

Evidence Based Environmental Design for Improving Medical Outcomes

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Introduction

Healthcare facility design traditionally has emphasized concerns such as functional efficiency, costs, and providing effective platforms for medical treatments and technology. A consequence of this perspective has been that psychological and social needs of patients have been largely disregarded in the design of healthcare facilities – and often marginalized in creating visitor and staff spaces. In spite of traumatizing hospital experiences and major stress from illness, little priority has been given to creating surroundings that calm patients, or help to strengthen coping resources and healthful processes. Rather, the functional emphasis often produced environments now considered starkly institutional, stressful, and detrimental to care quality (Ulrich, 1992; Horsburgh, 1995).

There is a growing awareness internationally among healthcare administrators and medical professionals of the need to create functional environments that also have patient-centered or *supportive* characteristics that help patients cope with the stress that accompanies illness (Ulrich, 1991). The key factor motivating awareness of facility design has been mounting scientific evidence that environmental characteristics influence patient health outcomes. Many studies have shown that well-designed environments can, for instance, reduce anxiety, lower blood pressure, and lessen pain. Conversely, research has linked poor design – or psychosocially unsupportive surroundings – to negative effects such as higher occurrence of delirium, elevated depression, greater need for pain drugs, and in certain situations longer hospital stays (Ulrich, 1991, 1992).

Further, staff as well as patients benefit from good design. Supportive design of staff spaces can help employees cope better with workplace stress, reduce absenteeism, may lower turnover, and in several ways support employees in providing quality care. Well-designed staff environments are a positive factor in attracting and retaining qualified employees.

Objectives of This Presentation

- Briefly assess the overall state of scientific knowledge concerning the effects of environmental design on patient health outcomes.
- Concisely review the limited amount of available scientific

research, and identify the specific types of environmental characteristics that studies indicate affect outcomes. Discuss implications for creating supportive environments that reduce stress and promote other improved outcomes.

- Describe a research-informed Theory of Supportive Healthcare Design that can be used for identifying promising design approaches for many questions where directly relevant research is lacking.
- Summarize the improved outcomes and other advantages that seem realistically attainable through research-informed supportive design of a new healthcare facility.

State of Scientific Knowledge

A few years ago the Center for Health Design commissioned an impartial group of researchers at the Johns Hopkins Medical School, led by Dr. Haya Rubin, to evaluate the status of research on design/health relationships. The conclusions of the Johns Hopkins report were moderately encouraging (Rubin et al., 1998). The investigators found upwards of 85 published studies, which met criteria for scientific rigor, such as using an experimental design with random assignment. (The number of such studies may now have grown to approximately 100.) The authors observed that this amount of research is small by the standards of established medical fields, but there is now enough quality research to justify the conclusion that "there is suggestive evidence that aspects of the designed environment exerts significant effects on clinical outcomes for patients" (Rubin et al., 1998).

The next section lists and briefly discusses several types of environmental characteristics that research indicates can affect outcomes. The discussion is not intended to be comprehensive or include all environmental factors that may influence patient health. The discussion draws on the report by Rubin and her associates (Rubin et al., 1998) and research surveys by the author (Ulrich, 1991, 2000).

Environmental Properties Found to Affect Outcome

Noise

There is considerable evidence that noise produces *annoyance* across different patient groups. A smaller amount of research has investigated the effects of noise on outcomes, especially in critical or intensive care units. Most studies suggest that noise detrimentally affects at least some critical care outcomes, for example, increasing sleeplessness and elevating heart rate (e.g., Hilton, 1985). Apart from patients, noise is often a major source of stress for staff and can detrimentally affect workplace performance (Evans and Cohen, 1987). There appears to be sufficient evidence on negative effects of noise to justify the recommendation that noise reduction should be a major consideration in the design of new healthcare buildings.

Music

Several studies have shown across a variety of patient groups that pleasant music, especially when controllable, often can reduce anxiety or stress and helps some patients cope with pain (e.g., Standley, 1986; Menegazzi et al., 1991).

Windows Versus No Windows

Research on intensive or critical care units strongly suggests that a lack of windows can detrimentally affect patients. Lack of windows in ICUs is associated with higher rates of anxiety, depression, and delirium compared to rates for units with windows (e.g., Keep et al., 1980). Questionnaire evidence indicates that patients in acute care consider windows to be very important, and assign especially high value to nature views (Verderber, 1986).

Regarding staff, many studies across a variety of workplaces (healthcare, office buildings) have found that employees, like patients, attach high importance to having windows, and nature views are most preferred. Further, employees with nature window views are less stressed, report better health, and higher levels of job satisfaction than comparable groups who lack nature views – particularly those without windows (e.g., Leather et al., 1997). A later section will discuss research suggesting that nature views also foster gains in patient outcomes.

Sunny Rooms and Views

Two studies performed in a Canadian hospital raise the possibility that patient rooms looking out on *sunshine*, rather than cloudy or drab conditions, are linked with more favorable outcomes (Beauchemin and Hays, 1996, 1998). The first study found that patients hospitalized for severe depression had shorter stays if assigned to a sunny rather than non-sunny room. The finding that viewing sunshine apparently alleviates depression may explain the results of the second study – that mortality of myocardial infarction patients was lower for patients assigned to sunny critical care rooms rather than to north-facing dull rooms (Beauchemin and Hays, 1998). Regarding staff, questionnaire studies indicate that employees likewise prefer window views of spaces illuminated by sunlight rather than cloudy conditions.

Single Rooms Versus Multi-Bed Units

There is limited evidence that infection rates in critical care units are lower in single rooms than open wards. A burn unit study, for example, found that multi-bed units were associated with increased infection occurrences (Shirani et al., 1986). A related issue that implies important advantages for single bed intensive care units is the growing concern for controlling infection with respect to antibiotic resistant pathogens (Ognibene, 2000).

Sound research is lacking that could clarify the important question of whether single occupancy rooms, compared to double rooms, are better for acute care patients from the standpoint of supportive surroundings and improved outcomes. Advocates of double rooms point to a vast body of anecdotal evidence suggesting that patients who share a room often provide each other with healthful social/emotional support. Double room proponents further contend that initial construction costs are lower for double than single room

inpatient units.

Single room proponents, on the other hand, point to a different but again vast anecdotal literature indicating that patients in double rooms frequently complain about roommates who have an incompatible personality, invade privacy, or disturb sleep. Single room advocates can also claim that incompatibility among roommates leads to costly room changes and patient moves that erode or even outweigh initial construction cost advantages for double occupancy rooms. (See Kirk Hamilton's paper.) These arguments notwithstanding, more research is needed to shed light on the single versus double room debate.

Flooring Material

A small but growing body of research has compared the advantages for patients of different types of flooring materials, including carpet and "hard" or glossy materials such as vinyl composition and linoleum. A few studies have yielded a rather surprising preliminary finding: hard materials may not significantly or consistently outperform carpet with respect to epidemiological concerns and certain health-related environmental conditions – for example, hospital-acquired infection rates and bacteria in the air (e.g., Anderson et al., 1982).

There is growing evidence that carpet is often superior from the standpoint of several supportive or patient-centered considerations. Elderly patients walk more efficiently (have greater step length, speed) and feel more secure and confident on carpeted compared to vinyl surfaces (Wilmott, 1986). A recent study by Harris (2000) of rehabilitation patients in a telemetry unit found that visitors spent more time with patients in rooms with carpet than rooms with vinyl composition flooring. This finding is important because it raises the possibility that carpet might promote improved health outcomes via an effect of heightening social support. Harris' study also indicated that the vast majority of patients preferred carpet to vinyl composition flooring, for reasons that included slip resistance, comfort, and perceived noise reduction. The vast majority of staff (83%), however, preferred the vinyl composition surface, primarily because of greater ease in cleaning up spills (Harris, 2000).

Furniture Arrangements

A number of studies have investigated how furniture arrangements in healthcare environments influence social interaction and eating behaviors of patients. Melin and Gotestam (1981) found that by changing ward furniture arrangements appropriately it was possible to improve eating behaviors of psychogeriatric patients. Studies of day rooms, lounges, and waiting areas have shown that social interaction falls markedly when seating is arranged side-by-side along the walls of the room. These findings indicate that levels of social interaction – and presumably healthful social support – can be considerably increased for patients in day rooms and lounges by providing comfortable, movable furniture that can be arranged in small flexible groupings (e.g., Sommer and Ross, 1958).

A Theory of Supportive Design

The foregoing sections discussed examples from the limited number of scientific studies on the links between environmental characteristics and outcomes. The amount of research is growing, but there is no sound, directly relevant research yet available for many healthcare design questions or situations. To suggest preliminary answers and design directions in situations when gaps exist in research knowledge, the next sections outline a Theory of Supportive Design that generates broad and flexible design guidelines that can be applied to a wide range of healthcare issues or situations. The supportive design guidelines are underpinned by a large amount of "indirectly" relevant research in health psychology, environmental psychology, behavioral medicine, and other health-related fields (Ulrich, 1991, 1997). The guidelines suggest comparatively evidence-informed general directions for successful supportive design solutions.

A basic premise underlying the Theory of Supportive Design is that the potential for environments to promote improved outcomes is linked to their effectiveness in facilitating stress coping and restoration (Ulrich, 1991, 1997, 1999). The great majority of patients experience stress, and many unfortunately suffer acute stress. As well, stress is a problem for families of patients and visitors, and is pervasive among healthcare staff. In the case of patients, stress is an important medical concern because it is both a significant health outcome in itself, and it directly and negatively affects many other outcomes (e.g., Cohen et al. 1991). Negative health effects stem from the fact that stress responses include numerous psychological/emotional, physiological, biochemical, and behavioral changes.

Against this background, it is clear why healthcare facilities should be designed in ways that support patients in their coping with stress. *Supportive* healthcare design begins by eliminating environmental characteristics (loud noise, for instance) that are stressful or can have direct negative impacts on outcomes. Additionally, supportive design goes a significant step further by including features in the environment that research indicates can calm patients, reduce stress, and strengthen coping resources and healthful processes (Ulrich, 1991, 1997, 1999).

General Guidelines for Supportive Design

Research suggests that healthcare environments will support coping with stress and thereby promote improved outcomes if the design is oriented to fostering:

- **Sense of control and access to privacy**
- **Social support**
- **Access to nature and other positive distractions**

Design Guideline: Foster sense of control and access to privacy

Control refers to persons' real or perceived ability to determine what they do, to affect their situations, and determine what others do to them (Gatchel et al., 1989). Much research has shown that

people who feel they have some control over situations cope better with stress, are less stressed, and have better health than people who feel they lack control (Evans and Cohen, 1987; Ulrich, 1999). Among patients, loss of sense of control is a major problem that produces stress and negatively affects outcomes (Ulrich, 1991). Aspects of illness and hospitalization that erode feelings of control include, for example, unavoidable and painful medical procedures, lack of information and uncertainty, long waiting times, and loss of control over eating and sleeping times (Taylor, 1979). It should be emphasized that additional loss of control results from unsupportively designed environments that, for example, deny privacy, are noisy, have rooms arranged so that patients cannot see out of windows, force bedridden patients to stare at glaring ceiling lights, or are confusing from the standpoint of way-finding (Ulrich, 1999).

Examples of design approaches for fostering greater sense of control for patients include providing: privacy in imaging areas; bedside dimmers that enable control over lighting; headphones that allow patients to select music; televisions controllable by individual patients; architectural design and signage that facilitate wayfinding; and gardens and other attractive grounds accessible to patients in wheelchairs. Examples of design approaches for enhancing control and reducing stress for *staff* include providing easily adjustable workstations (O'Neill and Evans, 2000), and comfortable break areas that give employees a sense they can temporarily escape the demands and stress of hospital workplaces.

Design Guideline: Foster access to social support

Social support refers to emotional support or caring and tangible assistance that a person receives from others. Much scientific research has shown across a variety of healthcare and other situations (workplaces, for example) that people who receive higher social support generally experience less stress and have better health than persons who are more socially isolated. Several studies in healthcare contexts have indicated that social support improves, for example, recovery outcomes in myocardial infarction patients, and survival length in patients with metastatic cancer (e.g., Spiegel et al. 1989). Despite a lack of studies focusing directly on healthcare facility design, the evidence showing benefits of social support across other health-relevant contexts is so convincing that it seems clearly justified to suggest that design that promotes social support for patients should tend to ameliorate stress and improve other outcomes (Ulrich, 1991, 1997).

Examples of the many possible design approaches for fostering social support for patients include providing the following for family and visitors: comfortable, pleasant waiting areas; convenient access to food, telephones, and restrooms; convenient overnight accommodations; and accessible gardens with sitting areas that encourage socializing between visitors and patients. Regarding staff, it should be mentioned that there is limited evidence that gardens in healthcare facilities can be especially effective vehicles for fostering staff access to social support from other staff (Marcus and Barnes, 1999).

Design Guideline: Foster access to nature and other positive

distractions

Positive distractions are a small subset of environmental-social phenomena that are distinguished by their capacity to quickly and effectively promote restoration from stress (Ulrich, 1999). Types of positive distractions that have received the most attention in healthcare include music, art, comedy, companion animals, and nature. This section concentrates on the last of these, nature, giving particular emphasis to stress reducing and other beneficial influences of viewing nature in indoor and outdoor settings.

Several studies of nonpatient groups (such as university students) as well as patients have consistently indicated that simply viewing nature can produce significant recovery or restoration from stress within about three to five minutes. (For a survey of studies see Ulrich, 1999.) For persons experiencing anxiety or stress, studies indicate that certain types of nature scenes rather quickly foster more positive feelings, and promote beneficial changes in physiological systems – for instance, lower blood pressure (e.g., Ulrich et al., 1991). A limited amount of healthcare research suggests that even acutely stressed patients can experience significant lessening of stress after only a few minutes of viewing nature settings with greenery, flowers, or water.

In other research, a study in a Swedish university hospital investigated whether exposing heart surgery patients in intensive care units to nature pictures improved outcomes (Ulrich, Lundén, and Eltinge, 1993). Those patients assigned a landscape with trees and water experienced less anxiety, and required fewer strong pain doses, than control groups assigned no pictures. Another study of patients recovering from abdominal surgery found that individuals had more favorable postoperative courses if their bedside windows overlooked trees rather than a brick building wall (Ulrich, 1984). Those with the nature window view had shorter hospital stays, received far fewer negative evaluative comments in nurses' notes, tended to have fewer minor complications, and needed fewer doses of strong pain drugs than the wall view patients.

A few studies of patient reactions to different types of art have yielded additional evidence of positive influences of nature. (For surveys of studies see Ulrich, 1991, 1999.) The great majority of patients prefer representational art depicting serene, spatially open natural environments having scattered trees and/or non-turbulent water features--but consistently dislike abstract art. Although designers, artists, and some healthcare staff react positively to abstract images, or to art having a sense of "challenge" or ambiguity, there is evidence that such properties in pictures can negatively affect patient stress and worsen other outcomes (Ulrich, 1991, 1992, 1999). Caution should be exercised before displaying ambiguous, challenging art in patient spaces or high stress waiting and treatment areas (Ulrich, 1999).

Examples of design approaches for fostering access to nature include providing: nature window views for patient rooms, waiting areas, and staff spaces; a soothing garden that family, patients, staff can easily access for relief from the hospital environment; an aquarium in a high-stress waiting area; an atrium with greenery and a fountain; and calming nature art mounted where bedridden

patients can readily see it.

Summary: Advantages of Evidence-Informed Supportive Design

What advantages can healthcare administrators, designers, medical professionals (and the public) reasonably expect to achieve by including psychosocially supportive design criteria in the objectives for a new facility? On the basis of a broad assessment of the available scientific research, the following list was compiled of the advantages in terms of improved outcomes that seem realistically attainable in a well-designed facility. The list is not comprehensive.

- **Reduced stress/anxiety** for patients and family/visitors
- Likelihood of achieving, given current knowledge: *very high*
- **Improved sleep**
- Likelihood of achieving: *high*
- **Reduced pain**
- Likelihood: *moderately high* depending on patient category
- **Lower infection occurrence**
- Likelihood: *moderately high*, especially for intensive care patients
- **Improved patient satisfaction**
- Likelihood: *high*
- **Benefits for staff** (reduced stress, improved job satisfaction, possibility of reduced turnover, greater attraction of qualified employees)
- Likelihood: *very high* that at least some will be achieved
- **Cost savings** by improving medical outcomes (examples: reduced infection occurrence; reduced intake of costly strong analgesics; some patients might be moved sooner from intensive or acute care to less costly care units)
- Likelihood: *moderate to moderately high*, depending on extent to which hospital is well designed throughout

Finally, administrators and medical staff (and the public) might wonder whether an emphasis on supportive design would increase construction costs for a major facility. Most supportive characteristics or strategies probably cost no more than poorly designed or unsupportive facilities and many cost less. It is only too common to find facilities that were costly to build but nonetheless fail in major respects when judged according to evidence-informed supportive criteria. To reduce costs and greatly increase the potential benefits of supportive design, it is important that supportive knowledge and objectives are included early rather than late in facility design and programming. Taking a long-term perspective on costs, facility design and construction costs are low compared to expenses for facility operation, staff salaries, and the day-to-day delivery of healthcare (Ulrich, 1992).

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