

Cancer Treatment Environments: From pre-design research to post-occupancy evaluation

This research focuses on patient needs in ambulatory cancer treatment environments and identifies a range of design strategies to create an environment that fosters patient care and satisfaction – including a feeling of hope

Zhe Wang, Ph.D., RA, LEED AP, EDAC, Michael Pukszta, AIA, Natalie R. Petzoldt, AIA, LEED AP, EDAC, Jennifer Hendrich Cayton, LEED AP

Each year 1.5 million people are diagnosed with cancer in the US – it is the second leading cause of death in the country. Although the five-year relative survival rate in cancer patients increased from 50% in the 1970s to 66% in 2009, quality of care and patient satisfaction need to be further improved to support this patient population¹.

Very limited research has been conducted to investigate cancer treatment environments where the typical treatment regimen is ambulatory-based. More than 50% of cancer patients receive chemotherapy², for which they visit infusion centres. However, findings from research studies on inpatient environments may not be applicable to these environments. For instance, while there may be compelling evidence on infection reduction with single-patient rooms, such treatment settings may reduce the ability to summon help from nurses in infusion environments^{3,4}.

Credible research needs to be conducted to promote evidence-based design for quality infusion patient care and satisfaction. In our project, an interdisciplinary team systematically conducted pre-design and post-occupancy research on cancer treatment environments, with an emphasis on infusion settings. The aims of this research were: to identify the needs of patients while undergoing infusion treatment; to develop potential environmental design solutions to fulfill the needs; and to validate significant environmental design strategies for infusion patient care and satisfaction.

Pre-design research

During infusion treatment, patients are administered fluid medication intravenously, which may be associated with physical

reactions such as feeling cold, nauseous and/or dizzy. Procedures for an infusion treatment session vary in length of treatment time ranging from 15 minutes to over eight hours.

Pre-design research regarding patient experiences of infusion environments was conducted in five cancer centres in the US. From 2000 to 2007, more than 300 cancer patients participated in a series of surveys, interviews and focus-group discussions at the Siteman Cancer Center (St Louis, Missouri), the Clarian IU Simon Cancer Center (Indianapolis, Indiana), the Todd Cancer Institute (Long Beach, California), CancerCare of Maine (Bangor, Maine) and the Karmanos Cancer Institute (Detroit, Michigan). These cancer centres include both community-based cancer centres and National Cancer Institute (NCI)-designated comprehensive cancer centres. The participants represented a broad spectrum of cancer types (e.g. brain, breast, lung, stomach, colon and blood); 76% were female and 70% were over the age of 50.

Interviews and patient surveys were conducted to collect data on patient needs during infusion treatment, using a questionnaire developed specifically for infusion patients. It included a group of open-ended questions asking what types of treatment environment patients experienced, what their feelings were with regard to how these environments met their needs, what kind of amenities they desired in their treatment environments, and what was important to them in a future treatment environment. Participants could select multiple options from a list or write their own answers. Questionnaires were distributed to patients; their family members were also encouraged to participate. Face-to-face interviews were held with patients and their family members at the cancer centres. Participants discussed their experiences regarding what environmental

elements had helped, or could help, them to get through the treatment sessions and what their ideal treatment environment would be. Responses to the questionnaire surveys were documented in computer programs and interviews were video-recorded. A panel of healthcare designers conducted content analysis of these data.

Based on these surveys and interviews, focus-group sessions were held to discuss preliminary results from the content analysis and to establish design concepts. The sessions were attended by facility managers, architects, interior designers, planners, engineers and project executives at the cancer centres.

Findings and discussion

Associated with demographic factors, results from this pre-design research revealed



Family lounge at the Simon Cancer Infusion Center
Photo: Hedrich Blessing Photography

prominent needs of infusion patients, which can be classified into three categories: 1) choice and control; 2) privacy and social support; and 3) positive distractions. Fulfilling these needs is thought to foster a feeling of hope for future treatment. It helps patients to endure chemotherapy and maintain the willingness to continue the treatment.

Choice and control. Choice and control are of high importance to patients⁵⁻⁷. "A sense of control is important because cancer takes away your control," was stated by a patient in a focus-group discussion at the Todd Cancer Institute. Questionnaire responses to "what control would an infusion patient most want?" were related to light, sound and temperature. Temperature control ranked as the top priority by these participants. This is most likely related to patient reactions to chilled fluid medications. Allowing patients to individually control their treatment environments may increase patient satisfaction. From the perspective of environmental design, possible solutions included multiple HVAC control zones, radiant heaters over each patient station and/or infusion recliners with heated-seat options. These solutions should be considered in the planning and early design.

Privacy and social support. Private treatment rooms were preferred by 50% of the survey participants, while 28% always chose a shared space and 22% were flexible - it depended on how they felt on a treatment day. Interestingly, these responses varied depending on the type and location of participants⁸. For instance, in Chicago, 67% of the respondents at a women's cancer centre preferred private rooms. Sixty-five percent of the participants in a large NCI-designated cancer centre in the Midwest also desired a private room for their treatments, while the percentage in a community-based cancer centre in the Southwest was 27.

During the focus-group discussions, the desired type of treatment environments varied as well. Some patients stated that they may not like having others with them during the treatment sessions. One patient stated: "Don't put us in a big fish bowl!" – referencing a large space with patient treatment recliners facing one another. This reflected patients' negative responses to shared treatment spaces. However, other patients spoke about the incredible support they received from peers going



Figure 1: Floor plan of the Simon Cancer Infusion Center

through similar treatment. A patient in the Todd Cancer Institute said: "I really felt good about helping a patient sitting next to me. She didn't speak English, but holding hands with another patient means the same thing in any language."

In order to meet the different patient preferences, the team noted that an infusion environment should have three types of treatment settings: private treatment rooms, semi-open areas (defined as treatment areas with other infusion patients and retractable screens or curtains), and open areas with other patients receiving infusion treatments. This offers patients the potential ability to choose a desired treatment setting depending on how they feel on the day of treatment. Given the demographic and geographic changes in preference, it is important that design teams work with the staff at each centre to understand the unique characteristics of the patient population and to determine the appropriate mix of private and open treatment stations.

On the other hand, nurses noted the importance of seeing patients' faces in case of medication reaction. Most patients also expressed a desire to 'be seen' by nurses during treatment rather than being physically isolated from them⁹. Compared to watching infusion patients in open areas, providing direct visual control to patients in private rooms may be more challenging to nurses. The proximity of private treatment rooms to nurse stations should be ensured.

Positive distractions. Regarding positive

distractions, survey participants were asked what types of amenities they would like to have in an infusion treatment area. Reading, television, computer access, window views, access to food and drink, and taking a nap were popular amenities. Therefore, design strategies for providing areas for reading, private television, wireless computer access, views to landscaped environments, access to nutrition areas and spaces for blanket storage should be considered.

Surprisingly, the most desired amenity was a guest chair for companions and visitors – cited by 90% of survey respondents. Therefore, to enhance the social amenity, a design strategy of planning space for at least one guest chair beside each treatment recliner was identified by the team. The team also suggested family lounge spaces to facilitate social interaction.

Development of design strategies

Outcomes from the pre-design research informed decision-making during the planning and design of six cancer centres, including the Simon Cancer Infusion Center in Indianapolis, Indiana. Design strategies developed from the pre-design research were applied in the infusion environments to promote patient care and increase satisfaction¹⁰.

The previous setting for infusion services at the Simon Cancer Center was on one floor of a small office building designed in 1990. As the need for infusion services grew, the cancer centre had to put more patients in the environment than it was



Figure 2: Photo of semi-open infusion station with screens

originally designed to accommodate. As a result, there was little room for family members to be with the patient during treatment. Planning spaces for family members was an important design consideration when planning started in 2005. The 28,500 sq ft department was anticipated to include 60 patient stations at full build-out, tripling the previous setting's capacity. The population served was a mixture of urban and rural patients, ranging in age from 18 to 80 years and over, with the majority between 65 and 85. The centre treats most cancer types with the exception of bone marrow transplant.

Methodology

The design team consisted of architects, interior designers, engineers and facility administrators at the cancer centre. During early discussions between team members, it was agreed that the previous environment did not accommodate patient needs. To better understand patient needs, the design team established a patient focus group whose role was to inform the team about the unique needs of this patient population. The focus group consisted of a representative cross-sample of 15 patients who had received infusion care at the Simon Cancer Center or at other cancer centres in the county.

The design team met with the focus group on a regular basis during the design process, as well as with infusion staff. During the meetings, a detailed survey with open-

end questions was implemented to better understand patient needs as they related to the treatment environments. Comments and suggestions from this survey and insights brought forward by patient were openly discussed in two one-hour meeting sessions. The insights brought forward by patients were discussed in depth. To further incorporate inputs, a visioning session was held with the focus group to understand the cancer care environment they would create if they could. Photographs of all types of infusion environments were reviewed with the focus group and staff, and consensus was reached with regard to what the desired environment would be.

Design strategies

To promote patient choice and control, the design team established the following strategies:

- providing different types of treatment areas including private, semi-open and open stations;
- providing retractable screens in each semi-open treatment station;
- distributing service areas including nurse stations, nourishment stations and patient toilet rooms to reduce the distances that patients need to travel;
- differentiating treatment pods to improve legibility for wayfinding;
- providing spaces for information desks and graphic signage; and
- providing alternate environments for patients and family members to

experience during treatment that were in close proximity to the infusion area, including a roof garden and a cafeteria. Heated-seat treatment recliners were also recommended to the centre to promote patient control.

To balance patient needs for privacy and social support, design strategies applied in the infusion centre included:

- providing private/semi-open/open treatment stations;
- providing retractable screens in each semi-open treatment station;
- distributing patient toilets;
- providing spaces for guest chairs; and
- creating a lounge area with a faux fireplace adjacent to the nurse station.

To develop positive distractions in the treatment environments, the team developed both architectural and interior design strategies. The architectural strategies focused on developing quality window views, including: selecting appropriate building orientation to invite daylight and active views into the interior; developing a multiple-edge floor plan to increase opportunities to open windows to the outside; appropriately placing windows for quality views; and creating a garden adjacent to the building for visual access to nature.

The interior design strategies included: providing appropriate artwork, developing areas for book/magazine reading, providing patient recliners with tablet arms, providing a wireless internet connection, providing spaces for personal television, and providing food/drink and personal storage spaces.

Most cancer centres use fabric cubicle curtains to divide open treatment areas between patients for privacy. In the design of the Simon Cancer Center, the team designed a retractable screen between each of the semi-open treatment stations. In a fully open position, the patient could interact with one or more patients. In a closed position, the patient was visually separated from other patients but staff could still observe the patients. The three-part screens were frosted glass in a wood frame, installed with a ceiling track only to address concerns of infection control.

In addition to the semi-open treatment areas with screens, the design team planned four open stations with a faux fireplace adjacent to the nurse station. Here patients

could sit in an 'informal' setting with all the required access to medical gas and electrical power for the chemotherapy infusion pumps. The centre was built and opened for patient care in September 2009. Shell space was included to allow future build-out of 20 treatment stations and associated support spaces.

Post-occupancy research

Post-occupancy research, including surveys and observations, was completed in the Simon Cancer Infusion Center to investigate the significance of the applied

design strategies. Significant strategies were revealed by quantitative and qualitative data analysis.

In May 2010, on-site observation regarding the design and utilisation of treatment environments was completed in the infusion centre. In June 2010, 165 patients were surveyed in the centre, regarding their environmental experiences and perceptions of privacy, stress, comfort, satisfaction and hope (defined as feeling hopeful about future treatments). All patients were invited to participate and participants were screened by nurses to

verify their competence for answering survey questions. Hard-copy questionnaires were distributed to patients at the beginning of their treatment sessions and collected at the end. Response rates were from 20% to 45% depending on the survey day. The average age of participants was at the range of 51~60; 70% were female; 85% were Caucasian.

Methodology

Before the aforementioned surveys were distributed, two researchers observed the use of public spaces and treatment stations

| Patient needs | Design strategies to help fulfill the needs | Significance identified by POE | Methodology | |
|--|--|---|--------------------|---|
| Choice & control | <i>Providing multiple types of treatment environment to allow choice</i> | Having a desired treatment space in term of type* was positively related to patient satisfaction, comfort and hope | Survey data, ANOVA | |
| | <i>Providing adjustable screens in each treatment station to facilitate control</i> | 27 out of 165 patients used their retractable screens | Observation | |
| | <i>Reducing the distances between places that patients need to travel</i> | Wayfinding** and distances** were related to patient stress, comfort, satisfaction and hope | Survey data, ANOVA | |
| | <i>Differentiating treatment pods to improve legibility</i> | | | |
| | <i>Providing spaces for information desks and graphic signage</i> | n/a | | |
| | <i>Multiple HVAC control zones</i> | | | |
| <i>Providing comfortable recliners</i> | Recliner comfort* was positively related to patient satisfaction | Survey data, Regression | | |
| Privacy | <i>Providing multiple types of treatment environment to allow choice</i> | Having a desired treatment space (type*) promoted satisfaction, comfort and hope | Survey data, ANOVA | |
| | <i>Providing adjustable screens in each treatment station</i> | 27 out of 165 patients used their retractable screens. | Observation | |
| | <i>Distributing patient toilet locations</i> | Accessibility to patient toilets** was related to patient privacy, stress, satisfaction, comfort and hope for future treatments | Survey data, ANOVA | |
| Social support | <i>Providing spaces for guest chairs</i> | Of 248 patients, 99 had one guest and 20 had two or more in their treatment stations | Observation | |
| | <i>Creating lounge spaces</i> | 93 of 160 patients would not like to stay in a lounge space during treatment | Survey | |
| Positive distractions | <i>Selecting appropriate building orientations</i> | Window view** was associated with patient privacy, stress, comfort, satisfaction and hope | Survey data, ANOVA | |
| | <i>Developing a floor plan with multiple edges for windows to the outside</i> | | | |
| | <i>Appropriately placing windows</i> | | | |
| | <i>Developing a roof garden</i> | 1 of 148 patients watched artwork in observation | Observation | |
| | <i>Providing appropriate artwork</i> | | | |
| | <i>Providing areas for book and magazine reading</i> | | | 35 of 148 patients read during observation |
| | <i>Providing recliner with tablet arm</i> | | | 89 of 106 patients used their tablet arms |
| | <i>Providing wireless internet access</i> | | | 9 of 148 patients used their computers |
| | <i>Providing spaces for personal television</i> | | | 56 of 146 patients watched their television |
| | <i>Providing spaces for food/drink storage</i> | | | 74 of 137 patients drank and 10 of 141 ate during observation |
| <i>Providing spaces for social interaction</i> | 57 of 88 patients interacted with guests and two of 98 patients interacted with each other during observation. See also Social Support | | | |

Table 1: Patient needs, design strategies and significance

Note: Design strategies in italic font were applied in the Simon Cancer Infusion Center. Multivariate Ordinal Regression Model Fitting: p<0.001; * p<0.05; ** p<0.01 n/a: not applicable in this POE research.

Numbers of total patients in the observations may be different due to data availability. Hope is defined as feeling hopeful for future treatments.

for two weekdays in the infusion centre. Patients and staff were not informed of the observation in advance. The observation protocol included two parts: environmental items and user behaviour. To represent a typical work day in the centre, one-hour timeslots were selected for the observation: the early morning, late morning, after lunch and mid-afternoon. The researchers were trained on observation coding and used consistently in the observation to ensure similar decisions about similar events on the different occasions. The inter-observer agreement was almost perfect ($Kappa > 0.8$).

A questionnaire was specifically developed for the surveys, with an emphasis on the applied design strategies. Questionnaire items on infusion environmental design were created for this research. Participants were asked in which type of infusion environment (private/semi-open/open area) that they received treatment in the survey day. The patient's preferred type of treatment environment was also ascertained. Detailed environmental items were surveyed, regarding the recliner, window view, lounge spaces, access to patient toilets, wayfinding and distances between places where patients needed to travel. Besides demographic factors, social items considered as possible confounding variables were also collected, such as interactions with other patients. Survey items on stress, that had acceptable validity, were adapted from Filege's study¹¹. A six-point Likert Scale from 'strongly disagree' to 'strongly agree' was used to measure responses.

Analysis of the survey data was conducted using the Statistical Package for the Social Sciences (SPSS, version 16.0). Normality plots and histograms were used to test the distributive normality of all study variables. Bivariate correlations among variables were analysed through Spearman Correlation and Chi-square. T-test and one-way ANOVA were conducted to identify significant differences between groups.

Findings and discussion

Having infusion treatment in one's desired treatment environments, in terms of type (private/semi-open/open areas), was positively associated with perceived environmental comfort, satisfaction and hope ($p < 0.02$). Other significant

environmental features associated with patient care and satisfaction included access to patient toilets, window view, wayfinding and distances between places that require patients to travel ($p < 0.01$). Patients' perception and utilisation of the lounge spaces were different from what was expected. Findings from the surveys were supported by those from the observation. Observations further identified the importance of including patient tablets, food/drink storages and guest chairs in the treatment environments.

Typology of treatment stations. Reported environmental satisfaction, comfort and hope were significantly higher among the patients whose treatment environments were in their desired types than those among other patients ($p < 0.02$). Allowing patients to choose desired spaces for treatment may improve patient satisfaction and thus help them to feel hopeful for future treatments. To allow choices, offering different types of spaces for infusion treatment is necessary and should be a basic provision in the design of an infusion centre.

The three types of treatment stations in the Simon Cancer Infusion Center are private stations in single-patient rooms, semi-open stations with retractable screens and open stations. Details of the retractable screen have been introduced previously. According to the data from our observations, some patients closed their screens during napping, procedures and if they had several guests. Meanwhile, staff also informed the team that moving the screens had been suggested to patients after their first visit, as a result of the staff's need to observe new patients for possible adverse reaction to medication. Allowing patients a choice to screen their treatment environments may psychologically foster a sense of control and help patients feel satisfied, comforted and hopeful⁵.

Access to patient toilets. Access to patient toilets during infusion treatment was highly associated with patient privacy, stress, satisfaction, comfort and hope ($p < 0.01$). These findings emphasised the importance of patient toilet accessibility in infusion settings. When planning infusion environments, it is critical to consider distributed locations of patient toilets. Infusion patients may use toilets more frequently than typical patients in healthcare

facilities due to long treatment sessions and administration of fluid medications. Based on appropriate building codes and accumulated professional experiences, the ratio of toilet rooms to patient treatment stations applied in the Simon Cancer Center's infusion centre was 1:6. During on-site observation, no patients were documented waiting for toilets.

Window view. Patients who had an enjoyable window view to the outside during infusion treatment reported higher levels of privacy, comfort, satisfaction and hope and lower levels of stress than those who did not have the view. Findings from previous research have shown that quality window views help reduce stress, decrease pain medication usage and promote faster patient recovery¹²⁻¹⁴. Our study further supports these findings. To increase the opportunities for accessing views to the outside, the design strategy of developing a floor plan with multiple edges should be considered.

To improve the quality of window view, strategies of appropriately placing windows with views to landscaped space should be considered. Previous design research also recommends designers carefully consider the surroundings while making decisions about site planning and building orientation, to invite quality window views including active street views and appropriate daylight to the interior^{15, 16}. Due to site constraints and connections to existing buildings, the Simon Cancer infusion centre did not allow opportunity for windows in private treatment rooms, but moving forward this should be considered.

Wayfinding and distances. Good wayfinding was associated with high levels of patient comfort, satisfaction and hope, and lower levels of stress. Previous studies have shown that stressful wayfinding problems could be addressed by appropriate spatial reference frames¹⁷⁻¹⁹. These findings further support the design strategy of distributing service areas, including toilet rooms, medication, nourishment and blanket storage, in infusion settings. This strategy helps to reduce the distances between places that require patients to travel and thus facilitate wayfinding. Appropriate distances between these places were also associated with high levels of patient comfort, satisfaction and hope, and lower levels of stress. In addition, the Simon

Cancer infusion centre is legibly divided into three pods linked by a short corridor with direct access to the waiting room. Graphic signage and staff designation are also applied to reinforce wayfinding.

Lounge spaces and guest chairs. Surprisingly, 93 of the 160 survey participants indicated in their questionnaire responses that they would not like to sit in the lounge area designed for them. One possible explanation is that patients may not like sitting in an 'informal' setting during infusion treatment. Additionally, during observation, the design team learned that the staff did not allow the patients to choose a recliner in the lounge space. However, the lounge space was used by patient companions during treatment procedures for napping and reading.

In future planning, it is important to understand whether the staff would support a group space for patients receiving treatment. Given the observed guest use of the lounge area, additional places of respite for patient companions should be considered in planning.

Moreover, interaction with other patients was not shown to be related to perceived care and increased satisfaction. During the on-site observations, a few patients interacted with each other. However, most patients did interact with their companions in their treatment stations. An important design consideration is the selection of appropriate guest chairs for long periods of sitting. The team also noted that 119 out of 248 patients had 1-5 companions in their

treatment stations and nursing staff had made accommodation for addition flexible seating and storage. To plan an appropriate size for treatment stations, it is important to identify how many guests typically accompany patients.

Other interior design strategies. Recliner comfort was positively related to patient comfort, satisfaction, hope and stress reduction. When selecting furniture, design teams should pay special attention to the comfort level of recliners. If possible, a focus group of chemotherapy patients should be included in the selection process. During the observation, 89 out of 106 patients used their recliner's tablet, a swivel table built into the recliner. Patient tablets play an important role in treatment sessions, providing a place where patients can put their personal belongings, beverages and books. Given the side-effects of chemotherapy, it is critical for patients to drink water during infusion treatment. During the observation time, 74 out of 137 patients drank. Spaces for food/drink storage should be included in the treatment environments for patient convenience.

Conclusion

With a strong impact in future research and evidence-based design, this project identified that significant environmental features in outpatient settings are similar but different from that in inpatient environments. Design strategies developed through inductive analysis of the needs may

help to improve patient care and increase satisfaction. However, designers should not assume the same results of their design. The validity and reliability of suggested design strategies need to be examined with respect to the unique characteristics of target patient population.

As more than 70% of participants in the pre-design and post-occupancy research were female and 85% of the POE survey participants were Caucasian, male patients and other races were not well represented in this research. Future studies on cancer treatment environments should incorporate more gender-balanced and ethnically diverse samples. The survey items created for this study to investigate design strategies can be further developed to guide future research.

Acknowledgements

We would like to thank Peter Hourihan for his valuable recommendations that improved the quality of this paper, and Dore J Shepard for her kind assistance in the POE surveys.

Authors

Zhe Wang, PhD, RA, LEED AP, EDAC, is a senior researcher with Cannon Design in St Louis, Missouri

Michael Pukstza, AIA, is a principal at Cannon Design

Natalie R Petzoldt, AIA, LEED AP, EDAC, is an associate principal at Cannon Design

Jennifer Hendrich Cayton, LEED AP, is an architect at Cannon Design

References

1. American Cancer Society. *Cancer Facts & Figures 2009*. Atlanta, GA: American Cancer Society; 2009.
2. AMGEN. *Treating Cancer With Chemotherapy*. Available at: www.chemotherapy.com. Accessed 1 March 2010.
3. Ulrich RS, Quan X, Zimring C, Joseph A, Choudhary R. *The Role of the Physical Environment in the Hospital of the 21st Century: A once-in-a-lifetime opportunity*. Report to Center for Health Design for the Designing the 21st Century Hospital Project. Center for Health Design; 2004.
4. Lawson B, Phiri M. Hospital Design: Room for improvement. *Health Service Journal* 2000; 110(5688):24-26.
5. Stokols D. Establishing and Maintaining Healthy Environments: Towards a social ecology of health promotion. *American Psychologist* 1992; 47(1):6-22.
6. Scheidt RJ, Norris BC. Place Therapies for Older Adults: Conceptual and interventive approaches. *International Journal of Aging & Human Development* 1999; 48(1):1-15.
7. Ella KO, Mantell JE, Hamovitch MB, Nishimoto RH. Social Support, Sense of Control, and Coping Among Patients with Breast, Lung, or Colorectal Cancer. *Journal of Psychosocial Oncology* 1989; 7(3):63-89.
8. Pukstza M. Balancing Patient Desires with Environmental Evidence. *Oncology Issues* 2010; May/June 2010:25-29.
9. Petzoldt N. Infusion of Design with Evidence. *Journal of Multidisciplinary Cancer Care* 2010; 3(8).
10. Pukstza M, Petzoldt N, Wang Z, Cayton J. *Start Your Research Engine! Research-informed design of the Simon Cancer Center*. Paper presented at Policy & the Environment – Proceedings of the Environmental Design Research Association's 41th annual conference, 2010; Washington, DC.
11. Fliege H, Rose M, Arck P et al. The Perceived Stress Questionnaire (PSEQ) Reconsidered: Validation and Reference Values From Different Clinical and Healthy Adult Samples. *Psychosomatic Medicine* 2005; 67:78-88.
12. Ulrich RS. View Through a Window May Influence Recovery from Surgery. *Science* 1984; 224(4647):420-421.
13. Marcus CC, Barnes M. *Gardens in Healthcare Facilities: Uses, therapeutic benefits, & design recommendations*. Martinez, CA: Center for Health Design; 1995.
14. Kline G. Does A View of Nature Promote Relief From Acute Pain? *Journal of Holistic Nursing* 2009; 27(3):159-166.
15. Wang Z, Lee C. Site and Neighborhood Environments for Walking among Older Adults. *Health & Place* 2010; 16:1268-1279.
16. Wang Z, Rodiek S, Shepley M. Residential Site Environments and Yard Activities of Older Adults. *Report on University Research Vol 2*. Washington, DC: The American Institute of Architects; 2006:37-57.
17. Werner S, Schindler LE. The Role of Spatial Reference Frames in Architecture, Misalignment Impairs Wayfinding Performance. *Environment and Behavior* 2004; 36(4):461-482.
18. Peponis J, Zimring C, Choi YK. Finding the Building in Wayfinding. *Environment and Behavior* 1990; 22(5):555-590.
19. Haq S, Zimring C. Just Down The Road A Piece: The development of topological knowledge of building layouts. *Environment and Behavior* 2003; 35(1):132-160.