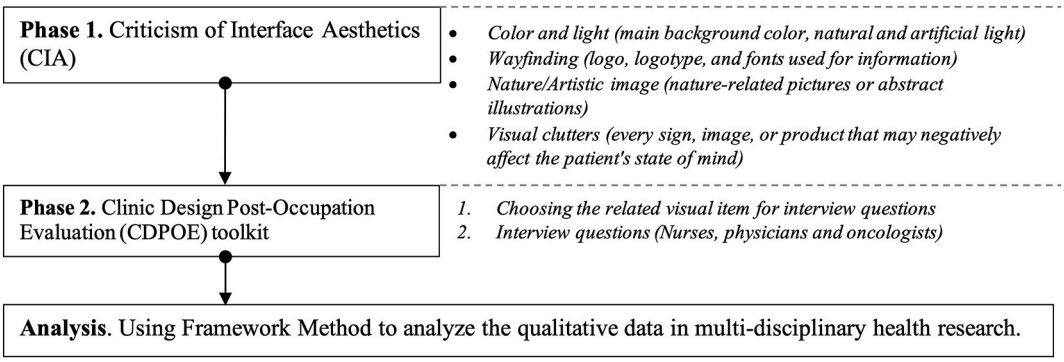

Fig. 1. The methodological procedure is in two main phases. © Image by Authors.

Subsequently, based on the 'stylistic reference' analysis from the CIA, four visual factors, including color and light, way-finding, nature/artistic images, and visual clutter were extracted from the images along with their definitions. We then integrated these images with the guidelines of the CDPOE toolkit and shared the corresponding meanings of each visual factor with the interviewees (Fig. 2).

2.2.3. *Clinic design post-occupation evaluation (CDPOE) toolkit*

The CDPOE toolkit was developed by the Center for Health Design (CHD) at the California HealthCare Foundation (CHCF) (2015). This toolkit aims to support the continual cycle of evidence-based design (EBD) and construction by evaluating the effectiveness of built projects in meeting design and performance goals (Joseph et al., 2014). This toolkit strongly prioritizes evaluation and feedback, aiding care facilitators in identifying and addressing built-environment issues for better alignment with user needs and adaptability to evolving organizational requirements. It is comprised of five steps: Tool 1: *General Information, Organizational Goals & Design Principles*; Tool 2: *Audit of Physical Environment*; Tool 3: *Patient Questionnaire*; Tool 4: *Staff Questionnaire*; and Tool 5: *Outcome Data Collection Form* (The Center for Health Design, 2015).

2.3. *Interviewees recruitment*

According to the aim of our study, inclusion criteria were (1) qualification as an oncologist, licensed physician, or registered nurse, (2) working in a cancer unit for over 5 years, and (3) showing willingness to give informed consent and participate voluntarily. The exclusion criteria were simultaneous participation in studies unrelated to cancer. Using a combination of purposive and snowball sampling, nine participants, including oncologists, a general physician, and nurses with extensive experience working with cancer inpatients, agreed to participate in the interview. Before the interview, participants received an email containing an information leaflet and an invitation letter. There was no pre-existing personal relationship or connection between the authors and the participants.

2.4. *Data collection*

The interview encompassed both broad and specific inquiries regarding each visual element to understand their potential impact on inpatients. After obtaining written consent, in-depth, open-ended interviews lasting 50–120 min were conducted privately via virtual

Fig. 2. Sample of collected photos for analyses in CIA-stylistic reference method. © Image by Authors.

meetings from December 2021 to July 2022 (Table 1). The interview's voice contents were digitally recorded. Beginning with initial broad questions, participants were then presented with selected MUHC photos before addressing the core questions. During the interviews, a quiet environment was maintained to ensure the respondents felt relaxed and comfortable. The interview guideline, developed from existing literature and insights from the research team, flexibly guided the discussion until data saturation was reached.

The study took place within the McGill University Health Center's (MUHC) (https://muhc.ca) Cancer wards in Montreal, Quebec. The MUHC is one of two major healthcare networks in Montreal (Dougherty, 2012). The oncology and cancer center of this hospital consists of departments of Oncology/Hematology, Palliative Care, Radiation Oncology, and the Inpatient Unit-Hematology Oncology (located on block B, level 07 and room number 3528) (MUHC, 2021).

2.5. Data analysis

Within 48 h of each interview session, detailed transcriptions of audio recordings were meticulously generated in textual format. Then, all the participant's names and identities were eliminated, and two authors then reviewed and archived these transcriptions. The transcripts and interpretations were sent to the participants for member validation. In addition, interviewers posed additional questions during the interviews to confirm their understanding of the participants' remarks. After transcription and initial verification, the coding procedure was carried out independently. CC, MR, and GF held several meetings to deliberate on the coding, generation of initial codes, and construction of initial themes. Subsequently, MR and GF drafted the results, which were then refined by the research team to ensure clarity before finalizing the overarching themes. Key quotes were collected and used to support the data within the themes. For the analysis of data, all transcriptions were analyzed using the "Framework method" for thematic content. This method involves a systematic and inductive approach that includes reviewing and re-reading transcripts, coding transcripts, and organizing the analytical branches (Gale et al., 2013; McCaughan et al., 2018). The Framework Method, also known as thematic analysis or qualitative content analysis, is gaining popularity in medical and health-based research. This approach identifies commonalities and differences in qualitative data, aiming to draw descriptive and/or explanatory conclusions centered around relevant themes (Gale et al., 2013). Accordingly, common patterns and themes were recognized and interpreted by exploring meanings, significances, and relationships. Subsequently, the data were reviewed and refined to pinpoint deviant points (Lincoln, 2007). Finally, data handling, charting, and comparison within and between cases were conducted (Fig. 3).

Once the themes were derived, we classified them into the subcategories of the Ulrich Theories model (Patrick and Hollenbeck, 2021). Table 2 presents the initial interview analysis, showcasing the classification of themes and subthemes.

Table 1
Background of participants and interview timing (N = 9).

P[a] #	Professions	Years of experience	Time of interview (Minutes)	Working experience
1	Oncologist	30	120	Full time-Oncology ward
2	Nurse	20	60	Full time-Oncology ward
3	Oncologist	20	50	Part-time-Oncology ward
4	Nurse	26	70	Full time-Oncology ward
5	Nurse	12	50	Full time-Oncology ward
6	General Physician	15	50	Full time-Oncology ward
7	Nurse	18	55	Full time-Oncology ward
8	Oncologist	15	120	Full time-Oncology ward
9	Nurse	6	70	Part-time-Oncology ward
Total	9	162	645	–
Average	–	18	71.6	–

[a] P means participant number.

2.6. Ethical considerations

The study was approved by Concordia University's Ethical Review of Human Subject Research policy, VPRGS-3 (Certificate number: 30015410 issued on October 26, 2021). At the beginning of the interviews, participants signed written informed consent and were informed of their right to withdraw at any time and the confidentiality of their information.

3. Results

In the initial step of analyzing the transcribed interviews, we identified 138 codes and grouped them into 14 themes across all question groups. Subsequently, 12 sub-themes were presented to provide further detail and nuance to the main themes, illustrating different aspects and dimensions of visual investigation. Table 2 shows these main themes and sub-themes, classified according to the three sections of Ulrich's theory. We justified the main themes based on each category of questions (i.e., broad questions, colors and lights, natural/artistic images, way-finding, and visual clutter) by presenting samples of quotes. To arrive visual design framework, we compared all the main themes within each row with those within other categories (i.e., finding the hidden relationships and similarities). We then formulated four combined themes based on their shared objectives and functions. In some cases, each theme provided two or three meanings; therefore, we considered all the possible meanings for combined themes, and came up with four combined themes:

- CO- Th. I. Applying Simplicity and Usability;
- CO- Th. II. Developing Naturality;
- CO- Th. III. Creating Homeyness and Respecting Patients' Authorities;
- CO- Th. IV. Promoting Trustworthiness.

The visual design framework, along with its subcategories (i.e., combined themes), equips designers with a perspective to determine how visual characteristics should be implemented within an integrated design framework concerning visual elements. Fig. 4 illustrates the relationship between themes and combined themes.

a. Broad Questions (BQ): generating a sense of nature, physical and psychological comfort, and an emotional relationship between professional caregivers and patients.

Before investigating each visual characteristic separately, we first asked participants for their general ideas about improving the appearance of the cancer wards. The themes within the categories of broad questions do not act independently to shape the combined themes; instead, they serve to reinforce and solidify the other themes.

As a first theme in the broad questions, most participants (7) expressed that proximity to nature can significantly affect patients' spiritual well-being. The following quotes illustrate cancer patients' need for natural elements:

> *"Paint[ings] of nature on the ceiling of the patient room like a sky with some clouds and branches of trees really help a patient to feel hope and*

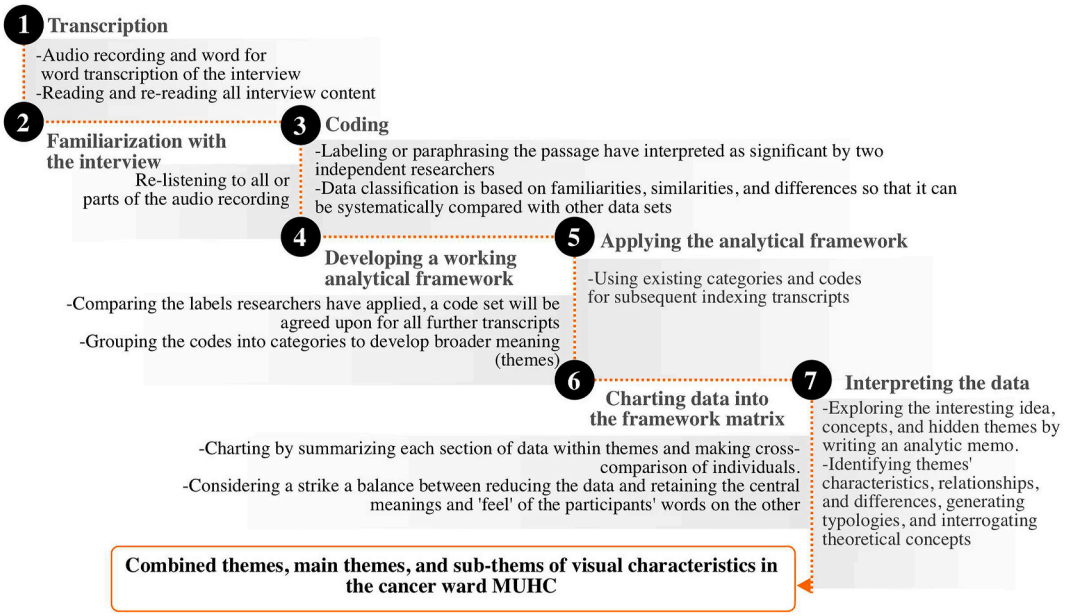

Fig. 3. The procedure of data analysis using the framework approach (Gale et al., 2013). © Image by Authors.

relaxation …" (Oncologist, 1), "I think the appropriate natural light with good colored walls make [cancer patients] feel they are in a kinder garden to give them hope for a new life …" (Nurse, 2)

Neither physical nor psychological obstacles should irritate them. One of the participants also notes that:

"Nothing should annoy [cancer patients], for example, the medical devices and drugs are a kind of stress[or], so placing that stuff in corridors make them feel of being in an insecure space, so we need to give them relaxation by removing those medical icons, or even by a simple hugging at their first entrance " (Nurse, 4).

Furthermore, entering a new healthcare setting may lead to feelings of isolation and separation from family support. A warm welcome from professional caregivers and nurses can offer patients a sense of support, helping alleviate the anxiety and phobia associated with the medical environment.

"Nurses […] usually make a close connection with [cancer patients]. [We] can enter the room with a smile which really reduces their stress, so they like to talk with me to share their personal stories … sometimes I think they like to be friends with us for the sake of feeling heartwarming" (Nurse, 7).

b. Colors and Lights (CL): simulation of natural sense, control of the light level, using vibrant and livelier colors.

In this section, three main themes and four sub-themes emerged. simulation of natural sense was the primary theme, frequently mentioned by interviewees. The majority of participants emphasized the significance of windows, offering scenic views of nature and natural light. Despite some MUHC rooms having obstructed views that may block the natural light, it is still preferred over artificial lighting and benefits inpatients.

"The patients do not like very small windows nor very very big windows. Actually, they are seeking to see a scenery view of nature of at least 50–100 m" (Nurse, 4). "A nice view of nature would be really helpful for those long-term inpatients" (Oncologist, 1).

Interviewees also noted that morning light has a more positive impact on patients' moods than evening light, creating a livelier and fresher atmosphere. Additionally, patients prefer to control and reduce high-intensity lighting, which can enhance their mood and perception of environmental control.

"Adjusting the light with their mood [gives] them a feeling of flexibility and a right of choosing their own space ". (Nurse, 4).

Light control would be even more optimized if patients could balance natural and artificial light around the clock. Ideally, patients could enjoy natural light during the morning and adjust the artificial light in the afternoon and evening. Also, lighting, whether natural or artificial, influences room color quality, affecting patients' moods. Vibrant colors can create a joyful atmosphere, offering a fresh internal space and helping distract patients from negative thoughts and feelings.

"I think they (cancer patients) tend to have a space colored with bright and lively themes" (Oncologist, 1).

Although there was not a solid consensus for any one specific color, five participants emphasized applying the vibrant natural color (e.g., light blue, soil color) to a great extent. That's a possible reason for the marked tendency toward warm light, which we selected as a subtheme for this section.

c. Natural/Artistic Images (N/AI): personalizing the environment, getting close to natural elements.

Using images can positively impact a patient's mental state, with two key themes. First, it is proposed that patients should have the freedom to choose their preferred images. Second, participants recommend that inpatients be allowed to bring their creative tools for personal activities such as painting and embroidery.

"Bringing personal items such as religious or Christmas decorations is promising for them, and even bringing pictures like photo frames keeps them happy. It would be even more helpful if they could have personal hobbies like making art" (General physician, 6). "Sometimes they asked whether they could put the pictures on the wall" (Nurse, 9).

The second factor involves conveying a sense of nature through images. Participants consistently suggested connecting with the natural world through flowers and nature photos. Placing flowers in patients' rooms is a simple yet effective action. In cases of allergies, nature images

Table 2
Classification of themes and sub-themes in each visual element category. Main themes (N = 14) and subthemes (N = 12).

	Main themes	Sub-themes	Branches of Ulrich's theory
Broad Questions (BQ)	I. Generating a sense of nature	- Using livelier and more vibrant colors, lights, nature images, and flowers	PD
	II. Developing physical and psychological comfort	- Homey and comfortable atmosphere	PC, SS, PD, ×
	III. Improving the emotional relationship (between professional caregivers and patients)	- Well-educated staff, having a history of patients, interact with a smile and hugs	× , SS
Color and Lights (CL)	I. Simulation of nature	- Large windows for a view of nature	PD
	II. Control of the light level	- Moderating the high intensity of light	PC
		- Using a combination of artificial and natural light	PC
	III. Using the vibrant and livelier color	- A preference for warm light	PD
Natural/ Artistic Images (N/AI)	I. Personalizing the environment	- Having the personal stuff and family support	PD, PC
	II. Getting close to natural elements	- Having flowers and nature images present	PD
Way-Finding (WF)	I. Legibility of information and signs	NA	PC
	II. Receiving info from a credible source	- Human interaction	× , SS
	III. Emphasizing color differences	- Using color variation in each room	PC
Visual Clutter (VC)	I. De-stressing a space filled with medical devices	- NA	PD, ×
	II. Prioritizing a homey atmosphere	- Considering all senses, providing music, having nice aromas, using vibrant colors	SS, PC
	III. Considering the private atmosphere	- NA	PC, SS

Note: PC, SS, and PD mean Perceptions of control, social support, and positive distraction respectively, and ×= Not fully distinguishable.

can be hung on the walls to evoke a sense of freshness. One oncologist shared an ideal image.

> *"They would like to have a very big painting of nature including a waterfall, a cottage, with sheep or goose or like to hear the sound of a waterfall in the room […] They'd like it if the hospital was built in the middle of the jungle. "(Oncologist, 8).*

The two themes of personalizing the environment and getting close to natural elements are respectively in line with the perception of control and positive distraction of Ulrich's theory.

d. Way-Finding (WF): legibility of information and signs, receiving info from a credible source, emphasizing the color differences.

In this section, we decoded three primary themes and two subthemes. Participants highlighted the critical challenge of signage legibility and information presentation. Clear, easy-to-read signage, avoiding unnecessary complexity, was noted as a top priority for inpatients. Participants emphasized the importance of legible signs, detectable lines, and room differentiation.

> *"The use of distinct colors for each room remarkably aids patients in easily finding their room or the required ward" (Nurse, 2).*

> *"Often, patients have no patience to pay attention to signs when coming for treatment. They don't like to be drowned in the midst of compact signs … They like to find and go to their intended place quickly and without any annoyance, and any tiny interruption may irritate them." (Nurse, 7).*

In addition, participants suggested using colored lines on walls and floors. However, there was no single popular suggestion for drawing these colored lines—although some creative ideas, such as using colored lights, were proposed. Another theme that commonly helps patients and their families with internal way-finding is the ability to ask a professional caregiver or information desk service for directions. It not only assures them of being in control, but they also feel socially supported by the hospital staff.

> *"I think it's easier for them to ask people in the hospital more than the signage … It seems that when they ask a person, they feel less that they might lose their way". (Oncologist, 8).*

According to highly experienced participants, the information desk service only responds to questions related to finding directions hastily and with little patience. However, if they realized their potential, they could be made to positively affect patients' mental states with just a short conversation.

> *"Friendly interactions with patients in medical settings can serve as an icebreaker and can lead to them trusting patient's surroundings". (Oncologist, 7).*

e. Visual Clutters (VC): de-stressing a space filled with medical devices, requiring a homey atmosphere, considering the private atmosphere.

This part represents three main themes and one subtheme. First, participants emphasized the negative impact of medical devices and gadgets, which can induce fear in patients. Observing these devices, with their intricate interfaces and sounds, can create an extremely stressful environment. Patients might feel as if they are in a laboratory, where doctors treat them as mere test subjects. Rather than experiencing a pleasant sense of intimacy (e.g., music, enjoyable aromas, vibrant colors), inpatients are confronted with the presence of these intricate devices continuously producing jarring sounds, creating an environment that feels unfamiliar and strange. Consider the following quote, which illustrates how such devices could negatively affect a patient's state of mind:

> *"Medical devices with a complex appearance and stressful repetitive sounds like a hospital pacemaker or even preparing injections in front of the eyes of the patient can cause them distress that they are getting close to death …" (Nurse, 4).*

Inpatients are also interested in being in a home-like environment but being surrounded by medical devices or sounds makes them feel more like they are in an institute and a non-supportive environment.

> *"We can use some specific material for a floor that makes the feeling of home and not medical institutes … for instance putting the drug sections out of inpatients view may reduce the experience of institutional atmosphere" (Oncologist, 3).*

Patients feel that their private safe space has not been respected as they are the subject of medical tests in an unsupportive environment of an office.

> *"We need to provide a private or even hotel-like design such as using a beautiful sofa, light, specific music for each patient with an acoustic room […] glass dividers between patients' chairs in chemotherapy rooms would be a good idea to less[en] their stress." (Nurse, 2). "I wish there [was] a separate corridor for conveying dead bodies, it really makes them stressed and completely upset them …" (Nurse, 5).*

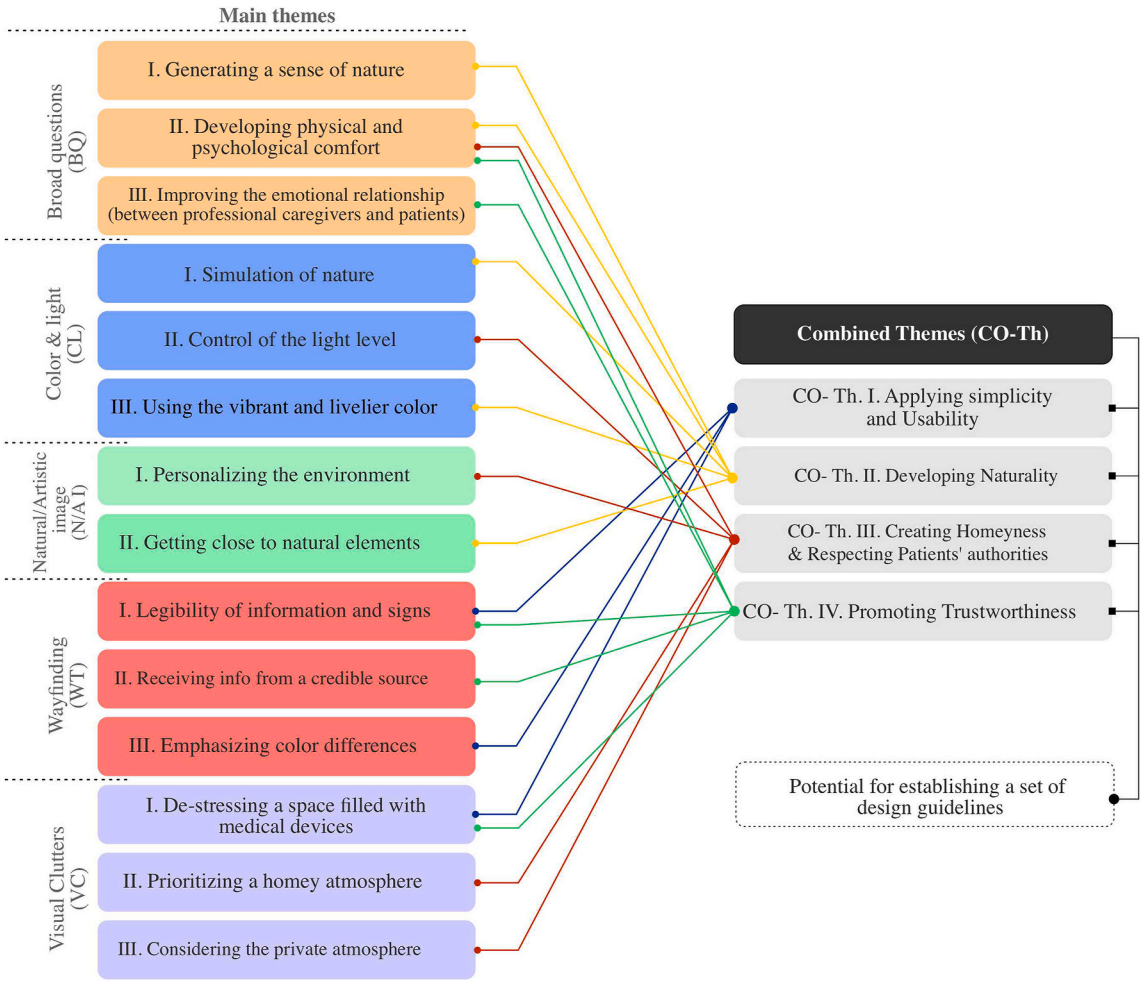

Fig. 4. The relationship between themes and combined themes. © Image by Authors. The abbreviated code (e.g., CL.II) is presented for better readability of combined themes within the text.

4. Discussion

According to the results, we reviewed each category of visual elements, and 11 main themes (excluding the broad questions) and four combined themes have been presented. For designers, these main themes are not only practical in and of themselves, but we can also classify them based on their goal: offering unique combined-visual characteristics and strategies to control and optimize the effect of visual elements on inpatients' state of mind. Accordingly, in this section, we elaborate on and justify each of the combined themes that shape our visual design framework (Fig. 5).

4.1. CO- Th. I. Applying simplicity and usability

The first combined theme is a result of WF. I. (Legibility of information and signs), WF. III. (Emphasizing the color differences), and VC. I. (De-stressing a space filled with medical devices). This combined theme corresponds to the Ulrich theory in the branch of perception of control.

Cancer patients typically are in a precarious condition of depression and anxiety (Linden et al., 2012), in which every tiny disruption can affect their behavior, and temper, leading to poor cognition, social withdrawal, and fatigue (Nadjar et al., 2005). Therefore, we should avoid intensifying such feelings in the hospital environment—an environment that may indirectly echo mental exhaustion in and of itself. For instance, any tiny disruption in the interior navigation of hospitals or from a distressful source could affect patient temper. This means there is

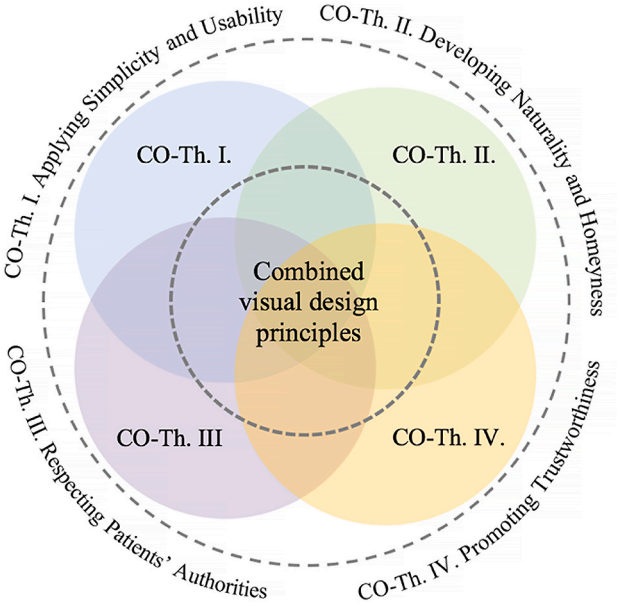

Fig. 5. Visual design framework and domain of the combined themes for producing visual design principles. © Image by Authors.

a clear need for a space with no nuisances and no chaos—a common tendency among all these main themes. Patients seek clear and simple signage for quick and easy access to information via way-finding services. Previous studies on hospital way-finding factors also confirmed the importance of simplicity, consistency, flexibility, and visibility as critical for effective and legible way-finding systems (Alam, 2018; Kim et al., 2023). The color differences provide a simple and useful way to familiarize each ward; research reveals that people prefer familiar rooms over decorative rooms (Karlin and Zeiss, 2006). Also, de-stressing a space filled with medical devices gets them away from the fear and anxiety of the medical process. Designers and professional caregivers alike emphasize the benefits of minimalism for patient wellness (Gold, 2019). Lola A. Åkerström, author of *LAGOM: Swedish Secret of Living Well*, noted that " a minimal style of environment allows people to enjoy their tastes without worrying about clutters" (Åkerström, 2017).

To justify *usability*, we considered two approaches: "Content and Shape Matching" and "Reaction Time". Visual communication experts endorse that aligning meanings with shapes is the most effective way to create a successful logotype (Georgi V et al., 2007). The usability of such visual elements (e.g., logotype or way-finding) can be enhanced when they are presented in layperson's terms and shapes (Koleini Mamaghani and Farhoudi, 2018). This is particularly vital in hospital settings where numerous visual elements coexist in a crowded space filled with symbols and tasks, potentially affecting legibility and intended function. Hence, minimalistic visual elements should prioritize not only aesthetics but also usability, encompassing readability and content-shape alignment, to prevent negative distractions. In other words, every visual element in the hospital should blend practicality with aesthetic design. In addition, usability would improve through simplicity and a minimalistic design approach regarding Hick's theory. Essentially, this law notes that the more stimuli the user is presented with, the longer it takes to react, decide, and interact with them (Hick, 1952) (e.g., here, the visual elements). Although this law talks about the number of options (Soegaard, 2022), it is also useful when it comes to quality and design style. In other words, if the inpatients are exposed to plenty of visual element options with a complicated style, their reaction time for decisions (e.g., finding the way) and reaction type (e.g., feeling comfort in a nonmedical setting) would be reduced. It means the visual elements have not done their primary mission of communication. Therefore, we can claim that: the simpler and more minimalistic, the more expected usability of visual elements would happen. Consequently, this justification supports the adoption of simplicity, along with a usability approach.

To address this issue, *"Cuteness Engineering"* as a universal language method is one of the recent approaches that can be adopted to improve the legibility and effectiveness of wayfinding elements and signages (Marcus et al., 2017). For example, emojis or cartoonish images are samples of cuteness design that are simple, useable, and readable. This method has some guidelines, such as being simple, avoiding complexity, using sociable colors, being warm and friendly, inoffensive, and predictable (Rokey, 2019).

Although this combined theme is not lexically coordinated with all branches of supportive theory, it does work in the direction of the Ulrich theory–perception of control (to a great extent), because all three main themes assist patients' independent, needs to be aware of their physical and psychological position in the hospital and to avoid confusion. Therefore, we can confirm that the combined theme of "Applying Simplicity and Usability" in visual characteristics aligns with the patient's perception of control to improve the cancer inpatient's state of mind.

4.2. CO- Th. II. Developing naturality

This combined theme comprises five main themes (the yellow arrows in Fig. 4); BQ. I. (Generating a sense of nature), BQ. II. (Generating physical and psychological comfort), CL. I. (Simulation of nature sense), CL. III. (Using the vibrant and livelier color), and N/AI. II. (Getting close to natural elements). All these main themes converge under the objective of *Developing Naturality* as a common objective. The emphasis on nature and natural elements is consistent across these themes, potentially contributing to comfort and evoking a sense of freshness and hope. Emphasizing harmony with nature can positively influence patients' psychological well-being and expectations, leading to psychological benefits (Shin et al., 2010). This outcome is supported by previous findings suggesting that exposure to nature and nature-related visual elements can reduce stress, anxiety, and pain perception (Nanda et al., 2012). Furthermore, exposure to nature has been identified by patients as a design factor of high priority in general healthcare environments (Karlin and Zeiss, 2006). Lidwell and colleagues–resting on the foundation of decades of empirical studies on the biophilia effect–argue that the emotional, cognitive, and physical benefits of exposure to nature and nature-related views emanate from an innate bias for greenery. They claim this has evolved in early humans as it conferred a selective advantage or a bias likely related to savanna preference (Lidwell et al., 2010). The Savanna Hypothesis argues that those who lived in savannas (open areas, uniform grassiness, jungle, and water) enjoyed a survival advantage over those who lived elsewhere (simpler surroundings such as desert) (Rathmann et al., 2022). This issue would be more crucial for cancer patients who find themselves in a critical step of life. Hence, based on participants' experiences, the nature element has been frequently desired by many cancer inpatients. While the savanna hypothesis is countered by some studies (Moura et al., 2018), plenty of research still supports this hypothesis (Falk and Balling, 2010; Klasios, 2016; Townsend and Barton, 2018). For example, evidence shows that tree shape holds emotional resonance for modern humans and a tree canopy represents habitat and safety in primates' history (Klasios, 2016). We recommend further investigations on savanna preference in design research. In summary, we can confirm that the combined theme of Developing Naturality—in visual characteristics—aligns with the Ulrich theory–positive distraction– (to a great extent) and social support (to some extent) to improve cancer inpatients' state of mind.

4.3. CO- Th. III. Creating homeyness and respecting patients' authorities

This combined theme comprises five main themes, including BQ. II. (Generating physical and psychological comfort), CL. II. (Control of the light level), N/AI. I. (Personalizing the environment), VC. II. (Prioritizing homey atmosphere), and VC. III. (Considering the private atmosphere). We consider both elements of homeyness and respect for personal autonomy as follows:

Based on the interviews, the lack of separability of spaces and privacy has unpleasantly impacted inpatients' state of mind or even dissatisfaction. This situation might give them the feeling of being continuously observed and monitored. Our findings are supported by previous studies reporting that not only do private visiting areas increase satisfaction (Atsavapranee et al., 2023) but they also affect patients' attitudes and perceptions regarding the built environment of hospital facilities; they have a direct bearing on whether or not the hospital provides a welcoming and homely environment (Douglas and Douglas, 2004). Hence, the satisfaction of target groups is improved when the private spaces for every patient are respected (Marin et al., 2018) and created separately (Lawson and Phiri, 2000). Also, it can be expected that having private and homey spaces can achieve heightened comfort levels for cancer inpatients (Marin et al., 2018).

For the element of homeyness, several factors contribute to the sense of home, including psychological factors such as acknowledgment and autonomy, and social factors such as relationships with family and staff, along with having private spaces and personal belongings (Rijnaard et al., 2016). However, a subtle change in furniture arrangements aimed at creating privacy can enhance feelings of homeyness and social support (Rasoulivalajoozi and Farzamfar, 2022).

Beyond ensuring privacy, cancer inpatients also require flexibility in personal activities (e.g., adjusting light levels, decorating, and pursuing

hobbies). In other words, they should feel empowered within their private spaces. While visual elements alone may not instill this sense of authority, we could at least indirectly reduce the effects of unpleasant representative signs and symbols that reproduce the negative metaphors of a hospital. For example, designers can provide patients with a space to bring their personal belongings (Henry Ford Health Staff, 2021), (e.g., plants, pillows, blankets, reading materials, and arts and crafts supplies) (Rasoulivalajoozi and Farzamfar, 2022). In addition, professional caregivers can remove unnecessary medical posters, leaflets, signs, and reminders. This group of visual symbols and images in interior design triggers a sense of non-intimacy and an administrative atmosphere, potentially reproducing medical power-knowledge metaphors (Robert and Wenzel, 2005). "Knowledge is power" suggests that having knowledge provides individuals with control, a concept emphasized by Michel Foucault (White, 2002). Exposure to such meanings and icons potentially gives them a feeling of powerlessness, inflexibility, and non-authority. Instead, we could provide patients with initiatives like music engagement, art therapy, creative expression, and expressive writing (Stuckey and Nobel, 2010). In addition, flexible space in hospital design can be achieved through modular designs, allowing patients to personalize their environments (Price and Lu, 2013).

This combined theme indicates that all five main themes aim to empower patients by providing experiences reminiscent of home. It also recognizes patients' need for flexibility and social support. Therefore, we can affirm that the combined theme of Creating Homeyness and Respecting Patients' Authority—in terms of visual characteristics—aligns with the Ulrich theory—Perception of control (to a great extent), social support (to some extent), and positive distraction (to a lesser extent)—to enhance the state of mind of cancer inpatients.

4.4. CO- Th. IV. Promoting trustworthiness

This combined theme consists of five main themes, including BQ. II. (Generating physical and psychological comfort), BQ. III. (Emotional relationship between professional caregivers and patients), WF. I. (Legibility of information and signs), WF. II. (Receiving info from a credible source), and VC. I. (De-stressing a space filled with medical devices). By juxtaposing these main themes, we identified a new implicit meaning that is not entirely covered by Ulrich's theory. In other words, this group of themes suggests needs beyond those addressed by Ulrich's theory. For example, "WF. II. Receiving info from a credible source implies the patient's dependency on others' help, not merely for help itself, but also for ensuring they are on the right track. Therefore, besides offering social support, the environment should also include elements that provide confirmation and reassurance.

The theme "VC. I. De-stressing a space filled with medical devices," contributes to positive distractions. When we asked our participants about patients' negative reactions to medical devices, the majority agreed that these devices add complexity to an already challenging condition, such as cancer. This situation can create a stressful environment devoid of comforting elements, reinforcing a strictly clinical atmosphere (Care, N.R.C. C. on the R. of H.F. in H.H., 2010). Previous studies confirm that design can work as a language for users (Krippendorff, 2006); here, it seems that being exposed to medical devices or lack of appropriate space allocations may lead to a message of untrustworthiness.

Our findings in this section are supported by studies that have found patients spontaneously discuss trust and its importance, adding to the evidence that trust is essential to patients (Wade, 2020). In the absence of trust, physicians cannot expect patients to disclose their complete medical history, undergo physical examinations, or adhere to recommendations for tests or treatment. Generating trustworthiness may even have therapeutic value, enhancing the efficacy of prescribed treatment (Goold, 2002). Accordingly, all visual elements should highlight a sense of patient trustworthiness, and positively enforce their psychological comfort and the medical procedure in turn. Studies on trust in healthcare are increasing in empirical and conceptual studies (Douglass and Calnan, 2016; Wilk and Platt, 2016) and areas of communications in healthcare centers (Sousa-Duarte et al., 2020). In the realm of service design, prior studies highlighted the role of interactive and trustworthy services in high-risk medical treatments, aiding in informed decisions regarding medication (Rasoulivalajoozi and Touir, 2023). In the field of interior design, designers and nurses can insert factors that contribute to inclusivity, like, for example, using visual languages that match the patients' culture (Lidwell et al., 2010) or employing familiar colors to create a more comfortable environment for patients (Karlin and Zeiss, 2006). Even subtle cues, such as the appearance of medical devices, colors commonly associated with medical spaces, or the attire of professional caregivers, can influence perceptions of trustworthiness.

While most combined themes (CO- I, II, and III) indirectly relate to Ulrich's theory, the combined theme of promoting trustworthiness isn't neatly completely covered by Ulrich's supportive theories. Although promoting reliability is partly linked to social support and a sense of control, the distinction lies in how patients perceive trust within the intangible environment in patients' minds, leading to confidence in the entire caregiving service. This insight enriches existing literature significantly, however, we need further research on this combined theme (CO-IV) within the interiors of cancer wards and other medical facilities.

Limitations and future studies: We conducted this study during COVID-19 (Sep-2021-August 2022), and health protocols limited our access to certain parts of the hospital space which hindered us from taking photographs and interviewing more participants. We were only able to interview nine participants. However, we tried to improve the interview quality by increasing the interview time. More accurate results can be obtained by involving more participants in future research. Furthermore, it was impossible to interview cancer patients due to ethical protocols. Although we limited our study to experienced professionals, they may not have been able to express patients' full inner dialogue and experiences. Accordingly, we recommend that future studies consider both professional caregivers and cancer patients equally so that more comprehensive data can be obtained.

No practical design recommendations are offered in this study. Therefore, future research in design fields can delineate practical design interventions based on our visual design framework and gather patient feedback. This process will help to strengthen or refine the framework presented in this study. In addition, the findings of this study can be compared with existing literature through a systematic review, contributing to the development of a design toolkit for nurses and healthcare interior designers. Ultimately, given that cancer patient groups represent a unique group of patients with heightened sensitivity to their surroundings, our protocol can also be applied to other patient cohorts.

5. Conclusions

In this study, we examined visual elements collectively to understand how these combined themes assist designers in achieving specific design principles and influencing the state of mind of cancer inpatients in the MUHC cancer wards. For this purpose, we employed Ulrich's theory, which considers the factors of perceptions of control (PC), social support (SS), and positive distraction (PD). In our two-step investigation, 14 themes (11 of which related to color and light, natural/artistic image, way-finding, and visual clutters) were found. We demonstrated how each branch of these main themes aligns with the subcategories of Ulrich's theories, namely supportive design theory (PC, SS, and PD). Furthermore, by recognizing similarities in the content and objectives of the main themes, we discussed four combined themes: CO- Th. I. (Applying Simplicity and Usability), CO- Th. II. (Developing Naturality and Homeyness), CO- Th. III. (Respecting Patients' Authorities), and CO-Th. IV. (Promoting Trustworthiness). Our discussion showed that while the first three of the combined themes (I, II, and III) are aligned with

Ulrich's theory, we could not confirm that the fourth combined theme (promoting trustworthiness) fits exactly with Ulrich's theory. Hence, further research on the hospital's visual characteristics could enhance our understanding of trustworthiness. This study aimed to contribute to the toolkits of experts in design practice in health and guide their experimentation with graphics and form language of interior spaces. It also aims to help health managers and professional caregivers adapt to patients' psychological needs and facilitate the treatment process. This study contributes to enriching design interventions in healthcare, specifically principles for interior space visual design. It also aids healthcare managers and professional caregivers in addressing patients' psychological needs and facilitating treatment during hospitalization.

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CRediT authorship contribution statement

Carmela Cucuzzella: Writing – review & editing, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Mohsen Rasoulivalajoozi:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Golriz Farzamfar:** Writing – original draft, Visualization, Resources, Methodology, Formal analysis, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A

Interview Guide

Interview guidelines for the project entitled, "Spatial Experience of Cancer Inpatients in the Oncology Wards: A Qualitative Study in Visual Design Aspects"
Broad questions: (5–7 Min) Please tell me about your professional experience and responsibilities. Probes: job title, years of experience, … How important is it to ensure that patients are in a comfortable place? Are you satisfied with the overall design of the hospital? How might the design and aesthetics of interior space be improved? Let's focus on the particular characteristics of visual items (wayfinding, color, natural/artistic).
Color and light (15–17 Min) How might the lighting (Natural and Artificial) of interior space be improved? How can patients control their desired light? How do the patients feel about the light of the corridor and their rooms? Complaints or suggestions? How do they address their needs for control of lighting? What are their complaints, preferences, influences on mood, and suggestions for improving the rooms' color quality and level of lighting? Do patients have any preference for low or high lighting levels? How do they feel about each type of lighting? How can the windows be improved for the quality of light in interior space? Are the windows well-designed and properly located? How do the patients feel about the scenery outside of the windows? Complaints or suggestions? How might the color of the interior spaces be improved? How do the patients feel about the color of their rooms and the corridor? Complaints or suggestions?
Wayfinding: (7 Min) How might the wayfinding in interior spaces be improved? Please share your challenges and ideas. What is the most visited place by patients in the cancer wards? How do patients usually find their room or specific sections? By asking for help from others, following the floor color or the wall color? How can color help patients find their rooms or other places? (On walls or floor
Nature/Artistic images (5 Min) How do patients feel and react to having painted frames in the hallways or their rooms? Have you heard any suggestions for having their favorite image or painting in their room? How would patients feel if they could bring their plants and flowers into their room?
Visual clutters (7 Min) What are the patients' most common complaints about the interior design of the oncology ward and rooms? How do patients feel when they are surrounded by medical devices and tools? Are they nervous? Do they panic? How would the aesthetic quality of the interior space be improved? For example, could the aesthetic quality be improved by removing some of the drugs and toolboxes (containing brochures, sanitizers, and bins)? How could this interior place create a sense of comfort and/or a sense of belonging for patients and their families? What additional suggestions can you make to improve the aesthetic of the cancer ward? (1 min)
The interview is now over. We greatly appreciate your participation. Please feel free to share any other ideas or comments you have regarding the interior design of the cancer hospital by replying to the invitation email.

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