A Comprehensive Method for Evaluating Healthcare Environments, Resilience and Wellbeing

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SUMMARY

This study describes a mixed-methods methodology using a survey, focus groups and functional scenario analysis to examine the interplay between the built environment, resilience, and wellbeing within a healthcare setting. Results and implications from a pilot study in three operating rooms at a large US hospital are presented.

KEYWORDS

Resilience, Built Environment, Wellbeing

Introduction

Working in a healthcare facility, healthcare professionals are expected to endure high pressure situations without much focus on how these affect wellbeing. Notably, the prevalence of burnout symptoms, stemming from work-related stress (Shanafelt & Noseworthy, 2017), is alarmingly high among healthcare workers, with rates nearly double those found among other professionals in the United States (Shanafelt et al., 2019). This was exacerbated during the COVID-19 pandemic, with approximately 70% of nurses reporting burnout in its aftermath (Wei et al., 2022). Burnout, a prevalent issue within the healthcare field, has been linked to staff turnover, diminished productivity, decreased patient satisfaction, and heightened occurrence of medical errors (De Hert, 2020). The development of resilient systems, that is systems that are able to withstand, respond, and/or adapt to various disruptive events while preserving critical functionality (Hollnagel, 2013), is one way healthcare organisations can mitigate burnout.

The physical environment of healthcare facilities can also significantly affect stress and burnout levels. These spaces can act as stressors negatively impacting mental health or provide restorative experiences for staff (Nejati et al., 2016; Valipoor & Bosch, 2021; Gregory et al., 2022). Recent studies linking healthcare environments to psychological wellbeing with factors such as workspace layout, access to nature, and lighting found to be associated with mental health (Jin et al., 2023). In terms of stress, diffuse lighting is preferred as bright, glaring light can increase stress and making sure the layout of a work area has adequate space for people to move freely can decrease stress (Engineer et al., 2021).

Resilience has also played a pivotal role in the ongoing development of the built environment. Existing research examining the relationship between resilience and the built environment has focused on natural disasters, with a noticeable lack of attention given to healthcare facilities. Literature reviews exploring the healthcare built environment (Bueno et al., 2019; Ellis et al., 2019) do not mention a connection to resilience.

While some research has investigated the influence of the built environment on resilient performance and its connection to burnout, there remains a significant gap in our understanding of how these factors interact within healthcare facilities. Here, we present a methodological approach to examine this relationship. This method assesses the design of a physical space from the viewpoint of the users while also capturing individual and team resilience and staff wellbeing.

Methodological Approach

The method in this study utilises three techniques: surveys, focus groups, and functional scenario analysis. Each contributes unique information to capture the experience of the staff in a given environment and helps to define the relationship between the built environment, resilience, and wellbeing.

Survey

The survey comprises three assessment areas: individual and team resilience, perceptions of the physical workspace, and measures burnout and wellbeing (as well as questions assessing sample demographics).

The need to understand and measure the resilient performance of frontline workers is considerable and led to the development of the Resilience Analysis Grid (RAG; Hollnagel, 2017). This is a commonly utilised tool which was initially developed for team resilience assessment and has been applied across various industries. In standard form it lacks the ability to measure individual resilience but Darrow and Eseonu (2017) adapted RAG to include questions related to individual resilience. The resulting 50-item questionnaire explores each of the resilient capabilities; Anticipate, Monitor, Respond, and Learn. To capitalise on the limited time available to healthcare staff in this project and to decrease response burden, the questionnaire was reduced to 25 questions, 15 questions focus on team resilience and 10 on individual resilience. All of these questions are answered on a five-point Likert scale ranging from Strongly Agree to Strongly Disagree.

The survey asked questions to assess perceptions of unit layout and design to develop an understanding of team collaboration, movement efficiency, and accessibility to key areas (based on Fay et al, 2017). The clinical area beyond the OR was also explored and potential stressors associated with the built environment were explored in a question with a multiple-choice selection based on Lupo et al. (2021). Issues related to burnout and wellbeing were explored using three questions based on Maslach (1981, 2001).

Matterport Integrated Focus Groups

The focus groups were established to explore the challenges and potential remedies originating from the physical environment of the ORs and its impact on staff stress and satisfaction. It was essential for participants to have a good recall of the ORs under study and be able to illustrate discussion points using the physical space. However, conducting the focus groups in the actual ORs was not feasible so the sessions were conducted in a meeting room close to the ORs and Matterport 3D scans of the rooms were utilized to allow participants to interact with an immersive digital twin model of the OR.

The 45 minute focus group sessions followed a semi-structured group interview format and were led by the same researcher for consistency. A set of questions were used to elaborate on the details provided in the survey (e.g., “Why do you think environmental factor a, b, and c were considered more significant causes of stress?”). Strategies were employed to counter perceived concerns originating from organisational hierarchical influences. For each OR two separate sessions were

held—one for anaesthesiologists and surgeons, and one for ancillary staff and to enable participants to offer comments anonymously, responses were collected through an online forum accessed via tablets.

The research team took notes during the sessions, which were later reviewed with comments submitted through the anonymous online form. The data was organised into separate matrices for each participant. These matrices were coded for key themes identified through the survey and participant perceptions that emerged during the focus group discussions.

To test the perceived hierarchical issue one question was posed during the focus groups solely through the anonymous online form to safeguard anonymity: "If the entire OR team was here for this discussion (Surgeon, Surgical Tech, RN, Anaesthesiologist, CRNA), would you feel comfortable to share your honest feedback?" Participants were asked to respond with either yes or no and provide an explanation for their answer.

Functional Scenario Analysis

The functional scenario analysis (Denham et al, 2018; Matić et al, 2022) was used to fully evaluate the physical environment from the perspective of the user. It is an effective tool for understanding how users interact with their environment.

In order to conduct the FS analysis, two sets of information are needed:

(1) Functional scenarios (FSs), illustrating the critical needs of the users in relation to the specific goals or experiences. A list of functional scenarios of users is derived from the focus groups in which we can gather invaluable insights into their spatial demands and lived experiences, especially in relation to stress and mental health.
(2) Spatial evaluation criteria (C), enabling quantification of the design affordance (i.e., how the space supports the users to achieve their desired behaviors) for the defined FSs. The criteria are developed by the team using domain knowledge considering the ergonomics of individuals and the corresponding design elements.

The list of functional scenarios and their related spatial criteria enable the quantification of design affordance of the selected design options from the perspective of specific experiences of the users.

Results

Three operating rooms (OR) at a large US hospital were examined. These were specifically chosen as they had differing spatial layouts and levels of renovation. OR-1 is 712.59 square feet and was last renovated in 2017; OR-2 is 498.05 square feet and was last updated in 1993; and OR-3 is 600.46 and was last updated in 2021.

19 individuals working in the identified ORs participated in the research - three certified registered nurse anaesthetists (CRNA), six registered nurses (RN), seven physicians, and three others (i.e., surgical technologists).

Results Related to Resilience and Teamwork

This study has demonstrated that the layout and state of modernization of the OR space appears to affect both team and individual resilience as well as communication and wellbeing. Participants working in OR-3, the most recently renovated OR, had the highest mean overall scores in communication, team resilience and in the specific team resilience potentials related to anticipate, learn, and monitor. These participants also report a high sense of belonging and a low level of burnout. However, this group had the lowest score in response and the second to last lowest score in

individual resilience. It is proposed that the recency of changes to this OR has resulted in a lack of time working in this new OR lessening their confidence to respond to disruptive events.

It is also concluded that different roles within the OR experience resilience, communication, and wellbeing differently which is not related to the layout of modernity of the OR space. Those participants who classified themselves as "other" (i.e. not CRNA, nurse, or physician) had the highest scores in each category. Physicians had the lowest scores in each team resilience category and the second lowest overall team resilience score. Physicians also experienced the greatest sense of belonging while experiencing the lowest levels of joy. Whilst this appears counterintuitive it is suggested this is due to the greater responsibility felt by participants in those roles, especially for the patient, but this will be explored in future research.

This study has reinforced results from previous research including O'Leary et al., (2011) suggesting that working in more than one team negatively impacts individual and team performance. The results showed that participants working in more than one OR scored lowest in both individual and team resilience, the lowest levels of joy and the second lowest score in communication.

Regarding the perceived organisational hierarchy limiting responses, although many participants felt comfortable sharing their opinions with everyone on their team, some responded that they would feel more comfortable participating in groups that separated physicians from support staff.

Results Related to Functional Scenario Analysis

From the focus group results of the selected ORs, a total of 15 FS under four main themes were developed, as follows:

Theme 1. Patient flow

- FS 1. Team members must be able to move the bed in and out of the room efficiently
- FS 2. Team members need to access pre-op area from the OR efficiently
- FS 3. Team members must access Post-Anaesthetic Care Unit area from the OR efficiently

Theme 2. Organization of the room

- FS 4. Team members need enough space in the OR to move around during the operation
- FS 5. Team members need a clear area to move equipment around without obstructing the sterile field in the Room

Theme 3. Access to facilities, medical equipment, support staff, and team members

- FS 6. RN needs to chart and attend to the needs of the OR
- FS 7. Surgeons need to access a whiteboard to illustrate things during the operation
- FS 8. Team members should be able to visually access screens and monitors during the operation
- FS 9. Team members need to have lightings that provide sufficient visibility to the operating table
- FS 10. Surgeons need to access dictation rooms to chart and attend to the needs of the OR
- FS 11. Team members need to access other team members for work-related and nonwork-related interactions

Theme 4. Staff Well-being

- FS 12. Team members need to access restrooms from the OR efficiently
- FS 13. Team members need to access lounge/break rooms from the OR efficiently

- FS 14. Team members need to access stairways from the OR efficiently in order to use the amenity spaces on other floors, such as locker room and cafeteria
- FS 15. Team members need to access windows from the OR efficiently

The participants reported the important roles of OR room and unit design on their experiences and stress, especially regarding the patient flow (theme 1), organisation of the room (theme 2), access to facilities, medical equipment, support staff, and team members (theme 3), and staff well-being (theme 4). More detailed information regarding the functional scenarios and their spatial criteria could be found on our upcoming publication, Oh. et al. (2024).

Example analysis of Functional Scenarios of the three ORs:

Among the listed FSs, the analysis process of the selected ORs and its entire floor using the two example FSs: FS 2 and FS4

FS 2. Team members need to access preop area from the OR efficiently

For FS2, we evaluate the walking distance from each operating room to various essential areas within the same floor. The importance of this was highlighted by several participants during the focus group discussions. This particular FS focuses on measuring the distance and number of turns necessary to the closest pre-operative area, a location pointed out by multiple participants as crucial due to its significant role in both pre-surgical preparation and post-operative care.

The distances from each operating room to the nearest pre-operative area varied considerably. For OR-1, the distance was 570 feet, while for OR-2, it was significantly less at 249 feet. OR-3 was somewhere in between, with a distance of 488 feet. When considering the number of turns needed to navigate from each OR to the pre-operative area, OR-1, and OR-3 both required 5 turns, while OR-2 necessitated 4 turns (See Figure 1)

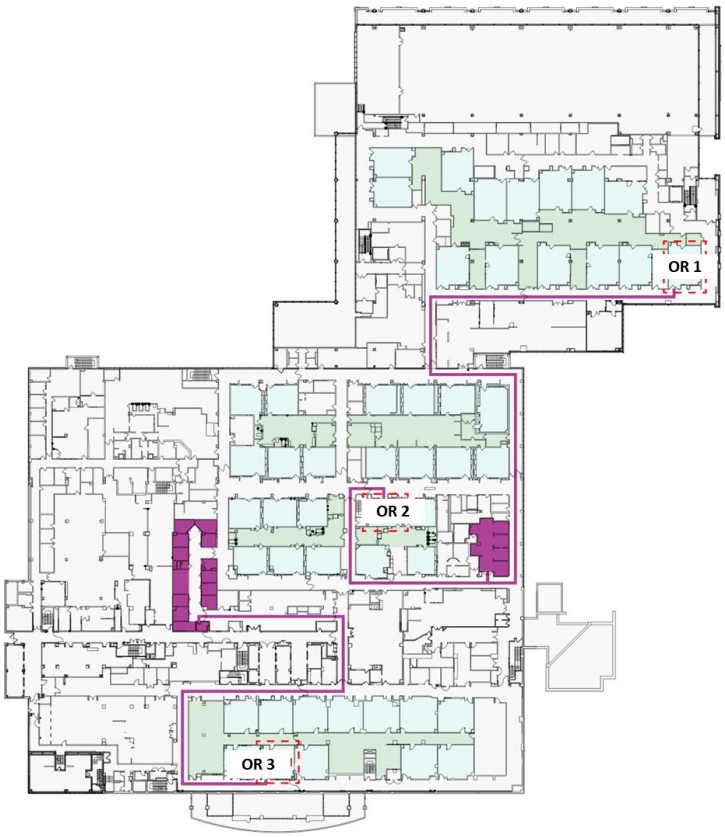

Figure 1. Analysis results of accessibility to pre-op area from selected ORs.

FS 4. Team members need enough space in the OR to move around during the operation

The focus group responses included the clutter issues arising from overcrowding of people and equipment during operating procedures. We address this in our second FS4, by quantifying the unobstructed area available when the room is operating at its maximum capacity, including all necessary equipment and personnel (with 14 individuals with an additional C-ARM equipment). Conversely, as a second criterion, we also evaluate the unobstructed space when the room is at its minimum occupancy (with 5 individuals). This two-pronged approach allows us to assess the spatial functionality of the OR under differing conditions of usage. We include minimum clearance around the personnel and minimum clearance around the surgical table as an obstruction zone as well.

Due to a lack of comprehensive information regarding the positioning of equipment in OR-2, our analysis for this FS was confined to OR-1 and OR-3. In the analysis of room obstruction, we discovered that OR-1 was obstructed by 256 square feet (representing 36% of the total space) in a minimum capacity scenario, and by 378 square feet (amounting to 53% of the total space) in a maximum capacity scenario. For OR-3, the obstruction accounted for 226 square feet (or 37.7% of the total area) in a minimum capacity scenario and escalated to 291 square feet (which is 48.5% of the total area) in a maximum capacity scenario. See Figure 2.

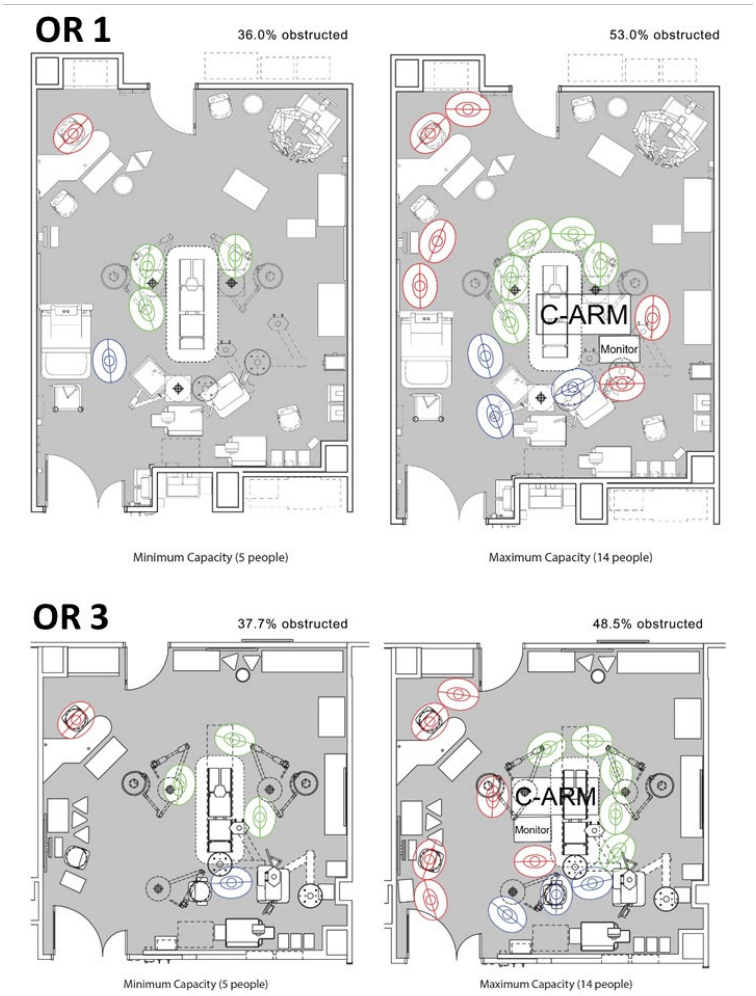

Figure 2. Analysis results of unobstructed area of the ORs

Conclusions

Our results suggest that those who worked in the most recently renovated OR had higher ratings of team resilience and sense of belonging and lower feelings of burnout. Four environmental design factors were found to be associated with feelings of stress: patient flow, room organization, access to proper equipment/staff/facilities, and staff wellbeing. The two more recently renovated ORs performed better in functional scenarios that captured these four categories. However, targeted improvements could be made in all the ORs to improve user experience.

This methodology allows for the robust evaluation of the built environment, transforming anecdotal evidence and personal experiences into actionable, empirical data that can inform future design improvements. Our pilot study confirmed that our new method is a valid and feasible way of understanding the intersection between the built environment, resilience, and well-being. Future work will expand this work to other physical areas of the healthcare environment.

References

Bueno, W. P., Saurin, T.A., Wachs, P., Kuchenbecker, R., & Braithwaite, J. (2019). Coping with complexity in intensive care units: a systematic literature review of improvement interventions. Safety Science, 188, 814-825. https://doi.org/10.1016/j.ssci.2019.06.023

Darrow, L. & Eseonu, C. (2017) Development of a resilience analysis grid survey tool for healthcare. Proc 2017 Ind Syst Eng Conf. Published online 2017:1163-1168

De Hert, S. (2020) Burnout in Healthcare Workers: Prevalence, Impact and Preventative Strategies. Local Reg Anesth. 2020;13:171-183. doi:10.2147/LRA.S240564

Denham, M.E, Bushehri, Y. & Lim, L. (2018) Through the Eyes of the User: Evaluating Neonatal Intensive Care Unit Design. HERD Health Environ Res Des J. 2018;11(3):49-65.

Ellis, L. A., Churruca, K., Clay-Williams, R., Pomare, C., Austin, E. E., Long, J. C., Grodahl, A., & Braithwaite, J. (2019). Patterns of resilience: a scoping review and bibliometric analysis of resilient health care. Safety Science, 118, 241-257. https://doi.org/10.1016/j.ssci.2019.04.044.

Engineer, A., Gualano, R. J., Crocker, R. L., Smith, J. L., Maizes, V., Weil, A., & Sternberg, E. M. (2021). An integrative health framework for wellbeing in the built environment. Building and Environment, 205, 108253. https://doi.org/10.1016/j.buildenv.2021.108253.

Fay, L., Carll-White, A., Schadler, A., Isaacs, K.B., Real, K. (2017) Shifting Landscapes: The Impact of Centralized and Decentralized Nursing Station Models on the Efficiency of Care. HERD Health Environ Res Des J. 2017;10(5):80-94. doi:10.1177/1937586717698812

Gregory, D.D., Stichler, J.F., & Zborowsky, T. (2022). Adapting and creating healing environments: lessons nurses have learned from the COVID-19 pandemic. Nurse Leader, 20(2), 201-207.

Hollnagel, E. (2013). A tale of two safeties. Nuclear Safety and Simulation, 4(1), 1-9.

Hollnagel, E. (2017). Safety-II in practice: Developing the resilience potentials. Routledge. http://dx.doi.org/10.4324/9781315201023.

Jin, H.-Y., Gold, C., Cho, J., Marzban, F., & Lim, L. (2023). The role of healthcare facility design on the mental health of healthcare professionals: A literature review. HERD: Health Environments Research & Design Journal, 16(1), 270-286

Lupo, R., Lezzi, A., Conte, L., Santoro, P., Carvello, M., Artioli, G., Calabr `o, A., Caldararo, C., Botti, S., & Carriero, M. C. (2021). Work environment and related burnout levels: Survey among healthcare workers in two hospitals of Southern Italy. Acta BioMedica: Atenei Parmensis, 92(Suppl 2), e2021009.

Maslach, C. & Jackson, S.E. (1981) The measurement of experienced burnout. J Organ Behav. 1981;2(2):99-113. doi:10.1002/job.4030020205

Maslach, C., Schaufeli, W.B. & Leiter M.P. (2001) Job Burnout. Annu Rev Psychol. 2001;52(1):397-422. doi:10.1146/annurev.psych.52.1.397

Matić, Z., Oh, Y., Lim, L. & Zimring, C. (2022) Placing Users at the Center: Evaluating Exam Room Design for Improved User Experience. HERD Health Environ Res Des J. 2022;15(4):152-166.

Nejati, A., Shepley, M., Rodiek, S., Lee, C., & Varni, J. (2016). Restorative design features for hospital staff break areas: A multi-method study. HERD: Health Environments Research & Design Journal, 9(2), 16-35.

O'Leary, M. B., Mortensen, M., & Woolley, A. W. (2011). Multiple team membership: a theoretical model of its effects on productivity and learning for individuals and teams. Academy of Management Review, 36(3), 461-478.

Oh, Y., Gill, S.A., Daehwa Baek, D., Watral, A., Pulos, B., Thompson, B., Young, S., Guyer, J.M., McCoy, J., Phillips, M., Potts, K., Evenson, L., Lim, L. & Blocker, R. (2024) Improving the Mental Health of Surgical Teams Through Operating Room Design; To be published in HERD: Health Environments Research & Design Journal

Shanafelt, T. D., & Noseworthy, J. H. (2017). Executive leadership and physician well-being: nine organizational strategies to promote engagement and reduce burnout. Mayo Clinic Proceedings, 92(1), 129-146. https://doi.org/10.1016/j.mayocp.2016.10.004.

Shanafelt, T. D., West, C. P., Sinsky, C., Trockel, M., Tutty, M., Satele, D. V., Carlasare, L. E., & Dyrbye, L. N. (2019). Changes in burnout and satisfaction with work-life integration in physicians and the general US working population between 2011 and 2017. Mayo Clinic Proceedings, 94(9), 1681-1694. https://doi.org/10.1016/j.mayocp.2018.10.023.

Valipoor, S., & Bosch, S. J. (2021). In the moment: Fostering mindfulness and reducing stressors in the healthcare workplace. HERD: Health Environments Research & Design Journal, 14(3), 386-398.

Wei, H., Aucoin, J., Kuntapay, G. R., Justice, A., Jones, A., Zhang, C., Santos, H. P., Jr., & Hall, L. A. (2022). The prevalence of nurse burnout and its association with telomere length pre and during the COVID-19 pandemic. PLOS ONE, 17(3), e0263603. https://doi.org/10.1371/journal.pone.0263603