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The Health Impacts of the Design of Hospital Facilities on Patient Recovery and Wellbeing, and Staff Wellbeing:

A Review of the Literature

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EXECUTIVE SUMMARY

This review of literature was commissioned by Population Health, Sydney South West Area Health Service (SSWAHS) to inform a Health Impact Assessment (HIA) on the redevelopment of Liverpool Hospital. The purpose of the HIA is to identify the potential positive and negative health impacts that may result from the completed redevelopment project. The scope of the review is confined to those impacts of hospital design on patient recovery and wellbeing, and on staff wellbeing, as identified in the international literature.

Literature searching was undertaken using databases accessed via the University of New South Wales (UNSW) library; sources were predominantly peer-reviewed journals; relevant literature reviews, research articles and opinion pieces have been included.

This review reports potential health outcomes for patients and staff associated with hospital design features, as well as the associated design recommendations. The findings have been organised around the ambient environment, architectural features, interior design features, social features, wayfinding and safety issues. Major issues include the association between health outcomes and natural light, noise, contact with nature, using design to promote family involvement and patient control, safety and accessibility.

Overview of Main Findings and Recommendations

The design of a hospital has impact on potential health outcomes for patients and staff. These include:

Potential health outcomes for patients

- Sleep disturbance associated with excessive noise potentially leading to increased morbidity, delirium and agitation
- Increased pain as a result of excessive noise; and pain reduction with exposure to sunlight and provision of a window with a view
- Fewer post surgical complications (leading to reduced length of hospital stay) and less boredom associated with provision of a window with a view of nature or everyday activities/life outside

- Risk of hearing loss among premature babies as a result of excessive noise
- Risk of increased medical error resulting from communication difficulties amongst staff as a result of excessive noise, and from inadequate procedural lighting
- Poorer communication with staff as a result of lack of privacy and confidentiality associated with open bay environments
- Improvement in mood for depressed patients with associated reduction in length of hospital stay when exposed to morning light; and reduction in agitation for patients with Alzheimer's Disease when exposed to a constant level of light intensity
- Maintenance of Circadian Rhythm when exposed to normal day/night light cycle with better sleep, increased weight gain for premature babies, and decreased risk for "ICU psychosis" for those in intensive care environments
- Risk of vitamin D deficiency associated with inadequate exposure to daylight
- Reduced mortality post myocardial infarction associated with exposure to sunlight
- Risk of poor health impacts (depression, passivity, reduced immune function and agitation) associated with loss of control and removal of normalcy
- Better cognitive functioning associated with presence of windows
- Heightened sense of wellbeing with design that encourages presence and involvement of family members, with specific health outcomes for neonates (such as increased breastfeeding) when family members play an active role
- Decreased risk of medication errors and patient falls with introduction of acuity-adaptable rooms, associated with better staff surveillance with associated decentralisation of nurses' stations and supply areas
- Decreased agitation and aggressive behaviour amongst psychogeriatric patients when they had free access to outdoor areas; with self-reported positive mood changes in the general patient population associated with access to garden areas

Potential health outcomes for staff

- Increased stress levels, burn-out and emotional exhaustions associated with excessive noise
- Decreased self-reported stress associated with exposure to a minimum of three hours natural light per day, and by visiting the hospital garden
- Decreased tiredness, headaches and sore throats with reduction in sick leave associated with installation of full spectrum lighting and indoor green plants
- Headaches associated with excessive noise and artificial lighting

- Communication difficulties associated with excessive noise
- Fatigue associated with walking long distances (frequency and transit length)

Interventions / Recommendations

- Reduce sound by installation of sound-absorbing tiles and surfaces; greater provision of single rooms; specific design features including reduction in hard surfaces and flooring; reduction in length of corridors
- Encourage family involvement by provision of welcoming reception areas, family areas including overnight accommodation and children's play areas, comfortable waiting and lounge areas and single rooms; reduction of desk heights and ''opening up" nurses' stations
- Increase potential time for patient care (with associated potential safety implications) by decentralising both supply rooms and nurses' stations
- Increase privacy to enhance a sense of dignity as well as improve patient/staff communication by provision of private areas as well as single rooms, and separate public from staff/patient transport routes
- Improve safety aspects and reduce potential for error with adequate procedural lighting; standardisation of patient rooms; design features to improve patient visibility
- Provide garden areas and outdoor spaces for patients and staff, taking care with allergenic plants and accessibility
- Improve staff communication by provision of comfortable staff areas, alcoves in corridors, reduced noise
- Increase opportunities for normality, patients' control over their environment and sense of wellbeing by provision of single patient rooms and areas for spiritual retreat; individual lighting switches and controls on televisions; integrated and accessible wayfinding systems
- Reduce patient disorientation by reducing glare and corridor clutter (by provision of adequate storage space); limiting the length of corridors; providing access to normal day/night light or cycled lighting
- Improve accessibility around the hospital, with consideration given to wheelchair access, installation of grab and handrails and frequent seating and rest spaces; use of contrasting colour to highlight potential hazards; and position lifts close to reception areas

- Consider colour in the design (suggestions include warm colours for higher energy areas, cool for resting areas, and neutral to minimise attention)

Added to the above recommendations is the need for wide staff and community consultation throughout the design process (Reiling, Knutzen et al. 2004); and the recognition that design may force work practice change which requires staff support (Tyson GA, Lambert et al. 2002).

INTRODUCTION

Purpose

This review of literature was commissioned by Population Health, Sydney South West Area Health Service (SSWAHS) to inform a Health Impact Assessment (HIA) on the redevelopment of Liverpool Hospital. The purpose of the HIA is to identify the potential positive and negative health impacts that may result from the completed redevelopment project. A scoping process for the HIA which included a scan of relevant literature and consultation with the HIA Steering Committee determined three areas of focus for the HIA – environmental effects; health promoting effects; and effects on patient recovery and staff wellbeing.

As part of the identification step of the HIA, the HIA Steering Committee recommended that a rigorous review of current evidence on the health impacts of hospital design be conducted (Harris, Harris-Roxas et al. 2007).

The HIA Steering Committee acknowledged that the Green Star Guide (Green Building Council Australia 2005) is being used to lead the development of Liverpool Hospital with regards to environmental and sustainability issues. Therefore, the scope of this literature review is confined to the health impacts of health promotion initiatives and design features for patient recovery and wellbeing and staff wellbeing.

The question that directed this literature review was: What are the health impacts of the physical design of hospitals on patient recovery and wellbeing and staff wellbeing? An HIA has already been undertaken for the construction phase of Liverpool Hospital; this literature review describes potential impacts of the completed design and architectural features of the hospital.

Background to the redevelopment of Liverpool Hospital

Liverpool Hospital is the major tertiary referral hospital in the southwest region of Sydney. As a result of increased demand for services together with an expanding population, Sydney South West Area Health Service (SSWAHS) has completed a draft Healthcare Services Plan that identifies a long-term strategy for the delivery of health services in SSWAHS to 2020. A key component of the Healthcare Services Plan is the

physical redevelopment of Liverpool Hospital to provide for its current catchment population, the new developing communities and the initial land releases of the South West Sector. The redeveloped Liverpool Hospital will continue to be the major health facility, within a network of comprehensive health services, provided in the Sydney South West region.

It is proposed that the capacity of Liverpool Hospital be significantly expanded to meet current and projected service activity demands, noting that by 2016, almost 1 million people will be residing in the Sydney South West region. The hospital's presence is an important stimulus for the economy of the City of Liverpool. The redevelopment will provide significant economic contributions in the form of jobs and growth. It is anticipated that the redevelopment will generate employment opportunities during construction and upon completion. Liverpool Hospital is considered to be a major focal point within the community. The presence of a major hospital within the CBD, close to major public transport links, provides a vital service for the residents of the Liverpool Local Government Area, and also for people from throughout the broader Sydney South West region.

Audience

We recommend this literature review to population health practitioners, health planners, capital works managers, builders, redevelopment teams and health service managers. It may also be useful for others with a general interest in HIA or healthy urban development.

In addition to informing the HIA, this literature review will also be useful for others who are planning future hospital redevelopments in Australia and internationally.

Disclaimer

This review provides an overview of evidence from literature reviews, research articles and opinion pieces sourced predominantly from peer-reviewed journals using terms described in the search strategy. The topic under consideration is very broad, and can potentially be broken down into specific areas that lend themselves to individual

searches (for example the effects of hospital lighting; the implication of signage for wayfinding etc). It is not the authors' intention to provide comprehensive evidence about each component, but to provide a broad overview and highlight areas for further consideration for the HIA. It is recommended that users seek further detailed evidence on specific areas to inform decisions, including building guidelines, standards and recommendations for best practice. Where conclusions reached by other literature reviews are cited in this document, it may also be necessary to refer to the original sources for clarification.

THE ISSUE

The design of a healthcare facility has an effect on the people it treats and on those who deliver the care. This literature review examines the evidence regarding the association between a hospital's physical environment and the outcomes of both patients and staff, specifically through a health lens.

The belief that the physical healthcare setting has an affect on the health outcomes of patients is not new; over 100 years ago Florence Nightingale suggested that patients would recover more quickly if they were cared for in an environment that had natural light, ventilation, cleanliness and basic sanitation (Altimier 2004). Recent empirical evidence to support this belief for improved patient outcomes is accumulating. The physical health care environment also has an effect on the wellbeing and job satisfaction of staff. Job satisfaction and employee wellbeing are associated with work performance, productivity, and ultimately with the quality of healthcare (Lundstrom, Pugliese et al. 2002 cited by Dijkstra et al 2008 p1). Physical working conditions contribute to nursing turnover and burnout, which further add to the current nursing shortage. This shortage is putting patients' lives in danger (Joint Commission on Accreditation of Healthcare Organizations report 2002, cited in Ulrich and Quan 2004a p4).

The term **"healing environment"** is used to describe the factors that positively affect (both physically and psychologically) the community served by the healthcare facility, and includes the physical setting as well as the organisational culture. The importance of humanising and improving health care environments in order to increase users' wellbeing has been stressed, and is one aspect of "user-centred" healthcare (Gesler,

Bell et al 2004; Fornara, Bonaiuto et al. 2006). There is growing recognition that architecture is a tool in the healing process. The term “therapeutic environment” refers to one which incorporates certain architectural characteristics which aid in recovery (Gross, Sasson et al. 1998 p322). This has been supported through research into people’s experiences and emotional responses to their healthcare (Burton 2005).

Consideration of the differential impact of hospital design is also important. A major teaching hospital involves a wide community comprising the staff, the ambulatory and inpatients, as well as family and friends who accompany and visit patients. When changes to the built environment are considered, it is important to acknowledge for whom these changes are beneficial; changes that may be positive for one group may not be for another, with possibilities of conflict arising (Tyson GA, Lambert et al. 2002). Patient outcomes may improve, but staff needs might be compromised and vice versa. For example, there is some evidence to demonstrate that certain aspects of the hospital environment are of more concern to patients than to staff (for example constant lighting, unfamiliar noises) (Jastremski 2000). With this in mind, it is important to consider how the whole community might be affected.

SEARCH STRATEGY

The search was undertaken during May-July 2008, with the final search update occurring on 29 July 2008. Terms used during searching included: (("hospital design" OR "health care environment" OR "hospital development" OR "hospital redevelopment" OR "hospital plan" OR "hospital architecture" OR "health facility architecture" OR "health care architecture" OR "ambient environment" OR "patient room" OR "healing environment") AND ("environmental health" OR "health promotion" OR outcome* OR wellbeing OR well-being OR "well being" OR recovery)).

Literature reviews, research articles and opinion pieces were all included in the search. Limiters were set for the time period 1998 – 2008, English language, and for articles which were electronically available either through UNSW library subscription or free download access from the internet.

Databases accessed via UNSW library were used for searching and included Scopus (which includes 100% of Medline coverage), Cinahl, PsychINFO, Embase and Cochrane. Selections of specific subject headings were made for Scopus (Medicine, Nursing, Social sciences, Health professions, Environmental science, Psychology and Engineering). In searching via Cinahl, the Medline option was excluded in order to minimise duplication as it had already been searched via Scopus, and the option "Apply related words" was selected.

The main source of grey literature was the Center for Health Design, using links to their publications (http://www.healthdesign.org).

All article titles and/or abstracts were assessed for relevance, with emphasis on the effect of design and architectural features of a large hospital on patients and staff. Inclusion criteria specified acute care health facilities/hospitals in Western countries. Articles were excluded if their main content consisted of:

- Modification of work practices, policies and procedures
- Detailed infection studies
- Specific clinical interventions and outcomes
- Detailed costing analyses
- Medical/nursing education
- Primary health care settings
- Vet/animal related articles
- Evaluation of the methodologies used in quality assurance activities
- Description and evaluation of assessment tool development
- Descriptions of non acute settings, for example hospice, long-term residential
- Music therapy or music/nature sound exposure
- Evaluation of art work
- Evaluation of specific hospital equipment
- Organisational culture

The initial hit rate prior to assessing and removing duplicates, and the number of available articles after reviewing and assessing availability are presented in Table 1.

Table 1 – Main databases accessed and numbers of articles retrieved

Name of database	No of initial articles prior to assessing for relevance & removing duplicates	No of relevant articles prior to removing duplicates
Scopus (which includes 100% coverage of Medline)	357	51
Cinahl (with Medline excluded)	138	20
Embase	360	19
PsychINFO	70	5
The Cochrane Collaboration	58	2
The Center for Health Design	10	4
TOTAL	**993**	**101**

The final number of articles accepted from this search strategy was fifty-nine (of which fifty-four were from peer-reviewed journals) and comprised:

- Twelve literature reviews
- Seventeen research/empirical articles
- Thirty opinion/non-empirical articles

Not all the findings from the literature reviews were relevant to our investigation; therefore not all the studies reported in each literature review have been included for synthesis. Emphasis was given to the reporting of empirical studies from peer reviewed journals.

It is recognised that the search terms for this review are fairly broad, and as such, articles concentrating on specific and detailed areas of hospital design and its effects may not have been accessed.

THE EVIDENCE BASE

The body of literature on the effects of health care environments is diverse in terms of its focus and findings (Devlin and Arneill 2003 p666). The diversity of settings, interventions and outcome measures means that it is difficult to synthesise the data (Daykin, Byrne et al. 2008). For example, multiple design and broad-sweeping architectural changes often occur with new hospital developments, and thus “bundled effects” are often reported (for example see Finefrock 2006), as well as organisational and cultural changes that occur (Marmot 2002). In recognition of this, many project evaluations do not attempt to tease

out the individual variables, but report on outcomes from groupings of environmental variables as case studies (Joseph and Hamilton 2008). Added to this problem is a criticism of a lack of high quality evidence (Daykin, Byrne et al. 2008). As a result there has been a call for more rigorous enquiry to direct evidence-based research (Lorenz 2007). Reasons offered for the lack of high quality research are both disciplinary (for example architecture lacking a tradition of research and medicine overlooking the role of the physical environment in patient wellbeing) (Devlin and Arneill 2003), and methodological (for example lack of controls, randomisation, and failure to report rigour such as sample size) (Ruddy and Miles 2005, cited by Daykin, Byrne et al. 2008 p87).

With this need for more evidence to inform healthcare environmental design, new Cochrane Collaboration protocols outline two systematic reviews which are currently being undertaken in order to collate existing evidence (for the protocols see Dijkstra, Pieterse et al. 2008; Drahota, Stores et al. 2008).

Twelve literature reviews were sourced for this review. They varied considerably in their quality, focus, inclusion criteria, and level of integration. Some reviews included opinion pieces, whilst others only reported on research articles in peer-reviewed journals. For example, the most comprehensive literature review with over 600 cited articles lacked a detailed search strategy (Ulrich and Quan 2004a). Some authors integrated their findings and synthesised conclusions from many studies, whilst others reported each study in a separate summarised fashion with little integration. Different literature reviews sometimes gave different emphases to conclusions regarding the same study (for example Barlas et al 2001 cited by Joseph and Ulrich 2007 p6; van de Glind, de Roode et al. 2007 pp157-8; Ulrich and Quan 2004a p14). This should alert readers to refer to original studies when major design issues are being planned.

THIS REVIEW

With the purpose of this literature review in mind, we have presented the evidence according to the design and architectural features which have the potential to influence health outcomes. The categories outlined by Karlin and Zeiss (2006) have been adapted to help structure this review. These categories consist of:

- the ambient environment
- architectural features
- interior design features
- social features
- specific issues

Specific health impacts and effects are embedded within these categories, and are discussed throughout this review. Other literature reviews have structured their findings under different categories (for example see Lorenz 2007).

There is much evidence to support an association between the physical environment of a healthcare facility and health outcomes for both patients and staff. These include changes in wellbeing, stress, length of hospital stay, the need for medication and physiological changes. For patient recovery and wellbeing, a common feature in many of these positive outcomes is a heightened sense of control leading to more positive psychological health.

While some of the more rigorous studies attempt to isolate the effect of one or two variables (for example noise or lighting levels), other authors report and describe redesign undertakings that encompass a range of variables in which multiple stimuli have been manipulated (for example whole ward redesign). This literature review emphasises those studies that provide enough detail to ascertain which variables have been manipulated (or how the environment has actually changed).

Where literature reviews are cited throughout the body of this review, citations are only to the author of the literature review, and not to the original studies.

FINDINGS

1. The Ambient Environment

1.1 Noise

The Issue
Excessive noise can cause negative physiological changes and disturbed sleep for patients. It can lead to communication difficulties for staff, and has been implicated in error generation and burnout.

Recommendations
- Install sound-absorbing ceiling tiles (demonstrated effectiveness in reducing volume in 3 studies)
- Neonatal intensive care unit design features to reduce sound:
    - Demonstrated effectiveness as a set of interventions in a prospective cohort study:
        - Install weather stripping on doors and drawer fronts
        - Replace metal rubbish bins with plastic
        - Install carpet over central walkway
        - Install sound-absorbing materials
        - Place covers on incubators
    - Recommendations in literature (no reference to evidence):
        - Install soft linoleum flooring
        - Place sinks away from infant beds (contrary to advice re strategies to reduce infections)
        - Place air conditioning ducts away from infant beds
        - Place infant beds away from nurses' station (depends on visibility issues – see section 2.3)
        - Place exit and entry doors within a vestibule
- Provide single rooms (based on patient and nurse surveys)

The topic of noise consumes the largest amount of research enquiry into the hospital's ambient environment, with a major literature search identifying more than 130 articles (Ulrich and Quan 2004a).

The World Health Organization (WHO) recommends sound levels of 35dB for continuous background noise in hospital patient rooms, with maximum night-time peaks of 40dB. Many studies have demonstrated noise levels far exceeding these guidelines, with ranges cited from 45 to 90dB, with peaks frequently exceeding 85-90dB and some as high as120dB (Ulrich and Quan 2004a p15). According to another review, not one study published over the last forty-five years has reported noise levels that complied with the WHO guidelines for hospitals (Joseph and Ulrich 2007 p2). Other individual

healthcare areas have their own specific acoustic guidelines, for example the neonatal intensive care unit (NICU) (Philbin and Evans 2006).

The noise sources in hospitals are numerous and the noises are often loud. Sources of sound generation include paging systems (more applicable to US than to Australia), alarms, bedrails moving up and down, telephones, conversations, laughter, trolleys, roommates, sinks and taps, medical equipment such as suction tubes and ventilators, cleaning equipment, footsteps and banging of metal trays (Ulrich and Quan 2004a p15; (Bremmer, Byers et al. 2003 p449; Jastremski 2000 p726). The sound of people talking has been identified as one of the most disturbing of all background noise for patients, with conversation between three people at the foot of a patient bed reaching 60-80dB Ulrich and Quan 2004a p15; Jastremski 2000 p726). Conversation is associated with increases in patients' heart rates over and above other high ambient stressors (Lorenz 2007 p265).

A major contribution to hospital noise levels are the environmental surfaces which are often hard and sound-reflecting, promoting noise volume by reverberation. Architectural features such as long corridors also produce echoing. The problem is compounded as noise levels rise, and staff raise their voices in order to be heard (Joseph and Ulrich 2007 pp 4-5).

Certain sub groups are also more vulnerable to noise and include many of those people found among the patient population, such as those with hearing or visual impairment, the young, the elderly, the depressed, and those who have particular medical conditions.

Effects of Noise on Patients

Stress response and sleep disturbance

Many studies report the outcomes of noise on individuals. Within four literature reviews, a total of twelve studies were reported that demonstrated either stress responses in adults with increases in heart rate and blood pressure, and/or sleep disturbances in both adults and children (Lorenz 2007 p265; van de Glind, de Roode et al. 2007 p158; Ulrich and Quan 2004a pp16-17; Devlin and Arneill 2003 pp67-8). The majority of studies were undertaken in an acute healthcare setting, with two occurring outside the hospital in a

sleep laboratory. The evidence was predominantly gathered by measurement of sound volume and associated physiological readings, with some studies using polysonography to assess rapid eye movement (REM) sleep. The sleep disturbances associated with noise included difficulty falling asleep, more fragmented sleep and less REM sleep. A survey administered to 102 patients who had been in an intensive care unit (ICU) identified equipment noise, alarms, paging systems, talking, sounds of cleaning and other equipment as specifically interfering with sleep (Simpson et al 1996 cited by Jastremski 2000 p725).

By disrupting sleep, noise also has the potential to affect the healing process and recovery, with sleep deprivation implicated in immunosuppression and lowered protein synthesis, delirium, agitation, patient morbidity, and increased pain (van de Glind, de Roode et al. 2007 p158; Ulrich and Quan 2004b p78; Devlin and Arneill 2003 p678). Further negative effects of sleep deprivation are well cited in the larger body of literature outside the scope of this review.

The view that noise has a large effect on sleep in hospitals is challenged by one study that concluded noise may be responsible for less than 30% of sleep arousal and awakenings (Gabor et al 2003 cited by Lorenz 2007 p265). Although these authors regard this amount as less than previously thought, these findings cannot entirely discount noise as a feature of sleep disturbance.

Pain tolerance

There is also a suggestion that excess noise can lead to decreased pain tolerance for patients in intensive care unit environments (Jastremski 2000p726).

Neonates

The effect of noise on infants in the neonatal intensive care environment has been studied extensively. Outcomes found in two literature reviews from a total of 14 studies include decreased oxygen saturation, elevated blood pressure, abrupt fluctuations in heart and respiratory rates, apnoea and poorer sleep quality (Ulrich and Quan 2004a p16; Bremmer, Byers et al. 2003 pp445-8). Successful noise reduction strategies resulted in less crying and deeper sleep for infants, demonstrating an association

between noise and behaviour (Bremmer, Byers et al. 2003 p450). Additionally, long term sequelae of constant noise exposure included a risk of sensory hearing loss and abnormal auditory development, as well as suggestion of a link between excessive noise and attention deficit hyperactivity disorder (Bremmer, Byers et al. 2003 p 448,451).

Effects of Noise on Staff

Excessive noise affects staff as well as patients, with noise implicated in staff stress levels, burnout and emotional exhaustion (Ulrich and Quan 2004a p5). There is evidence that in noisy environments people increase their effort to maintain exacting standards when there is incentive to do so, with corresponding heightened cardiovascular response and other physiological changes, potentially further contributing to emotional exhaustion and burnout (Joseph and Ulrich 2007 p4). Another study revealed that noise-induced stress could account for 6% of the independent variance in headaches at work, as self-reported by nurses in critical care areas. When noise levels were reduced, staff report less stress and overall better working environments (Devlin and Arneill 2003 p678).

Safety

Excessive noise is also implicated in error generation. Audiotapes of operating suite noise at typical conditions (>77dB) played to anaesthetists in an audiology laboratory demonstrated the emergence of communication difficulties. Speech communication was only possible by raising one's voice, and in so doing, speech discrimination reduced by 23% (Ulrich and Quan 2004b p75). As good communication is one of the foundations of error reduction in healthcare, this study demonstrates such conditions have serious implications for patient safety.

Interventions / Recommendations to Reduce Noise

Sound absorbing tiles

Installation of sound absorbing tiles is one of the most frequently recommended interventions for sound reduction in wards, with a number of authors of the non-empirical articles in this literature review endorsing such a strategy (Barach 2008; White 2006; Altimier 2004; Reiling, Knutzen et al. 2004; Brown and Taquino 2001). The positive

effect of installing sound absorbing ceiling tiles has been demonstrated in three separate studies reported by the literature reviews. In one study, healthy adult volunteers sleeping in a former surgical ward with a non sound-reducing ceiling, were exposed to typical ward sounds. Following the installation of sound-absorbing tiles, the volunteers demonstrated less fragmented sleep (Ulrich and Quan 2004b p47). In another well-cited pre/post study, sound-reflecting ceiling tiles were replaced by sound-absorbing tiles in a coronary care unit. Pre/post questionnaires to 36 nursing staff and pre/post acoustic measurements revealed that reverberation times were reduced, and that staff experienced less strain and pressure, overall positive effects on their work environment and improved speech intelligibility. The authors speculated that the improvement in acoustics and the communication environment might lead to reduced errors and conflict (Blomkvist, Eriksen et al. 2005). In the most recent study, a controlled clinical trial also conducted in a coronary care unit with 94 patients, physiological differences were demonstrated for those patients exposed to the sound-reducing ceiling tiles. There were positive differences in heart rate, blood pressure and sleep fragmentation, with a decreased need for certain medications. Added to these outcomes was a patient perception of higher quality of care as well as reduced rates of re-hospitalization for the experimental group (Dijkstra, Pieterse et al. 2006 p175).

Single rooms

The provision of single rooms is often argued to be an effective intervention for reduction of noise levels, with many opinion pieces discussing this option (Nelson 2006; Rashid 2006; Jastremski 2000). This view is supported within two of the literature reviews (Joseph and Ulrich 2007; Ulrich and Quan 2004a), but only marginally supported by another (van de Glind, de Roode et al. 2007). The supporting conclusions are based on four studies which demonstrate major noise sources as coming from the presence of other patients in shared rooms, with higher noise levels within multi-bay units (Joseph and Ulrich 2007 p5; Ulrich and Quan 2004a p16). As stated previously, conversation is a significant contributor to noise in an acute care environment. As single rooms provide less opportunity for conversation, it would appear logical that the noise level would be decreased. By closing the door to single rooms, much of the ward/unit background noise can also be reduced. This is supported by a large study which compared data from over two million satisfaction surveys from patients who had received care in 1,462 healthcare facilities in the US during 2003. Patients who were accommodated in single rooms

reported an 11% increase in patient satisfaction with noise levels (Ulrich and Quan 2004a p16). This finding is echoed by a previous study: following randomisation to single or traditional four-bedded rooms, low risk maternity patients who were cared for in single rooms rated noise as significantly less of a problem (van de Glind, de Roode et al. 2007p156).

Nurses also rated single rooms as effective in reducing noise levels. The results of surveys administered to 77 nurses regarding their perceptions of single rooms demonstrated that nurses believed single rooms provided a more restful environment with less noise and overall disturbance, which could contribute to improved recovery rates (Chaudhury, Mahmood et al. 2006).

Other design features

Within the neonatal intensive care environment, certain simple and cost-effective design features have been demonstrated to have an impact on sound reduction in a prospective cohort study. Design features were incorporated to reduce sound and included: placement of weather stripping on all doors and drawer fronts; replacement of metal trash cans with plastic; placement of covers over incubators; installation of carpet along the centre of the nursery; and the placement of sound-absorbing materials in all bays. Sound measurement revealed a significant reduction from averages of 72dB to 64dB. Sixty-four percent of staff answered a questionnaire with 95% of respondents stating the modified nursery was quieter than the control, and 86% felt the changes produced a better environment for carers (Walsh-Sukys, Reitenbach et al. 2001). Other design features aimed at reducing sound in the neonatal care environment reported in the literature include: installation of soft linoleum flooring; placement of sinks away from infant beds; use of curtains; arrangement of beds as far from nurses station as possible; placement of air conditioning ducts in corners (not near infant beds); provision of entry and exit doors within a vestibule with sliding or swinging doors and creation of storage spaces with open shelving away from infant beds (Bremmer, Byers et al. 2003); restriction of glass to areas that actually require visualisation as glass is highly sound reflective; choice of taps that are quiet and produce instant warm water (to minimise sound of running water); acoustic isolation of noise-generating activities; as well as employment of an acoustical engineer for redevelopment projects (White 2006).

1.2 Light

The Issue

- Exposure to bright light (especially morning sunlight) assists in mood elevation, is associated with reduced length of stay for certain patients and reduction in mortality as well as reduced need for analgaesia
- Exposure to daylight is associated with less stress and higher job satisfaction for staff
- Exposure to daylight and night darkness cycles is necessary for maintenance of Circadian rhythm
- Lighting has effects on agitation levels for patients with Alzheimer's Disease (controlled trial).
- Most people prefer natural over artificial lighting, with artificial lighting implicated in headaches. Natural light is necessary for Vitamin D metabolism (important for the elderly and long-term hospitalised patients)
- 24 hour high-intensity lighting is implicated in intensive care unit dementia
- As people age they require higher intensity lighting (relevant for staff and patients)
- There is an association between high intensity lighting and reduction in dispensing errors for pharmacists

Recommendations

- Provide individually controlled lighting for work areas
- Ensure daylight/sunlight in patient and staff areas (eg windows, skylights, atria) – particularly morning light
- Consider lighting manipulation to reduce agitation for patients with Alzheimer's Disease
- In the absence of normal daylight rhythms, provide cycled lighting
- Adhere to specific lighting standards where they apply (eg neonatal nurseries, operating theatres)
- Reduce institutional lighting and emphasise residential style lighting where possible

The topic of light and lighting as part of the ambient environment in a hospital covers a range of issues, from constant over-illumination as a source of irritation to patients (especially in situations where patients lie on their backs staring at ceiling lights) (Jastremski 2000) to the depressing effects of poor lighting, as well as the need for daylight, natural lighting rhythms, and good procedural lighting. Effects of poor lighting design can impact on mood, rates of medical errors and safety. The most consistent message is that different lighting is needed for particular situations, and a range of lighting options should be available as appropriate to need.

It is also argued that lighting can influence patients' and visitors' perceptions of the environment as welcoming or cold and institutionalised, and as such can have psychological effects (Devlin and Arneill 2003 p683).

Daylight

With its high light levels and good colour rendering properties, daylight is an excellent source of free, energy-saving light for a hospital environment. People generally prefer daylight to artificial lighting (Devlin and Arneill 2003), and it is believed that artificial light can cause visual fatigue and headaches (Altimier 2004). Many studies have demonstrated the health-related importance of exposure to daylight, including vitamin D metabolism and assistance with establishing Circadian rhythms (Figueiro, Appleman et al. 2006; Joseph 2006a). This is especially important for the institutionalised elderly, and those hospitalised indoors for long periods of time. Further examples of the effects of daylight (on mood, morbidity and mortality, as well as staff satisfaction and performance) are provided in the following sections.

Effects of Light on Patients

Mood

Bright light is effective in elevating mood in depressed patients (12 studies cited in four literature reviews (Lorenz 2007 p265; Dijkstra, Pieterse et al. 2006 p174; Joseph 2006a p5; Ulrich and Quan 2004a p20)), with nine of the cited studies demonstrating that morning light is more effective. Some studies have used artificial light whilst others have used natural light as the intervention. Improvement in mood has been the main outcome measured, but it is also noted that length of stay has also been reduced for many of the patients in these studies and is used as a proxy measurement for improvement in clinical mood status.

Morbidity and mortality

An association has also been found between staying in a sunny room and a decreased need for analgaesic medication following surgery, as evidenced by a randomised prospective study cited in two literature reviews (Dijkstra, Pieterse et al. 2006 p174; Joseph 2006a p6). Patients who were accommodated on the brighter side of the hospital (with 46% higher-intensity sunlight on average) perceived less stress and took 22% less analgaesic medication than those on the duller side.

Residential sunlight has also been associated with lower frequencies of breast and colon cancers (Freedman 2002 cited by McCuskey Shepley 2006 pS35).

A relationship between mortality and light intensity was also found in one retrospective naturalistic study cited in four literature reviews (Lorenz 2007 p265; Dijkstra, Pieterse et al. 2006 p173; Joseph 2006a p5; Ulrich and Quan 2004b p46). Mortality was consistently higher in patients who had had a myocardial infarction and were nursed in dull rooms compared to sunny (39/335 dull, 21/293 sunny). This study also demonstrated that female patients who were in the sunny rooms had reduced length of stay (3.3 days in dull rooms, 2.3 days in sunny rooms).

Behaviour

Lighting intensity has an effect on the behaviour of patients with Alzheimer's Disease. When a constant level of light intensity was maintained using design adjustments, such as microslatted glazed windows and electronic lighting controls, a significant drop in agitated and disruptive behaviours was demonstrated. The control group who had no such intervention did not demonstrate any changes to their behaviour (Joseph 2006a p6).

Other studies have also demonstrated improvement in agitation in patients with Alzheimer's Disease, and improvement in alertness for shift workers (Joseph 2006a p7; Ulrich and Quan 2004a p20). These studies concentrate on the provision of artificial light, which is less of a design feature and more of a clinical intervention, and therefore beyond the scope of this review.

Effects of constant high illumination

Prolonged exposure to high intensity lighting is believed to be detrimental to health, and has been implicated (along with sleep disruption caused by noise) in the development of ICU-induced dementia, "ICU syndrome" or "ICU psychosis" (Donchin and Seagull 2002; Joseph and Rashid 2007).

The body's Circadian rhythm is affected by changes in light intensity over a 24 hour period. When patients experience constant and high illumination levels, they lose a major stimulus for maintenance of normal 24 hour functioning. One example of this was demonstrated in three studies in which premature neonates in intensive care areas

gained more weight and exhibited improved sleep when exposed to cycled lighting which consisted of reduced night light intensity (Joseph 2006a p6).

Concern has been expressed regarding the high levels of illumination in hospital nurseries, potentially leading to retinal damage of premature infants. No causal link between reduction of ambient lighting and retinopathy has been definitively demonstrated, but the suggestion still remains a cause for concern in the literature (Joseph 2006a p9).

Effects of Lighting on Staff

The lighting (both artificial and natural) in a healthcare facility affects the staff as well as the patients. When nurses were exposed to daylight for at least three hours each day, they experienced less stress and were more satisfied at work (Joseph 2006a p8). The provision of natural light is especially important as current diagnostic and treatment areas tend to offer the least access to daylight of any regularly inhabited building type (Guenther and Hall 2007).

Evidence is mounting that staff value provision of daylight. On moving to a new US hospital that incorporated features of a healing environment, staff were asked to rate how specific design elements impacted upon them and their work. The increase in natural light in the new facility was provided by a large atrium with a skylight, and windows in all patient, staff and laboratory areas as well as in the operating theatre. Seventy percent of the staff rated increased natural lighting as having a positive or very positive effect on their work life, which was the most highly rated design feature of the new building (Mroczek, Mikitarian et al. 2005).

There is also evidence that bright light can improve performance, leading to a decrease in errors. Pharmacists working in dispensing areas were exposed to three different illumination levels (450lux, 1100lux and 1500lux). Medication dispensing error rate dropped from 3.8% to 2.6% corresponding with the lowest to the highest illumination (Ulrich and Quan 2004a p12).

As part of the ageing process, less light is transmitted to the retina, and more light is needed to perform work tasks (Devlin and Arneill 2003 p682). This has implications for ageing patients but also for the health care workforce whose average age is increasing.

Interventions / Recommendations Regarding Light

The following recommendations have been made for lighting in healthcare settings:

- Provide windows for access to natural daylight in patient rooms, along with provisions for controlling glare and temperature
- Orient patient rooms to maximise early-morning sun and light exposure
- Assess adequacy of lighting levels in staff work areas
- Provide high lighting levels for complex visual tasks
- Provide windows in staff break rooms so staff has access to natural light

(Joseph 2006a p9)

The provision of windows will obviously affect the amount of natural light, but the effect will be defeated if tinting is applied as an aid to privacy. Atria and skylights can also provide natural light, however care needs to be taken with glare and temperature control (Ulrich and Quan 2004a p21).

In units that have traditionally been highly illuminated for 24 hours per day, provision needs to be made in the lighting design for the delivery of cycled light mimicking day/night cues to assist in establishing Circadian rhythms if access to daylight is not sufficient to provide these cues (Figueiro, Appleman et al. 2006).

Certain areas within a healthcare facility have specific guidelines for lighting, for example operating theatres (Patkin 2003) and neonatal intensive care areas (Figueiro, Appleman et al. 2006; Brown and Taquino 2001). Within the neonatal areas, there is a need for supporting the developmental stage of the infant. The need for different levels of illumination is reflected in neonatal lighting standards, with different requirements for ambient lighting, procedural lighting and support areas (White 2006). The provision of single rooms allows for greater flexibility in individual lighting control, with design suggestions including indirect lighting controlled by a dimmer switch around the perimeter of the room, a central procedural light, small task and under counter lights. Switches for all lights should be placed at the entrance to each room to cater for

emergencies, and a master switch for control of all lights should be installed to allow for immediate darkness as needed for transillumination (Brown and Taquino 2001 p77). Consideration of colour rendering has been incorporated in new standards for lighting in this specialised environment, and different types of light will have to meet certain standards. Halogen lights are unlikely to meet to these colour standards, and are also ill-advised due their thermal properties with potential to overheat neonates (Figueiro, Appleman et al. 2006).

In consideration of the psychological effects of lighting, recommendations are made for the reduction of institutional lighting with the provision of softer lighting, and an emphasis on residential aspects of lighting (Benya 1989 cited by Devlin 2003 p 683).

1.3 Patient Control over the Ambient Environment

The Issue
Having some control over one's environment has positive health outcomes
Patients wish for a sense of control and normality (4 qualitative studies)

Recommendations
Enable individual control where possible – eg light switches, volume controls, blind adjustments
Provide single rooms where possible to achieve a higher level of individual patient control

Having some control adds to a feeling of normality and to psychological wellbeing. Lack of control has been associated with depression, passivity, increased blood pressure and reduced immune function (Devlin and Arneill 2003 p672), and was regarded as a source of additional stress by patients in haemodialysis units who were already experiencing stress related to their illness (Devlin and Arneill 2003 p673).

The literature demonstrates that patients desire a sense of normalcy in a hospital environment. One study involving 140 medical inpatients investigated their perceptions on moving from an old to a new hospital building. Many perceptions were positive, however patients expressed a dislike of lack of control in both environments – the design of the new building did not allow patients to control aspects of lighting, noise, air quality and temperature (Daykin, Byrne et al. 2008 p91). This desire is echoed in other studies

which reveal that patients wanted control over their own environment (Douglas and Douglas 2005), including the window (Ulrich and Quan 2004a p21) and lighting (Harris, Shepley et al. 2006).

Interventions / Recommendations to Promote Choice

Patient control over lighting can be enhanced by providing individual switches including dimmers, curtains and blinds over windows (Dalke, Little et al. 2006) and over noise by having the option to close doors, adjust volume settings on televisions (as well as the station choice) or turn off the television. Patient control of the ambient environment has the greatest potential when patients are provided with single rooms (Devlin and Arneill 2003 p677).

2. Architectural Features

The main architectural (or permanent design) features of a hospital that have been the subject of empirical research include windows, the physical layout of wards, provision of single patient rooms including acuity-adaptable spaces and access to gardens and nature.

2.1 Windows (including Daylight and Views)

The Issue

- Windows provide access to daylight with its associated health benefits
- Windows can provide access to a view, which has been associated with reduced length of stay and reduced need for analgaesic medication
- The presence of windows has been associated with better orientation and less delirium, plus positive outcomes
- Patients report preferences for windows with views, and highly value connections to the outside world

Recommendations

- Provide as many windows with views as possible (views of nature as well as views to normal outside life activities)
- Provide glare and shade control, but use tinting with caution
- One recommendation found for window area – should occupy 20-30% of the window wall
- The view from a window needs to be visible from the perspective of a patient in bed

Presence of Windows

The presence of windows has been associated with improvement in mental functioning for hospitalised patients in two separate studies (cited in Dijkstra, Pieterse et al. 2006 pp175-176). Patients who had been treated in an ICU with windows remembered their admission and discharge more accurately, had better orientation of the day and time, experienced less sleep disturbance and less visual disturbance, and suffered less from hallucinations. The other study revealed more post surgical delirium reactions for patients cared for in a windowless environment. Not enough information is provided to differentiate between the influence of the view or the influence of normal daylight rhythms. Similarly, five other citations associate the presence of windows with positively influencing patients' hospitalisation (Devlin and Arneill 2003 p680), but no differentiating details are provided.

Daylight

The provision of windows for exposure to natural light (and consequently normal daylight rhythms) has been discussed in section 1.2, with strong evidence pointing to an association with enhanced recovery and wellbeing.

Views

Windows have another dimension in that they potentially provide a view to the outside world, adding to a sense of normalcy for patients. Although old, a sentinel and highly cited study undertaken in 1984 demonstrated that the presence of a view of nature compared to a view of a brick wall was associated with shorter hospital stays following surgery, fewer negative evaluative nursing comments, less need for analgesia (frequency and strength) and slightly less complications (Ulrich 1984).

Patients have stated their preference for views from their hospital room (Daykin, Byrne et al. 2008 p91; Caspari, Naden et al. 2007; Douglas and Douglas 2005; Douglas and Douglas 2004), with bedridden patients especially valuing a window with a view of nature (Ulrich and Quan 2004a p21). Another study specifically investigating colour and lighting in hospitals in the UK reported that patients felt that connections to the outside world were paramount. The older patients found that watching everyday life going on

outside the hospital was very entertaining; this appeared to be regardless of the types of views or the activities (Dalke, Little et al. 2006 p347).

Interventions / Recommendations Regarding Windows

Hospital design should include provision for windows in patient rooms, with orientation towards morning light (Joseph 2006a). Care needs to be taken with glare from windows, and heating from sunlight (Figueiro, Appleman et al. 2006). Blinds, shades and/or curtains should be part of the design, remembering patients' preference for individual control.

Little is mentioned in the literature regarding the details of the windows, apart from one specific guideline: "satisfaction is generally achieved when the window area occupies 20-30% of the window wall" (Keep 1981 cited by Devlin and Arneill 2003 p681); and the warning to use tinted windows with caution, owing to their potential to reduce available daylight (Ulrich and Quan 2004a). The view afforded by any window should be visible from the patient's bed (Dalke, Little et al. 2006). Windows that are very small, distant or high, are not thought of as windows at all (Verderber 1986 cited by McCuskey Shepley 2006 pS35).

2.2 Physical Plan of Ward/Unit

The Issue:

- The layout of the ward/unit is associated with the amount of walking staff undertake, the access to windows and natural lighting, and the opportunity for "corridor conversations".
- The layout may have the unintended consequence of making it more difficult for nurses to observe patients
- The provision of family areas is valued by patients and staff, and is especially important when families need to take on carer's role on discharge (eg NICU, paediatric areas).
- Decentralisation of supply areas and nurses' stations may free up more time for direct patient care, and may improve safety

Recommendations

- Consider the purpose of each unit and the needs of the particular patient population
- Remove high counters at nurses' stations to enhance interaction with patients and families
- Avoid hallways that finish in dead ends
- Consider decentralisation of nurses' stations and supply areas
- Provide private staff areas on each ward to encourage team communication
- Provide family areas including sleeping facilities

2.2.1 Overall Layout

The basic layout of the hospital ward impacts on staff and patients. There are many variations and possibilities, for example one author provides 21 different design permutations for an intensive care unit (Rashid 2006 p287). Units that have been awarded design prizes have shown a preference for the "racetrack" configuration with patient beds on the perimeter of the unit, service rooms and areas in the centre, and corridors in between. One benefit of this design is that the use of the perimeter wall is maximised, thus allowing for more patient rooms to have natural light and outdoor views. Many factors will influence the choice of design, the scope of which is outside this literature review. However some points are worth considering in relation to staff and patient wellbeing.

Effect of Ward Layout on Nurses' Time in Transit/Walking

The ward layout is thought to affect the amount of time nurses spend in different activities. Various studies have attempted to quantify the time nurses spend walking and in transit, with estimates ranging from 8% of time in transit (Ampt, Westbrook et al. 2007) to 29% of time spent in walking (Joseph 2006b p7). The racetrack design is stated to minimise nurses' walking distances (Rashid 2006), and consequently their time spent walking. Radial units are also thought to be preferential to rectangular units in regard to decreased walking distances for staff (Ulrich and Quan 2004a p6). Whether any time saved by such design is transferred to patient care activities is unknown.

Corridors

Corridors serve more of a purpose than just transit. They are also important locations for "the corridor conversations", which include both social interaction and knowledge transfer. Ideally, they need to be wide enough to accommodate a small group of people, however there is concern that not enough attention has been given to corridors even in the best design examples (Rashid 2006). Long corridors contribute to noise volume, and make wayfinding more difficult especially for the elderly (Karlin and Zeiss 2006).

Interventions / Recommendations Regarding Overall Layout

Specific recommendations are made in the literature regarding particular patient populations. In caring for those people with dementia for example, it is suggested that walkways should not finish in dead ends as these cause frustration but should consist of looped paths, and that central open areas (like a widened hallway) or open activity areas can reduce disorientation (Devlin and Arneill 2003 p685). Corridors should be as short as possible to reduce disorientation and noise (Karlin and Zeiss 2006).

2.2.2 Areas for Patients and Visitors

Separate areas that give patients and their families the opportunity for quiet time together are valued as evidenced by qualitative studies. This is especially relevant if the patient is not accommodated in a single room. Comfortable sleeping accommodation for families is also desired (Joseph 2006b; Douglas and Douglas 2004). Those visiting patients in intensive care units wish for more comfortable family areas in close proximity to the patient, in order to ease the difficulties experienced in an intensive care waiting room (Kutash and Northrop 2007).

Family involvement is promoted in neonatal nurseries, with carers playing a more active role. This facilitates infants' development (for example by increasing skin-to-skin contact and promoting breastfeeding), and better prepares families for discharge (Johnson, Abraham et al. 2004).

Although generally viewed as favourable, design features providing additional areas for patients can be associated with unintended negative consequences. One Australian study acknowledged that a new purpose-built psychiatric facility led to an increase in burn-out amongst staff (measured by decrease in sense of accomplishment and emotional exhaustion). This was attributed to increased difficulty observing patients associated with increases in patient privacy and choices of personal space. More space also made staff feel isolated at times as they moved further away from each other (Tyson GA, Lambert et al. 2002). Staff however acknowledged that the facilities were better for the patients. This is a good example of design forcing work practice changes, and the need for staff support through these changes.

Interventions / Recommendations Regarding Areas for Patients & Visitors

There are numerous recommendations for the provision of areas for patients, families and visitors (Kutash and Northrop 2007; Joseph 2006b; Douglas and Douglas 2004; Johnson, Abraham et al. 2004). These include the provision of family space (including accommodation, bathrooms, kitchenette areas, lockable storage areas) which help to encourage family involvement both in neonatal, intensive care and more general ward areas.

2.2.3 Ward Supply Areas and Nurses' Stations

Time and Safety Implications

Much of nurses' time is spent not just walking to and from patients' rooms, but also in locating and gathering supplies, finding other staff members as well as walking back and forward to nursing stations. Both supply rooms and nurses' stations are typically large and centralised on each ward/unit. There is potential to transfer the time spent on walking, gathering supplies and finding other staff members to patient care activities (Joseph 2006b pp7,8). More time in closer proximity to patients may result in improved safety (Reiling, Knutzen et al. 2004).

The Role of the Nurses' Station

Nurses' stations are typically busy centralised areas where nurses and staff gather, and provide focal points for camaraderie (Joseph 2006b). However, they traditionally have high counters, are relatively inaccessible and can be interpreted as providing spatial and symbolic distinctions between those providing and those receiving the care, producing a physical and psychological barrier between staff and patients, and potentially deterring patients and families from being active participants in the care process (Joseph 2006b p10). Active participation is considered by many authors a necessary component of healing environments, resulting in more positive health outcomes (Devlin and Arneill 2003).

Interventions / Recommendations Regarding Supply Areas & Nurses' Stations

Decentralisation of supply areas and nurses' stations can occur by providing smaller and more frequently located supply areas, as well as smaller work stations closer to patient rooms. Much of the evaluation around this particular intervention has been undertaken in conjunction with the introduction of acuity-adaptable rooms (see section 2.3), of which a major feature is decentralisation. Investigation of the effects of this new model of care compared two years of baseline data with three years of data collected after implementation of 56 acuity-adaptable rooms in a coronary care unit (Hendrich, Fay et al. 2004). Patient falls decreased by 75% and medication errors by 70%. With all multifactorial interventions, it is not possible to directly attribute these outcomes to one architectural factor, but the authors emphasised that decentralisation contributed strongly to better patient surveillance which resulted in improved safety.

Removing the high counter at nurses' stations has been recommended to improve the openness of the station (Joseph 2006b). Some nurses have expressed concern that opening up the nurses' station to easier patient access may result in patients abusing this access, presumably by patients spending more time at the station (Gross, Sasson et al. 1998 p122). With the redevelopment of a psychiatric unit in which many changes were undertaken including opening up the nurses' station and making it more accessible, few patients actually spent much of their time near the open nurses' station. Instead, it appeared that the openness of the design may have encouraged staff to leave the station and spend more time with the patients (Whitehad et al 1984 cited by Gross, Sasson et al. 1998 p122).

The concern expressed by nurses regarding the access of patients to nurses around the nurses' station contradicts a view held by some medical staff within the psychiatric setting. Nurses generally believed that the station provided a place from which to observe patients; whereas some consultant psychiatrists believed that passive observation provided no therapeutic purpose, the nurses should be more actively interacting with the patients and that there was no need for a nurses' station at all (Curtis, Gesler et al. 2007 p599). This exemplifies the need for clarification of the purpose of the design in the first place, demonstrates the need for divergent views to be considered, and users' needs to be fully taken into account.

Redesigning the nurses' station is not without other potential repercussions. Anecdotal evidence points towards nurses missing the camaraderie that is often part of gathering around the central desk area. There could be potentially less social interaction on the ward, as well as less information sharing and support. With this in mind, it is even more important to consider staff areas on each unit for social interaction during breaks (Joseph 2006b p8).

2.3 The Single Patient Room

The Issue:

- Single rooms are associated with
  - Decreased noise
  - Safer care
  - Improved patient control of own environment
  - Improved privacy and overall satisfaction with care
  - Better environment for examination and history taking
  - More opportunity for family involvement
- Curtained bed bays provide less privacy for confidential consultations – may affect patient outcomes with some patients withholding information
- Unintended consequences of single rooms can include:
  - Decreased visibility of patients
  - Less staff interaction
- Possibly with reductions in nosocomial infection rates (inconclusive)

Recommendations:

- Consider providing as many single rooms as possible
- Standardise the layout of single rooms, including:
  - Locate patient bathroom close to the head of the bed
  - Provide handrail supports around the walls of each room
  - Install handwashing sinks in each room
  - Provide small alcove outside each room
- Provide other design features to increase visibility throughout specialised units (eg NICU)
- Provide areas for consultation with healthcare staff that enhance visual and auditory privacy
- Provide areas to promote staff interaction
- Consider provision of acuity-adaptable rooms

There is divergence of opinion regarding the benefits of single rooms. The literature review which specifically addresses this issue concludes that rigorous evidence supporting the benefits of single rooms is scarce (van de Glind, de Roode et al. 2007). The authors report that the provision of single rooms to patients is usually an

intervention that involves manipulation of multiple stimuli, for example design changes to increase the number of single rooms may also involve the provision of decentralised nurses' stations, or an apparent reduction in noise may stem from other organisational changes. Often outcome measures were not systematically studied but were implicit side effects of other research questions. It is thus hard to attribute a cause and effect relationship to a single room and outcome per se (van de Glind, de Roode et al. 2007p159). Nonetheless the authors concluded that single rooms have a moderate effect on patient satisfaction, noise and quality of sleep, and the experience of privacy and dignity. This is in contrast with conclusions drawn by other more general literature reviews that definitively espouse the benefits of single rooms (for example see Ulrich and Quan 2004a p24).

Evidence for the Health Effects of Single Rooms

Satisfaction with care

Overall satisfaction with care does appear from the evidence to be influenced by single room accommodation, with a variety of studies reporting this finding, although many confounders are often present. For example, the results from a questionnaire completed by low risk maternity patients who were either nursed in a traditional four-bedded unit or moved to a single room demonstrated that those in single room accommodation were much more satisfied with the care on a variety of factors, including: overall layout of accommodation (spaciousness, availability of supplies and comfort for the support person), lighting, professional support for learning mothercraft skills including feeding baby and discharge planning. Significantly fewer babies from single room care received formula supplementation – an important finding for hospitals aiming for 'Baby Friendly' accreditation (McKenzie 2004). Other patient satisfaction surveys have also reported positive responses to single room accommodation (van de Glind, de Roode et al. 2007 p158; Ulrich and Quan 2004a pp14&24).

Social factors

The issue of whether single rooms could lead to feelings of isolation by patients was raised (van de Glind, de Roode et al. 2007 p159). However this issue is addressed by studies which indicated the presence of a roommate is more often a source of stress, for

example by causing loss of privacy, being unfriendly or seriously ill, or having too many visitors rather than providing positive social support (Ulrich and Quan 2004a p24).

Neonatal intensive care areas

New construction projects for neonatal intensive care areas include single rooms as common practice (White 2006; Brown and Taquino 2000). Justifications include increased control for temperature, noise and lighting; greater family privacy, confidentiality and involvement, with a better environment to support breastfeeding (Johnson, Abraham et al. 2004); increased nurse and family satisfaction; and trends towards reduced length of stay (Carlson, Walsh et al. 2006). However it is also acknowledged that families and staff may have different needs, for example family privacy has to be balanced with visibility of and access to neonates by staff. Nurses from neonatal intensive care environments felt that single rooms provided less stressful environments for both families and staff (Harris, Shepley et al. 2006).

Privacy and dignity

Architectural features of a ward/unit have direct impact on patients' privacy and sense of dignity, with evidence from four quasi-experimental studies suggesting that it is increased for patients nursed in single rooms (van de Glind, de Roode et al. 2007 p157). Encapsulated within this issue is the concept of the 'healing environment', with its element of humanising the hospital experience for patients. Single rooms give patients more opportunity to have support from family and friends, especially when family accommodation is provided. This is often discussed in reference to neonatal and paediatric care. Evaluation of the redesign of a neonatal unit, with provision of nursery pods and separated rooms, revealed that privacy was increased (Altimier 2004), and is echoed in other studies (Harris, Shepley et al. 2006). It is also a common finding from adult patient satisfaction surveys.

Communication with healthcare providers

As well as affecting patients' emotional responses and sense of wellbeing, the provision of privacy can also influence communication between the healthcare provider and the patient, with significant implications for patient disclosure of information and health outcomes. Such breakdown in communication can have serious implications for patient

safety. One study (a controlled trial with a sample of 108 patients in an emergency department of a major teaching hospital) was cited in four literature reviews. Patients in multi-bay curtained areas of an emergency department, compared with those in solid-walled rooms, believed more often that others could hear them, that they could overhear others, and that others could inappropriately view them and view personal parts of their bodies. This perceived invasion of auditory and visual privacy led to five percent of the patients in the curtained areas admitting that they withheld aspects of their medical history and refused parts of their physical examination. None of the patients in rooms with solid walls reported withholding information (Joseph and Ulrich 2007 p6; van de Glind, de Roode et al. 2007 p156; Dijkstra, Pieterse et al. 2006 p176; Ulrich and Quan 2004a p14).

This patient perception of reduction of privacy leading to poorer communication with healthcare staff is supported by evidence from an earlier observation study of an emergency department. Breaches of confidentiality occurred more often in multi-bedded curtained areas than solid-walled rooms (Ulrich and Quan 2004a p14). Other studies investigating patients' perceptions of hospital environments have revealed that provision of areas for confidential discussions with medical staff is of high priority for patients (Douglas and Douglas 2004).

Nurses also have a preference for single rooms. Results from a questionnaire to 77 nurses from a variety of settings demonstrated that 85% believed single rooms were more appropriate for patient examination, and 82% for history taking (Chaudhury, Mahmood et al. 2006).

Nosocomial infections

There is debate in the literature regarding the association of single rooms and decreases in hospital-acquired infections. Different reviewers vary in their conclusions, from reporting of conflicting results (van de Glind, de Roode et al. 2007) to definitive statements about the benefits (Ulrich and Quan 2004a). Some studies cite specific instances, for example a reduction in respiratory and urinary tract infections occurred in a paediatric ICU following transformation from open-plan to single room design (comparative study using retrospective data and prospective surveillance) (Ben-Abraham, Keller et al. 2002). Many other studies and reviews report on a variety of

issues around nosocomial infections including environmental control measures for specific organisms, for example methicillin-resistant Staphylococcus Aureus (MRSA); or the effect of isolating already colonised patients in single rooms, rather than nursing all patients in single rooms (van de Glind, de Roode et al. 2007).

Many confounders are present and include such factors as presence and location of handwashing sinks, work practices, types of organisms and transmission (air-borne or contact), presence or absence of air ventilation systems, number of staff, turnover of neighbouring patients and bed occupancy rates (Jastremski 2000; Ulrich and Quan 2004a; Joseph and Rashid 2007).

Interventions / Recommendations in the Provision of Single Rooms

The majority of the authors in this literature review recommend the provision of single rooms. The single bed room has been adopted as the standard for all new construction in the US by the 2006 American Institute of Architects Guidelines for Design and Construction of Healthcare Facilities (Facilities Guidelines Institute 2006 cited by Joseph and Rashid p716). Specific recommendations for implementation are discussed in the following sections.

Safety and standardisation

Standardised rooms including layout, furniture and supplies are recommended, enabling staff to locate equipment and supplies regardless of which patient room they are in. This is especially important in emergencies (Reiling, Knutzen et al. 2004). Further recommendations include locating the patient bathroom at the head of the bed (thus reducing the distance to the bathroom), providing handrail supports for the patient throughout the room, and installing handwashing sinks in each room to help reduce nosocomial infections. Another design recommendation incorporates the inclusion of a small alcove adjacent to the patient room to allow nurses to observe patients through a window without disturbing the patient's rest – this gives greater visibility of patients to staff, and assists the nurse to keep patient information, supplies and medication separate from those of other patients (Reiling, Knutzen et al. 2004).

Patient visibility

Although solid-walled rooms in emergency department patient rooms are associated with more confidentiality in patient and staff communication, this needs to be balanced "…with the conflicting need for direct patient observation" (van de Glind, de Roode et al. 2007 p158). No recommendations are suggested for the emergency department, however concern that visibility of neonates may decrease with increases in single rooms was addressed in a NICU redesign. Interventions included having each single room open onto a central area; desk, counter and corridor walls kept low to maximise visibility through the unit; installation of small internal windows and angled walls; and the entrance to each room consisting of a glass sliding door (Brown and Taquino 2001).

Acuity-adaptable rooms

A major pre/post study involving the implementation of specialised single rooms (acuity-adaptable rooms) demonstrated a 90% reduction in patient transfers, 75% reduction in patient falls and 70% reduction in medication errors (Hendrich, Fay et al. 2004). The authors describe an acuity adaptable room as one which is designed to cater for all patients regardless of their status – thus eliminating the need for specific intensive care, step-down and standard wards. The patient is not transferred out of the unit if his/her condition changes, and as a result staff need to have the competence and skill to care for the patient though a range of conditions. Although the implementation of acuity-adaptable rooms involves a major work process redesign, and necessitates staff education and support, it also has architectural and design implications. Environmental changes in this study included single room accommodation with three zones – patient, family and caregiver; all equipment and supplies for a critically ill patient available in each room with headwall capacity for multiple gases, lines and outlets; and computerised decentralised work stations attached to each room which also had its own supply stores.

It is recommended that the patient room design of today will have to be appropriate for future needs, and thus as much flexibility as possible should be its aim (Jastremski 2000). Suggestions given to promote flexibility parallel the design principles of the acuity-adaptable room, with the addition of medical gas, suction and electrical outlets extending from a pendent (or ceiling boom), rather than a headwall. This provides greater access to the patient, allows for more flexibility in room space, and has also

been chosen as a design feature in neonatal nurseries for the above reasons (Brown and Taquino 2001).

2.4 Access to Nature and Gardens

The Issue:
- There is an association between nature and positive health outcomes
- Provision of natural features are also of benefit to staff

Recommendations:
- Provide contact with nature where possible – views from windows, indoor features or access to outside gardens

Evidence for the Health Effects of Contact with Nature

Morbidity

Contact with nature can have beneficial health effects (Young-Mason 2005). Patients who had a view of trees from their window (compared with others who only had a view of a brick wall) experienced shorter hospital stays, had less need for pain-reducing medication and slightly less complications (Ulrich 1984). This finding is supported by a Swedish study which demonstrated that patients who had a view of vegetation from their beds had shorter convalescences, fewer complications and took less painkilling or sleep-inducing medications. Normal blood pressure was also more prevalent in the experimental group than in the control group (Kuller and Laike 1998 cited by Caspari, Eriksson et al. 2006 p857).

Behaviour and mood

Mental health providers in Australia had the opportunity to study the effects of denying free access to an outdoor garden area for psychogeriatric patients in an admission and assessment unit. A 32 day construction period necessitated mandatory indoor confinement. Once patients were permitted to go into the garden at their free will, the authors reported that both verbal and physical aggression decreased, as well as nurse-initiated medication. The response was greater for those patients who had been more

aggressive. This finding did not differentiate between extra space or the garden per se. The authors concluded that “The freedom to go outdoors or have access to extra space should be an important component of the environmental design…” (McMinn and Hinton 2000 p40). This finding of decreased violent behaviour being associated with access to secure outdoor environments was echoed in a previous studies regarding patients with Alzheimer’s Disease (Mooney and Nicell 1992, Namazi and Johnson 1992 cited by Mitrione 2008).

Many of the qualitative, self-report or satisfaction surveys demonstrate that patients appreciate and desire access to gardens, with evidence arising from mental health patients (Curtis, Gesler et al. 2007), and general patient populations (Douglas and Douglas 2004). Patients who used gardens reported positive mood changes and stress reduction (Cooper Marcus and Barnes 1995 cited by McCuskey Shepley 2006 pS35; Whitehouse, Varni et al. 2001). With these findings in mind, many new hospital developments are paying particular attention to landscaping and gardens, for example two new “super hospitals” in the UK – University Hospital of North Staffordshire and Hope Hospital Salford (Anon 2007).

Images of nature

The majority of other empirical studies aiming to provide evidence for tangible positive health outcomes of nature relied on assessing the association of pictures, photographs, or videos of nature with changes in physiological variables or with the need for pain medications (Dijkstra, Pieterse et al. 2006 p177; Ulrich 1993, Ulrich 1991, Ulrich 1979 cited by McCuskey Shepley 2006). The evidence strongly supports that such images are associated with positive health outcomes. The logical extension that actual natural environments are also beneficial is reasonable, but not empirically supported by these discrete studies.

Effects on Staff

The provision of natural features and gardens also has positive effects on staff. One study undertaken in an X-ray ward reported the impact of installing 25 groups of green plants along with full spectrum daylight bulbs. This intervention was associated with reductions in sick leave (25%), tiredness (32%), headaches (45%) and sore throats

(31%) (Fjeld 1998 cited by Caspari, Eriksson et al. 2006 p857). Another evaluation study revealed that staff who visited the hospital garden reported positive benefits in stress reduction (Whitehouse, Varni et al. 2001).

Interventions / Recommendations for Contact with Nature

Specific recommendations for access to nature and gardens are prevalent in the literature, with specific suggestions including the addition of greenhouse spaces adjacent to ground floor rooms, providing spaces for indoor plants as well as window seats (Burnett and Hamilton 2000 cited by McCuskey Shepley 2006 pS35); ensuring gardens have access for handicapped people, choosing plants with care to avoid allergenic varieties, providing for night use of gardens in their design (Cooper Marcus and Barnes 1995 cited by McCuskey Shepley 2006 pS36); and installing water features (both indoors and outdoors) with associated seating (Mroczek, Mikitarian et al. 2005).

2.5 Provision of Staff Areas

The Issue:
- Staff lounges provide areas for communication and relaxation

Recommendations:
- Provide staff lounges and areas to relax
- Design features should consider the ambient environment, with consideration for lighting and noise reduction
- Provide multi-disciplinary areas to encourage more communication between all healthcare workers

There are many recommendations for the provision of areas for staff to relax, replenish and network with colleagues (Dalke, Little et al. 2006; Joseph 2006b; Johnson, Abraham et al. 2004). By promoting staff interaction, a culture of communication, information sharing and teamwork can be promoted which is believed to be the cornerstone of a safer and more effective healthcare service (Joseph 2006b). Some of the authors of previous recommendations such as redesigning nurses' stations and providing patients with more personal space and single rooms, have also raised concern that these strategies might result in a decrease in staff camaraderie and interaction, and an

increase in isolation (Joseph 2006b; Tyson GA, Lambert et al. 2002). Learning and collaboration are facilitated by providing many different types of settings within the workplace where spontaneous and planned face-to-face interactions might occur (Becker 2006 cited by Joseph 2006b p9).

With the adoption of such recommendations it is even more important to consider the benefits in providing staff with their own comfortable private areas.

Interventions / Recommendations for Staff Areas

These staff areas should have features of the ambient environment that have previously been discussed as beneficial. It is recommended that windows with views at best, or at least natural light with possibility of skylighting are included in their design (McCuskey Shepley 2006).

In order to encourage multi-disciplinary approaches to care, recommendations are made to decrease uni-disciplinary staff areas (for example doctors' lounge rooms) and provide more 'neutral zones', decreasing the spatial and symbolic distinctions between different healthcare groups (Joseph 2006b pp9&10). It is recognised that some of these ideas may be contentious as they challenge hierarchies and patterns of communication within hospitals.

To facilitate learning and collaboration via communication and interaction, consideration should also be given to the construction of staff alcoves (Joseph 2006b p9), presumably aiding the "corridor conversation" .

2.6 Physical Plan of Hospital

The Issue:
Qualitative research has demonstrated various architectural features of the overall hospital plan as being important to the wellbeing of patients and their families/visitors

Recommendations:
- Suggestions made by patients and families include:
    - Provide moving walkways
    - Install lifts close to reception areas
    - Promote accessibility:
        - Provide wheelchair access to all areas
        - Install hand and grab rails in all main thoroughfares
    - Provide prayer/spiritual areas
    - Provide play areas for children
    - Ensure corridors remain uncluttered, have regular rest areas and access to outdoors
- Suggestions made by staff include:
    - Provide separate transport areas for patients/staff and the general public
    - Provide separate entrances for staff

The general physical plan of the hospital will have impact on many factors including accessibility, functionality and efficiency.

Recommendations / Interventions for the Physical Plan of the Hospital

Patient perspectives
Many issues arise from patient surveys and questionnaires. A large enquiry into patients' perspectives revealed that patients wished for moving walkways, lifts close to the reception area, a prayer room and play areas for visiting children, wheelchair accessibility, and grab rails and handrails (Douglas and Douglas 2004). Many other authors echo these suggestions in their recommendations, for example proposing prayer rooms and children's play areas (Johnson, Abraham et al. 2004).

Long and echoic corridors are a feature of many hospitals. They contribute to noise volumes, and can contribute to perceptual distortions experienced by some patients (Karlin and Zeiss 2006). Patients reported specific problems with long corridors as having no where to rest, having no access to the outside and being cluttered with obstacles (Douglas and Douglas 2005; Douglas and Douglas 2004). It is recommended that adequate storage space be provided to reduce visual clutter which can contribute to confusion and disorientation (Dalke, Little et al. 2006).

Staff perspectives

An interesting finding from an investigation into the factors that staff particularly liked in a new hospital was the deliberate separation of public areas from staff/patient transport areas – this resulted in perceived improved transport efficiency for patients and staff, and afforded better privacy for patients (Mroczek, Mikitarian et al. 2005).

Information from 25 different hospital post occupancy evaluations (POEs) led to the development of guidelines for community health centres. Included in these guidelines were recommendations for room-to-room transparency (being able to see from one room to the location of another) and providing separate entrances for patients and staff (Verderber and Refuerzo 1999 cited by Devlin and Arneill 2003 p668). From the context of the guidelines, it is assumed that these POEs sought staff rather than patient evaluations, but this is not specifically stated in the literature.

3. Interior Design Features

Interior design features incorporate the less permanent elements of a hospital's physical environment, and often include the personalising aspects. They also tend to be the less researched areas of the environment. General recommendations exist in much of the literature, and although not yet supported by rigorous research, are still worth considering. Many of the recommendations for particular design features stem from audits, as well as patient and staff interviews and questionnaires (Dalke, Little et al. 2006).

3.1 Reception Areas

The Issue:
Reception areas can set a welcoming tone, and as such can send messages that the hospital/unit has patient and family centredness as a core principle, thus encouraging patient participation and family involvement in the care.

Recommendations/Suggestions:
- Reception areas should be visually prominent
- Areas for private conversation should be immediately available
- Counters and desk heights should be low enough to allow for access to everyone

Reception areas can set the tone of the hospital/unit and send messages to the community, for example having a clearly identifiable reception area and a method of welcoming patients and visitors reflects customer service values, patient centeredness and encourages family involvement (White 2006; Karlin 2006).

Recommendations / Interventions for Reception Areas

General recommendations for reception areas include desks that are open, well illuminated and prominent. It is suggested that use of a strong colour behind a desk/information area will make it more noticeable. Reception desks need to be accessible to all users and at wheelchair users' height (Dalke, Little et al. 2006; Joseph 2006b). Provision should also be given to privacy for discussion especially in admission areas, as these areas have been demonstrated to be source of serious confidentiality breaches (Ulrich and Quan 2004b p73).

3.2 Floor Coverings and Surfaces

The Issue:
- Floor coverings and surfaces can contribute to glare by interfering with visual perception, and to noise volume
- The association between patient falls and floor coverings is inconclusive

Recommendations/Suggestions:
- Avoid highly polished surfaces
- Provide soft floor coverings and surfaces
- Ensure finishings are true to expectations (eg wooden finishings should feel like wood)

Recommendations / Interventions for Prevention of Glare

Highly polished surfaces are often a feature of hospitals. They are reflective and add a significant amount of glare to the internal environment. Glare interferes with visual perception, and makes environments more confusing and difficult to negotiate for the elderly and those with visual impairment. For these reasons, one of the major recommendations concerning floor coverings and surfaces is the warning to avoid highly polished surfaces (Figueiro, Appleman et al. 2006; Karlin and Zeiss 2006; Devlin and Arneill 2003).

Recommendations / Interventions for Prevention of Falls

The evidence regarding floor surfaces and the incidence of falls is inconclusive. Studies (cited by Joseph and Rashid 2007 p716) report fewer falls on vinyl floors compared with carpeted floors (Donald et al 2000); more injuries when falls occur on vinyl compared with carpet (Healey 1994), and greater risk of fracture if the sub-flooring is wooden rather than concrete (Simpson et al 2004). However a meta-analysis of RCTs did not reveal any evidence for the independent effectiveness of any environmental modification program on patient falls (Joseph and Rashid 2007 p716). The use of softer flooring in order to minimise staff fatigue has been suggested (Joseph, Reiling et al. 2004).

Recommendations / Interventions for Reduction of Noise

The use of hard surfaces also contributes to noise production. By increasing the amount of softer surfaces, less reverberation and echoing will occur.

Recommendations / Interventions for Reduction of Perceptual Confusion

Internal environments that avoid perceptual confusion are especially important for people with emotional and thought disturbance. It is postulated that reassurance can be gained by helping people with mental health problems re-engage with the materiality of the surrounding world. In doing so, however, things should feel true to expectations, with surfaces being “true and honest to their materials”. For example wood-grain finishes on metal doors can lead to confusion because the doors will be unexpectedly heavy and cold (Mazuch and Stephen 2005 p49).

3.3 Colour and Lighting as a Design Feature

The Issue:
- There is tentative evidence that colour may affect mood and behaviour.
- Colour and lighting can be used as a signal to alert people to hazards or supportive features, and to add visual interest and distraction

Recommendations/Suggestions:
- Consider using cool colours to promote relaxation, warm colours to energise and neutral colours to minimise attention
- Use contrasting colours as an alert for potential hazards and to attract to other features

While evidence of the association of colour with particular health outcomes was not found in this literature review, the importance of colour was still recognised in the belief that colour does have meaning to most individuals (Altimier 2004).

Recommendations / Interventions for Colour & Lighting Design

Despite a shortage of evidence, there is general consensus that warmer colours tend to activate and energise, while cooler colours are more relaxing. With this in mind, it has been suggested to use reds/oranges/yellows in areas to promote physical and social activity (for example in rehabilitation gyms); blue/greens to enhance calm and relaxation (for example in sleeping, counselling and staff relaxation areas); and neutral colours such as greys/beiges to minimise attention to certain areas (for example areas restricted to staff only such as supply areas)(Dalke, Little et al. 2006).

Following interviews and discussion with staff and patients from 20 hospitals in the UK, and reporting of the relevant literature, various recommendations have been made in relation to colour and lighting (Dalke, Little et al. 2006). Neither a search strategy nor any assessment of the quality of evidence was reported, and it was unclear if recommendations were made on the basis of the literature or on the basis of the authors' own research. Despite this, the article provides many commonsense concerns and recommendations supported by photographic evidence of good practice, including:

- Isolated patches of bright sunlight contribute to glare in an internal environment. This can be especially disorientating when dark long corridors run into patches of bright light, and needs to be considered in the overall lighting design plan.

- Contrasting colour can be used to alert patients and visitors (especially those with visual impairment) to obstacles in the environment (for example by brightly painting potential hazards such as seating that could easily be bumped into), as well as supportive features such as handrails.
- Colour and lighting can be used to provide visual interest and distraction, for example coloured glass.

4. Social Features

Although privacy is stressed as desirable by most patients in most situations, the value of social support should not be ignored. This was evidenced by a study investigating family members' experiences of the intensive care waiting room, with one finding being that relatives appreciated contact with others in similar situations (Kutash and Northrop 2007).

Promotion of social interaction is also a part of the therapeutic process for mental health patients, and can be enhanced by the physical environment (Gross, Sasson et al 1998).

Recommendations / Interventions for Social Features

The best way to achieve balance between privacy and contact with others is to give patients and families some level of control, with opportunities for interaction as well as privacy. Although contact with others was appreciated in the waiting room, another finding was that chairs should not be too close together, and that the chairs need to be comfortable with a home-like feel (Kutash and Northrop 2007).

Ward redesign in a psychiatric unit included a variety of spaces supporting social interaction (large day room, spacious lobby areas, dining room) which gave patients the opportunity to interact with others, but also allowed for physical retreat where necessary (Gross, Sasson et al. 1998).

There is evidence to support the enhancement or diminution of social interaction by design features such as furniture arrangement (Ulrich and Quan 2004a), with shoulder-to-shoulder seating discouraging social interaction.

5. Specific Features

5.1 Wayfinding

Problems in wayfinding for patients and visitors are common in hospitals. These difficulties can result in feelings of agitation, disorientation and a loss of control (Devlin 2003 p 672). The elderly, visually impaired, and people of non-English speaking background are at higher risk of losing their way. One literature review identified more than 17 studies investigating wayfinding in hospitals and other buildings, and stated that this issue was complex as single variables could not be considered separately (Ulrich and Quan 2004a p19).

Building cues and architectural features provide significant prompts, and are more powerful than signage for wayfinding. This is especially true for people who have dementia and rely less on memory, and was highlighted in an observation study of people with Alzheimer's Disease as they negotiated their way around a hospital (Daykin, Byrne et al. 2008 p90; Ulrich and Quan 2004a p18). Although colour coding is often used to assist in wayfinding, one group of authors warns that it is often misunderstood by patients and visitors to the hospital (Dalke, Little et al. 2006) .

Recommendations / Interventions for Wayfinding

Colour should be used as a cue in wayfinding for simple zoning of no more than four main areas of a building, the colours should be easily recognised by their descriptive words (for example blue, red, yellow), and care should be taken as the elderly have more difficulty recognising colour due to yellowing lenses. Use of colour can also be confusing for the visually impaired, including those with colour-blindness (Dalke, Little et al. 2006).

Due to the complexity of wayfinding, a fully integrated and planned wayfinding system is necessary (Ulrich and Quan 2004a p19).

5.2 Safety Issues

Designing specifically to reduce errors and promote safety

Following the release of the Institute of Medicine's pivotal report "To Err is Human", which claimed that medical errors caused between 44,000 and 98,000 preventable deaths per year in American hospitals, safety issues and the development of safer systems have been given greater attention (Leape 2008). Some design features already discussed previously are associated with safer outcomes for patients. It is argued that hospital design should explicitly consider patient safety, and that this consideration should be integrated into all consultations at the earliest opportunity.

Recommendations / Interventions for Promoting Safety

The redevelopment of St Joseph's Community Hospital in the US involved team approaches with hospital staff, patients, the wider community, architects, building designers and safety experts. It also involved identification of precarious situations from a database of sentinel events and a Failure Mode and Effects Analysis (FMEA) of specific situations. Facility design principles for safety resulted, and included the following to help guide the planning of the new facility:

- Visibility of patients to staff (for example by inclusion of charting alcoves next to patient rooms)
- Standardisation of patient rooms
- Scalability and adaptability – to allow for flexibility for future changes in work processes and technology
- Immediate access to point of care information
- Noise reduction
- Strategies for involving patients in their care – includes space for family to remain with the patient
- Minimizing staff fatigue (for example by soft flooring, minimising walking distances)
- Use of FMEA tool
- Design specifically for the most vulnerable patient
- Incorporate a human factors review
- Design around precarious situations that could lead (or have lead to) sentinel incidents

The authors believe that adherence to this process will result in a safer environment for both patients and staff (Reiling, Knutzen et al. 2004).

Redevelopments and design modifications which have manipulated multiple factors and resulted in improvements in safety include the allocation of more space for medication rooms with installation of sound-reducing panels and reorganisation of medical supplies. These were associated with a 30% reduction in medical errors on two new inpatient units (Barach 2008 p15).

CONCLUSION

This literature review has provided findings concerning the health impacts of the physical design of a hospital on the wellbeing of both staff and patients and on the recovery of patients. The evidence base is mixed, both in terms of methodological rigour and conclusions drawn by authors. Despite this, the review points to some main issues that result from the interface of physical design and the health and wellbeing of patients and staff and that should be considered in an HIA. To enhance wellbeing and facilitate patient recovery, these include reducing noise, increasing natural light, providing contact with nature and the outdoor world, promoting family involvement, increasing the opportunity for patient control, promoting accessibility and wayfinding, improving safety, improving settings and opportunities for communication, maximising potential time with patients and providing a welcoming environment.

For other issues that an HIA may include, evidence is more variable or requires more detailed consideration. For example, the recommendation to provide single patient rooms is a recurrent theme and is associated with a number of health impacts including noise reduction, patients' control over their own environment and family involvement. Although frequently advocated, the supporting evidence is not as strong as other recommendations, demonstrating that care needs to be taken with interpretation. In addition the majority of empirical work within the literature focuses predominantly on how the physical environment affects patient outcomes and perceptions, with less emphasis on staff effects (Mroczek, Mikitarian et al. 2005; Devlin and Arneill 2003). As a result although some recommendations are straightforward and would appear to benefit all (for example installation of sound-absorbing tiles to reduce noise), other recommendations

require consideration of the unanticipated impact on staff. For example the recommendation is made to decentralise nurses' stations in order to potentially increase the time available for care (by reducing time spent in walking) and remove barriers to communication between staff and patients/family. This might however lead to a decrease in communication, camaraderie and information sharing amongst staff. For an HIA, this highlights the need for consultation with all potentially affected groups as part of the HIA process, and greater consideration of the potential unanticipated impacts on different groups such as staff.

This literature review provides a broad overview of the predominant themes in the literature concerning the potential impact of hospital design on staff and patient wellbeing and patient recovery. The primary purpose is to inform the HIA of Liverpool Hospital redevelopment, although there are clear implications for related HIAs and hospital designs in other contexts and setting. However, in achieving this purpose, it is hoped that the review may also more broadly serve as a springboard for further enquiry to underpin the growing recognition of the link between hospital design and health and wellbeing.

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APPENDIX 1 - SUMMARY OF MAIN ISSUES AND RECOMMENDATIONS

NOISE

Excessive noise can cause negative physiological changes and disturbed sleep for patients, can lead to communication difficulties for staff, and has been implicated in error generation and burnout.

Recommendations

- Install sound-absorbing ceiling tiles
- Reduce sound in neonatal intensive care units by:
    - Installing weather stripping on doors and drawer fronts
    - Replacing metal rubbish bins with plastic
    - Installing carpet over central walkway
    - Installing sound-absorbing materials

  Consider placing covers on incubators, installing soft linoleum flooring, positioning sinks and air conditioning ducts away from infant beds, placing infant beds away from nurses' station (depending on visibility issues), positioning exit and entry doors within a vestibule, and providing single rooms.

LIGHT

Exposure to bright light (especially morning sunlight) assists in mood elevation, and is associated with reduced length of stay, reduction in mortality and reduced need for analgaesia. Exposure to daylight is associated with less stress and higher job satisfaction for staff, is necessary for vitamin D metabolism, and is generally preferred over artificial lighting (which is implicated in headache generation). Daylight/night darkness cycles are necessary for maintenance of normal Circadian body rhythms, with prolonged 24 hour high-intensity lighting implicated in intensive care unit dementia. Lighting also has effects on agitation levels for patients with Alzheimer's Disease. Ageing increases the need for higher intensity lighting, with higher intensity lighting associated with reduction in medication dispensing errors.

Recommendations

- Provide individually controlled lighting for work areas with access to high intensity lighting
- Ensure provision of daylight/sunlight (especially morning light) in patient and staff areas (windows, atria, skylights etc)
- In the absence of normal daylight rhythms, provide cycled lighting
- Adhere to specific lighting standards where they apply (eg neonatal nurseries, operating theatres)
- Reduce institutional lighting and emphasise residential style lighting where possible
- Consider lighting manipulation to reduce agitation for patients with Alzheimer's Disease

PATIENT CONTROL OVER THE AMBIENT ENVIRONMENT

Having some control over one's environment has positive health outcomes and improves sense of wellbeing. Patients wish for a sense of control and normality.

Recommendations

- Enable individual control – eg light switches, volume controls, blind adjustments
- Provide single rooms where possible

WINDOWS (DAYLIGHT AND VIEWS)

Windows, with their access to daylight and views, have been associated with reduced length of stay, reduced need for analgaesic medication and less delirium. Patients report preferences for windows with views, and highly value connections to the outside world.

Recommendations

- Provide as many windows as possible (with views of nature and of normal life activities outside hospital), with consideration given to visibility of view from perspective of patient in bed
- Provide glare and shade control, but use tinting with caution
- Consider window area to occupy at least 20-30% of window wall

PHYSICAL PLAN OF WARD/UNIT

The layout of the ward/unit is associated with the amount of walking staff undertake, the access to windows and natural lighting, the opportunity for "corridor conversations" and the ease or difficulty of observing patients. The provision of family areas is valued by patients and staff, and is especially important when families need to take on carers' role on discharge (eg NICU, paediatric areas). Decentralisation of supply areas and nurses' stations may free up more time for direct patient care, and may improve safety.

Recommendations

- Consider decentralisation of nurses' stations and supply areas
- Provide private staff areas on each ward to encourage team communication
- Remove high counters at nurses' stations to enhance interaction with patients and families
- Avoid hallways that finish in dead ends
- Provide family areas including sleeping facilities

THE SINGLE PATIENT ROOM

Single patient rooms are associated with decreased noise, safer care, improved patient control of environment, improved privacy and overall satisfaction with care, a better environment for examination and history taking, and more opportunity for family involvement. Curtained bay beds provide less privacy for confidential consultations – this may affect patient outcomes with some patients withholding information. Unintended consequences can include decreased patient visibility and less staff interaction. There is possible association with reduction in nosocomial infections.

Recommendations

- Consider providing as many single rooms as possible
- Standardise the layout of single rooms, including locating patient bathroom close to the head of the bed, providing handrail supports around the walls of each room, installing handwashing sinks in each room and providing a small alcove outside each room
- Provide other design features to increase visibility throughout specialised units (eg for NICU keep counter and corridor walls low)
- Provide consultation areas that enhance visual and auditory privacy

- Provide areas to promote staff interaction
- Consider provision of acuity-adaptable rooms

ACCESS TO NATURE AND GARDENS

Provision of natural features are associated with positive health outcomes and improved sense of wellbeing for patients and staff.

Recommendations

- Provide contact with nature where possible – views from windows, indoor features or access to outside gardens with consideration given to accessibility issues

PROVISION OF STAFF AREAS

Staff lounges provide areas for communication and relaxation.

Recommendations

- Provide staff lounges, including multi-disciplinary areas to encourage more communication between all healthcare workers
- Consider the ambient environment in the design features, with consideration for appropriate lighting and noise reduction

PHYSICAL PLAN OF THE HOSPITAL

Various architectural features of the overall hospital plan are important to the wellbeing of patients and their families/visitors, as well as to staff.

Recommendations

- Suggestions made by patients and families include providing moving walkways; installing lifts close to reception areas; promoting accessibility (wheelchair access and hand rails); providing prayer/spiritual areas and play areas for children; and ensuring corridors remain uncluttered, have regular rest areas and access to outdoors
- Suggestions made by staff include providing separate transport areas for patients/staff and the general public, and providing separate entrances for staff

INTERIOR DESIGN FEATURES

Reception Areas

Reception areas can set a welcoming tone, and as such can send messages that the hospital/unit has patient and family centredness as a core principle, thus encouraging patient participation and family involvement in the care.

Recommendations

- Reception areas should be visually prominent
- Areas for private conversation should be immediately available
- Counters and desk heights should be low enough to allow for access to everyone

Floor coverings and surfaces

Floor coverings and surfaces can contribute to glare and noise volume. The association between patient falls and floor coverings is inconclusive

Recommendations

- Avoid highly polished surfaces
- Provide soft floor coverings and surfaces
- Ensure finishings are true to expectations (eg wooden finishings should feel like wood)

Colour and Lighting

There is tentative evidence that colour may affect mood and behaviour. Colour and lighting can be used as a signal to alert people to hazards or supportive features, and to add visual interest and distraction.

Recommendations

- Consider using cool colours to promote relaxation, warm colours to energise and neutral colours to minimise attention
- Use contrasting colours as an alert for potential hazards and to attract to other supportive features (such as handrails)

SOCIAL FEATURES

Although privacy is stressed as desirable by most patients, there is also value in providing an environment to encouragement social support. Provision of social interaction is also part of the therapeutic process for mental health patients.

Recommendations

- Provide patients and families with a level of control over the amount of social interaction they wish to have

WAYFINDING

Problems in wayfinding are common in hospitals, with the elderly, visually impaired and people of non-English speaking backgrounds at higher risk of losing their way. Building cues are more powerful than signage for wayfinding. Colour coding is often misinterpreted by patients and visitors to hospitals.

Recommendations

- Use colour coding for simple zoning of no more than main areas of a building
- Implement a fully integrated and planned wayfinding system where possible

SAFETY ISSUES

Hospital design has a definite role in promoting a safer environment.

Recommendations

- Promote patient visibility
- Standardise patient rooms
- Install point of care information systems
- Reduce noise
- Provide for family members to stay with patients
- Minimize staff fatigue (eg by reducing walking distances, installing soft flooring)
- Consider use of Failure Mode and Effects Analysis (FMEA) tool
- Design around the most vulnerable patient, and around precarious situations that could lead to sentinel incidents

APPENDIX 2 - LITERATURE REVIEWS

Only those findings relevant to the search question: "*What are the health impacts of the physical design of hospitals on patient recovery and wellbeing and on staff wellbeing?*" are described.

Author/Title	Methods/Comments	Findings	Implications for Practice/Design
Bremmer, Byers et al. 2003 **Noise and the premature infant: Physiological effects and practice implications**	<u>Search strategy:</u> Not stated <u>Explicit study design criteria:</u> Not stated <u>Number of studies:</u> 24 refs – not all research studies <u>Time frame:</u> 1974 – 2002	Premature infants lack physiological maturity to cope with excessive noise, resulting in detrimental effects (apnoea, bradycardia & heart fluctuations, respiratory rate BP & oxygen saturation Long-term sequelae of constant noise exposure including increased risk of sensory hearing loss & abnormal auditory development, with some authors suggesting a link between excessive noise in NICU and attention hyperactivity disorder (ADHD) NICUs typically exceed recommended noise levels Noise sources identified Construction/design suggestions and clinical interventions to reduce noise listed	Recommendations to reduce noise from a design perspective: Install soft linoleum or dense carpet Use sound absorbing surfaces & ceiling tiles Place sinks in corners away from patient beds Replace metal bins with plastic Use fabric or vinyl wrapped acoustical wall panels, and curtains over windows Place stripping along doors & drawer fronts (reduce sound of slamming) Arrange beds as far from nurses' station as possible Place air conditioning ducts in corners, not directly near beds Provide entry/exit doors within a vestibule with sliding or swinging doors Where space limited, use sound-rated frame & door assemblies Consider vibration &/or light alarms to reduce amount of sound alarms Install "quiet please" signs Use open shelving, with storage spaces away from beds ***Although these recommendations are specifically for neonatal ICUs, many could be applied to other wards/units***

Author/Title	Methods/Comments	Findings	Implications for Practice/Design
Daykin, Byrne et al. 2008 **The impact of art, design and environment in mental healthcare: a systematic review of the literature**	Search strategy: Detailed - 14 e-databases, search terms & in/exclusion criteria stated. Explicit study design criteria: Quantitative, qualitative & mixed methods Number of studies: 19 (10 relevant for HIA literature review) Time frame: 1985 - 2005 Comments: Focuses on impact of arts, design and environment in healthcare settings, with particular emphasis on mental healthcare Authors state "The diversity of settings, interventions and outcome measures used in these studies means that it is difficult to synthesise the data" – this review tended to report studies individually.	Less stress response (measured by changes in BP/pulse, & psychosocial self-report) with exposure to nature scenes compared with normal TV programming & urban scenes Changes to acoustic conditions in ICU produced self-perceived (by nurses) improved working conditions incl improved speech intelligibility, potentially reducing conflicts & errors Nonsignificant reduction in falls assoc with vinyl floor covering compared with carpets for elderly patients Patients with Alzheimers more likely to make way-finding decisions in the hospital environment based on explicit architectural features, rather than memory, inferences or graphical displays Patients preferred features that engendered normality, comfort & privacy	Include nature scenes in waiting areas – carefully consider whether constant background TV advisable Install sound absorbing ceiling tiles Flooring choice and association with patient falls requires further literature searching/research Use architectural cues to assist in wayfinding rather than signage or memory based inferences Keep information displays simple and uncluttered, eg separate staff notices (suggest use alcove notice displays) away from patient information notices
Devlin and Arneill 2003 **Health Care environments and patient outcomes: a review of the literature**	Search strategy: Not stated Explicit study design criteria: Not stated Many non empirical refs	Lack of control by patients may lead to poorer outcomes (depression, passivity, incr BP, reduce immune system functioning) – environmental factors include: • Confusing way-finding • Lack of privacy • Excessive noise	Provide as much individual control for patients over their own environment as possible

Author/Title	Methods/Comments	Findings	Implications for Practice/Design
Devlin and Arneill 2003 (Contd) **Health Care environments and patient outcomes: a review of the literature**	Number of studies: >100 Time frame: Not stated	• Lack of control over TV • Lack of view • Lighting • Temperature "Patient-centred care" recommended & involves giving patients choice where possible – increases pts' overall satisfaction Noise: • Not only annoying, also disrupts sleep, can lead to confusion & stress • Potential to affect healing • Sleep deprivation can lead to immunosuppression • Affects staff as well as patients – measure of burn-out correlated with degree of noise-induced stress, affects (self-reported) staff health eg headaches Windows/Views • Presence of a view of nature from window rather than view of brick wall resulted in shorter post-op stays, fewer negative evaluative nursing comments in notes, fewer & less strong analgaesia, slightly less complications (sentinel study) also older study showed patients with windows had less incidence of delirium • "Satisfaction (with window) is generally achieved when window area occupies 20-30% of window wall" Lighting & Colour (references appear more opinion than research oriented) • Lighting will have more impacts for certain groups eg the elderly with visual impairment	Noise reduction (design) recommendations: • Use light dimmers (reducing light tends to lower voices) • Place doors on rooms • Use carpeting Provide view of nature through window (not brick wall) Ensure window at least 20-30% of window wall Lighting & colour recommendations: • Provide bright indirect light • Provide more of a residential feel to lighting (instead of institutional) • Paint restricted areas pale colours

Author/Title	Methods/Comments	Findings	Implications for Practice/Design
		• Colour can be used to attract/reduce attention Much detail provided for specialised units (eg dementia specific planning, birthing units and rehabilitation centres) – appears to reference many opinion pieces	• Take care with using colour for wayfinding (difficult for visually impaired) Dementia specific recommendations/suggestions: • Establish open plan for better visual monitoring of patients by staff, to aid patients in orientating to their surroundings, and to encourage social interaction • Continuity in pathways & corridors (loop) less frustrating than dead ends • Provide outdoor spaces, including gardens • Provide floor lighting at bedside
Dijkstra, Pieterse et al. 2006 **Physical environment stimuli that turn healthcare facilities into healing environments through psychologically mediated effects: Systematic review**	<u>Search strategy:</u> Detailed, well reported & rigorous. Followed Cochrane Collaboration method Databases listed MeSH headings and additional search terms stated Exclusion/inclusion criteria stated <u>Explicit study design criteria:</u> Controlled trials <u>Number of studies:</u> 503 articles full text assessed – 30 included: • 18 controlled clinical trials • 2 RCTs • 10 natural expts	Effects of multiple stimuli – (remodelled wards, treatment areas & waiting rooms) – mainly de-institutionalising attempts, brighter colours, more homelike furniture, carpeting, more social areas etc) For specific groups: • Pts with mental illness – improvements in social behaviour & neg self-image • Mentally handicapped – improv'ts in activity (but deterioration in self-help) • Aged – improvement in ADLs & pathological behaviour, deterioration in isolated passivity, hostility, self-maintenance skills & tension In general (across all populations studied) • More positive environmental appraisal • Less convincing results for patient evaluation of care • No effect on clinical outcomes • Conflicting impacts on social behaviour Sunlight – mainly positive effects for LoS, mortality rate, perceived stress and pain	On the basis of these results: although relocation/redesign appreciated by patients *"…evidence of clinical effects still lacking…conflicting results…renovation may have negative consequences for specific types of patients and should be planned carefully) p178* Most convincing of ambient effects is sunlight,

Author/Title	Methods/Comments	Findings	Implications for Practice/Design
Dijkstra, Pieterse et al. 2006 (Contd) **Physical environment stimuli that turn healthcare facilities into healing environments through psychologically mediated effects: Systematic review**	<u>Time frame:</u> Not stated <u>Comments</u>: Many inconsistent findings – *"At this stage, formulating guidelines for evidence-based design of healthcare facilities seems premature" p179*	(populations groups included depressed, cardiac and surgical patients). Bipolar depression responded to morning sunlight, unipolar to afternoon sun Noise – best results for preventing negative effects of sound – eg sound absorbing ceiling tiles, rehospitalisation rate lower, medication rate lower, also positively affect perceived quality of care Windows – presence of windows and a natural view have positive effects on clinical outcomes (better orientation for time & day, less hallucinations & delerium, better sleep, shorter LoS, slightly less post-surgical complications, fewer analgaesics) (however confounders present) Spatial layout – positive effects re perception of privacy & effect on disturbance due to noise (Nightingale vs bay wards, solid walls vs curtains) Design – TV, exposure to nature (images or video), slight pain reduction with images and sounds of nature, no TV showed reduced pulse rates, and TV showed no effect as a distractor in a waiting room	however author still advises prudence as special effects dependent on patient population Install sound absorbing ceiling tiles Provide windows with view of nature Little evidence for providing TV as positive distractor

Joseph 2006a
The Impact of Light on Outcomes in Healthcare Settings
	<u>Search strategy:</u>
	Key words stated.
	Sources included "peer-reviewed journal articles and research reports published in medicine, psychology, ergonomics, and lighting design
		Light impacts on health and performance by:
		• Enabling performance of visual tasks:
		  ○ more light needed as people age
		  ○ task performance improves with increased light levels
		• Controlling body's circadian system
			Ensure appropriate lighting for complex tasks, especially considering the health workforce is ageing
			
			Maximise staff and patient exposure to daylight

Author/Title	Methods/Comments	Findings	Implications for Practice/Design
Joseph 2006a (Contd) **The Impact of Light on Outcomes in Healthcare Settings**	periodicals and books" . Explicit study design criteria: Not stated Number of references: Approx 46 Time frame: Not stated	• Improving mood and perception • Facilitating chemical reactions in the body, including Vitamin D metabolism	(windows, atria etc) Maximise number of patient rooms exposed to morning light Provide glare protection and temperature control
Joseph 2006b **The Role of the Physical and Social Environment in Promoting Health, Safety, and Effectiveness in the Healthcare Workplace**	Search strategy: Key words stated. Sources included "peer-reviewed journal articles and research reports published in medicine, nursing, psychology, ergonomics, and architecture periodicals and books" . Explicit study design criteria: Not stated Number of references: Approx 70 Time frame: Not stated	Poor handwashing compliance amongst staff is primary cause of contact transmission of infections Reduction of back pain and staff injuries by attention to ergonomic design principles, equipment and practices Excessive noise produces stress in staff, leads to burn out and reduces speech intelligibility Staff effectiveness is reduced by • Multiple patient transfers • Time wasted in locating & gathering supplies Communication central to safe care Environmental factors contributing to errors incl: • Low light levels • Inadequate private space for work • Noise Environments in which families and patients are active participants in the care process result in higher levels of satisfaction	Provide convenient, highly visible handwashing sinks Use softer flooring (eg rubber) to reduce staff fatigue and reduce back and leg discomfort Install sound-absorbing ceiling tiles Consider implementation of acuity-adaptable rooms with decentralised work stations and decentralised supply areas With decentralised work stations, even more important to consider provision of informal 'neutral' (multidisciplinary) staff areas Provide appropriate lighting Consider use of the Failure Modes Effects Analysis (a tool for planning to highlight safety concerns) Provide space for families in the patient room and on the unit/ward

Author/Title	Methods/Comments	Findings	Implications for Practice/Design
Joseph and Rashid 2007 **The Architecture of Safety: Hospital Design**	Search strategy: None stated Explicit study design criteria: Not stated Number of references: 67 Time frame: Not stated	Direct impacts on patient safety: • Single rooms appear to be associated with decreased infection rates, but confounders such as type of filters often present • Bright or constant lighting associated with ICU psychosis • Dull rooms may be associated with increased mortality, poor lighting associated with increases in dispensing errors and may negatively impact on physiological development of infants • Excessive noise can induce stress responses, and is associated with sleep difficulties • Evidence on falls inconclusive Design features also impact on staff, incl: • Noisy environments contribute to communication difficulties, emotional exhaustion and burnout • Loss of productivity associated with patient transfers • Fatigue associated with walking long and unnecessary distances Patients should be as visible to staff Family involvement in the care process can reduce patient mortality	Single bed room adopted as the standard for all new healthcare facility construction in the US Consider cycled lighting and access to day/night lighting rhythms Utilise noise reducing strategies incl ceiling tiles Consider acuity-adaptable rooms, with decentralised supply areas Decentralise work stations closer to patient rooms Encourage family involvement providing spaces for families to stay for extended periods of time
Joseph and Ulrich 2007 **Sound Control for Improved Outcomes in Healthcare Settings**	Search strategy: Key words stated Sources included "peer-reviewed journal articles, research reports, and books published in medicine, psychology, architecture,	Hospitals are excessively noisy Impacts on staff: • Increased perceived work pressure, stress & annoyance • Increased fatigue, emotional exhaustion & burnout • Difficulty in communication – potential	Environmental strategies to reduce noise in hospitals discussed, including: • Installation of sound-absorbing ceiling tiles • Provision of single rooms • Reduction of the sources of noise (eg reduction in alarms, removing ice machines)

Author/Title	Methods/Comments	Findings	Implications for Practice/Design
Joseph and Ulrich 2007 (Contd) **Sound Control for Improved Outcomes in Healthcare Settings**	and acoustics publications" <u>Explicit study design criteria:</u> Not stated <u>Number of references:</u> Approx 70 <u>Time frame:</u> Not stated	for errors Impacts on patients: • Annoyance, sleep disruption & awakening • Physiological changes amongst neonates • Decreased wound healing • Higher incidence of rehospitalisation Communication & privacy aspects, discussed including: • Poor provision of space for private and confidential discussion between healthcare provider & patient, and between patient and family • Speech intelligibility often affected by high noise levels	Environmental strategies to increase confidentiality and speech intelligibility discussed, including: • Provision of single rooms, especially for examination and for confidential discussion • Ensuring single rooms are enclosed, with walls extending to ceiling height
Karlin and Zeiss 2006 **Environment and therapeutic issues in psychiatric hospital design**: **Toward best practices**	<u>Search strategy:</u> No search terms stated Databases listed <u>Explicit study design criteria:</u> Not stated Included non-empirical refs <u>Number of studies:</u> Approx 100 <u>Time frame:</u> Not stated <u>Comments</u>: No assessment of quality of references Rarely links findings with the original research in this	Sunlight can promote recovery in psychiatric patients with depression Good air quality can facilitate recovery Single or non dormitory rooms can enhance privacy, private visiting areas increase privacy & intimacy Views of nature can reduce psychological stress, recovery time, enhance staff functioning & job satisfaction	Makes following recommendations/statements (no comment re rigour or origin of evidence) Lighting • Soft, indirect, and pervasive or full-spectrum. • Spotlight recessed lighting should be used sparingly, not directly focused on individuals • Ample natural daylight, with sunlight in patient rooms • Avoid highly polished floors or other reflective surfaces (to decrease glare) Provide good ventilation & neutral odours Reduce dormitory style rooms

Author/Title	Methods/Comments	Findings	Implications for Practice/Design
Karlin and Zeiss 2006 (Contd) **Environment and therapeutic issues in psychiatric hospital design**: **Toward best practices**	article	Large, low windows may improve sensory abilities & reduce paranoia & delirium Exposure to nature reduces fatigue & stress, may facilitate recovery Long echoic corridors may be associated with perceptual disorders (esp psych patients) Seclusion rooms close to nursing stations may be safer, but impacted by environmental disturbances Staff lounge/garden/congregate space can improve job satisfaction, promote professional communication "Physical ethos" or "latent message" of a unit/ward conveyed In its design features – eg customer service values Non-institutionalised furniture preferred by patients & medical staff, more homely atmosphere associated with enhanced emotional & intellectual well-being, and psychiatric patients' behaviour Studies of colour show inconsistent results, some trends emerge: • Warm blue tones have soothing, sedating effect • Blue-green colours have negative effect on depressed and low energy patients Removal of glass partitions around nursing stations (closed to open planning) demonstrated positive psychological,	Provide large low windows with views of nature, and laminated safety glass in group rooms to open up interiors & provide visual connection to outside Provide access to nature Reduce long corridors, provide flexible room dividers to allow for maximum use of available space Avoid reverberant spaces (noise reduction) Position "seclusion" rooms within sight & near to nursing stations, but outside of main patient corridors/activity areas Provide staff spaces, and spaces for patients/family/visitors Provide clearly defined reception area for greeting patients & visitors Provide non-institutionalised and familiar type furnishings Avoid monochromatic and pastel colour schemes, take care with bright colours where patients could be agitated, use blue tones where calming effect is desired

Author/Title	Methods/Comments	Findings	Implications for Practice/Design
Karlin and Zeiss 2006 (Contd) **Environment and therapeutic issues in psychiatric hospital design: Toward best practices**		behavioural & social effects. Reports of open nursing stations do not support concerns regarding staff abuse by patients Psychogeriatric patients: • Glare & noise aggravating • Higher levels of illumination needed, low levels of light decrease visibility & increase agitation • Shorter corridors provide easier navigation & reduce reverberation	Recommendations specific for psychogeriatric patients: • Reduce glare & noise • Provide overall higher levels of illumination • Provide shorter corridors • Provide handrails & grab bars • Ensure bathrooms big enough to accommodate wheelchairs and staff Other recommendations specific to psychiatric units; use: • Shatterproof windows • Breakaway curtain rods • Tamperproof electrical outlets • Stainless steel mirrors • Lockable water taps Avoid construction of blind corners
Lorenz 2007 **The potential of the patient room to promote healing and well-being in patients and nurses**	<u>Search strategy:</u> Databases listed Key words stated <u>Explicit study design criteria:</u> Peer-reviewed Studies in which an intervention or condition impacted on healing &/or wellness in pts &/or staff Non-empirical excluded <u>Number of studies:</u> 18	3 studies investigated views & brightness of room – demonstrated these factors significantly affected LoS (as proxy for morbidity) and mortality, with POE demonstrating most positive response was for provision of natural light Environmental noise significantly affects patients' sleep & their perceptions of their healing ability. Conversation is a significant contributor to noise. Heart rates of patients in ICU responded to different types of noise. Patients more content in quieter areas. Following installation of acoustic ceiling tiles, the psychosocial health of an ICU	Provide views and natural light Install acoustic ceiling tiles

Author/Title	Methods/Comments	Findings	Implications for Practice/Design
Lorenz 2007 (Contd) **The potential of the patient room to promote healing and well-being in patients and nurses**	 <u>Time frame:</u> From 1984 to present	improved according to staff (better acoustics, better speech intelligibility) Bay ward preferred by patients over Nightingale ward (75% to 22%) Physicians' (but not nurses') care was rated more favourably by patients in more "appealing" rooms Patients have a need for personal space, a homely welcoming atmosphere, a supportive environment, good physical design, and access to areas for recreation and leisure Nurses favoured single room care, esp regarding patient examination, interaction with family members, and lower probability of dietary mix-ups.	 Select bay ward design over Nightingale design Provide personal pace for patients, a homely welcoming atmosphere, a supportive environment, good physical design, and access to areas for recreation and leisure Consider single room accommodation
Ulrich and Quan 2004a **The role of the physical environment in the hospital of the 21st century: A once-in-a-lifetime opportunity** (Report to the Center for health Design for the Designing the 21st Century Hospital Project)	<u>Search strategy:</u> Not stated <u>Explicit study design criteria:</u> Not stated Stated <u>Number of studies:</u> >600 <u>Time frame:</u> Not stated <u>Comments</u>: Authors stated most articles came from "top peer-reviewed journals"	Results presented in 4 areas: <u>1/ Reduce Staff Stress & Fatigue and Increase Effectiveness in Delivering Care:</u> • Noise-induced stress correlates with emotional exhaustion & staff burnout • Reduced noise levels linked with reduced perceived work demands, increased workplace social support, improved quality of care and better speech intelligibility • Modification of toilet & shower rooms (plus staff training & pt transferring devices) lead to significant reduction of back injuries (nearly 50%) • Nurses spend much time walking – influenced by type of unit layout, radial as opposed to rectangular design result	Reduce noise levels (install ceiling tiles) Apply ergonomic design of patient areas Consider ward design in regard to walking distances to/from patients and nurses' station and supply areas

Author/Title	Methods/Comments	Findings	Implications for Practice/Design
Ulrich and Quan 2004a (Contd) **The role of the physical environment in the hospital of the 21st century: A once-in-a-lifetime opportunity** (Report to the Center for health Design for the Designing the 21st Century Hospital Project)	Included studies that are "rigorous…assessed on quality of research design, sample sizes & degree of control" And "High-impact"	in less walking, potential for time to be transferred to patient care • Decentralised nursing stations decreased walking time, increased patient care, esp when supply areas were decentralized <u>2/ Improve Patient Safety</u> <u>a) Hospital acquired infection</u> • 120 studies linking infection to built environment of hospital Single room influence: 16 studies identified, infection rates usually lower in single rooms by the following mechanisms: • Easier to reduce airborne transmission of pathogens • Easier to thoroughly decontaminate after patients are discharged • Appropriately placed sinks in each room may influence rate of handwashing <u>b) Reducing medication errors</u> Mounting evidence that transfers contribute to med errors with delays, communication discontinuities & loss of information amongst staff, & changes in computer systems Reduction in transfers saves staff time, shortens pt stays & reduces costs 90% reduction in transfers and 67% reduction in medication errors with acuity-adaptable single rooms <u>c) Reducing patient falls</u> Large amt of literature – however a meta analysis & systematic review of RCTs of fall prevention interventions found no clear	Consider decentralised nursing stations and decentralized ward supply areas Consider provision of single rooms, however this finding not strongly supported by van de Glind, de Roode et al's (2007) literature review Consider provision of acuity adaptable rooms

Author/Title	Methods/Comments	Findings	Implications for Practice/Design
Ulrich and Quan 2004a (Contd) **The role of the physical environment in the hospital of the 21st century: A once-in-a-lifetime opportunity** (Report to the Center for health Design for the Designing the 21st Century Hospital Project)		evidence for independent effectiveness of environmental-modification programs One study reported transfers to & from bed comprised 42% of inpatient falls – design faults (in bedroom & bathroom area) slippery falls, inappropriate door openings, poor placement of rail & accessories, & incorrect toilet & furniture heights Many falls occur when pts attempt getting into & out of bed alone. Note – bedrails ineffective for reducing incidence, may actually increase severity Reduction in falls with decentralized nursing stations & single rooms <u>d) Improving patient confidentiality & privacy</u> Nurses & physicians frequently breach confidentiality & privacy by talking in spaces where overheard by others, increased patient perception of more auditory & visual privacy in solid walled rooms, up to 5% of patients withheld information due to lack of privacy Nurses judged single rooms superior to double for examination & history Pt satisfaction with privacy higher for single rooms <u>3/ Reduce Stress & Improve Outcomes</u> <u>a) Noise</u> • Hospitals excessively noisy, noise sources numerous & loud, hard reflecting environment adds to reverberation times	In order to potentially help reduce patient falls in patient room & bathroom, consider following design features • Non-slip floors • Door openings • Placement of rails & accessories • Toilet & furniture height Decentralise nurses' stations and increase single room provision Provide private solid walled areas for consultations Consider single room accommodation Reduce hard reflective surfaces

Author/Title	Methods/Comments	Findings	Implications for Practice/Design
Ulrich and Quan 2004a (Contd) **The role of the physical environment in the hospital of the 21st century: A once-in-a-lifetime opportunity** (Report to the Center for health Design for the Designing the 21st Century Hospital Project)		• Noise has detrimental effect on patient outcomes – for infants in NICU it can decrease O2 saturation, incr Bp HR & RR. • Strong evidence noise increases stress in adult pts • Noise affects sleep quality • Excessive noise during hospital stay can affect re-admission rates. • Effective design/environmental interventions include sound-absorbing ceiling tiles and reducing sound sources (soundless paging system). Acoustic ceiling tiles – pts slept better, less stressed, reported nurses gave them better care plus indications rehospitalization lower The evidence is very strong that providing single bed rooms is the most effective intervention for noise reduction, studies show most noises in acute care multi-bed rooms settings arise from another people (staff talking or caring for another pt eg bed rails, crying coughing etc) <u>b) Spatial Disorientation (Wayfinding)</u> • Prospective visitors ignored signs for parking drop-off point, preferring to drop off at a recognizable entry (signage had less effect on behaviour than visual clues) • Visitors interpret "you-are-here" maps and signage more easily if the top of the signage points in the direction of movement (not necessarily to the North) • Patients/visitors prefer simple signage terms such as "walkway" or "general	Install sound-absorbing ceiling tiles Orient "you-are-here" maps with direction of movement at the top Keep hospital signs simple, with familiar names and descriptions

Author/Title	Methods/Comments	Findings	Implications for Practice/Design
Ulrich and Quan 2004a (Contd) **The role of the physical environment in the hospital of the 21st century: A once-in-a-lifetime opportunity** (Report to the Center for health Design for the Designing the 21st Century Hospital Project)		hospital" compared with more complex/less-familiar terms (such as "overhead link", "medical pavilion" or "health-sciences complex" • Patients who had access to more signage towards a destination arrived faster with less need to clarify directions from staff • People tend to move along "integrated routes" (those that are more accessible, with fewer turns from other routes around the hospital) <u>c) Reduce Depression</u> • 11 studies support findings that bright light effective in reducing depression in people with bipolar (with 7 studies demonstrating morning light more effective) • Elderly patients with dementia less agitated when exposed to morning light • Exposure to bright light improves sleep & circadian rhythms • Patients in brighter rooms have shorter LoS • Post surgical patients in brighter rooms (higher intensity sunlight) experienced less perceived stress, less pain & took less analgesia <u>d) Nature as a Positive Distractor</u> • Mounting evidence that providing hospitalised patients with visual exposure to nature is associated with reduced stress, faster recovery & less pain	Provide signage before or at every major intersection, at destination points, and where building cues show new area (eg change in flooring) In the absence of key decision points along a route, place signs every 150-250 feet Key locations (such as entrances) need to be on pathways of integrated routes Optimize exposure to morning light in patient rooms Use tinted windows with caution Provide views of nature, or images of nature

Author/Title	Methods/Comments	Findings	Implications for Practice/Design
Ulrich and Quan 2004a (Contd) **The role of the physical environment in the hospital of the 21st century: A once-in-a-lifetime opportunity** (Report to the Center for health Design for the Designing the 21st Century Hospital Project)		• Positive mood changes associated with use of gardens by both staff and patients, can result in measures of improved satisfaction with care <u>e) Social Support</u> • Reduces stress, aids in recovery (eg improves outcomes for patients who have had myocardial infarctions) • Access to social support can be increased by provision of comfortable areas for visiting and single rooms which are rated more highly by both patients and nurses • The presence of a room mate is more likely to be associated with added stress than social support	Provide gardens within access Provide lounge areas for visiting Maximize single rooms to accommodate family/friends
van de Glind, de Roode et al. 2007 **Do patients in hospitals benefit from single rooms? A literature review**	<u>Search strategy:</u> Search terms stated Databases listed <u>Explicit study design criteria:</u> No exclusion stated Non-empirical included <u>Number of studies:</u> 25 <u>Time frame:</u> 1970-2006 <u>Comments</u>: Judgment re evidence stated as “strong”, “moderate”, “weak” or “contested” based on rigor of study and results	Main finding: “Too few sound studies were found to evaluate the effects of single patient rooms thoroughly” Summary of main findings: “Single rooms have a moderate effect on patient satisfaction with care, noise & quality of sleep, and the experience of privacy and dignity. Conflicting results have been found on hospital infection rates. Some studies did show significant differences, while others concluded that single rooms decrease the risk of hospital acquired infections. Evidence on recovery rates and patient safety was lacking”. No negative effects of single rooms were documented in these studies	Further investigate impact of single rooms to better inform decisions

APPENDIX 3 - RESEARCH STUDIES

Author & Study	Study Type & Intervention	Population	Findings	Implications for practice/design
(Ben-Abraham, Keller et al. 2002) **Do isolation rooms reduce the rate of nosocomial infections in the paediatric intensive care unit ?** **(Israel)**	Prospective comparative study Pre/post rates of infection in paediatric intensive unit Intervention: Redesign of one large open space plan with 6 isolation rooms (with separate sinks)	Paediatric intensive care unit patients Pre N=78 Post N=115	• Significant decrease in rate of nosocomial infections specifically, there was a reduction in respiratory and urinary tract infections as well as those related to central venous and drainage catheters. • Significant decrease in LoS	• Consider single isolation rooms in paediatric intensive care areas
Caspari, Naden et al. 2007 **Why not ask the patient? An evaluation of the aesthetic surroundings in hospitals by patients** **(Norway)**	Questionnaire (likert scale) to patients for evaluation & opinion of aesthetic dimension, incl how it affects well-being	400 surveys to inpatients across 6 hospitals N (returned) not stated	• Aesthetics rated in importance for patients in self-reported influence on psych & physical health • Pts rated the aesthetics as having small pos to fairly large potential influence • Colour, view, architecture and sound were rated as poor in these hospitals – potential for improvement	• According to authors, patients rate the aesthetics as a neglected field in hospital design, but felt they deserved more consideration • Particular attention should be given to: o Colour o Views, incl arrangement of beds in multibed room so all patients have a view, consideration of window size & location o Architecture (entrance to hospital should be welcoming, avoidance of large concrete blocks) o Noise reduction

Author & Study	Study Type & Intervention	Population	Findings	Implications for practice/design
Caspari, Eriksson et al. 2006 **The aesthetic dimension in hospital plans – An investigation into strategic plans** **(Norway)**	Analysis of strategic plans of general hospitals in Norway Strategic plans analysed for occurrence of aesthetic terms To assist with analysis, a matrix of aesthetic domains was devised to record all occurrences of relevant words under each domain	N=64 hospitals (74% response rate)	• Very few guidelines regarding aesthetics in Norwegian Hospitals exist • Vague statements rather than specific guidelines existed	• Matrix may be useful for analysis of aesthetic considerations of hospital redevelopment plans refer p854 • Matrix domains consist of: o Harmony o Food o Art o Room o Light o Colours o Design o Sound o Nature o Aesthetics o Quality • Authors emphasise importance of aesthetic considerations to well-being of staff and patients, and stress the value of explicit guidelines in hospital plans
(Chaudhury, Mahmood et al. 2006) **Nurses' perception of single-occupancy versus multioccupancy rooms in acute care environments: an exploratory comparative assessment** **(Canada)**	Survey to nursing staff re their perceptions of single vs double occupancy rooms Low level of evidence – perception only	N=77 (administrative & nursing staff) from 4 hospitals	Nurses' perceptions: single rooms advantageous due to • Flexibility for accommodating family • Suitability for examination & history • Increase in patient's comfort level & recovery rate (more rest, less disturbance) • Decreased probability of medication error • Decreased noise Physical characteristics that nurses rated more highly for	Nurses rate provision of single rooms as worthwhile, supporting other literature – consider maximizing provision of single rooms

Author & Study	Study Type & Intervention	Population	Findings	Implications for practice/design
			single rooms include: • General layout • Availability of space & furniture arrangement • Privacy	
Curtis, Gesler et al. 2007 **Therapeutic landscapes in hospital design: a qualitative assessment by staff and service users of the design of a new mental health inpatient unit** **(UK)**	Post Occupancy Evaluation of new mental health inpatient unit In-depth discussion groups & interviews Feedback sessions held for validation Guided by main question: *"What specific features of the hospital …are good/not good for the well-being of users and staff?"*	Self-selecting N= 13 Staff (nursing, managerial & consultants (doctors) N=7 Ex-patients (currently well) (English-speaking)	• New clean building reflects a respectful attitude towards people with mental illness, however concern location was near old sewage & noisy motorway • Disgust expressed at visible "incarceration" elements – eg fence around psych ICU should be better disguised • Diverse views re location of nursing station at intersection of 3 corridors – nurses requiring observation station, consultants feeling nurses should not be congregating & passively observing but either interacting with patients or doing paper work in the office • Windows were locked to prevent absconding or jumping, but no air-conditioning or fresh air provided • Security risk – inadequate lighting to entrances at night • Need for personal, private space (staff and patients) balanced with need for interactive space	• Provide acoustic barriers to environmental noise • If fence necessary, disguise to eliminate "incarceration" message • Good example of design linked to staff behaviour – consider intended purposes of each area in the design and consult with the users • Provide fresh air flow, and temperature modification if windows cannot be opened • Provide lighting to entranceway all night • Provide variety of spaces for different purposes for staff & patients (incl staff rest lounges away from patients, and enough spaces for patients to self select which other patients they want

Author & Study	Study Type & Intervention	Population	Findings	Implications for practice/design
			• Appreciated more "home-like" nature of design esp garden & universal praise for large amount of natural light; however some consultants wanted to convey message to patients that ward was temporary and not home – "our job is to help people leave" • Need for spaces for faith-related practices • Provision of purpose built spaces for skill development appreciated • Poor transport access (lack of proper footpaths, inability of bus to access road into hospital)	to be with) • Provide as much daylight as possible and garden areas to remove institutional feel • Provide spaces for faith related practices • Provide spaces for rehab & skill development as appropriate (eg kitchen area, art room etc) • Ensure safe & sustainable transport links to the wider community
(Dalke, Little et al. 2006) **Colour and lighting in hospital design** **(UK)**	Report to NHS Estates N=20 NHS hospitals Audits Interviews with management Discussions with staff & patients Visual recording of good & bad practice Related audit findings to many literature recommendations, but didn't		• Pts stated connections to outside world paramount, for older patients just watching everyday activities outside important • Staff believed well designed environment can aid recruitment and retention • Staff require privacy & security in their rest areas Many statements made about the use of colour – some well referenced, others not	• Provide view to outside world • Provide private & secure rest spaces for staff • Colour implications (evidence not conclusive) ○ Use 'cool colours' (blue/greens) to enhance calm & relaxation (eg in

Author & Study	Study Type & Intervention	Population	Findings	Implications for practice/design
	provide any search strategy or assessment of quality of studies Very hard to discriminate if statements/recommendations made on the basis of this research or the literature in general – combined in findings/implications column			sleeping, counselling, staff relaxation areas) ○ Use 'warm colours' (reds/oranges/yellows) in areas to promote physical & social activity (eg in rehab gyms) ○ Use 'neutral' colours' (greys/beiges) to minimise attention to certain areas (eg supply areas)
			• Colour 'can control bright reflected light and make the most of available daylight and help to reduce glare" • Can provide wayfinding and locational cues	○ Colour can provide wayfinding and locational cues (but do not rely on this alone – difficult for people who are colour blind, vision impaired & the elderly) – use no more than 4 simple easily distinguishable colours.
			• " The nurses' station is the hub of the ward unit. It needs to be visually prominent and provide colour and lighting for maximum efficiency for all users" • "…colours and designs were helpful as they acted as a focal point when treating patients, particularly children" • Visual interest during daylight can be provided by coloured glass designs in panels or	• Use a combination of colour and lighting to attract attention to key areas eg reception and nurses' stations • Use colour and lighting for visual interest & distraction (coloured glass designs)

Author & Study	Study Type & Intervention	Population	Findings	Implications for practice/design
			windows in entrances, waiting areas or corridors. These can also be used as landmarks for visual referencing • Colour coding often used, but often not recognized by hospital visitors – "as many as 2/3 are apparently misunderstood"– They also need to be checked with the vision impaired to establish effective use. • Colour can be used to provide contrast & visual clues for people who are visually impaired (VIPs), eg by contrasting colours to alert VIPs to obstacles (eg seats should be finished in contrasting colours) and give clues to architectural features such as handrails • Glare & reflection particularly disabling for VIPs, as well as extemes of lighting (eg dark corridors running into bright patches of sunlight) • Extreme full chroma colours can be desensitizing • Furnishings & fittings: o Pts report looking at reverse of unlined curtains monotonous & drab o More colourful textiles and patterns can give more of a home-like feel to a patient's bed area	• Colour should be used for no more than four spaces of a building , should be simple, and be known by their descriptive words (blue, red, yellow). The elderly may have problems with discerning colours due to yellowing lenses • Use colour to provide visual cues to potential obstacles (eg painting protruding objects in contrasting colours to avoid people bumping into them) and to draw attention to aids such as hand and grab rails • Avoid glare and highly reflecting surfaces – eg dark corridors running into bright patches of sunlight • Avoid drab furnishings and curtains – provide textiles with visual interest

Author & Study	Study Type & Intervention	Population	Findings	Implications for practice/design
			○ Care with height of furnishings –eg reception desk area should have accessibility for those people in wheelchairs • Key areas (such as reception) can be made more prominent with use of colour & lighting • Patient control over individual spaces assisted by individual lighting switches and dimmers • Windows need to be at a height whereby the view can be appreciated from the bed • Staff rooms can achieve a more restful ambience by incorporating different colour & lighting schemes than those used for treatment and ward areas. • Visual noise (or clutter) should be reduced, as it can be confusing and distressing. Equipment should have proper storage space (not lined up along corridors) and signage and leaflet displays should be minimal and appropriate. Staff notice boards can be placed in separate alcoves or staff areas.	• Ensure all areas are accessible for people in wheelchairs, eg have a portion of the desk lowered in reception areas • Provide individual light controls (dimmers and switches) • Ensure windows are an appropriate height for bed bound patients to see the view • Provide enough storage space and alcoves to reduce clutter along corridors and public areas

Author & Study	Study Type & Intervention	Population	Findings	Implications for practice/design
Douglas and Douglas 2005 **Patient-centred improvements in health-care built environments: perspectives and design indicators** Douglas and Douglas 2004 **Patient-friendly hospital environments: exploring the patients' perspective** **(UK)**	Multi method Autophotographic survey "Novice/expert" Focus groups Personal interviews ('04 study) Mailed survey to past patients Aim: To establish a set of patient-centred indicators to appraise future health-care designs	N=35 patients in autophotographic survey N=8 focus groups N=50 interviews N=785 survey to past patients	Patients deemed as impt and affected sense of well-being: • Some control over their own environment, create a sense of normalcy • Access to external areas • Facilities for recreation & leisure • Environment that meets the needs of visitors (eg catering, transport, parking & accommodation) • Easy wayfinding • Provision of privacy & sense of own space • Views of outside areas & of everyday activities when unable to go outside • Quietness (esp at night)	Presents large table of patient preferences that might be useful as checklists pp 69-71 ('04) Summary of design/architectural features from table to consider providing: • Means of privacy with visitors eg separate room or single room accommodation or family room • Area for confidential discussions with doctor • Enough space around bed • Bright, cheery, homely décor • Noise reduction • Individual control at bedside of TVs, radio, window shade, curtains, temperature regulation • Overnight facilities for family members • Facilities & play area for visiting children • Enough parking (incl disabled) • Care with signage & wayfinding cues • Wheelchair access throughout all areas • Storage for personal belongings • Handrails & grab rails throughout hospital • Moving walkways along corridors • Lifts close to reception • Access to outside, eg balconies or gardens, somewhere to walk • Windows with view (from bed) • Bedside telephone facilities &

Author & Study	Study Type & Intervention	Population	Findings	Implications for practice/design
				internet access • Prayer room
(Harris, Shepley et al. 2006) **The impact of single family room design on patients and caregivers: executive summary** **(USA)**	Site visits POEs Surveys of healthcare staff	11 NICUs N=75 healthcare staff surveyed	Single rooms: • Provide better privacy for families, as well as sleeping accommodation • Are less stressful environments for both family & staff • Provide more space around bedside • More opportunity for controlled lighting	Maximize provision of single rooms
(Hendrich, Fay et al. 2004) **Effects of acuity-adaptable rooms on flow of patients and delivery of care** **(USA)**	Pre/post data collection: • Patient satisfaction (using Patient Expectation Project standardised tool) • Medication errors • Rates of falls • LoS Intervention: introduction of acuity adaptable rooms Confounders: • new approach to care • decentralized nursing stations • cultural changes needed for this to be implemented • staff education implemented	Inpatients in 56 new acuity-adaptable rooms	• Transports (transfers between wards) reduced by 90%, thus reducing "non-value" staff time, & potential for introducing errors • 70% reduction in medication errors • Falls reduced • Level of patient dissatisfaction decreased	Consider introduction of acuity-adaptable rooms, however such introduction involves huge cultural shift in organisation as well as staff education.

Author & Study	Study Type & Intervention	Population	Findings	Implications for practice/design
(Kutash and Northrop 2007) **Family members' experiences of the intensive care unit waiting room** **(USA)**	Semi-structured interviews	N=6 visitors from 3 different adult waiting rooms	Findings relating to design: • Need for room to be comfortable (chairs not too close together) and in close proximity to patient • Support from other visitors in similar situations – liked opportunity for social support • Need for general information in waiting room – eg hospital noticeboard with available services displayed	• Provide home-like feel to the waiting room, care with arrangement of chairs • Waiting room should be in close proximity to the unit • Although much of the literature stresses the need for privacy, the social support opportunity of the shared waiting room was valued, provision of shared and private spaces would be the ideal • Provide information in waiting room – eg noticeboards
(McMinn and Hinton 2000) **Confined to barracks: The effects of indoor confinement on aggressive behaviour among inpatients of an acute psychogeriatric unit.** **(Australia)**	Assessment of levels of aggression and use of prn psychotropic medication – single group post-test quasi-experimental design Intervention – denial of normal free access to outdoor garden during 32day construction and maintenance activities	N=13 convenience sample psychogeriatric patients in 22 bed admission & assessment unit Admission criteria: Dementia &/or mental disorder, plus psychiatric & behavioural disturbance	• "release from mandatory confinement indoors was correlated with decrease in both verbal & physical aggression as well as nurse-initiated medication use" p39 • This response was greater for those patients who had been more aggressive	"The freedom to go outdoors or have access to extra space should be an important component of the environmental design and care philosophy for the acute admission of people who experience dementia and associated psychiatric and behavioural disturbance" p40
(Mroczek, Mikitarian et al. 2005) **Hospital design and staff perceptions: an exploratory**	Analysis of subset of data from employee questionnaire (Likert-scaled) – asked staff to rate how specific design elements impacted on their work	Staff from a large new US hosp (part of Pebble Project), that aimed to have the features of a "healing environment" N=734 (78% had worked in the old facility)	Design features that impacted most positively (from highest impact) • Increase in natural light	• Provide as much light as possible eg via windows, skylights, light wells (also provide glare & temp control)

Author & Study	Study Type & Intervention	Population	Findings	Implications for practice/design
analysis **(USA)**			• Live music in atrium • Air flow • Separation of public areas from pt transport areas (pt privacy issues, increase in transport efficiency for patients & staff) • Water features • Home-like pt rooms – valued by staff for effect on patients	• Provide atrium which is large enough for public performances • Refer to health guidelines re recommended specific airflow exchanges per hour • Provide patients with non-public transport routes through main thoroughfares of hospital • Consider provision of water features with seating for relaxation • Provide home-like rooms eg with furnishings, non-institutional colours, ample space for belongings and family
(Rashid 2006) **A decade of adult intensive care unit design: A study of the physical design features of the best-practice examples** **(USA)**	Analysis of booklets and videos published by the ICU Design Award (Soc of Critical Care Med, the American Assoc of Crit Care Nurses & the American Instit of Architects) which showcase the units that have won design awards	N=19 adult ICUs built between 1993-2003 that had received a design award	• Layout o 12 are racetrack design (service in centre, patient beds on perimeter, with corridor in between) o Maximises natural light for patients o Minimizes nurses' walking distances • Circulation spaces (internal hallways, corridors &/or aisles used patients, staff & visitors) o Important for social gathering and knowledge transfer (corridor conversations) – Rashid states not enough attention given even in these best design examples, need to be wide enough to accommodate small gathering but if too large inefficient use of space • Patient rooms, important to consider: o Storage space near patient for supplies, as well as area for charting – reduces multiple trips o 360 degree access to the bed o Enough space for families (suggestion 3 zones ideal: a patient zone, a family zone & a caregiver zone) • Single rooms o Reduce noise	

Author & Study	Study Type & Intervention	Population	Findings	Implications for practice/design
			○ Improve privacy, sleep quality, patient satisfaction & staff-patient communication ○ Visibility and access to patient by staff may be compromised, best practice examples include those units with glass breakaway (or sliding) doors (for visibility & flexibility); or those units that have multi-bay observation beds as well as single rooms ○ Medical gas, suction, electrical & data outlets extending from a ceiling boom (rather than a 'headwall'), thus giving greater access to patient & room flexibility (but these are costly) ○ Private bathroom, with bedpan cleaning equipment • Care to mimic natural endogenous rhythms, eg access to natural light – improvement in patient well-being with windows (with views) also providing sensory orientation • Reduction of staff stress (aiming to accommodate ageing staff and affect turnover rate), suggest: ○ Decentralized nurse stations (reduce noise, crowding; might have effect on medical error rate), closer to patients – but might decrease staff interaction ○ Availability of staff lounge • Provision of family areas • Provision of quiet family consulting room	
(Tyson GA, Lambert et al. 2002) **The impact of ward design on the behaviour, occupational satisfaction and well-being of psychiatric nurses** **(Australia)**	Pre/Post Study Intervention: Re-location to new purpose-built psychiatric facility (more aesthetic & pleasant, more privacy & personal space for patients, separate accommodation for acutely ill) Observation of staff by work sampling methodology (pre & post separate samples – analysed by 2x2 ANOVA) Staff questionnaires Interviews	Observation N=40 nurses Questionnaires (pre N=37, post N=34) Interviews N=16 staff	• Staff/patient interaction increased in new ward, with much higher rating as positive interactions • Increase in burn-out in the new wards (measured by decrease in sense of accomplishment & emotional exhaustion) • Staff acknowledged that the facilities were better for the patients, esp privacy & personal space • Increased privacy & space made it more difficult for staff to observe patients, which had the potential to be a safety issue	• Staff need support through design induced change • Design implications of providing more space for patients affects staff support for one another • More space has implications for observation of patients

Author & Study	Study Type & Intervention	Population	Findings	Implications for practice/design
	Confounders acknowledged: shifts in work culture, change in unit manager		• More space made staff feel isolated at times • Staff reported more stress in new wards	
(Walsh-Sukys, Reitenbach et al. 2001)	<u>STUDY DESIGN:</u> Prospective comparison of light & sound levels, safety (incl med errors, infections, mortality) & staff perceptions following modification to reduce light & sound of one (6-bedded) nursery room Unmodified room served as control Survey to staff	Physicians N=35 Nurses N=34 Expt neonates N-62 Control group N=64	Both light and sound were reduced with modifications that incurred modest costs. No sig change in patient safety. Staff members were highly satisfied with reductions in sound levels. Reactions to reduced lighting levels were more mixed and led to modification of bedside lighting.	Noise reduction strategies: • weather stripping was placed on all doors and drawer fronts; • all metal trash cans were replaced with rubber cans; covers were placed over incubators; • carpet was installed along the centre of the nursery; • sound-absorbing acoustic material was installed in all monitor bays Lighting modifications: 3 individual halogen spotlights were fitted over the bed space of each neonate, with a variable intensity rheostat permitting individualised lighting for each patient.
(Whitehouse, Varni et al. 2001) **Evaluating a children's hospital garden environment: Utilization and consumer satisfaction**	Post occupancy evaluation – observation of garden users, questionnaire, interviews	Mixed population of 83 – included included patients, visitors and staff (adults and children)	• Predominant reasons for going to the garden were to rest, relax & improve mood (adults), for active play and exploration (children) • Its use associated with increased general satisfaction with the hospital • Nor used as often nor as extensively as intended, and visits were of short duration • Positive evaluation for achieving rest and relaxation	Suggested changes: • More greenery and more trees • More interactive for children to actively play