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Best Practices for Wayfinding in a Hospital Setting

CAPSTONE REPORT

Jerrod S. Potter
Clinical Informaticist
Salem Health

University of Oregon
Applied Information
Management
Program

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Academic Extension
1277 University of Oregon
Eugene, OR 97403-1277
(800) 824-2714

Approved by

Dr. Kara McFall
Director, AIM Program

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Salem Health

Abstract

Wayfinding within healthcare facilities has been a task for designers for many decades, but with a low priority. In recent years, the discipline has become recognized as a viable option for hospital executives and administrators as a means to cost-savings. The implementation of signage consisting of symbols and pictograms leads to better patient outcomes and increased staff satisfaction. This annotated bibliography provides best practices for implementing wayfinding in a hospital setting.

Keywords: wayfinding, symbols, healthcare, return-on-investment, hospital, navigation, images, pictograms, decreased costs

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Introduction to the Annotated Bibliography

Wayfinding Challenges in a Large Hospital

Hospitals have complex functions and programs, and thus their facilities can become mazes of disconnected, disorienting spaces (Rousek & Hallbeck, 2011a). There are myriad difficulties that new employees, patients, patient family members, and visitors of all sorts have while navigating their ways through large hospital settings, including hospitals with over 400 patient beds (Cooper, 2010). Many hospitals and healthcare facilities have been expanded and reorganized because of mergers, integration, and strategy changes, which make it more challenging for patients and even workers to find their destinations (Rousek & Hallbeck, 2011b). Hospital expansions create new corridors that people use to travel to other buildings, and those buildings have their own sets of navigation challenges, including multiple levels, hallways, and rooms (Cooper, 2010). As a result of these changes, navigating a large hospital may be overwhelming (Cooper, 2010).

According to Mollerup (2009), there are four reasons why people have difficulty finding their way around a hospital. Firstly, hospitals are complicated built environments. There was probably a clear plan when the hospital was founded. However, later additions and changes may have compromised the good intentions of the original planners. A second cause why many patients and visitors have problems finding their way in hospitals is that they are first time visitors, or that the hospital has been rebuilt, or its functions have been relocated, since their last visit. A third cause of wayfinding difficulties in hospitals is the names of units on signs. They are often long, difficult, and similar to each other. A visitor heading for the gastroenterologic clinic, for example, may head for the first unit with a name beginning with *gastro*. A fourth cause for wayfinding problems is that many patients and other visitors have reduced capacities of one kind

or another. Perhaps visual impairment, reduced mobility, or reduced mental capacities are the causes for their reduced capacities. Finally, anxiety is known to weaken the wayfinding capabilities of both patients and visitors (Mollerup, 2009).

Large hospitals typically have service areas in common, including surgery, labor and delivery, and cardiology. These areas involve a high volume of patients, visitors, and employees who all navigate their ways to their ultimate destinations, and they need effective assistance in doing so (Campbell & Scott, 2014). Nurses and other healthcare providers must sometimes stop their work to direct lost individuals looking for their destinations. This problem affects the morale of the staff and can lead to a decline in good patient care (Cooper, 2010). More than 1,000 research studies suggest better healthcare facility design can improve patient care and medical outcomes and can decrease medical errors and waste (McCullough, 2009).

Effective wayfinding, defined for the purposes of this study as the use of symbols and images on signage, can help people traveling through hospitals to do so efficiently (Cooper, 2010). Ineffective wayfinding in common areas can result in several of the following problems: late arrival to scheduled outpatient visits or inpatient admissions that lead to a disruption in care for the patient, as well as stress and difficulty for the staff who manage a daily schedule involving many patients throughout a workday (Cooper, 2010). A specific example is delivering mothers who are unable to locate the labor and delivery floors and, therefore, face risks for unsuccessful deliveries (Cooper, 2010). There are safety risks for friends and family who are unable to find the patients they are visiting, as poor wayfinding can lead them into restricted areas that can pose either security problems or, worse, hazards to their health and the health of others (Cooper, 2010). Lastly, ineffective wayfinding can leave patients and visitors with a bad impression of the hospital (Larsen & Tatarka, 2008). Being lost undeniably leads to an increase

in stress levels, which are already taxed by ill health or anxiety (Hale & Stanney, 2014). The lost patient's level of satisfaction drops, and with it, the organization's reputation (Cooper, 2010).

While hospitals and other healthcare facilities use signage to assist in directing people to their destinations (Cooper, 2010), signage often uses medical jargon that is not commonly known or understood by people who do not have experience with medical terminology (Campbell & Scott, 2014). With high patient and visitor stress levels, hospitals are particularly difficult to navigate with such foreign terms as PACU and Otolaryngology (Rousek & Hallbeck, 2011a). Moreover, medical language may be inconsistent from facility to facility. For example, a department may be called *Imaging*, *Radiology*, or *X-ray* (Cooper, 2010).

Signage is not always clear and does not accommodate those who are unable to read English or those who cannot read at all (Cooper, 2010). Hospital patients and visitors from other countries encounter additional navigation challenges (Cowgill & Bolek, 2003). As there is an increasing number of global citizens who travel to seek medical care outside of their own countries, it is critical to make wayfinding easy for visitors who are not familiar with the language in a foreign country (Cowgill & Bolek, 2003).

The issues posed by navigational challenges in hospitals include losses in efficiency that translate into productivity and financial losses (Cooper, 2010). Hospital employees who are travelling to meetings in various locations of the hospital are often stopped in the hallways to provide directions. These interruptions in movement may cause delays for the employees and impact productivity (Harris, 2014). Patients who face navigational challenges result in financial losses; when patients are lost, money is lost. Patients who are unsuccessful in their wayfinding arrive late for appointments. These delays cause downtimes and disruptions in schedules and staffing (Cooper, 2010). Money is lost not only on idle staff but also on idle equipment, an

expense that cannot be recouped with nonbillable downtime (Horblyuk et al., 2012). Physicians may have to reschedule other appointments and feel their time is being wasted (Cooper, 2010).

Purpose

The purpose of this annotated bibliography is to present selected literature that explores the current problems posed by insufficient wayfinding within large hospital settings in the US. Literature is presented that describes benefits from wayfinding improvements, including how improved wayfinding can lead to cost-savings, positive returns on investment, and improved employee satisfaction. Finally, literature is presented that identifies the potential best practices that foster more effective hospital wayfinding, focusing on the potential to create more informative means for employees, patients, and family members to find their ways to their destinations.

Research Questions

Main question. What are best practices in using wayfinding in hospitals, specifically signage that displays no words or sentences, only images and symbols?

Sub-questions. How do patients, family members, and staff respond to wayfinding that uses only images and symbols? How can the use of wayfinding in a hospital setting provide a positive return on investment (ROI)? How will improved wayfinding lead to better outcomes in hospital employee satisfaction scores?

Audience

Anyone who has tried to find his/her way around a large hospital, airport, or other large, complicated building knows the importance of easy-to-understand signage (Gibson, 2009). While this study is applicable to anyone who is concerned with wayfinding in a large facility, the primary focus is for those who work in and serve hospitals. Stakeholders for this study include

executives who are in positions to implement systems of information management based on symbols. These stakeholders operate in roles that exist in medium to large hospitals that have between 150 and 400 beds (Hearld, Alexander, Fraser, & Jiang, 2007).

The chief operating officer (COO) plays a key role in these initiatives (Marcel, 2009). The role of the COO is to oversee the daily operations of the organization, including how customers are able to move about within the organization (Charan, Carey, & Useem, 2014). Depending on any technological needs or impact, the chief information officer (CIO) could also play a role. The role of the CIO would be to approve technologies that serve to improve the organization, as well as allocate resources for any resulting projects (Hunter, 2010). Next, the chief financial officer will be an integral figure in driving decisions for wayfinding projects based on initial costs, cost-savings, and estimated return on investment.

Lastly, because of the potential impact on staff and how they interact with signage while navigating through facilities, the vice president of human resources is another key stakeholder. This stakeholder should have particular interest in the employee productivity and efficiency gains resulting from literature represented in this paper, and interest in learning how potential solutions to the problem of insufficient wayfinding could improve the lives of patients and all those walking through the doors.

All of these roles have similar concerns, which are tied to discovering and maintaining efficiencies in cost. These concerns are the following:

- Improve patient safety;
- Improve patient outcomes;
- Increase patient, family, and staff satisfaction;
- Improve the efficiency and effectiveness of staff; and

- Have a positive impact on the budget (McCullough, 2009).

Search Report

Search strategy. The problem identified for this Capstone study was wayfinding in a hospital setting. Attention focused on the usage of symbols as a means of wayfinding and associated increases in efficiency, employee satisfaction, and cost-savings for an organization.

A search was conducted within the UO Libraries on books, ebooks, media, microforms, journals, and e-journals owned by the UO Libraries, items from Summit academic libraries in the Pacific Northwest region, and full-text articles from journals, magazines, and newspapers. Searching on the keyword *wayfinding* within the UO Libraries website returned over 3,100 results, mostly consisting of articles. However, when performing a Boolean search on *wayfinding* and *hospital*, the results were far fewer, producing 62 items. These items were rich in nature and provided promising possibilities for this Capstone paper.

Next, use of Google Scholar was employed. Results using the above criteria were much greater in number, so the time range filtering function was used, which allowed sources to be filtered on a date more recent than 2007. This approach still produced over 1,900 results, but by using the sorting tool to sort by relevance, results that were highly cited rose to the top. By eliminating older sources, a more relevant and up-to-date picture of the field of wayfinding was captured. Sources that showed signs of sponsorship and/or a biased nature were approached with caution. Google Scholar has a function that allows the searcher to find similar articles related to the article currently selected, which was helpful in identifying additional sources.

Below is a list of search engines and databases that were used for this annotated bibliography:

- UO OneSearch,

- UO Libraries Search,
- Project Muse,
- Web of Science,
- ProQuest,
- Social Sciences Premium Collection,
- MEDLINE/PubMed,
- SAGE Journals,
- Academic OneFile,
- EBSCO Host,
- JSTOR,
- Academic Search Premier, and
- Google Scholar.

Both UO Libraries and Google Scholar have an option to reveal all references used within the chosen article. Using this function was helpful in discovering useful references related to the topic.

Information evaluation criteria. Each reference source was evaluated and chosen based on the timeliness of the work; quality of the grammar, spelling, and punctuation; relevancy to the problem being explored; and lack of bias, based on the Center for Public Issues Education's (n.d.) *Evaluating Information Sources*. A source was considered unbiased if it was published in either a journal or as a case study where no goods or services were being sold as a result of the study. Authority was evaluated mostly by the author's involvement and participation in the academic community, and whether the item was written by an individual or team that holds advanced degrees or titles in the area related to the study. The quality of the source was based on

whether or not it had been peer-reviewed and whether the author(s) supported the findings with evidence. Sources were considered timely for this study if they were published in 2000 or after, to reflect the time period during which wayfinding approaches have received scholarly focus and improvements. An increase in the focus of wayfinding has spiked since the year 2000, and the number of scholarly articles has subsequently followed (Cooper, 2010). Sources were deemed relevant based on breadth of information, access to further sources, and whether the source was from either a scholarly or unbiased publication that was written specifically for the purpose of healthcare wayfinding and design.

Documentation approach. Each reference was electronically logged into a secure Excel spreadsheet. In this context, *secure* is evaluated by where the documentation was stored. Google Docs was used for the storage of this document for both security and convenience. This document was organized based on the following categories:

- Wayfinding background and principles,
- Benefits of wayfinding, and
- Best practices in wayfinding.

In addition, a link to the reference material, a short description of the source, key words that were used to discover the source, and the database used to find the source were logged.

Key terms. The following is a list of key words and terms used to retrieve relevant articles:

- Hospital wayfinding,
- Healthcare wayfinding,
- Wayfinding,
- Wayfinding AND symbols,

- Wayfinding AND images,
- Healthcare wayfinding symbols and images,
- Hospital wayfinding symbols and images,
- Wayfinding return on investment,
- Wayfinding best practices,
- Hospital AND design,
- Wayfinding AND hospital AND cost,
- Hospital leadership structure,
- Hospital navigation problems, and
- Wayfinding AND cost-savings.

Annotated Bibliography

The following annotated bibliography presents 15 references that explore the best practices of effective wayfinding and intentional design within hospitals and other public spaces. References are selected to help hospital senior executives, administrators, and other leaders within the healthcare industry to improve facility design so that they may help reduce costs; improve patient, staff, and visitor satisfaction; and increase efficiency. References are presented in three categories: (a) wayfinding background and principles, (b) benefits of effective wayfinding, and (c) best practices of wayfinding.

Each annotation consists of three elements: (a) the full bibliographic citation, (b) an abstract, and (c) a summary. Each of the 15 annotations have a summary that presents an overview of the key points made by the author(s) and the findings that inform the research questions for this study.

Wayfinding Background and Principles

Ezzat, A. E. M., Hamoud, H. S., & Fadlallah, B. E. (2014, December). Factors affecting patient flow planning in hospitals. *IOSR Journal of Dental and Medical Sciences*, 13(12), 22-24. doi:10.9790/0853-131222224

Abstract. Patient flow management is considered a persistent and refractory problem in most countries surveyed. However, now, the ability to perform such analyses is severely limited by a lack of data. In most countries, there is no link between ambulatory and non-ambulatory patient data, which makes it difficult to carry out studies that find out common factors that affect these flows. Hence, by knowing the factors that have a negative influence on the efficiency of patient flow planning and the factors that have a positive influence, the efficiency of the hospital could be increased through overcoming the negative factors and improving the positive one.

Summary. In this article, the authors seek to explain why it is important to place a heavy focus on wayfinding within the hospital setting. They argue that patient flow represents the ability of the healthcare system to serve patients quickly and efficiently as they move through the stages of care (Ezzat, Hamoud, & Fadlallah, 2014). When there are blockages in the flow of patient care, it can increase the amount of time patients must wait, which creates a negative effect on the quality of service delivery. The authors note that when implementing more effective wayfinding designs within healthcare facilities, patients have shorter wait-times in registration, diagnostic testing, surgery, placement in beds, and discharge.

The article is useful to this specific research study because it identifies specific areas within a hospital that struggle with efficient patient throughput that if not efficient can cause delays in care and result in low patient satisfaction scores, frustrated staff, and increased costs. The article also explains the importance of cooperation between departments in establishing an efficient patient flow and how effective wayfinding can contribute to this cooperation.

Gibson, D. (2009). *The wayfinding handbook: Information design for public places*. New York, NY: Princeton Architectural Press.

Abstract. Where am I? What can I do here? Where can I go from here? How do I get out of here? Consciously or not, we ask such questions every day as we navigate the places and spaces of our lives. Whether we find ourselves in a museum, hospital, airport, mall, or a street in an unfamiliar city, we depend on systems of visual, audible, and tactile cues not only to lead the way, but also to keep us safe. They are the fundamental questions of wayfinding—a process that encompasses both the experience of choosing a path within a built environment and the set of design elements that aid in such a decision. A decade ago, the professional practice of wayfinding design simply involved devising sign systems. Today, the field is much broader and

continues to expand to address technological developments-kinetic media, GPS systems, web connectivity, smart materials -as well as cultural changes in areas such as branding and environmental awareness. Similarly, a cross-disciplinary familiarity with graphic, architectural, landscape, interior, industrial, and information design has become an essential requirement of twenty-first-century wayfinding design. *The Wayfinding Handbook* is an exciting new volume in our acclaimed Design Briefs series. Professional wayfinding designer David Gibson draws on more than thirty years of experience collaborating with architects, planners, developers, managers, and civic leaders to offer an insider's view of this rapidly evolving discipline. Using real-life examples, Gibson illustrates the way type, color, mapmaking, dimensional forms, material selection, and new media are used to create effective wayfinding systems.

Summary. In his book, which centers on wayfinding and information design in public places, Gibson (2009) examines the practical, fundamental elements of implementing effective wayfinding practices for large, high-traffic facilities such as large hospitals and airports. According to Gibson, his book is meant to serve as a textbook for design professors and students, and as a design resource for recent graduates and mature designers interested in wayfinding. There are four main categories discussed in the book that are intended to assist with implementing a wayfinding strategy in business: (a) the discipline of wayfinding, including how wayfinding impacts people and places; (b) planning wayfinding systems, including the design process, planning, strategy, categories of signs, and sign content and their locations; (c) wayfinding design, including branding, placemaking, typography, layout, color, symbols, maps, forms, materials, media, and green design for sustainability; and lastly (d) the practical considerations of wayfinding including how to initiate a wayfinding project, the public review process, code requirements, documentation, and fabrication. Speaking about the discipline of

wayfinding, Gibson argues that it is a profession and an art that has the potential to make a drastic impact in not only business practices, but also the lives of everyday people traveling through public facilities.

The book is useful to this specific research study because it reveals the importance of improving the throughput of large crowds of people for the purpose of increasing efficiency, which leads to dollars saved over time (Gibson, 2009). It also provides a number of best practices for this paper and is a solid source to inform the main research question.

Hashim, M. J., Alkaabi, M. S. K. M., & Bharwani, S. (2014, May). Interpretation of way-finding healthcare symbols by a multicultural population: Navigation signage design for global health. *Applied Ergonomics*, 45(3), 503-509.

<https://doi.org/10.1016/j.apergo.2013.07.002>

Abstract. The interpretation of way-finding symbols for healthcare facilities in a multicultural community was assessed in a cross-sectional study. One hundred participants recruited from Al Ain city in the United Arab Emirates were asked to interpret 28 healthcare symbols developed at Hablamos Juntos (such as vaccinations and laboratory) as well as 18 general-purpose symbols (such as elevators and restrooms). The mean age was 27.6 years (16–55 years) of whom 84 (84%) were females. Healthcare symbols were more difficult to comprehend than general-purpose signs. Symbols referring to abstract concepts were the most misinterpreted including oncology, diabetes education, outpatient clinic, interpretive services, pharmacy, internal medicine, registration, social services, obstetrics, gynecology, pediatrics, and infectious diseases. Interpretation rates varied across cultural backgrounds and increased with higher education and younger age. Signage within healthcare facilities should be tested among older persons, those with limited literacy and across a wide range of cultures.

Summary. Hashim, Alkaabi, and Bharwani (2014) note the importance of considering multi-cultural populations when designing and implementing symbols in a hospital's effort to create better wayfinding. The article explores three main points:

- The comprehension of healthcare symbols increases with a more literate population, while the comprehension of healthcare symbols decreases with an older population.
- Symbols for more abstract referents, such as the oncology unit or the diabetes education department, are more difficult to interpret correctly as compared to departments in the hospital such as imaging or surgery.
- Those who design healthcare symbols should consider cultural factors of the audience, as these factors may influence comprehension.

The authors conducted a study with 100 participants over the age of 16, consisting of both men and women from the United Arab Emirates, with the intent of finding out if persons from different cultures, age-groups and literacy levels interpret standard healthcare symbols correctly. Based on this study, and considering various cultural factors, the authors determined that the design of wayfinding symbols should take into consideration cultural, age, and gender aspects to accommodate a broader population of people who may have a different understanding and view of more specialized healthcare disciplines. The authors conducted their research in a country outside the US, which does have an impact on the relevancy to this study as it seeks best practices in wayfinding as they pertain to the symbols that are used, or lack thereof, in America.

This article is important for this study because it discusses standards and best practices in healthcare wayfinding outside of the US and illuminates principles that hospitals in the US should consider implementing. The United States is a diverse country filled with people from all

over the globe, and many of those people are familiar with a different set of wayfinding principles. This article is useful in discovering areas where standardization of symbols may exist.

Lee, S., Dazkir, S. S., Paik, H. S., & Coskun, A. (2014). Comprehensibility of universal healthcare symbols for wayfinding in healthcare facilities. *Applied Ergonomics*, 45(4), 878-885. doi:10.1016/j.apergo.2013.11.003

Abstract. Healthcare facilities are often complex and overwhelming for visitors, and wayfinding in healthcare facilities can be challenging. As there is an increasing number of global citizens who travel to seek medical care in another country, it is critical to make wayfinding easy for visitors who are not familiar with the language in foreign country. Among many wayfinding aids, symbols are helpful for those visitors who have limited ability to understand written language. This study tested universal healthcare symbols in the United States, South Korea, and Turkey to compare the comprehension of symbols cross-country and identify predictors of the correct comprehension. To explore statistically significant relationships between symbol comprehension and countries, Pearson's Chi-square tests, logistic regression, and ANOVA were conducted. The test results showed that ten symbols among 14 tested have significant relationship with countries. Results of this study demonstrate that symbol comprehension can be varied significantly in different countries.

Summary. Lee, Dazkir, Paik, and Coskun (2014) note the importance of considering hospital wayfinding for global citizens who seek medical care within the US. In their research study, the authors tested the comprehension of some existing healthcare graphical images. This study employed the stratified sampling technique to select survey participants. The population was first segmented into mutually exclusive sub-groups by age and gender. The sample contained three age groups: 18-30, 31-50, and over 50 years of age. In addition, there were two

gender groups: male and female. Participants were recruited from three countries among natives of each country: U. S., South Korea, and Turkey. These three countries are considered to represent three distinct cultures including Western, Eastern, and Middle-Eastern. Each age group from each of the three countries included 20 respondents, with 10 male and 10 female participants.

The authors assert that developing universal signs will allow people from different cultural and linguistic backgrounds to easily find their ways in hospitals and improve their experiences in those settings. This argument is made with the understanding that advancements in technology, communication, and transportation have expedited globalization, bringing the world closer. The globalization in the healthcare industry may cause confusion and miscommunication for patients and their families due to cultural differences. In the era of increased globalization, the authors assert that developing universal signs will make it easier for people traveling internationally to receive quality care in hospital settings. In addition to international patients, members of minority populations who do not speak the major or the official language of that country, and illiterate people, who have difficulty finding their way in complex public environments such as hospitals, will benefit from the use of universal signs.

This article is important for this study because it highlights the importance of a universal symbol system which allows people from multiple countries to more easily find their ways around healthcare settings. It also points out the importance of using symbols over words in the signage in healthcare settings. This article supports this study's research questions by expounding on the argument that wayfinding in healthcare should utilize more symbols that are commonly understood by people from around the world.

Pati, D., Harvey, T. E., Willis, D. A., & Pati, S. (2015). Identifying elements of the health care environment that contribute to wayfinding. *Health Environments Research & Design Journal*, 8(3), 44-67. doi:10.1177/1937586714568864

Abstract. Identify aspects of the physical environment that inform wayfinding for visitors. Compare and contrast the identified elements in frequency of use. Gain an understanding of the role the different elements and attributes play in the wayfinding process. Wayfinding by patients and visitors is a documented problem in health care facilities. The few studies that have been conducted have identified some of the environmental elements that influence wayfinding. Moreover, literatures comparing different design strategies are absent. Currently there is limited knowledge to inform prioritization of strategies to optimize wayfinding within capital budget. A multi-method, non-experimental, qualitative, exploratory study design was adopted. The study was conducted in a large, acute care facility in Texas. Ten healthy adults in five age groups, representing both sexes, participated in the study as simulated visitors. Data collection included (a) verbal protocols during navigation; (b) questionnaire; and (c) verbal directions from hospital employees. Data were collected during Fall 2013. Physical design elements contributing to wayfinding include signs, architectural features, maps, interior elements (artwork, display boards, information counters, etc.), functional clusters, interior elements pairing, structural elements, and furniture. The information is used in different ways - some for primary navigational information, some for supporting navigational information, and some as familiarity markers. The physical environment has a critical role in aiding navigation in health care facilities. Architectural feature is the top contributor in the domain of architecture. Artwork (painting, sculpture, etc.) is the top contributor in the domain of interior design.

Summary. The specific aim of this study was to examine the nature and extent of aid provided by various design elements in supporting wayfinding decisions by adult visitors in an acute care hospital. This study addresses three questions:

- What aspects of the physical environment aid in wayfinding decision-making for visitors?
- How do the various wayfinding strategies compare in frequency of use?
- What role do environmental cues in healthcare facilities, such as configuration, color, art, visible landmarks, maps, and visual signage play in the wayfinding process?

Wayfinding theories on urban environments were used as a starting point in the study to code and classify data. The basic data types included verbal protocol, digital photography, and subjects' responses on a survey questionnaire. The study was conducted in an 866-bed, tertiary care facility in Texas. Internet-based research was conducted by the design team to develop hypotheses on the type of elements or strategies that help people navigate through a building. The initial framework of the study identified a variety of environmental information that possibly supports wayfinding, including colors, numbers, landmarks, and orientation by direction or views. More specifically, the following strategies were incorporated:

- Each floor had its own unique landmarks. For instance, artwork in the elevator lobbies were unique to each floor.
- Each floor and each unit had its own unique numbering system. Rooms were identified by identifying the building, the floor number, and the room number. For example, patient tower room numbers started with an H followed by the floor number and the specific room number.

- Each floor had its own views to the outside to orient visitors and maintain a sense of direction. This was most prominent in the waiting areas at the elevator lobby and on the ends of the bed units.

The authors reached conclusions on a wide range of attributes that contribute to more comprehensive wayfinding. The findings that were most helpful to this study were those that identified the impact of labels. The authors found that data show that when confronted with a label the very first cognitive process, where subjects spent substantial amounts of time, was in attempting to find meaning in the label itself. Since labeling systems fall beyond the purview of the design profession, the authors noted that it is imperative that other professionals be engaged in developing and testing labeling and numbering systems for buildings, floors, rooms, and other program areas. The study revealed the importance of labels in the hospital setting, which is a key point to this paper, because labeling systems get distorted over time as new buildings are added to an existing hospital and the original labeling design must be expanded. While developing a labeling and numbering plan, the authors recommend focusing on devising systems that will retain their meaning over the long run, as the facility expands and new buildings are added.

Benefits of Effective Wayfinding

Chaudhury, H., Mahmood, A., & Valente, M. (2009). The effect of environmental design on reducing nursing errors and increasing efficiency in acute care settings: A review and analysis of the literature. *Environment and Behavior*, 41(6), 755-786.

doi:10.1177/0013916508330392

Abstract. Physical environment is an important component in the acute care setting that can affect nursing and medication accuracies, as any inadequacy in physical environment would contribute to staff fatigue, stress, and burnout and result in errors. The article discusses a study

conducted involving an extensive review and analysis of the literature on this topic and focus groups with various categories of staff members at three hospitals. The review demonstrates that the following environmental variables can contribute to errors in acute care settings: noise levels, ergonomics/furniture/equipment, lighting, and design/layout. Focus groups address the role of the physical environment on medication ordering, storage, delivery, dispensation, preparation, administration, and possible design responses to reduce errors. Integrating the major issues identified and the key findings from the focus groups, four design-related principles are recommended: balance between patient accessibility and reduction of disruptions, automation, minimize staff fatigue, and promoting a culture of safety.

Summary. Chaudhury, Mahmood, and Valente (2009) conducted an in-depth literature review and focus group with staff members of three hospitals to research the causes of workplace errors in a hospital environment. The authors found that these errors are largely due to the following physical environmental variables:

- noise,
- lighting,
- ergonomics/furniture/equipment, and
- design/layout.

The article explains why the design and layout of a hospital elevate the chances for medical errors and includes examples of the different factors that influence the likelihood of errors. For example, the authors identify the central idea that the physical environment within a hospital should be convenient and accessible, enable patients to connect with staff members, conducive to the patients' sense of well-being, and safe and secure and should foster connections to the outside world.

The study also studied the effect of the physical environment on hospital staff and revealed that a lack of space was associated with the impression that the hospital did not care about its nurses and generated stress among them. The physical environment for nurses in the hospitals studied provided few opportunities for the nurses to relax and relieve themselves of their anxieties.

The premise that difficult and poorly planned wayfinding features of large hospitals affected nurses' job satisfaction was a key element of the article. It explained how wayfinding is of particular importance because if patients or staff members have difficulties orienting themselves within the facility, they may become frustrated and disoriented, which in turn may lead them to experience stress, and that stress is often carried over to the nurses (Chaudhury, Mahmood, & Valente, 2009).

The authors also note that hospital administration can experience the weight of poor wayfinding design when portions of the hospital are redesigned and/or new buildings are built and are difficult to navigate. As a result, staff need to learn new routes to make their way around the facility, which can lead to stress and anxiety. If staff experience stress, absenteeism rates may increase and the hospital's ability to care for patients with quality and efficiency declines. Hospital administration such as the chief operating officer and the vice president of human resources are then burdened with low staffing levels, which leads to increased costs due to overtime pay and an elevated risk for medical errors. In their conclusion, the authors recommend that hospital administrators take seriously the designs of their facilities, as doing so will help increase staff satisfaction and reduce medical errors.

This article is important for this study because it highlights areas where improved wayfinding and the design of healthcare facilities correlate to cost savings. These cost savings

are a result of reductions in staff turnover and increases in patient and visitor satisfaction. Staff turnover is reduced when there are fewer interruptions due to lost patients, visitors, and new staff members. Patient and visitor satisfaction scores also rise when better wayfinding improves movement through the hospital, positively impacting the staff and reducing turnover. Finally, better design that facilitates a healthier, happier environment for staff helps to increase staff satisfaction.

Foster, J., & Afzalnia, M. (2005). International assessment of judged symbol

comprehensibility. *International Journal of Psychology*, 40(3), 169-175.

doi:10.1080/00207590444000258

Abstract. Symbols are widely used internationally to communicate to people with different languages, but the large number of symbols for any particular meaning or referent may cause confusion. Some international organizations attempt to prevent this confusion by recommending standard symbols, and in some cases base their recommendation on the results of assessing the comprehensibility of alternative symbol designs. In this study, four variants of a public information symbol for an automatic teller machine (cash machine) were compared in three countries (United Kingdom, Korea, and Iran) using the comprehension judgement test recommended by the International Standards Organization in ISO 9186: 2001. In this test respondents are shown variants of a symbol, told the intended meaning, and asked to estimate the percentage of the general population that they expect would understand each variant correctly. The data from the three countries are interpreted as supporting the view that the criterion a variant of a public information symbol must reach before it can be recommended as a standard should be 66% rather than 85%. The responses indicated that respondents in the three different countries agreed on the variant estimated to be most comprehensible. This showed the more

realistic representation of the position of a hand and fingers when using the machine, indicating that more realistic portrayals yield higher estimates. A variant that did not include a hand obtained the lowest estimates. Respondents from Iran gave lower estimates of comprehensibility than those from UK and Korea, emphasizing the need to collect data from different countries when gathering information on which to base an international standard symbol. The agreement between the three countries is seen as support for the view that there are general principles that can be applied to help make a symbol more meaningful, and for the use of the judgment test when deciding on an internationally standard symbol.

Summary. The authors conducted a study that employed a range of methods for measuring the effectiveness of a symbol or set of symbols: comprehensibility, conspicuity, and confusability. For each method, there were various techniques used to measure the effectiveness including rankings, ratings, and multiple-choice tests. The authors placed a high value on symbols as a means of effective communication. The authors found that symbols are increasingly used internationally to inform the public that specified services or objects are available due to their value as communication tools for people who do not share a common verbal language. The results of the study showed that a higher number of people responded positively and with comprehension to the symbols compared to words and sentences for wayfinding purposes.

This article is important for this study because it explains the degree to which humans respond positively to symbols over words, and is applicable to many types of facilities, including healthcare facilities. This concept is key for this study because it helps prove the importance for hospitals and other healthcare facilities of moving toward a more symbol-based form of wayfinding over word and sentence-based models. Moreover, the study provides an international framework for wayfinding, which is helpful when hospital administration seeks to implement a

symbol-based form of wayfinding that is comprehensible to an audience that includes international patients, staff, and visitors.

Shoemaker, L. K., Kazley, A. S., & White, A. (2010). Making the case for evidence-based design in healthcare: A descriptive case study of organizational decision making. *HERD: Health Environments Research & Design Journal*, 4(1), 56-88.
doi:10.1177/193758671000400105

Abstract. The aim of this study was to describe the organizational decision-making process used in the selection of evidence-based design (EBD) concepts, the criteria used to make these decisions, and the extent to which leadership style may have influenced the decision-making process. Five research questions were formulated to frame the direction of this study, including: (1) How did healthcare leaders learn of innovations in design? (2) How did healthcare leaders make decisions in the selection of healthcare design concepts? (3) What criteria did healthcare leaders use in the decision making process? (4) How did healthcare leaders consider input from the staff in design decisions? and, (5) what extent did the leadership style of administrators affect the outcomes of the decision-making process? Current issues affecting healthcare in the community led the principal investigator's organization to undertake an ambitious facilities expansion project, as part of its planning process, the organization learned of EBD principles that seemingly had a positive impact on patient care and safety and staff working conditions. Although promising, a paucity of empirical research addressed the cost/benefit of incorporating many EBD concepts into one hospital setting, and there was no research that articulated the organizational decision-making process used by healthcare administrators when considering the use of EBD in expansion projects. Methods: A mixed-method, descriptive, qualitative, single-case study, and quantitative design were used to address the five research

questions. The Systems Research Organizing Model provided the theoretical framework. A variety of data collection methods was used, including interviews of key respondents, the review of documentary evidence, and the Multifactor Leadership Questionnaire. Results: A participatory process was used throughout the design decision phases, involving staff at all levels of the organization. The Internet and architects facilitated learning about EBD. Financial considerations were a factor in decision making. The prevalence of the transformational leadership style among the organization's administrators exceeded the US mean.

Summary. Shoemaker, Kazley, and White (2010) explain the importance of using evidence-based design to achieve cost-savings. The authors note the urgent need to address evidence-based design to reduce the problems in healthcare environments that impede patient safety efforts and contribute to staff dissatisfaction and workplace injuries. To address these issues when designing hospitals, architects, clinicians, and administrators must work together in order to design, develop, and implement innovative care models to improve the quality of patient care and the workplace environment for staff.

As a result of the aging of existing hospitals, the aging of populations, and the introduction of many new technologies, the authors identify a great need for the construction of new and more modern hospitals in America. The authors recommend that architects, administrators, and clinicians seize the unique opportunity to fundamentally rethink the design of today's hospitals with these expected outcomes:

- Reduction of staff stress and fatigue,
- Increase of effectiveness in care delivery,
- Improvement of patient safety,
- Reduction of patient and family stress while improving patient outcomes,

- Improvement of overall healthcare quality,
- Improvement of overall operating performance, and
- Cost-savings.

The results of the study suggest that decision-makers embarking on a facilities design project should carefully think through the design decision process. The authors note that there are different decisions for new construction of a healthcare facility (or healthcare facilities) than the remodeling of current healthcare facilities.

This article is important for this study because it reveals key areas where hospital leadership is able to find cost-saving opportunities by implementing improved wayfinding and design.

Best Practices in Wayfinding

Carlson, L. A., Hölscher, C., Shipley, T. F., & Dalton, R. C. (2010). Getting lost in buildings. *Current Directions in Psychological Science*, 19(5), 284-289.

doi:10.1177/0963721410383243

Abstract. People often get lost in buildings, including but not limited to libraries, hospitals, conference centers, and shopping malls. There are at least three contributing factors: the spatial structure of the building, the cognitive maps that users construct as they navigate, and the strategies and spatial abilities of the building users. The goal of this article is to discuss recent research on each of these factors and to argue for an integrative framework that encompasses these factors and their intersections, focusing on the *correspondence* between the building and the cognitive map, the *completeness* of the cognitive map as a function of the strategies and individual abilities of the users, the *compatibility* between the building and the strategies and individual abilities of the users, and *complexity* that emerges from the intersection of all three

factors. We end with an illustrative analysis in which we apply this integrative framework to difficulty in way-finding.

Summary. This article illustrates the tension in architecture between aesthetic and functional features. It concentrates on three contributing factors of why people get lost in buildings: (a) the spatial structure of a building; (b) the cognitive maps that users construct as they navigate the building; and (c) the strategies and spatial abilities of the building's users. The authors discuss recent research on each factor and argue for an integrative framework that characterizes how these factors intersect. The article illustrates how a lack of correspondence, a lack of compatibility, and a lack of completeness may be associated with difficulty in wayfinding within buildings. Regarding correspondence, findings showed that users prefer more linear routes containing few turns. Regarding compatibility, the study found it to be advantageous to have unimpeded lines of sight connecting entrance spaces and other key central spaces to the means of vertical circulation such as stairs, elevators, and escalators. Finally, regarding completeness, the study concluded that the degree to which these architectural features of buildings impact wayfinding may depend upon the completeness of the cognitive maps that individual users construct. For example, the authors suspect that people who are not confident about finding the exit after two years of visiting a particular hospital have an incomplete cognitive map of the building; others who frequent the building equally often and can find the exits presumably have more complete cognitive maps. This article provides a unique view into possible reasons users experience difficulty in wayfinding, including the notion of a cognitive map.

Devlin, A. (2014). Wayfinding in healthcare facilities: Contributions from environmental psychology. *Behavioral Sciences*, 4(4), 423-436. doi:10.3390/bs4040423

Abstract. The ability to successfully navigate in healthcare facilities is an important goal for patients, visitors, and staff. Despite the fundamental nature of such behavior, it is not infrequent for planners to consider wayfinding only after the fact, once the building or building complex is complete. This review argues that more recognition is needed for the pivotal role of wayfinding in healthcare facilities. First, to provide context, the review presents a brief overview of the relationship between environmental psychology and healthcare facility design. Then, the core of the article covers advances in wayfinding research with an emphasis on healthcare environments, including the roles of plan configuration and manifest cues, technology, and user characteristics. Plan configuration and manifest cues, which appeared early on in wayfinding research, continue to play a role in wayfinding success and should inform design decisions. Such considerations are joined by emerging technologies (e.g., mobile applications, virtual reality, and computational models of wayfinding) as a way to both enhance our theoretical knowledge of wayfinding and advance its applications for users. Among the users discussed here are those with cognitive and/or visual challenges (e.g., Down syndrome, age-related decrements such as dementia, and limitations of vision). In addition, research on the role of cross-cultural comprehension and the effort to develop a system of universal healthcare symbols is included. The article concludes with a summary of the status of these advances and directions for future research.

Summary. In Devlin's (2014) article, "Wayfinding in Healthcare Facilities," the author focuses on the interdisciplinary quality between environmental psychology and facility design. The author argues that it is the intersection of architecture, other types of design, and environmental psychology that helps foster the types of healthcare facilities in which people are more likely to be happier and able to navigate easily.

This article was helpful for this study because it directed this researcher toward other key authors and articles in the discipline of advanced wayfinding research that emphasize wayfinding in healthcare environments. The author expounds on the advances in technology as they pertain to healthcare wayfinding and describes how those advances are able to lead to better outcomes in metrics. Also, the article provided a deeper understanding of why plan configuration and manifest cues still play a vital role in wayfinding research. Prior to reading this article, this researcher was unaware of plan configuration and manifest cues. Based on these new key terms, a new aspect of this research was explored.

This article was also helpful for this study because it provided specific dollar figures for cost savings associated with wayfinding. The article is unique because the content consists of a large amount of reference material in comparison to the other articles used in this annotated bibliography. It was highly useful in helping to discover other authoritative figures in the discipline of wayfinding, specifically in healthcare. Devlin's article draws heavily from the content of other scholarly articles, citing key pieces of information that were helpful for discovering similar articles on the focus of this research.

Lo, C.-W. J., Yien, H.-W., & Chen, L.-P. (2016). How universal are universal symbols? An estimation of cross-cultural adoption of universal healthcare symbols. *HERD: Health Environments Research & Design Journal*, 9(3), 116-134.

doi:10.1177/1937586715616360

Abstract. To evaluate the effectiveness of universal health symbol usage and to analyze the factors influencing the adoption of those symbols in Taiwan. Universal symbols are an important innovative tool for health facility wayfinding systems. Hablamos Juntos, a universal healthcare symbols system developed in the United States, is a thoughtful, well-designed, and

thoroughly tested symbol system that facilitates communication across languages and cultures. We designed a questionnaire to test how well the selected graphic symbols were understood by Taiwanese participants and determined factors related to successful symbol decoding, including participant-related factors, stimulation factors, and the interaction between stimulation and participants. Additionally, we further established a design principle for future development of localized healthcare symbols. (1) Eleven symbols were identified as highly comprehensible and effective symbols that can be directly adopted in Taiwanese healthcare settings. Sixteen symbols were deemed incomprehensible or confusing and thus had to be redesigned. Finally, 14 were identified as relatively incomprehensible and could thus be redesigned and then have their effectiveness evaluated again. (2) Three factors were found to influence the participants' differing levels of comprehension of the *Hablamos Juntos* symbols. In order to prevent the three aforementioned factors from causing difficulty in interpreting symbols, we suggest that the local symbol designers should (1) use more iconic images, (2) carefully evaluate the indexical and symbolic meaning of graphic symbols, and (3) collect the consensus of Taiwanese people with different educational backgrounds.

Summary. In this article, the authors sought to evaluate the effectiveness of universal health symbol usage and to analyze the factors influencing the adoption of those symbols in Taiwan. The authors utilized the universal healthcare symbol system from the US known as *Hablamos Juntos* for their study. Their study was conducted using a questionnaire designed to test how well the selected graphic symbols were understood by the Taiwanese participants and determine factors related to successful symbol decoding, including participant-related factors, stimulation factors, and the interaction between stimulation and participants. Additionally, the authors established a design principle for future development of localized healthcare symbols.

The results of the study yielded eleven symbols that were identified as highly comprehensible and effective that could be adopted within a Taiwanese healthcare setting and thirty symbols that were identified as incomprehensible and not implemented. In their conclusion, the authors suggest that wayfinding designers using symbols should follow three principles: (a) use more iconic images; (b) carefully evaluate the indexical and symbolic meaning of graphic symbols; and, (c) collect the consensus of Taiwanese people with different educational backgrounds (Lo et al., 2016).

Although this study was conducted outside of the US; this researcher found it useful for two reasons: (a) the study is less than two years old and, therefore, is quite relevant as it utilized current universal symbols that may be applied in other countries and cultures; and (b) the universal symbols that were used in the study were from Hablamos Juntos, the universal healthcare symbol system. In further research, this study could be used to determine which symbols to recommend for implementation in US healthcare settings that could be more easily identified among foreign-born visitors and patients.

Rousek, J. B., & Hallbeck, M. S. (2011a). Improving and analyzing signage within a healthcare setting. *Applied Ergonomics*, 42(6), 771-784.

<https://doi.org/10.1016/j.apergo.2010.12.004>

Abstract. Healthcare facilities are increasingly utilizing pictograms rather than text signs to help direct people. The purpose of this study was to analyze a wide variety of standardized healthcare pictograms and the effects of color contrasts and complexity for participants with both normal and impaired vision. Fifty (25 males, 25 females) participants completed a signage recognition questionnaire and identified pictograms while wearing vision simulators to represent specific visual impairment. The study showed that certain color contrasts, complexities, and

orientations can help or hinder comprehension of signage for people with and without visual impairment. High contrast signage with consistent pictograms involving human figures (not too detailed or too abstract) is most identifiable. Standardization of healthcare signage is recommended to speed up and aid the cognitive thought process in detecting signage and determining meaning. These fundamental signage principles are critical in producing an efficient, universal wayfinding system for healthcare facilities.

Summary. In “Improving and Analyzing Signage within a Healthcare Setting,” authors Rousek and Hallbeck (2011a) report on a study conducted using 25 males and 25 females to determine the effectiveness of pictograms within the healthcare setting. The authors compared the effectiveness of large, identifiable pictograms to the standard wayfinding method of using words and sentences as a means of assisting patients, family members, and staff to their desired locations within large hospitals. The study utilized familiar pictograms for both the visually capable, as well as the visually impaired.

The authors found that hospital signage does more than simply direct visitors to their destinations; signage also plays an integral role in setting the mood and making unfamiliar visitors comfortable. The authors concluded that pictograms served as a more viable and successful resource for wayfinding within the hospital than words and sentences, as well as helping to make visitors feel more at home. The study showed that people tend to ignore signage with words the first couple of times they come into contact with them, but notice signage with pictograms the first time they have contact with them (Rousek & Hallbeck, 2011a).

Improvements in wayfinding lead to an increase in patient, visitor, and staff satisfaction, which ultimately leads to cost-savings. Patients and visitors are more likely to return to the facility for

their medical care, and healthcare employers are more likely to retain staff more long-term, thus reducing costs by not having to expend time and resources in hiring and training new staff.

This article is helpful because it links wayfinding in healthcare to cost savings in a hospital. By utilizing pictograms over words and sentences, the authors show that healthcare facilities are able to use familiar symbols to help make the time spent by patients and visitors more comfortable and enjoyable (Rousek & Hallbeck, 2011a).

Sivaji, A., Radjo, H. K., Amin, M.-F., & Hashim, M. A. H. A. (2016). Design of a hospital interactive wayfinding system: Designing for Malaysian users. In *Critical Socio-Technical Issues Surrounding Mobile Computing* (pp. 88-123). Hershey, PA. IGI Global. doi:10.4018/978-1-4666-9438-5.ch005

Abstract. United Nations reported the importance of wayfinding as part of providing sustainable and beneficial accessibility to the public in built environment such as a hospital. Despite this, the survey conducted in this study found that current wayfinding system in hospitals does not meet the requirements of the Malaysian demography which is multilingual and multicultural. Furthermore, the various literacy levels in this country make the design more challenging. The objective of this study is to design, develop, and test a hospital interactive wayfinding system (HIWS) that is targeted towards the West Malaysian population. Using the established symbols that has been validated by other studies and from the survey feedback obtained, the HIWS was designed and developed and tested with 24 Malaysian users using the lab based user experience testing. Although the results seems promising whereby 83% of users liked the system, the qualitative feedback revealed various improvements to the system that would be valuable to the design and development team to improve HIWS.

Summary. In their study, the authors' goal was to design, develop, and test an interactive hospital wayfinding system that would be most helpful to the West Malaysian population. Their argument was that because of the growth of the population and the expansion of technology, there was an ever-growing demand for effective communication to fulfill the needs of people with various levels of literacy and memorizing abilities and different social cultures. The authors wanted to develop a wayfinding system with the intent of becoming a universal system, capable of being easily understood by people of various ages, literacy levels, languages, cultures, and genders. The authors narrowed their focus to wayfinding in the following locations of a hospital:

- Neurology department,
- Surgery department, and
- Women and children department.

Their study utilized 24 individuals using the lab-based user experience testing method.

The authors found that the existing signage within the hospital setting was ergonomically incorrect. Their study also showed that often the height of the signage did not meet the directional purposes of staff and visitors. In response to this problem, the authors proposed the use of wayfinding information systems in the form of mobile technology using specially customized software that would allow staff and visitors to interact with the technology for easier wayfinding.

This article was relevant to this study because it provided helpful information about the utilization of software and mobile technology as means to more efficient wayfinding within the hospital setting. The researchers narrowed the scope of the study to a manageable number of areas, which helps identify specific areas within a hospital that would need immediate attention before approaching less traveled areas within a hospital setting. Although the focus of this study

does not involve the use of technology as a means to more efficient wayfinding, this article is useful because of its consideration of symbols in the implantation of mobile wayfinding technology. It confirms the need to utilize symbols that are more widely known and comprehended among the larger population.

Young, S. L., & Wogalter, M. S. (2002). Predictors of pictorial symbol comprehension.

Information Design Journal, 10(2), 124-132. doi:10.1075/idj.10.2.07you

Abstract. Open-ended comprehension testing is a commonly recommended form of evaluation for safety symbols, but such testing can be costly in terms of time, effort and expense. The present study examines several issues related to symbol testing. First, two alternative rating methods intended to approximate open-ended comprehension results were evaluated in both Study 1 and 2. The first method, used previously in the literature, had participants estimate the percentage of the population that would correctly interpret the symbol's meaning. The second method involved providing participants with the symbol and its meaning and having them provide a rating of the correspondence between the two. Results demonstrated that both ratings correlated highly with participants' open-ended comprehension results. A second issue relates to the way in which people perceive various qualitative aspects of the symbols (e.g., quality of the drawing, clutter, legibility and the extent to which the symbol conveyed a sense of hazard or danger) and how these variables relate to one another. Implications for symbol evaluation are discussed.

Summary. This article provides a standard for best practices related to conducting symbol-interpretation tests. The authors conducted the study to evaluate several issues related to symbol comprehension testing.

This study examines an alternative method to evaluate open-ended comprehension. Alternative methods are of interest to the authors because of the issue of cost. There is a relatively high cost associated with conducting formal, open-ended comprehension tests. These costs can include:

- Developing/producing the symbol and any alternatives,
- Developing/producing data collection materials,
- Developing/producing contextual descriptions and/or graphics,
- Recruiting participants,
- Administering the tests,
- Compensating participants for their time,
- Scoring the open-ended responses by two or more judges, and
- Assessing inter-rater reliability and addressing disagreements between judges to determine comprehension scores.

This study demonstrated that participants were able to provide reasonably accurate predictions of population comprehension that corresponded to performance on an open-ended test.

The article addresses several issues related to the design and evaluation of symbols. The authors' research demonstrated that there may be several different formal methods of testing and evaluating symbols that can provide designers and researchers with information about the quality and interpretability of pictorials. Factors that influence the selection of a particular method could include time and monetary constraints, the number of symbols being evaluated, the number of people in the sample or expected population, and the stage of development in the design of the symbol.

This article is relevant to this study because it identifies the factors that influence the selection of methods when researching the impact and comprehensibility of symbols used for wayfinding. It also provides perspective about how to conduct a research study to determine the right symbols to use for a particular healthcare facility.

Zijlstra, E., Hagedoorn, M., Krijnen, W, P., van der Schans, C. P., & Mobach, M. P. (2016, September). Route complexity and simulated physical ageing negatively influence wayfinding. *Applied Ergonomics*, 56, 62-67.
<https://doi.org/10.1016/j.apergo.2016.03.009>

Abstract. The aim of this age-simulation field experiment was to assess the influence of route complexity and physical ageing on wayfinding. Seventy-five people (aged 18–28) performed a total of 108 wayfinding tasks (i.e., 42 participants performed two wayfinding tasks and 33 performed one wayfinding task), of which 59 tasks were performed wearing gerontologic ageing suits. Outcome variables were wayfinding performance (i.e., efficiency and walking speed) and physiological outcomes (i.e., heart and respiratory rates). Analysis of covariance showed that persons on more complex routes (i.e., more floor and building changes) walked less efficiently than persons on less complex routes. In addition, simulated elderly participants perform worse in wayfinding than young participants in terms of speed ($p < 0.001$). Moreover, a linear mixed model showed that simulated elderly persons had higher heart rates and respiratory rates compared to young people during a wayfinding task, suggesting that simulated elderly consumed more energy during this task.

Summary. The aim of this study is to assess the influence of route complexity and physical ageing on wayfinding (i.e., efficiency and walking speed) in a hospital setting. According to the authors, route complexity is a growing problem in hospitals because hospitals

are expanding in size due to the increasing demand for healthcare and more specialized care and diagnostic techniques. Consequently, hospital environments comprise more floor levels and multiple buildings, which make routes towards destinations more complex.

The method for this study utilized seventy-five bachelor degree students studying facility management at the Hanze University of Applied Sciences in Groningen, Netherlands. In total, 42 participants fulfilled one wayfinding task and 33 fulfilled two wayfinding tasks in order to have at least 10 participants walking each of the nine wayfinding routes. Participants were randomly assigned to a bundle of three wayfinding tasks in order to start each route from a different origin towards a different destination and, consequently, maximize systematic variation. In total 108 wayfinding tasks were studied. The study also focused on wayfinding for the elderly population.

The results of this study indicate that wayfinding strategies differ when persons find their way in a multi-level building or a multi-level, multi-building setting, which affects wayfinding performance in terms of time and efficiency. The researchers found that floor strategies (first moving to the correct floor) were more effective in multi-level settings while in multi-level multi-building settings people find their way more efficiently when they first move to the correct building during a route. In addition, the researchers found that the majority of wayfinders choose to turn left when they arrive at a T-intersection. The researchers noted that strategies that people use to find their way efficiently depend mostly on route complexity, depending on whether building or floor changes were required during a route.

This study showed that a required building change during a route negatively influenced wayfinding performance. The more building changes required during a wayfinding task, the less efficiently routes were walked. This might imply that participants have an incomplete representation of the spatial setting, and therefore rely on the central point wayfinding strategy,

meaning that they first walk towards a central point like the main entry hall or main corridors. The study also found it to be important to have clear signage at every entry point and hallway intersection. The signage should immediately be made clear to visitors when entering the building using wayfinding design, like well-located service points or wayfinding symbols.

The results also showed that participants on more complex routes showed lower wayfinding performance when compared to participants on less complex routes. Moreover, the findings indicate that participants wearing a gerontologic suit (a suit designed to mimic an elderly person) walked slower and had higher heart rates and respiratory rates, and therefore consumed more energy during a wayfinding task compared to participants not wearing a gerontologic suit.

The researchers also found that, because the memory capabilities of the elderly are not as good as the capabilities of younger people and their physical capacity is reduced, elderly people may experience problems with dual-task-performance, which requires cognitive and sensorimotor skills. By conducting a navigational study, the researchers found that elderly people perform worse than young people in cognitive navigational skills like route learning and route drawing.

This article is relevant to this study because it highlights the importance of considering the differences between younger and older populations and populations in poor physical condition and those in good physical condition when designing wayfinding. When looking to create route efficiency within a healthcare facility by utilizing comprehensible signage through multiple complex buildings with multiple floors, the authors recommend the implementation of a complete representation of the multiple building setting by using signage that is clearly marked and comprehensible.

Conclusion

There is an urgent need to address the problems in the healthcare environment that are impeding patient safety efforts and contributing to staff dissatisfaction and workplace injuries (Shoemaker, Kazley, & White, 2010). An opportunity exists for architects, administrators, and clinicians to work together to design, develop, and implement innovative care delivery models to improve the quality of patient care and the workplace environment for staff (Chaudhury et al., 2009).

The 15 references selected for this Annotated Bibliography serve to help executives and administrators of large healthcare facilities understand the importance of implementing key wayfinding principles, as well as provide a framework and guidance to the most impactful areas of wayfinding in healthcare. Themes include (a) the background of wayfinding, (b) benefits of effective wayfinding, and (c) best practices of wayfinding.

Background of Wayfinding

Wayfinding designers are largely from the baby boomer generation, and their political and environmental ideals were informed by the Vietnam conflict and subsequent social issues of the 1970s (Gibson, 2009). Motivated by a sense of service and zeal for creativity, designers gradually moved the wayfinding field into the 21st-century, building upon the foundation of experience established by early design pioneers over the course of the previous century (Gibson, 2009). World War II had a positive impact on their careers as well, either by forcing talented Europeans to immigrate to North America where opportunity awaited, or by providing art and design training to many veterans (Gibson, 2009). During the 1960s Cold War, critics, scholars, and designers felt an urgent need to make complex urban spaces easier to navigate (Gibson, 2009). The design discipline that evolved in response to the initiative has been called

architectural graphics, signage or sign-systems design; environmental graphic design; and wayfinding (Gibson, 2009).

Over time, design firms and individuals began to specialize in sign-systems design (Hashim, Alkaabi, & Bharwani, 2014). Some firms offered wayfinding design in tandem with other services, including exhibition, product, interior, and corporate identity design. Three writers are largely responsible for popularizing the term *wayfinding*, which seems to have stuck as the best name to describe both the process and profession dedicated to helping people navigate; these writers are Kevin Lynch (1960), Romedi Passini (1984), and Saul Wurman (Hashim et al., 2014).

In 1960, urban planner and teacher Kevin Lynch coined the term in his landmark book about urban space, *The Image of the City*. Lynch (1960) explains that wayfinding relates to the process of forming a mental picture of one's surroundings based on sensation and memory. The main idea is that becoming completely lost is perhaps a rare experience for most people in the modern city. Gibson (2009) explains that people are supported by the presence of others and by special wayfinding devices: maps, street numbers, route signs, and bus placards. Lynch himself recommends that people should allow themselves to become lost only once in order to become acutely aware of how dependent they are of their fear of disorientation (Gibson, 2009).

There are factors that influence the efficiency level of patient flow planning, and some factors frequently have a negative influence on patients, staff, and visitors (Ezzat et al., 2014). Negative wayfinding factors lower the level of efficiency in patient flow planning. Factors that influence the efficiency of patient flow planning negatively are: (a) complexity; (b) limited resources; (c) uncertainty of spatial orientation; (d) and process problems (Ezzat et al., 2014). It is easy to assume that the placement or content of a sign is obvious to the designer, or that a

symbol should mean what it is intended to mean, but to a patient, staff member, or visitor, these design considerations may not be quite as obvious (Gibson, 2009). For this reason, it has been an important and central tenant of the wayfinding discipline to ensure that signage, symbols, and pictograms are comprehensible to the general public (Lee, Dazkir, Paik, & Coskum 2014).

Concurrent with the patient safety movement is the largest hospital construction boom in US history (Shoemaker et al., 2010). The need to replace hospitals arises from a confluence of factors including the age of existing buildings, aging populations, and the introduction of new technologies (Shoemaker et al., 2010). There are thousands of building expansion projects across the United States, which are further fueled by Senate bills that require hospitals to retrofit or rebuild their facilities to meet seismic standards (Elf, Nordin, Wijk, & Mckee, 2017).

Benefits of Effective Wayfinding

The hospital construction boom affords healthcare architects and professionals the opportunity to fundamentally rethink hospital design and the manner in which healthcare is delivered in an attempt to (a) reduce staff stress and fatigue, (b) increase effectiveness in care delivery, (c) improve patient safety, (d) reduce patient and family stress while improving patient outcomes, (e) improve overall healthcare quality, and (f) improve overall hospital operating performance (Shoemaker et al., 2010). Just as healthcare practitioners use evidence-based medicine to drive clinical decisions, a deepening and widening base of research suggests that evidence-based design (EBD) can be used in parallel with evidence-based medicine to create healthcare systems and processes that better support patient care and safety (Shoemaker et al., 2010).

The improvement of wayfinding offers several potential benefits for hospitals, including increased patient, visitor, and staff satisfaction and an increase in overall efficiency (Pati,

Harvey, Willis, & Pati, 2015). Improved wayfinding in an organization that increases the satisfaction of patients, family members, and friends leads to significant cost savings because it reduces waste and increases efficiency (Shoemaker et al., 2010). One common example is that it allows individuals to move efficiently through a facility without causing staff to stop their work to provide directions to lost staff, patients, and/or visitors. This also helps to get patients to their appointments on time so that scheduled appointments are not delayed, which costs the hospital additional money (Pati et al., 2015).

Hospital employees who are travelling to meetings in various locations of the hospital are often stopped in the hallways to provide directions. This interruption in movement may cause delays for the employees and negative impacts to productivity (Harris, 2014). Reducing or eliminating this hurdle creates time-savings and helps hospital employees avoid tardiness, resulting in increased job satisfaction, productivity, and cost savings (Harris, 2014). Moreover, a solution to these interruptions provides an opportunity for an organization to find financial savings through the use of Lean methodology, which focuses on the eradication of waste (Harris, 2014).

Improved wayfinding in an organization is linked to improved employee satisfaction (Pati et al., 2015). A study conducted by the Design Management Institute revealed that improving the design of the physical space in which employees work improved morale, mood, and attitude and was shown to reduce stress (Lockwood, 2007). Seventy-two percent of employees claimed that design upgrades reduced stress while 84% of employees reported improvements in their moods and attitudes. Sixty-nine percent said the new designs improved their morale while 91% claimed that the improvement in wayfinding demonstrated the company's efforts to improve the work environment (Lockwood, 2007).

The use of symbols in wayfinding benefits to healthcare facilities not just in the United States, but world-wide (Foster & Afzalnia, 2005). Symbols are widely used internationally to communicate to people with different languages, and many institutions are preventing confusion regarding the meaning of the symbols by implementing designs that have been vetted through research studies and have subsequently become known as standardized symbols (Foster & Afzalnia, 2005). The success in using symbols for wayfinding, especially in their ability to communicate to people who do not share a common verbal language, has meant that they are increasingly used internationally to inform the public that specified services or objects are available (Foster & Afzalnia, 2005). Within healthcare, the use of symbols is important in directing patients, visitors, and staff to their appointments, exams, and consultations (Cooper, 2010).

Best Practices of Wayfinding

There are four main contributing factors related to wayfinding best practices: (a) spatial structure, (b) technology, (c) signage, and (d) symbols (Zijlstra, Hagedoorn, Krijnen, van der Schans, & Mobach, 2016). When approaching best practices in wayfinding, one key factor to consider is the spatial structure of the building(s) (Carlson, Hölscher, Shipley, & Dalton, 2010). There are a number of features of the spatial structure of a building, including: (a) visual access between key locations, or the degree to which one can see other parts of the building from a given location; (b) architectural differentiation, or the degree to which different parts of an environment appear unique or might be confused; and (c) layout complexity, or the number of rooms and corridors and their configuration (Carlson et al., 2010).

Those who design wayfinding should incorporate the floor plan (the building structure) and environmental cues such as landmarks and signage overlaid on that floor plan (Devlin,

2014). An aspect of plan configuration that merits consideration is the distinction between horizontality and verticality (Pati et al., 2015). Floors that are stacked on top of each other, which is commonly the case in multi-level public buildings, present particular challenges for wayfinding. The difficulty arises because these floors are typically perceived only indirectly, unless such design features as a central atrium make a visual reference between floors possible. Understanding such challenges could inform design decisions that facilitate successful wayfinding (Hashim et al., 2014).

The effective use of technology is another key factor in wayfinding best practices. The utilization of technology allows patients, visitors, and staff to interact with various tools that provide an extra level for efficient navigation (Devlin, 2014). Virtual reality maps and applications for mobile devices are two of the main types of technological advances for wayfinding (Devlin, 2014). Significant technologies are also being developed to enable persons with disabilities to navigate more independently in unfamiliar indoor environments (Hashim et al., 2014). Some systems utilize object detection for the visually impaired community; the technology is able to detect walls, doors, hallways, and people (Devlin, 2014). The technology also has the capability of performing text recognition to recognize wayfinding signs and other forms of communication that use text. The technology employs optical character recognition software currently available in the marketplace, which is then translated into speech for the user (Devlin, 2014). Several technologies have successfully used algorithms for the identification of geometric shapes to detect the location of such architectural elements as doors and elevators, which allows the visually impaired community to have the capability of navigating through their environments (Devlin, 2014).

Effective signage is an important element of wayfinding best practices. Signs do more than provide directions; they reach out to the visitors and make them feel more comfortable with their navigational experience (Sivaji, Radjo, Amin, & Hashim, 2016). It is true that wayfinding is more than just signage, but signage plays an important role. Public healthcare signage is widely used internationally to communicate to people with different languages, abilities and disabilities, and ages, which typically results in confusion and even anger (Rousek & Hallbeck, 2011a). Studies have shown that signage has a considerable impact upon wayfinding behavior that must be included in the overall plan configuration of a building (Rousek & Hallbeck, 2011a). Simply implementing signage within facilities such as hospitals does not necessarily improve people's wayfinding experiences. Faulty sign design can cause navigation problems in unfamiliar environments.

There are four key factors to consider when implementing effective signage for a wayfinding system: (a) signage recognition, (b) signage color, (c) signage font type, and (d) ADA building guidelines (Rousek & Hallbeck, 2011a). Signage recognition is the ability for the majority of a population within a community to be able to recognize and understand the meaning of a sign (Rousek & Hallbeck, 2011a). Signage color and font type need to be legible and made simple to read, leaving out faint colors and/or obscure and difficult-to-discern lettering (Rousek & Hallbeck, 2011a). Also, ADA building guidelines are important to consider when designing signage, because there are specific symbols that are important to the community of people with various disabilities that enable them to decide which direction to go based on their needs (Rousek & Hallbeck, 2011a). Design consistency in signage technology is an important consideration for these aforementioned wayfinding aspects (Sivaji et al., 2016).

The use of symbols to augment or replace words and sentences has become a hallmark trait in wayfinding (Lo, Yien, & Chen, 2016). With the increasing diversification of the population in the US and other countries, particular attention is needed to communicate meaning through symbols (Delvin, 2014). One approach to increase cross-cultural comprehension in healthcare settings is to use universal healthcare symbols (Devlin, 2014). Some symbols are well understood cross-culturally such as those that represent billing, obstetrics clinics, and radiology (Lo et al., 2016). Research indicates that people have trouble interpreting abstract signage, particularly when unique features of a specific hospital department are absent because the signage has been oversimplified (Young & Wogalter, 2002). Young and Wogalter (2002) found in one study that the use of human figures can be effective in healthcare signage (Young & Wogalter, 2002). For example, symbols that show the human body or body parts performing a specific action are easily understood (Delvin, 2014).

Summary

Wayfinding strategies should foster effective communication with the broadest group possible, including people with a wide range of languages, intellectual abilities, ages, and social and cultural backgrounds (Sivaji et al., 2016). Effective wayfinding should be an intuitive process that enables users to perceive and organize their environment in a way that allows for navigation with minimal confusion (Zijlstra et al., 2016). With new regulations requiring hospitals to make seismic upgrades, and with the scheduled construction of many new healthcare facilities across the United States and the world, healthcare executives can utilize this time to implement wayfinding strategies for purposes that will benefit their returns on investment and the public (Shoemaker et al., 2010). When wayfinding best practices recommended by experts in the field are followed, wayfinding in healthcare will benefit patients, visitors, staff, and leaders

by reducing medical errors, minimizing frustration, increasing satisfaction, and creating cost savings (Rousek & Hallbeck, 2011a).

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