Healthcare Outcome Related Inpatient Unit Environment Function Requirements Extraction: A Multidiscipline Collaborated Investigation

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ABSRUCT

Object: The aim of this paper is to learn from medical providers, patients and families, as well as healthcare environment design experts about the spatial environment function requirements (EFRs) most related to the hospital inpatient unit (IP) design. **Background:** The perspective that healthcare environment has influences on healthcare outcomes and medical activity participants' wellbeing has been the common view of medical, nursing and architecture researchers and practitioners. Besides, the needs of the inpatient unit users are vary with the development of medical, technology and life quality. Therefore, extracting the EFRs origins from the changing needs with regard to IP design is necessary. **Method:** Systemic literature review, expert panel, non-participant observation and affinity diagram were conducted successively to extract-enlarge-verify-modify-classify the EFRs. **Result:** The EFRs were divided into 4 theme categories and over 70 specific entries include: control medical safety, control security, promote care delivery efficiency, and improve physiological & psychological comfort. **Conclusion:** Large body of EFRs should be addressed in the future IP design, or when refurbishing existing counterparts, to order to keep pace with the updating and changes of medical process.

KEYWORDS

inpatient units, environment function requirement, design, medical safety, security, care delivery efficiency, physiological comfort, psychological comfort

INTRODUCTION

Growing numbers of evidence design researches show that healthcare environment is directly contribute to the healthcare outcomes and medical participants' wellbeing(Ulrich et al. 2008, Huisman et al. 2012). IP is critical space for patient recovery. IP EFRs, which act as the bridge between user's need and architecture environment physical element, has been a hot topic in architecture design and research field.

Healthcare Outcome Related Inpatient Unit Environment Functions

The IP EFRs, which have influence on medical outcomes, mainly origins from medical providers and patients & family members' environment related needs

throughout the medical and nursing process(Huisman et al. 2012, Hsu et al. 2019).

From the aspect of medical providers, the IP EFRs include but not limited to: control the medical safety & security risk (CHD 2017). Reduce unnecessary physical consumption. Improve work effectives & efficiency, comfortable and satisfaction(Kotzer et al. 2011). Relieve stress and burnout. Encourage communication & cooperation and simulate responsibility and compassion(Guarascio-Howard 2011). Provide easy access information. Ensure the supplement & technology support and the continuous of care(Jimenez et al. 2019). Help with the attention control & recovery and regulate day-night rhythm.

From the aspect of patients and families' aspect，the IP EFRs include but not limited to: control the safety & security issues and air cleanness. Decrease the average length of stay. Relive pain and negative mood. Encourage the family engagement and social support. Improve the sense of control, autonomy, comfort, orientation and the overall satisfaction(MacAllister, Zimring, and Ryherd 2019, Hsu et al. 2019, CFHD).

Inpatient Unit Environment Elements

Until recently, IP environment elements tend to draw the healthcare environment researches' attention. Growing bodies of researches focus on the physical elements design such as the whole IP, ward, nurse station, corridors, medication room, physician & nurse office and supplement & equipment storage. Physical environment designs, together with the internal elements design such as color, texture, nature and artwork decorations are also popular research target(Pati et al. 2018).

METORDS

The whole research is divided into 5 stages. The first stage is doing systematic literature review to extract the original IP EFRs from the existing researches. The second stage is to enlarge the new EFRs by holding the expert panel. The third stage of observation is to verify the former stages result, and enlarge the addition EFRs left out. The forth stage applies the expert panel again to modify and regulate the professional expressions of the EFRs. In the final stage, the authors together with the experts classify the EFRs with the method of affinity diagram.

Systematic Literature Review

The review followed a two-step process. In the first stage, we conducted key word searches to identify potentially IP-relevant studies published in English. 25 key words referring to physical environmental factors were used, such as *hospital, healthcare*

facility, inpatient unit, nursing unit, inpatient department, patient room, ward, ICU, universal room, nursing station, team work station, medication room, soiled utility room, nourishment pantry, linen storage, equipment storage, clean supply storage, hand hygiene station, physical environment, light sunlight, noise, thermal environment, ventilation. 17 key words referring to healthcare outcome were used, such as *safety, security, efficiency, effectiveness, comfort, privacy, average length of stay, satisfaction, quality, stress, burnout, anxiety, pain, sleep, standardization, sense of control, patient and family centered care.* We conducted an extensive series of cross-searches using combinations of key words through the EBSCO research database, which enabled the simultaneous search of multiple databases, As a supplement in addition, a search was conducted through Google Scholar. Finally we search through the specialized & trusted databases in healthcare design area including The Center for Health Design, Healthcare Design Website and PubMed.

In the second stage, we screen the identified references using two criteria: First, the study should be peer-reviewed. Second the study should apply researches in the field of the influence of Architectural environmental factors on patient, family, or staff outcomes. Over 200 academic papers were reviewed.

Expert Panel

Expert interview and focus group were conducted repeatedly in the second and forth research stage. The expert panelist consisted with physicians, nurse, patients, healthcare environment designers and researchers. The specific constitution shows in *Table 1*.

In the second stage, the EFRs were replenished and subdivided. Firstly, EFRs related to the professional medical process were learnt from physicians and nurses who have medical/ surgical/ maternity IP working experience by 6 Semi-structured interviews (4 physicians' & 2 nurses) and 2 focus groups. Secondly, recovery related EFRs were extracted by holding 2 interviews and 3 focus groups with patients and their family members who have inpatient experience. Finally, researches and designers helped to enlarge the list with their experience. In the forth stage, 2 physicians, 2 nurses, 2 researchers and 1 designers participated in to go through the EFRs list, with the purpose of correcting the impropriate expressions, and remove the controversial parts. （e.g. : whether family accompany should be encouraged in case of emergency procures.）

Table. 1 Expert Panelist

Category	Number	Percentage
Physicians	6	14.0%
Nurses	9	20.9%
Patient & families	16	37.2%
Healthcare environment designers	4	9.3%
Researchers with Ph.D. degree	8	18.6%
Total	43	100%

Non-participant Observation

In the third stage, the observer visits 4 IPs in china, and acted as the intern with permission. The floor layout of each IP was sketched on the record sheet prior to the observations. During the observation, the observer tried to secretly observe the medical provider and patient's needs with least disturbance. When user's need wasn't supported sufficient, the event was recorded together with a mark of location on the floor layout sketch. When collated the observation records, the environment related needs were transferred into the potential EFRs. No private material was collected during the observations.

Affinity Diagram & EFRs Classification

The EFRs collected it the former 4 stages may be overlapping and lack of logic. In the fifth stage, we adopted the affinity diagram to reorganize and classify the acquired EFRs. The author together with 1physician, 1 nurse and 2 researchers participated in the classification. Firstly the EFRs were described in brief sentences with clear original meaning. We wrote the EFR entries, which are elementary units with independent meaning on the blue tags (e.g.: reduce transfer), EFR entry groups with higher level compound meanings on the yellow tags (e.g.: ensure patient safe movement and prevent falls & injuries), while theme EFRs categories at the highest level on green tags (e.g.: control medical safety). Secondly we grouping the blue tags with similar connotations into same group and category after repeated analysis and discussion. Besides, the groups and theme categories descriptions were written on corresponding color tags after integrating with the previous obtained high level EFRs(Cagle 2003). Finally we arranged the blue, yellow and green tags into affinity diagram, whose structure could clearly present the hierarchy, component parts and relationship of all the IP EFRs.

RESULT

In the first stage literature review, 126 EFRs from different hierarchies were extracted, while there are entries overlapping or have similar meaning with different expression (e.g.: “co-location the similar services space” and “provide shortest transfer path”). In the second stage, the EFRs with compound meanings were split, and 6 new EFR entries were included. In the third stage, over 60% EFRs which are closely related to behaviors were observed. Beside we find out 2 extra EFRs by observation. In the forth stage, the experts normalized the inaccurate or similar EFRs (changing “monitor” into “observation”, “treatment” into “medical performance"), thus build the consensus. On the basis of previous four stage investigations，IP EFRs Checklist were finally established (see *Table 2*).

Table. 2 Inpatient Unit Environment Function Requirements Checklist

Theme EFR Category	IP EFR Group	IP EFR Entry
Control medical safety	Ensure patient safe movement and prevent falls & injuries	1.Reduce transfer
		2.Co-location the similar services space
		3.Provide sufficient space dimension and clearance for patient continuous handling and movement device (wheel chair, celling lift, etc.)
		4.Set guardrails
		5.Avoid obstructed or sliding floor, and unnecessary height or material change
		6.Avoid sharp angle, encourage the use of fillet edge
		7.Enable adequate and unobstructed natural/electrical observation
		8.Prevent glare
		9.Reduce visual confusion
		10.Provide controllable light environment
		11.Provide opportunity for accompany (family members, friends or chaperones) without disturbing medical procedures and patient recovery
		12.Enable emergency report, paging and support
	Avoid medical errors	13.Avoid misuse or mix use of space
		14.Provide sufficient space for medical procedures
		15.Encourage standardized process
		16.Prevent glare
		17.Reduce visual confusion
		18.Provide controllable light environment
		19.Reduce the noise
		20.Respect privacy
		21.Encourage intelligent and hand-free facilities
	Control the risk of healthcare associate infection and exposure	22.Avoid misuse or mix use of space
		23.Control access and path
		24.Set isolation ward
		25.Provide easy access hand hygiene station
		26.Use antibacterial and easy maintain materials
		27.Provide access to sunlight
		28.Avoid touch with biological infection sources
		29.Encourage intelligent and hand-free facilities
		30.Avoid sharp angle, encourage the use of fillet edge
		31.Provide controllable ventilation and temperature
		32.Preventing radiation exposure from bedside portable devices

		33.Use antibacterial and easy maintain materials
Control security	Prevent violence and criminal	34.Enable continuous safe guard
		35.Control access and path
		36.Minimize unexpected visibility
		37.Defend high security sensitive areas
		38.Enable emergency report, paging and support
	Prevent patient autonomy or suicide	39.Control the angle of opening window
		40.Set guardrails
Improve the efficiency of care delivery	Improve the efficiency of medical performance	41.Avoid misuse or mix use of space
		42.Encourage standardized process
		43.Provide sufficient space for medical procedures
		44.Reduce visual confusion
		45.Prevent glare
		46.Provide controllable light environment
		47.Reduce the noise
		48.Encourage intelligent and hand-free facilities
	Decrease unnecessary rotational activities	49.Reduce transfer
		50.Co-location the similar services space
		51.Provide easy access supplements (equipment, instruments, and medicine) while treatment
		52.Provide easy access medical record (paper & electrical vision)
		53.Provide easy access medical information (paper & electrical vision & education)
		54.Improve the ability of orientation
	Improve communication	55.Provide sufficient space for staff teamwork
		56.Reduce the noise
		57.Respect privacy
		58.Provide easy access medical record (paper & electrical vision)
		59.Provide easy access information (paper vision & electrical vision & education)
Improve physiological & psychological comfort	Relief negative feelings（stress，burnout, delirium, pain, etc.）	60.Provide accessible biophilic elements e of nature
		61.Provide accessible to peaceful image or music
	Relief fatigue and encourage positive activities	62.Provide controllable light environment
		63.Provide controllable ventilation and temperature environment
		64.Reduce the noise
		65.Prevent glare
		66.Provide staff rest facilities
		67.Provide patient public activity supportive space (nutrition kitchen, activity space, public WC)
	Improve the patient and family engagement	68.Provide easy access information (paper & electrical vision & education)
		69.Respect privacy
		70.Provide adequate space for personal belongings
		71.Provide opportunity for accompany (family members, friends or chaperones) without disturbing medical procedures and patient recovery

CONCLUSION AND DISCUSSION

The IP EFRs checklist incorporates both the existing and new extracted EFRs, which could reflect different IP users' various need. With the support from medical professionals, healthcare design & research expert, as well as the healthcare service

objects, we believe the IP EFRs could be the basis and foundation of the future IP facility design and refurbishment. We anticipate that new EFRs may be embraced continuously with the advancement of research. Besides, the following research may focus on annotating the source of the EFRs, labeling the pretention overlapping or conflicts between the EFRs, determining the priority of EFRs, and come up with the design strategies according to the corresponding EFRs. In order to encourage research findings play a propulsive role in design practice.

References

Cagle, Ronald B. 2003. "7.2 Ordering Techniques." In, 165-176.

CFHD. Patient Room Design Checklist and Evaluation Tool. https://www.healthdesign.org/patient-room-design-checklist-and-evaluation-tool.

CHD. 2017. Safety Modules. In *Safety Modules*.

Guarascio-Howard, Linda. 2011. "Examination of Wireless Technology To Improve Nurse Communication, Response Time to Bed Alarms, and Patient Safety." *Health Environments Research & Design Journal (HERD) (Vendome Group LLC)* 4 (2):109-120. doi: 10.1177/193758671100400209.

Hsu, Clarissa, Marlaine Figueroa Gray, Lauren Murray, Marie Abraham, Wendy Nickel, Jennifer M. Sweeney, Dominick L. Frosch, Tracy M. Mroz, Kelly Ehrlich, Bev Johnson, and Robert J. Reid. 2019. "Actions and processes that patients, family members, and physicians associate with patient- and family-centered care." *BMC Family Practice* (1). doi: 10.1186/s12875-019-0918-7.

Huisman, E. R. C. M., E. Morales, J. van Hoof, and H. S. M. Kort. 2012. "Healing environment: A review of the impact of physical environmental factors on users." *Building and Environment* 58:70-80. doi: 10.1016/j.buildenv.2012.06.016.

Jimenez, Francesqca E., Susan E. Puumala, Michael Apple, Lou Ann Bunker-Hellmich, Renae K. Rich, and Jeri Brittin. 2019. "Associations of Patient and Staff Outcomes With Inpatient Unit Designs Incorporating Decentralized Caregiver Workstations: A Systematic Review of Empirical

Evidence." *Health Environments Research & Design Journal (HERD) (Sage Publications, Ltd.)* 12 (1):26-43. doi: 10.1177/1937586718796590.

Kotzer, Anne Marie, Susan Koch Zacharakis, Mary Raynolds, and Fred Buenning. 2011. "Evaluation of the Built Environment: Staff and Family Satisfaction Pre- and Post-Occupancy of The Children's Hospital." *Health Environments Research & Design Journal (HERD) (Vendome Group LLC)* 4 (4):60-78. doi: 10.1177/193758671100400405.

MacAllister, Lorissa, Craig Zimring, and Erica Ryherd. 2019. "Exploring the Relationships Between Patient Room Layout and Patient Satisfaction." *Health Environments Research & Design Journal (HERD) (Sage Publications, Ltd.)* 12 (1):91-107. doi: 10.1177/1937586718782163.

Pati, Debajyoti, Jaehoon Lee, Sahar Mihandoust, Mahshad Kazem-Zadeh, and Youngha Oh. 2018. Top Five Physical Design Factors Contributing to Fall Initiation.

Ulrich, R. S., C Zimring, X. Zhu, J Dubose, H. B. Seo, Y. S. Choi, X. Quan, and A Joseph. 2008. "A review of the research literature on evidence-based healthcare design." *Herd* 1 (3):61.