



Aalborg Universitet

AALBORG UNIVERSITY
DENMARK

Towards a design theory for reducing aggression in psychiatric facilities

Ulrich, Roger S; Bogren, Lennart ; Lundin, Stefan

Published in:
ARCH 12: ARCHITECTURE / RESEARCH / CARE / HEALTH

Publication date:
2012

Document Version
Early version, also known as pre-print

[Link to publication from Aalborg University](#)

Citation for published version (APA):
Ulrich, R. S., Bogren, L., & Lundin, S. (2012). Towards a design theory for reducing aggression in psychiatric facilities. In *ARCH 12: ARCHITECTURE / RESEARCH / CARE / HEALTH* Chalmers Institute of Technology. <http://conferences.chalmers.se/index.php/ARCH/arch12/paper/view/426>

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- ? Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- ? You may not further distribute the material or use it for any profit-making activity or commercial gain
- ? You may freely distribute the URL identifying the publication in the public portal ?

Take down policy

If you believe that this document breaches copyright please contact us at vbn@aub.aau.dk providing details, and we will remove access to the work immediately and investigate your claim.

Title of paper: **TOWARD A DESIGN THEORY FOR REDUCING
AGGRESSION IN PSYCHIATRIC FACILITIES**

Authors: Roger S. Ulrich PhD*
Lennart Bogren MD, PhD**
Stefan Lundin SAR/MSA***

*Center for Healthcare Architecture and Department of Architecture, Chalmers University of Technology; and Department of Architecture, Design & Media Technology, Aalborg University

** Sahlgrenska University Hospital

*** Doctoral student, Center for Healthcare Architecture and Department of Architecture, Chalmers Institute of Technology; and White Architects

Paper submitted to the conference:

ARCH 12: ARCHITECTURE / RESEARCH / CARE / HEALTH

Chalmers, Gothenburg, November 13-14, 2012

Corresponding author:
Roger Ulrich PhD
roger.s.ulrich@gmail.com

October 14, 2012

ABSTRACT

The paper proposes a tentative theory for designing psychiatric environments to foster reduced aggression and violence. A basic premise underlying the design theory is that environmental and psycho-social stressors mediate and trigger aggression. The theory posits that aggression will be reduced if the facility has been designed with an evidence-based bundle of stress-reducing environmental characteristics that are identified and discussed. To make possible a tentative empirical evaluation of the theory, findings are described from a study that compared aggressive incidents in three Swedish psychiatric hospitals of different design. A newer hospital was evaluated as superior to both an old hospital it replaced and another comparison hospital (control) with respect to having nearly all the environmental features identified in the stress-reducing bundle of the design theory. Findings from restraint use data were consistent with the design theory prediction that aggression would be lower in the newer hospital having several stress-reducing environmental features than in either the old or control hospitals. The use of chemical and physical restraints decreased substantially in the new hospital compared to the old hospital it replaced. By contrast, restraint use *increased* in the control hospital that cared for comparable psychiatric patients according to similar treatment protocols during the same period. The design theory and preliminary findings suggest the possibility that providing better psychiatric buildings with design guided by the best available evidence and theory can play an important role in reducing the serious patient and staff safety problem of aggressive behavior.

Keywords: aggression, violence, psychiatric hospital, psychiatric patients, evidence-based design, stress, healthcare architecture

INTRODUCTION: AGGRESSION IN PSYCHIATRIC FACILITIES

Patient aggression in psychiatric facilities is a serious and worldwide problem that appears to be increasing. Incidents of violence cause psychological harm and often physical injury to other patients, to staff, to the aggressive individuals themselves, and property. A review of 122 studies carried out in 11 countries (among others, Sweden, Norway, Germany, Netherlands, United Kingdom) found that 32.4% of psychiatric inpatients engaged in aggressive behavior or violence (Bowers et al., 2011). The mean incidence of violent events per 100 patients sampled internationally was 224.4, or 2.24 per patient (Bowers et al., 2011). Rates vary by type of psychiatric treatment setting and country. Variation also arises from the use of different definitions and measurements of aggression and violence in studies. On average, nearly 50% of all aggressive incidents recorded internationally in psychiatric units involve physical violence. International data suggest that *37% of violent or aggressive incidents result in physical injury to staff* (Bowers et al., 2011), an alarming figure that underscores the seriousness of violence as a staff safety problem.

Much research in psychiatric settings has focused on patient characteristics (diagnosis, history, gender, for example) and staff variables (such as experience, ward staffing levels) in attempting to identify predictors or correlates of aggression/violence (Ulrich et al., 2008a). By contrast, there is a lack of theory and quality research concerning the link between characteristics of the physical environment of psychiatric facilities and patient violence. Although there is literature on best practices for designing acute psychiatric inpatient wards and psychogeriatric facilities (Karlin & Zeiss, 2006; Dobrohotoff &

Llewellyn-Jones, 2011), the recommendations are based mainly on clinical conjecture, professional experience, and anecdote, and do not provide explicit design guidelines for reducing aggression and violence. As a step toward addressing the lack of theory and research the paper proposes a tentative theory for designing psychiatric environments to foster reduced aggression. The theory posits that violence will be reduced if the ward has been designed with multiple stress-reducing environmental features. The discussion provides a brief overview of each stress-reducing design factor comprising the environmental bundle. The last section describes preliminary findings from a study that compares aggressive incidents in Swedish psychiatric hospitals of different design, making possible a tentative empirical evaluation of the theory.

RESEARCH ON CROWDING AND AGGRESSION IN PSYCHIATRIC FACILITIES

Crowding is the only environment-related variable to receive attention in multiple studies of aggression in psychiatric wards. Some researchers have proposed that ward crowding should foster increased violence by exposing patients to negative or stressful conditions such as higher stimulation levels, ward turmoil, and invasion of privacy (e.g., Palmstierna et al., 1991; Chou et al., 2002; Daffern & Howells, 2002). Unfortunately, studies in psychiatric facilities have not measured crowding in ways that explicitly consider environmental factors (Ulrich et al., 2008a). Reports rarely contain description of the physical environments of the wards studied, and there is little or no information about environmental features that have been shown by research in other fields to influence crowding, such as whether patients have single or shared bedrooms. Several aggression studies have defined crowding as a high ward bed occupancy rate, while others have interchangeably used terms such as crowding, patient density, or ward density. Across studies in psychiatric facilities there is no consistent association between crowding defined as high ward occupancy and violence. Some investigations have found a positive link with violence, while others have reported no correlation (e.g., Palmstierna et al., 1991, 1995; Nijman & Rector, 1999; Ng et al., 2001; Virtanen et al., 2011).

In contrast to mental health research, environmental psychology has long distinguished between *density* and *crowding* (Stokols, 1972). Density is defined as a physical-spatial, not psychological, condition -- the amount of space per person in a physical environment such as an apartment complex or mental health facility. Crowding, on the other hand, is a psychological and physiological state in which stress and negative emotions are experienced (Stokols, 1972; Ulrich et al., 2008a). Crowding stress is related to inadequacies in the configuration of the physical environment that constrain the ability of persons to seek privacy, regulate their relationships and degree of openness with others, and avoid stressors such as noise and arguments (Baum & Valins, 1979). When this distinction is made between density and crowding, studies carried out in non-hospital environments have shown that the correlation between spatial density and crowding stress is weak and inconsistent.

DESIGN THEORY FOR REDUCING AGGRESSION

Stress and Aggression

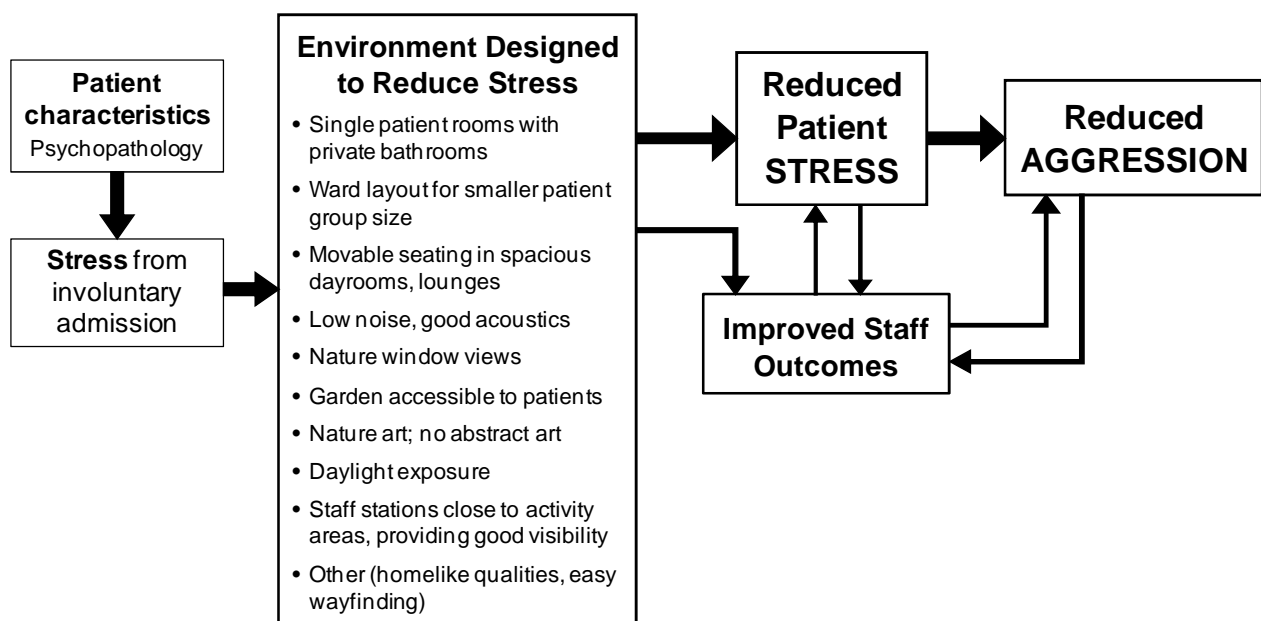
A key premise underlying the proposed design theory is that the stressors experienced by hospitalized psychiatric patients mediate and trigger aggression. A second major

proposition is that the ward physical environment strongly influences patient stress. From these arguments it follows that aggression/violence will be worsened if psychiatric facilities have environmental features that are stressors or obstruct control or coping. Psychiatric hospital environments will reduce aggression, however, if they are designed to minimize stressors such as crowding and noise, foster privacy, control, and other stress coping resources, and provide exposure to stress reducing features such as nature (Ulrich, 1991; Ulrich et al., 2008a). The premise that stress causes and exacerbates aggression is reflected in explanatory models of violence on inpatient psychiatric wards (Nijman et al., 1999, Nijman, 2002; Kumar & Ng, 2001).

A Tentative Design Theory

Figure 1 outlines the proposed design theory for reducing aggression. The lines and arrows in the figure indicate posited relationships among the main variables (see box labels). Beginning with the left hand boxes, the design theory is similar to an aggression framework developed by Nijman and colleagues (1999) in positing that patient characteristics (psychopathology) and stressors associated with involuntary admission (being locked up, for example) interact to intensify patient stress on admission to the ward. Moving to the right in the figure, the theory becomes quite different from models in psychiatry by proposing that the patient’s acute stress will be lessened after admission if the ward environment has been designed in evidence-informed ways to foster control and coping, mitigate crowding stress, minimize environmental stressors such as noise, and promote exposure to stress reducing or restorative features such as nature. The model’s Environment box lists several design factors that have been found by research to have stress-reducing influences. The models posits that implementing a multi-faceted design bundle of these evidence-informed factors increases prospects for achieving significant reduction of patient stress.

FIGURE 1: A Design Theory for Reducing Aggression in Psychiatric Facilities



Moving from the Environment box in Figure 1 to the right, the model posits that the environmental design bundle reduces patient stress, leading to reduced aggression. Diminished aggression is reflected in different outcome improvements such as reduced

physical violence, verbal aggression, and use of restraints and isolation. The Staff Outcomes box in the lower right-center of Figure 1 illustrates the proposition that the evidence-informed design features also directly and positively affect staff outcomes, for example, by reducing job strain, injuries, and fostering higher satisfaction. The enhanced staff outcomes are considered to feed back and contribute further to decreasing patient stress and aggression. Although the design theory features the role of the built environment in reducing stress and violence, it is also recognized that the competence and experience of clinicians, the quality of care protocols, organizational culture, ratio of staff to patients, and other variables influence these outcomes (Ulrich et al., 2010).

The next section provides an overview of each stress-reducing design factor listed in the Environment box in Figure 1. The purpose is to give the reader a basic introduction to each environmental variable and cite selected research examples, not provide detailed reviews. (For more detailed research reviews of the design factors see Ulrich et al., 2008a, 2008b; Ulrich, 2012.)

DESIGN FEATURES THAT REDUCE STRESS AND FOSTER REDUCED AGGRESSION

Single Patient Rooms

Providing single bedrooms may be the most important design intervention for reducing stress and thereby aggression in inpatient psychiatric wards. Considerable research on residential settings and prisons has shown that the number of persons sharing a bedroom, bathroom, or cell strongly correlates with higher crowding stress and lower privacy, perceived control, more disagreements with roommates, more illness complaints, and social withdrawal (Baum & Valins, 1977; Cox et al., 1984; Ruback et al., 1986). Research by Ittelson and colleagues of psychiatric inpatient wards similarly found a strong association between multi-bed rooms and social withdrawal (Ittelson et al., 1972). Crowding research in prisons has shown that prisoners in two-bed cells are more stressed, commit more disciplinary infractions (implying more aggression), and have higher rates of reported sickness than those in small single-bed cells (Cox et al., 1984). These findings emerge when studies control for spatial density or the amount of space per person (Evans, 2003). A related implication is that the architectural design and layout of psychiatric wards, by determining the number of rooms and hence directly affecting the number of patients per room, privacy access, and control, should be more important than spatial density in predicting crowding stress and probably aggression in mental health facilities.

Design for Smaller Ward Patient Group Size

Research on non-psychiatric residential settings such as student dormitories and apartment buildings has found that smaller population sizes on floors, corridors, or units (approximately 12-18 persons at full occupancy) are associated with lower perceived crowding and more interpersonal contacts and helping behavior, than floors or units of comparable spatial density but large populations (Baum & Davis, 1980). When spatial density is controlled for, students living on longer corridors with larger floor populations tend to report having fewer friends and acquaintances than those living on short corridors with smaller populations. Also, smaller ward population sizes in psychiatric hospitals likely foster control and help prevent crowding stress by enabling patients to

more easily regulate their personal spacing and relationships with others in shared spaces such as dayrooms and eating areas.

Design Feature: Movable Seating in Spacious Day Rooms

Evidence suggests that providing movable seating in dayrooms, lounges, and other shared spaces in psychiatric wards enhances the patient's capability to regulate personal space and interactions with others, achieve control, and reduce stress. One important way persons regulate interactions is by actively adjusting and using the space immediately around them -- by moving closer to or farther away, and altering orientation relative to others (Sommer, 1969). Much research has shown that persons are quite sensitive with respect to maintaining appropriate interpersonal distances and respond with stress, anxiety, and sometimes anger when others intrude into their personal space (Sommer, 1969). A study of videotaped incidents of violence in a psychiatric unit reported that assailants appeared to be especially sensitive when others moved close and invaded their personal space (Crownier et al., 1991). Dayrooms and other shared areas should be spacious to enable patients to easily regulate or maintain their personal space when others are in the room.

Design Feature: Noise Reduction

Noise studies are lacking for psychiatric hospitals but there is a large body of research on general hospitals (Ulrich et al., 2008b). Several studies have reported that reducing noise levels lowers stress in non-psychiatric inpatients as evidenced, for example, by reduced blood pressure (Hagerman et al., 2004). Other research on nurses in non-psychiatric facilities has found that noise reducing design measures lower staff stress, annoyance, perceived work demands and pressure, and may help reduce burnout (Blomkvist et al., 2005; Topf & Dillon, 1988). Given the focus on aggression and violence in the design theory, it should be emphasized there is strong evidence from studies of non-patients that exposure to unpredictable or uncontrollable noise facilitates and increases aggression (Green & O'Neal, 1969; Donnerstein & Wilson, 1976).

Design Feature: Nature Window Views

Several studies of non-psychiatric hospital patients and non-patient groups have found that viewing nature fosters rapid reduction of stress (e.g., Ulrich et al., 1991; Raanaas et al., 2011). Physiological restoration from stress is evident, for instance, in reduced blood pressure and changes in cardiac activity. These and other beneficial physiological changes are accompanied by increased positive emotions and reduced levels of negatively-toned feelings such as anxiety and anger (Ulrich et al., 1991). A study of patients recovering from surgery found that those assigned to rooms with a window view of nature (trees), compared to matched patients with windows overlooking a brick wall, had better emotional well-being, endured fewer stress-related minor complications such as persistent headache, suffered less pain, and had shorter stays (Ulrich, 1984). Limited research on nurses in non-psychiatric hospitals suggests that those having daily exposure to a nature window view in their work areas had lower stress than nurses with no window overlooking nature (Pati et al., 2008).

Design Feature: Garden Accessible to Patients

Evidence from studies in general hospitals indicates that patients and visitors who use gardens report reduced stress, improved emotional well-being, and higher satisfaction

with care quality (Marcus & Barnes, 1995; Whitehouse et al., 2001; Sherman et al., 2005). Gardens in hospitals not only provide stress-reducing nature views, but if well designed reduce stress through other established mechanisms (Ulrich, 1999). For example, a garden that is accessible to patients improves emotional well-being by increasing exposure to daylight, and promotes control and stress reduction by providing a calming and enticing getaway from familiar interior ward spaces. A garden designed with seating choices additionally provides patients with attractive places either to seek privacy or socialize (Marcus & Barnes, 1999; Ulrich, 1999). Limited evidence suggests that access to gardens reduces stress in nurses and other healthcare workers, increases job satisfaction, and may help foster recruitment and retention of personnel (Marcus & Barnes, 1995; Whitehouse et al., 2001; Sherman et al., 2005).

Design Feature: Nature Art

Studies in non-psychiatric or general hospitals of ethnically diverse groups of patients have consistently found that the great majority prefer and respond with positive emotions to representational nature art, but dislike abstract artwork and images displaying emotionally negative or challenging subject matter (Ulrich, 1991, 2009; Carpman and Grant, 1993; Nanda et al., 2007). There is some evidence that nature art also reduces patient stress (Heerwagen, 1990). A small-scale study in a Swedish psychiatric facility reported that patients had positive feelings and reactions with respect to nature art and prints, but had negative reactions to ward artwork that was abstract or could be interpreted in multiple ways (Ulrich, 1991). In the same study archival data showed that psychiatric patients had physically attacked several ward artworks, all of which displayed abstract subject matter and styles (Ulrich, 1991). A prospective study of elderly psychiatric patients found that placing a large realistic nature print in a ward lounge substantially reduced the number of injections given for aggressive behaviors (kicking, hitting, biting) and agitation (Nanda et al., 2010). Parallel findings were obtained in a randomized study of non-patient volunteers exposed to anger-provoking tasks in a simulated workplace (Kweon et al., 2008). Taken together, studies on psychiatric and non-psychiatric patients indicate that representational nature art should be provided, while abstract art should be avoided because it elicits dislike and stress and can trigger aggression.

Design Feature: Daylight Exposure

It appears that no study has yet investigated whether daylight levels influence aggression in psychiatric hospitals. However, several studies of psychiatric and non-psychiatric patients suggest that designing buildings to provide higher exposure to natural light, compared to low exposure, reduces depression and fosters shorter in-patient stays for depressed patients (Ulrich et al., 2008b; Ulrich, 2012). Assigning psychiatric patients with serious depression to rooms having higher daylight shortens stays compared to placing similar patients in rooms that receive less daylight or are always in shade (Beauchemin & Hays, 1996; Benedetti et al., 2001). An investigation of Alzheimer's patients found that agitation levels were lower in facilities designed for higher light exposure in interior spaces compared buildings with lower light (Sloane et al., 1998).

Design Feature: Staff Stations Close to Patient Activity Areas with Large Windows for Good Observation

The design and placement of staff stations influences the proximity and accessibility of staff to patients, and likely affects the quality of staff-patient communication. It has been proposed that inadequate or problematic communication between staff and patients contributes to stress and violence (Nijman et al., 1999). An observational study in a psychiatric hospital suggested that locating stations in front of day rooms and providing large observation windows encouraged staff to leave stations more frequently and spend increased time with patients in day rooms (Gross et al., 1998). Skillful design and siting of staff stations, in addition to enhancing observation of day rooms, also can enable good visibility of other ward locations found to be frequent sites of assaults, including corridors and dining rooms (Ulrich et al., 2008a; Chou et al., 2002).

Other Design Factors: Best Practices

There is no suggestion here that the list of stress-reducing environmental factors discussed above is comprehensive. It is likely that as research progresses other design measures can be added to the Environment box in the design theory (Figure 1). In the meantime it is appropriate to mention certain “best practice” design factors that possibly contribute to stress reduction. These factors are not yet directly supported by empirical evidence, but experience from existing clinical and design practice makes it plausible the design measures may influence patient stress in psychiatric facilities.

Wayfinding. Studies in general hospitals of patients and visitors have found that difficult wayfinding elicits stress (Carpman & Grant, 2002). Therefore, design approaches that promote easy wayfinding in psychiatric hospitals may lessen stress (Ulrich et al., 2008a).

Home-like characteristics. Providing home-like characteristics is widely recommended as best practice design for psychiatric hospitals, Alzheimer’s facilities, and nursing homes (long term care facilities) (Karlin & Zeiss, 2006). However, research evidence concerning possible influences on stress and aggression is sparse and inconsistent. Although some findings appear to link home-like characteristics in Alzheimer’s facilities with reduced agitation and aggression (Day et al., 2002), a study in a Norwegian psychiatric ward found that decorating a seclusion area in a home-like versus traditional manner did not reduce incidence of violent behavior (Vaaler et al., 2005). The home-like seclusion room, however, increased the satisfaction and reported well-being of patients, especially women.

PRELIMINARY EMPIRICAL ASSESSMENT OF THE DESIGN THEORY

A Swedish psychiatric hospital (84 inpatient beds) that opened in 2006 (Östra psykiatrisk sjukhus in Göteborg) was identified as having nearly all the environmental characteristics that the design theory proposes should diminish patient stress and thereby reduce aggression. The hospital replaced a psychiatric hospital dating from the 1940s-1970s. Additionally, a second psychiatric hospital located in the same region was identified as a comparison or control facility. Table 1 compares the design features of the three hospitals – the old facility, newer (replacement) hospital, and control hospital. Examination of Table 1 shows that the design of the newer hospital is superior to that of both the old and control hospitals in having environmental characteristics identified in the Design Theory as important for reducing stress. The information in Table 1 supports the prediction derived from the Design Theory that the environment of the newer hospital, compared to the old and control hospitals, should be more effective in diminishing patient stress and thereby reducing aggression.

TABLE 1: Comparison of ward environments in three psychiatric hospitals with respect to stress-reducing environmental features in the Design Theory.

Stress-Reducing Environmental Factors in Psychiatric Wards	Old hospital	Newer hospital	Control hospital
Bedrooms in one ward* (number of 1-bed and multi-bed rooms)	1-bed: 2 2-bed: 3 4-bed: 2	1-bed: 10 2-bed: 2	1-bed: 2 2-bed: 1 4-bed: 2
Patient population size of one ward at 100% designed bed occupancy	16	14	12
Movable seating + adequate space in day rooms to regulate relationships	movable: no spacious: no	movable: yes spacious: yes	movable: no spacious: no
Noise reduction features	no	yes	no
Garden accessible to ward patients	no	yes	no
Nature window views	a few	yes	no
Nature art, not abstract art	mixed	mixed	mixed
Design for higher daylight exposure	no	yes	no
Staff stations close to patient areas, with good visibility over areas	visibility: poor close: yes	visibility: good close: yes	visibility: poor close: yes
Other best practices: home-like	no	yes	no

* Ward layouts and bedroom mix varied somewhat in each hospital. The information in Table 1 represents the environmental features of a representative or typical ward in each facility.

To evaluate the influence of the new hospital on aggression, data on the use of chemical restraints (compulsory injections) and physical restraints were obtained retrospectively for the old hospital for 2005 and for the new hospital for 2007. No data from 2006 were included because the old hospital was being phased out and patients and staff were being relocated to the new building. For both the old and new hospitals, information was obtained concerning the number of patients who received chemical or physical restraints, and the number of occasions of restraint use (incidence). In addition, restraint data were collected for a second Swedish hospital (control) that cared for comparable psychiatric inpatients according to similar protocols during the same time period (2005 and 2007) but did not undergo replacement or major renovation. Unfortunately, the physical restraint data were incomplete for the control hospital for 2007 and therefore could not be included in the analysis. Restraint data were obtained for all patient diagnosis categories with the exception of forensic psychiatry, addictive disorders, and geropsychiatry. Between 2005 and 2007 there were no major changes in psychopharmacological treatment in the old versus new (replacement) hospitals or the control hospital. The old/new hospitals and the control hospital were also similar with respect to each serving a population of approximately 225,000 inhabitants during 2005 and 2007. No other inpatient psychiatric hospitals served the patients in the areas.

Preliminary Findings: Restraint Use in the Newer Psychiatric Hospital Compared to the Old and Control Hospitals

Consistent with the general prediction derived from the Design Theory, the preliminary findings suggest that the use of chemical and physical restraints declined in the new hospital compared to the old hospital it replaced. More specifically, the average number of patients in the old hospital per 3-month period in 2005 who received compulsory injections (chemical restraints) was 23 persons. By contrast, the average number declined to 17 persons per 3-month period in the new hospital. Importantly, the average incidence of chemical restraint use fell from 47 to 37 per quarter, a drop of 21%. These improvements occurred despite the fact that the patient population in the newer hospital was similar in size to that of the old facility and possibly slightly higher in clinical acuity. Regarding physical restraints, the average number of patients per 3-month period was 14 in the old hospital and 16 in the new building. It is noteworthy that the incidence per 3-month period of physical restraints fell from 63 in the old building to 35 in the new building, a decline of approximately 44%.

In the control hospital, the average number of patients per quarter receiving chemical restraints stayed the same from 2005 to 2007, 17 and 18 respectively. However, the average incidence of chemical restraints in the control hospital rose from 34 in 2005 to 44 in 2007, a 29% increase. The number of patients per quarter in the control hospital receiving physical restraints rose from 18 to 28.

DISCUSSION

The paper describes a tentative theory for designing psychiatric facilities to reduce patient aggression. A basic premise underlying the design theory is that environmental and psychosocial stressors mediate and trigger aggression. The theory proposes that a physical environment for psychiatric patients will foster reduced aggression if it is designed to minimize stressors such as noise, foster control and privacy access, and provide exposure to stress reducing features such as nature. The conceptual model identifies a bundle of evidence-based design features to reduce stress, and proposes that implementing the environmental bundle should be linked with reduced aggression.

To make possible a preliminary empirical evaluation of the design theory, information concerning the use of chemical and physical restraints was compared for three Swedish psychiatric hospitals that vary in ward design. The design of a newer hospital was superior to those of the old hospital it replaced and a comparison hospital (control) with respect to having nearly all the environmental features in the stress-reducing design bundle. Preliminary findings based on the restraint data were consistent with the design theory prediction that aggression (restraint use) would be lower in the newer hospital than in either the old or control hospitals. The use of chemical and physical restraints decreased substantially in the new hospital compared to the old hospital it replaced. By contrast, restraint use *increased* in the control hospital that cared for comparable psychiatric patients according to similar treatment protocols during the same period.

Although the preliminary results are encouraging, the methods and findings have limitations that should be mentioned. The restraint information would be stronger if it had been recorded at the individual patient level rather than group level. Also, the reliance on restraint data probably underreports the incidence of aggressive behavior in the hospitals (Bowers et al., 2011). Future studies on hospital design and aggressive behavior could be strengthened by collecting data using broader and more sensitive measures such as the Staff Observation Aggression Scale (SOAS) (Nijman et al., 2005).

The methods of the preliminary study do not make it possible to identify which specific stress-reducing design features may be most important for lessening aggression. The speculation seems justified that certain design factors are more important than others, and that some environmental features interact to influence stress and aggression. Irrespective of the question of relative importance, the design theory proposes that the implementation of a multi-faceted bundle of environmental features will be more effective than any single-feature intervention. Notwithstanding the limitations noted, the design theory and preliminary findings suggest the possibility that providing better psychiatric buildings with design guided by the best available evidence and theory can contribute significantly to reducing the major problem of aggressive behavior.

REFERENCES

- Baum, A. & Davis, G. E. (1980). Reducing the stress of high density living: An architectural intervention. *Journal of Personality and Social Psychology*, 38, 471-481.
- Baum, A. & Valins, S. (1977). *Architecture and Social Behavior: Psychological Studies of Social Density*. Hillsdale, NJ: Erlbaum.
- Baum, A. & Valins, S. (1979). Architectural mediation of residential density and control: Crowding and the regulation of social contact. Chapter in L. Berkowitz (Ed.), *Advances in Experimental Social Psychology*, Vol. 12. New York: Academic Press, 131-175.
- Beauchemin, K. M. and Hays, P. (1996). Sunny hospital rooms expedite recovery from severe and refractory depressions. *Journal of Affective Disorders*, 40(1-2), 49-51.
- Benedetti, F., Colombo, C., Barbini, B., Campori, E. & Smeraldi, E. (2001). Morning sunlight reduces length of hospitalization in bipolar depression. *Journal of Affective Disorders*, 62(3), 221-223.
- Blomkvist, V., Eriksen, C. A., Theorell, T. Ulrich, R. S. & Rasmanis, G. (2005). Acoustics and psychosocial environment in intensive coronary care. *Occupational and Environmental Medicine*, 62, 132-139.
- Bowers, I., Stewart, D., Papadopoulos, C., Dack, C., Ross, J., Khanom, H. & Jeffery, D. (2011). *Impatient Violence and Aggression: A Literature Review*. Report from the Conflict and Containment Reduction Research Programme, Institute of Psychiatry, Kings College London.
- Carpman, J. R. & Grant, M. A. (1993). *Design That Cares, 2nd Ed*. American Hospital Association.
- Chou, K. R., Lu, R. B. & Mao, W. C. (2002). Factors relevant to patient assaultive behavior and assault in acute inpatient psychiatric units in Taiwan. *Archives of Psychiatric Nursing*, 16(4), 187-195.
- Cox, V. C., Paulus, P. B. & McCain, G. (1984). Prison crowding research: The relevance for prison housing standards and a general approach regarding crowding phenomena. *American Psychologist*, 39(10), 1148-1160.
- Crowner, M. C., Douyon, R., Convit, A. & Volavka, J. (1991). Videotape recording of assaults on a state hospital inpatient ward. *Journal of Neuropsychiatry*, 3(2), 59-64.
- Daffern, M. & Howells, K. (2002). Psychiatric inpatient aggression - A review of structural and functional assessment approaches. *Aggression and Violent Behavior*, 7(5), 477-497.
- Day, K., Carreon, D. & Stump, C. (2000). The therapeutic design of environments for people with dementia: A review of the empirical research. *Gerontologist*, 40(4), 397-416.
- Dobrohotoff, J. T. & Llewellyn-Jones, R. H. (2011). Psychogeriatric inpatient unit design: A literature review. *International Psychogeriatrics*, 23, 174-189.
- Donnerstein, E. & Wilson, D. W. (1976). Effects of noise and perceived control on ongoing and subsequent aggressive behavior. *Journal of Personality and Social Psychology*, 34, 774-781.
- Evans, G. W. (2003). The built environment and mental health. *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, 80(4), 536-555.
- Green, R. G. & O'Neal, E. C. (1969). Activation of cue-elicited aggression by general arousal. *Journal of Personality and Social Psychology*, 11, 289-292.
- Hagerman, I., Rasmanis, G., Blomkvist, V., Ulrich, R., Eriksen, C. A. & Theorell, T. (2005). Influence of intensive coronary care acoustics on the quality of care and physiological state of patients. *International Journal of Cardiology*, 98(2), 267-270.
- Heerwagen, J. H. (1990). The psychological aspects of windows and window design. In K. H. Anthony, J. Choi, and B. Orland (Eds.), *Proceedings of 21st Annual Conference of the Environmental Design Research Association*. EDRA: Oklahoma City, 269-280.
- Ittelson, W. H., Proshansky, H. M. & Rivlin, L. G. (1972). Bedroom size and social interaction of the psychiatric ward. In J. Wohlwill & D. Carson (Eds.), *Environment and the Social Sciences*. Washington, DC: American Psychological Association, 95-104.

- Karlin, B. E. & Zeiss, R. A. (2006). Environmental and therapeutic issues in psychiatric hospital design: Toward best practice. *Psychiatric Services*, 57(10), 1376-1378.
- Kumar, S. & Ng, B. (2001). Crowding and violence on psychiatric wards: Explanatory models. *Canadian Journal of Psychiatry*, 46, 433-437.
- Kumar, S., Ng, B. & Robinson, E. (1999). The crowded ward. *Psychiatric Services*, 50, 1499.
- Kweon, B-S., Ulrich, R. S., Walker, V. & Tassinary, L. G. (2008). Anger and stress: The role of art in an office setting. *Environment and Behavior*, 40(3), 355-381.
- Marcus, C. C. & Barnes, M. (1995). *Gardens in Healthcare Facilities: Uses, Therapeutic Benefits, and Design Recommendations*. Martinez, CA: Center for Health Design.
- Marcus, C. C. & Barnes, M. (Eds.) (1999). *Healing Gardens: Therapeutic Benefits and Design Recommendations*. New York: Wiley.
- Nanda, U., Eisen, S. L. & Baladandayuthapani, V. (2008). Undertaking an art survey to compare patient versus student art preferences. *Environment and Behavior*, 40(2), 269-301.
- Nanda, U., Eisen, S., Zadeh, R. & Owen, D. (2011). Effect of visual art on patient anxiety and agitation in a mental health facility and implications for the business case. *Journal of Psychiatric and Mental Health Nursing*, 18(5), 386-393.
- Ng, B., Kumar, S., Ranclaud, M. & Robinson, E. (2001). Ward crowding and incidents of violence on an acute psychiatric inpatient unit. *Psychiatric Services*, 52(4), 521-525.
- Nijman, H. L. I. (2002). A model of aggression in psychiatric hospitals. *Acta Psychiatrica Scandinavica*, 106 (Suppl. 412), 142-143.
- Nijman, H. L. I., à Campo, J. M. L., Ravelli, D. P. & Merckelbach, H., L., G. (1999). A tentative model of aggression on inpatient psychiatric wards. *Psychiatric Services*, 50(6), 832-834.
- Nijman, H. L. I., Palmstierna, T., Almvik, R. & Stolker, J. (2005). Fifteen years of research with the Staff Observation Aggression Scale: A review. *Acta Psychiatrica Scandinavica*, 111, 12-21.
- Nijman, H. L. I. & Rector, G. (1999). Crowding and aggression on inpatient psychiatric wards. *Psychiatric Services*, 50, 830-831.
- Palmstierna, T. Huitfeldt, B. & Wistedt, B. (1991). The relationship of crowding and aggressive behavior on a psychiatric intensive care unit. *Hospital and Community Psychiatry*, 42, 1237-1240
- Palmstierna, T. & Wistedt, B. (1995). Changes in the pattern of aggressive behavior among inpatients with changed ward organization. *Acta Psychiatrica Scandinavica*, 91, 32-35.
- Pati, D., Harvey, T. E. & Barach, P. (2008). Relationship between exterior views and nurse stress: An exploratory examination. *Health Environments Research and Design (HERD)*, 1(2), 27-38.
- Raanaas, R. K., Patil, G. G. & Hartig, T. (2011). Health benefits of a view of nature through the window: A quasi-experimental study of patients in a residential rehabilitation center. *Clinical Rehabilitation*, 26(1), 21-32.
- Ruback, R. B., Carr, T. S. & Hopper, C. H. (1986). Perceived control in prison: Its relation to reported crowding stress, stress, and symptoms. *Journal of Applied Social Psychology*, 16(5), 375-386.
- Sherman, S. A., Varni, J. W., Ulrich, R. S. & Malcarne, V. L. (2005). Post-occupancy evaluation of healing gardens in a pediatric cancer center. *Landscape and Urban Planning*, 73, 167-183.
- Sloane, P. D., Mitchell, C. M., Preisser, J. S., Phillips, C., Commander, C. & Burker, E. (1998). Environmental correlates of resident agitation in Alzheimer's disease special care units. *Journal of American Geriatrics Society*, 46, 862-869.
- Sommer, R. (1969). *Personal Space*. Englewood Cliffs, NJ: Prentice Hall.
- Stokols, D. (1972). Distinction between density and crowding - Some implications for future research. *Psychological Review*, 79(3), 275-278.
- Topf, M. & Dillon, E. (1988). Noise-induced stress as a predictor of burnout in critical care nurses. *Heart Lung*, 17(5), 567-574.
- Ulrich, R. S. (1984). View through a window may influence recovery from surgery. *Science*, 224, 42-421.
- Ulrich, R. S. (1991). Effects of health facility interior design on wellness: Theory and recent scientific research. *Journal of Health Care Design*, 3, 97-109.
- Ulrich, R. S. (1999). Effects of gardens on health outcomes: Theory and research. In C.C. Marcus & M. Barnes (Eds.), *Healing Gardens*. New York: John Wiley, 27-86.
- Ulrich, R. S. (2009). Effects of viewing art on health outcomes. Chapter in S. B. Frampton (Ed.). *Putting Patients First, 2nd Edition: Best Practices in Patient-Centered Care*. San Francisco: Jossey-Bass, 129-149.
- Ulrich, R. (2012). *Evidensbas for vårdens arkitektur 1.0: Forskning som stöd för utformning av den fysiska vårdmiljön*. Göteborg: Centrum för vårdens arkitektur, Chalmers Tekniska Högskola.
- Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A. & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology*, 11, 201-230.

- Ulrich, R. S., Zhu, X. & Lu, Z. (2008a). *Effects of the Physical Environment of Mental Health Facilities on Patient Aggression: Implications for Facility Design*. Unpublished report for the Douglas Mental Health University Institute, Douglas Institute Renewal Project, Montreal.
- Ulrich, R. S., Zimring, C., Zhu, X., DuBose, J., Seo, H-B., Choi, Y-S., Quan, X. & Joseph, A. (2008b). A review of the research literature on evidence-based healthcare design. *Health Environments Research and Design*, 1(3), 101-165.
- Ulrich, R. S., Berry, L. L., Quan, X. & Parrish, J. (2010). A conceptual framework for the domain of evidence-based design. *Health Environments Research and Design*, 4(1), 95-114.
- Vaaler, A. E., Morken, G., & Linaker, O. M. (2005). Effects of different interior decorations in the seclusion area of a psychiatric acute ward. *Nordic Journal of Psychiatry*, 59(1), 19-24.
- Virtanen, M., Vahtera, J., Batty, G. D., Tuisku, K., Pentti, J., Oksanen, T., Salo, P., Ahola, K. & Kivimäki, M. (2011). Overcrowding in psychiatric wards and physical assaults on staff: Data-linked longitudinal study. *British Journal of Psychiatry*, 198, 149-155.
- Whitehouse, S., Varni, J. W., Seid, M., Cooper-Marcus, C., Ensberg, M. J., Jacobs, J. R. et al. (2001). Evaluating a children's hospital garden environment: Utilization and consumer satisfaction. *Journal of Environmental Psychology*, 21(3), 301-314.