EFFECTS OF THE BUILT ENVIRONMENT ON HEALTH OUTCOMES: CHALLENGES IN BUILDING THE EVIDENCE-BASE

R. Codinhoto, P. Tzortzopoulos, M. Kagioglou

Salford Centre for Research and Innovation – SCRI,
The University of Salford, Maxwell Building, Salford, M5 4WT, UK.

E-mail: R.Codinhoto@salford.ac.uk

Abstract:
Considerable attention has been given to the construction of an evidence-base relating the built environment and its impact on health outcomes. The driver of such attention is the assumption that the evidence-base may assist the decision making process in the development of new healthcare facilities. Considering this context, the aim of this paper is to explore the process of constructing an evidence-base about the built environment and health outcomes. The objective is to investigate the use of evidence-based approach in this research area. The research strategy is literature review with a focus on evidence-based approach and variables related to buildings and their impact on health. Results demonstrate that there is a great variety in the examined variables and, consequently, there is confusion, fragmentation and lack of clarity in the knowledge base.

Keywords:
Built Environment, Evidence-Base, Health Outcomes, Patient

1. Introduction

In the UK, there is currently a need for improving healthcare delivery mostly due to a lack of appropriate investment in the past. To tackle this issue the DOH (2004) established the following targets: **a)** reduction of waiting time, **b)** reduction of patient length of stay in hospitals, **c)** reduction of medicine use, **d)** increase of staff time per patient in hospitals, **e)** increase of staff work effectiveness, and **f)** improvement of the NHS experience for patients.

Aiming to support the achievement of these targets, the British government has been investing considerably in the improvement of healthcare delivery. The refurbishment and development of new healthcare facilities is part of the plan for achieving the targets. The development of new facilities has stimulated discussions about how to develop better healthcare facilities.

Several aspects have been discussed, for instance the provision of healthcare facilities through public and private partnerships and the development of a new healthcare business. Regarding the former, it seems that a new conceptualisation of healthcare facilities is taking place. For instance, leisure facilities have been developed alongside primary healthcare buildings aiming to stimulate healthier living styles and therefore prevent illnesses. However, such new concepts tend to increase building complexity as new functions are included.

There are also other factors impacting on the development of healthcare facilities. For instance, more flexibility has been demanded from the stakeholders, as new technologies (e.g. materials, equipment) have been developed and introduced into the healthcare delivery (Kendall, 2005). Demand is another factor which has changed. Due to population growth in the UK, more beds are necessary (Lawson and Phiri, 2004). New units specialised in specific illnesses, such as cancer and diabetes, need to be provided. Therefore, healthcare facilities should be able to accommodate service delivery flexibly as well as new technologies in future expansions.

Considering these aspects, i.e. a new program for development, higher product flexibility and constant change in demand, the complexity of the decision making process related to the development of healthcare facilities has increased (Tzortzopoulos et al., 2005). Therefore, academics and practitioners engaged on the debate about how to improve the decision making process of designing new facilities. Amongst other things this has led to the development of research aiming to investigate the use of scientific evidence to support decisions within the design process. This method has been called evidence-base design (Malkin, 2003).

Evidence-based design is an approach derived from evidence-based medicine (Malkin, 2003). A designer using an evidence-base, together with an informed client, makes decisions based on the best information available from research and project evaluations. This is a method applicable to many types of building projects, but is currently being used in the healthcare industry to help decision-makers (Malkin, 2003).

Research looking at the impact of the built environment in health outcomes has been used to build up an evidence-base. Such research is based on the assumption that the built environment can impact on humans' behaviour and influence people psychologically and physically.

There are several theories (e.g. Proshansky *et al.* 1976; Sundstron *et al.* 1996; and Lawson, 2001) which aim to explain how the built environment may affect humans in different ways. For instance, the environmental overload hypothesis assumes that humans have a finite capacity for processing stimuli and information

and predicts that we cope with sensory or information overload through selective attention and ignoring low-priority inputs (Sundstron *et al.*, 1996).

Theories have been developed within different research fields (e.g. architecture, sociology and psychology). Therefore, different frameworks have been used to map out the connections between the built environment and health outcomes. For instance, Ulrich and Zimring (2004), in their literature review, observed different aspects in the built environment that can improve staff work conditions and healthcare service. They also investigated features that may improve patient safety and reduce stress. Devlin and Arneill (2003) investigated evidence according to eight aspects of the built environment (including music, windows, views, art, light and colour) and their effect on health outcomes. Chaudhury *et al.* (2005) also explored this subject considering hospital managerial aspects as an input. Zeisel (2003) has investigated how the built environment affects Alzheimer's patients.

Hospitals have been the main focus of attention in this research area and there is a great variety of subjects and methods that have been used to investigate the effects of the built environment into health outcomes (Daykin and Byrne 2006). This is a consequence of the complexity of such buildings, composed by a large number of different settings designed to support people with varied illnesses and conditions. Due to such a variety, there is confusion, fragmentation and lack of clarity in the knowledge base.

Considering this context, the aim of this paper is to discuss the aspects involved in the construction of an evidence-base related to the impact of the built environment into health outcomes. The objective of the research is to present guidelines for developing an evidence-base about the impact of the built environment into health outcomes.

Considering the features, elements and variables which relate the built environment to health outcomes, the following sections aim is to discuss how the research result impact on the construction of an evidence-base. Firstly, the research method is presented. Secondly, an overview concerning evidence-based approach is presented. Thirdly, the built environment, its features and the characteristics which may affect patient's health are presented. Fourthly, the patient and the variables which may affect the search for evidence are discussed. Fifthly, a brief discussion regarding health outcomes is presented. Finally, conclusions are presented.

2. Research Method

The research strategy is based on literature review. The research process started with the development of a systematic review looking at the aspects of the built

environment within hospitals' settings affecting patients' health. A first search within six databases (ASSIA, CINAHL, DAAI, OCCL, HMIC and MEDLINE) resulted in 624 abstracts. The Safer Environment Database (NHS Estates 2005) was used as a second source of information. This database brings the abstracts of more than 500 papers related to the investigated subject.

Aiming to compile the research results, a first theoretical framework was designed with a basis on the information available in the abstracts. This framework considered four different areas of knowledge (ergonomics, performance, aesthetic and service) and three categories of patients' outcomes (psychological, physical and physiological outcomes).

The first theoretical framework was considered not appropriate because many relevant aspects presented in the selected abstracts and papers were not considered on it (e.g. patients' condition, which includes: age, gender and acquired illness or injury). Therefore, a decompositional analysis (i.e. the breaking down of the analysed object into its small parts) (Beaney, 2003) was adopted to map out the variables which can be used to describe the built environment, the patient and the outcomes. The analysis considered the elements and features identified in the selected abstracts and papers. In total, 176 features, elements and variables were identified. These features, elements and variables were grouped in categories which related to the built environment, patients characteristics and health outcomes.

3. Evidence-Base Approach

Evidence-base is an approach based on the use of information from scientific findings to support decisions (Malkin, 2003). In medical research, for instance, evidence-base has been developed aiming to determine which methods are most effective for changing clinicians' behaviour and patient health status (Cook et al. 1997). In other words, the evidence-base provides enough information for a clinician to safely change (or not) from a traditional (well tested) treatment to a new (alternative and less tested) more effective one.

It seems that the evidence-based approach has been used more enthusiastically in healthcare. However, the evidence-bases are not only related to clinical investigations and may include, for instance, research focused on improving educational aspects (e.g. Reed et al., 2005), increasing economical effectiveness (e.g. Pignone et al., 2005) and selecting the right range of design aspects within the development of a new facility (e.g. Ulrich, 2000).

The construction of evidence-bases has been based on the use of systematic literature reviews. Systematic reviews differ from traditional narrative reviews by

adopting a replicable, scientific and transparent process. The rigour related to systematic reviews aims to minimise bias through exhaustive literature searches and by providing an audit trail of the reviewer's decisions, procedures and conclusions (Cook et al. 1997; Tranfield et al. 2003).

Therefore, an evidence-base is the result of a rigorous research process looking at existing specific scientific studies addressing similar issues, using similar methodological approaches and measuring equivalent variables. In general, the research process starts with the definition of a relevant and sharply defined research question. This process is followed by mapping, as much as possible, all the impacting variables and its relationships. Subsequently, the types of study design to be included should be defined. Finally, a qualitative assessment of the research method of the documents included should be carried out (Meade and Richardson 1997). According to Meade and Richardson (1997) the methodological aspects are most important because methodological features of different investigations have been shown to influence the results of studies.

In general, studies to be included in a systematic review may consider research following slightly different approaches (e.g. using different factors such as direct and indirect evidence) (Mulrow, Langhorne et al. 1997). However, these authors state that the consideration of multiple factors may increase the complexity of integrating research results.

In summary, the construction of an evidence-base must be a rigorous process because it involves reliance on secondary sources of information. Therefore, the researcher should make explicit as much contextual information as possible aiming to identify similarities and differences amongst the studies. Additionally, the research process should be conducted formally in order to assure traceability. Therefore, all decisions and the reasons why they have been made should be documented.

Considering the aspects related to the construction of an evidence-base the following section presents the challenges of developing systematic reviews about the impact of the built environment into health outcomes.

4. Variables Related to the Built Environment and Health Outcomes

The following sections aim to present which aspects, features and variables have been used in the construction of an evidence-base about the impact of the built environment into health outcomes.

4.1 The Complexity of the Built Environment

The term built environment can be defined in many different ways. For instance, according to the Wikipedia (2006b) the built environment refers to the man made surroundings that provide the setting for human activity, ranging from the large-scale civic surroundings to the personal places. The Concise Oxford English Dictionary (2006) defines environment as the surroundings or conditions in which a person, animal, or plant lives or operates. These two definitions have complimentary aspects which help to define what the built environment is. From the former is the fact that the built environment refers to the man made surrounding. From the last is the surrounding which a person, animal or plant lives or operates. Hence, in this paper, the built environment is considered to include the surroundings or conditions designed and built through human intervention, where a person, animal or plant lives or operates.

Considering this definition, the question to be asked here is: "Is it possible to isolate and observe a specific feature of the built environment and its impact on patients' health?" This is a key question because the built environment constitutes a complex system of different features. This means that because there are a number of variables that may be considered, it is difficult to establish clear cause-effect relationships. For instance, patients are taken into different units of care because they have different needs. Thus, those units should have different characteristics in order to have the appropriate impact.

The investigation of building characteristics within healthcare environment has been the focus of different knowledge areas. For instance, in architecture considerable attention has been given to design solutions that improve the quality of healthcare environments (e.g. CABE, 2006). In engineering, research has been focused on the investigation of systems and the improvement of systems' performance (e.g. ventilation, illumination and air conditioning) and how the improvement of these systems affects healthcare delivery (e.g. Chow, 2003).

Additionally, rather than considering the result achieved by analysing different characteristics, it is also important to consider the different outcomes produced by a single characteristic. This problem is well described in Nuffield Provincial Hospitals Trust (1960) in relation to the design of a window. According to Nuffield Provincial Hospitals Trust (1960) sunlight is a characteristic which may have both a good and bad impact on health. On one hand, it is effective in killing haemolytic streptococci bacteria, but if the design does not consider the amount of glare generated, it may cause discomfort to the patient.

Another characteristic of the field relates to multi-levels of analysis. This is due to the fact that the built environment can be observed in different levels of detail, i.e. from the whole building to a group or individual elements or characteristics (e.g. a

chair, a colour or even texture on a wall). Consequently, the same element or characteristic can be observed under different levels of analysis, making it more difficult to integrate and generalise research results.

According to what was observed in the existing literature, a building can also be observed through its physical (e.g. temperature, ventilation), architectural (e.g. symmetry and balance) or functional characteristics (e.g. privacy and maintainability). These three constructs can be measured through different methods. Table 1 presents different levels of analysis, variables and variants that can be used to conduct research in healthcare facilities. This table was built during the literature review based on investigated environments and on the authors experience as an architect.

Table 1 – Examples of levels of analysis, variables and variants in healthcare facilities

Levels of analysis	***Variables***	***Variants***
Hospital Speciality: *primary care, secondary care, mental care, hospices* ***Care Units:*** *intensive care, coronary care, dental care, neonatal care* ***Settings:*** *ward, operation theatre, corridor, waiting area, hospital entrance, kitchen, bathroom, garden, haemodialysis room* ***Components:*** *furniture, equipments, installations, ceiling, window, floor, partitioning wall* ***Furniture and equipment:*** *sink, bed, alcohol-rub, television, over bed table, bed privacy curtain, door handle, curtains, blinders, bedside rail, shower, chair, computer* ***Systems:*** *ventilation, heating, sound, information and communication*	***Physical characteristics:*** *temperature, humidity, ventilation, luminosity (natural and artificial light), acoustics, colour, dimensions, texture, material* ***Architectural characteristics:*** *symmetry, balance, rhythm, movement, composition* ***Functional characteristics:*** *usability, safety, privacy, accessibility, functionality, maintainability, comfort, stability, locomotion*	***Lightning:*** *natural light, artificial light* ***Colour:*** *yellow, orange, red, black, white, blue, green* ***Pattern:*** *stripes, dots, chequer, plain* ***Textures:*** *smooth, rough, silky* ***Ventilation:*** *natural ventilation, artificial ventilation* ***Dimension:*** *size, height, width, depth* ***Material:*** *carpet, copper, steel, aluminium, plastic*

The number of levels of analysis, variables and variants related to a hospital is large and in combination with variables related to patients and outcomes may provide a large number of research scenarios. The variables related to patients and health outcomes are further described in the next sections.

4.2 The Patient Configuration

Research linking the built environment and health outcomes usually involves participants with varied characteristics and needs (Mulrow *et al.*, 1997a). Thus, an important question that should be considered when analysing the impact of the built environment on patient's health is: "Would patients of and under different conditions (e.g. age, gender, illness, treatments, and interventions) perceive and react similarly to the environment?"

Patients with different illnesses have different needs. For some, a stimulating environment will be important, whereas for others the priority would be to provide a quiet and private place in which to relax. Additionally, the need might change for a person over time, as it is the case of pre and pos-operative patients. For the former, the levels of anxiety might be high before the operation, whereas in the latter it might be the opposite.

Once again, the number of variables which characterise the patient is considerable. It seems that the condition of the patients in terms of illness and severity, the level of stress caused by previous experiences in hospitals and age seems to change the way that they are affected by the built environment. For example, patients with mental illnesses seem to have different perceptions of the built environment when compared with non mental-related illnesses (e.g. Laditka et al., 1985). Also, artificial light may cause damage in the vision of premature babies but not in adults (e.g. Glass et al., 1985).

Table 2 presents variables and variants configuring patient's conditions which may affect the way patients perceive and react to the environment. The Table 2 is not exhaustive as it does not include all variants and does not consider patients' cultural, social and economical aspects.

Considering the number of possible individual characteristics which may affect patient reaction, another question emerges: how to integrate research results from heterogeneous groups of patients? This is an important issue related to building an evidence-base. Adding to this problem, the number of outcomes that can be measured increase the difficult of build up an evidence-base. Variables which represent health outcomes are presented below.

Table 2 – Variables and variants related to patients' condition

Variables	***Variants***
Illness or injury	***Infectious diseases:*** *respiratory infections, HIV/AIDS, tuberculosis, meningitis, etc.* ***Injuries:*** *burns, fractures, wound, etc.* ***Physical diseases:*** *cancer, heart diseases, Parkinson, kidney dysfunctions, etc.* ***Psychological diseases:*** *Alzheimer, dementia, depression, chemical dependency, etc.*
Age	***Infant*** ***Adolescent*** ***Adult*** ***Elderly***
Gender	***Female*** ***Male***
Condition	***Pre-operative*** ***Pos-operative*** ***Pregnant*** ***Pos-Stroke / CVA*** ***Pos-Heart Attack*** ***Pos-Stop Breathing***
Treatment	***Dependant on illness***

4.3 The Variety of Outcomes

Health and well-being are here approached as outcomes. According to WHO (1946) health is broadly defined as a "state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity". Psychological well-being (mental well-being) is a mental condition characterised

by pleasant feelings of good health, exhilaration, high self-esteem and confidence, often associated with regular physical activity (Oxford, 2007).

Despite both concepts are essential, its definitions do not set what exactly is meant by health outcome. Thus, considering that health outcomes can be associated to a considerable number of variables and variants, the construction of an evidence-base should clearly establish what the researcher mean by using these terms.

In the literature, there is a variety of levels to which health can be associated. For instance, Wilson and Cleary (1995) proposed a conceptual model of health-related quality of life that integrates both biological and psychological aspects of health outcomes (Figure 1). According to these authors, there are at least five different levels of health outcomes.

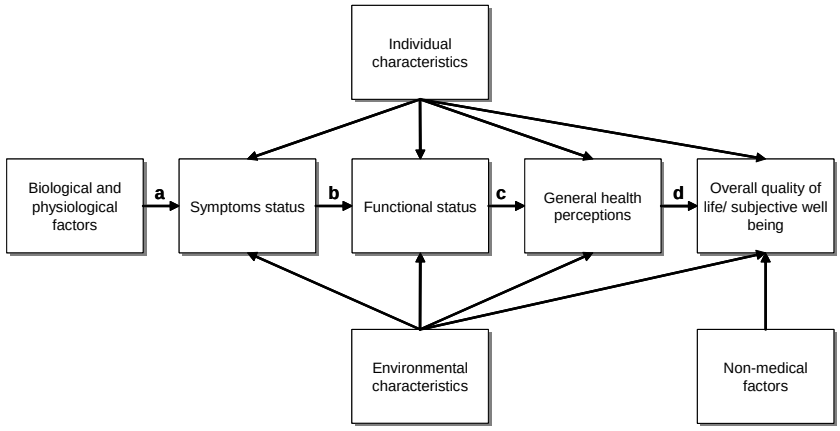

Fig. 1. Conceptual model of patient outcomes (source: Wilson and Cleary, 1995)

The measures can be presented in terms of positive and negative results. Moreover, both positive and negative can also be measured through different degrees, e.g. relevant or irrelevant to health enhancement or decline. Thus, the question to be asked is: is the resulting outcome measured in research relevant to health improvement and decline?

Considering all these aspects, in this paper both concepts are considered as constructs and therefore should be measured through the use of a set of different variables. Table 3 presents some of the variables that have been used to measure health outcomes.

Table 3 – Variables related to health outcomes

Classification	***Variables***
Psychological	*Depression, anxiety, stress, insecurity, fear, panic, mood, confusion, satisfaction, attentional capacity, arousal, sleeplessness, delirium*
Physical	*Heart rate, pain, hypothermia, blood pressure, infection, body integrity, broken bones*
Physiological	*Respiration, coordination, excretion, circulation, reproduction*
others	*Length of stay, healing time, well being, medicine use reduction, staff errors, substance use decrease, physical health improvement, social interaction improvement, psychological well being, health care independency, setting infection level, work effectiveness, staff time per patient, injury caused by falls, privacy*
Relevance	*Clinically relevant, surrogate, beneficial*

Additionally, health outcomes can be both direct and indirect. In the medical area, Eddy (1990) in Mulrow and Cook (1997) consider that the outcomes to be assessed should be clinically relevant to the patient. According to Fleming and DeMets (1996) and Mulrow *et al.* (1997a), relevant outcomes are symptoms, loss of function, and death. They must consider the perspective of the patient because physicians and patients often do not agree on what issues are important (Goodare and Smith, 1995; Smith, 1996 in Mulrow and Cook 1997). Indirect or surrogate outcome measures, such as laboratory or radiologic results, should be avoided or interpreted with extreme caution because they rarely predict clinically important outcomes accurately.

5. Discussion: The Challenges for Research

This paper presented variables and variants related to the built environment, patients' characteristics and health outcomes. These variables and variants were identified through the conduction of a literature review which allowed concluding that healthcare environments have been studied within different research fields and according to different interests. In the sense of constructing an evidence-base there is a positive aspect which relates to the variety of evidence that can be added to the evidence-base. However, the negative aspect relates to the lack of clarity related to the cause and effect relationships.

Due to its multidisciplinary characteristic, different terms have been adopted to refer to this research area (e.g., design for health, environmental psychology,

environment and behaviour, architectural psychology and people-environment). Therefore, the existence of different terms referring to the same concept may cause confusion and bias in the literature review, considering that the search for studies is based on the establishment of keywords.

Apart from the problems related to the use of different terms with similar meanings, there are also similar terms with different meanings. For instance, to some health and well being may signify the same thing; however to others they might have completely different meanings. This is an important issue to be considered in the integration of different research results.

Results from research looking at the built environment can be considered as indirect evidence. It seems that the built environment has an important role improving the patients' well being. It may bring comfort to the patient and for instance, impacting on the reduction of the levels of stress and anxiety (indirect outcomes).

Another indirect aspect of the built environment relates to the quality of the environment. For instance, cleaning and the appropriate amount of natural light are essential in killing bacteria and to keep the necessary hygiene. Both approaches can not cure patients, but if neglected can cause serious damage to patient's health. Thus, the performance aspects should be well specified.

Finally, hospitals environments are complex structures. Even specific settings are complex because they bring together a large variety of variables. Thus, experiments conducted in laboratory, under controlled situations should not be considered in isolation because they don not consider the interactions which occurs in real situations.

Considering all those issues, is possible to conclude that research looking at the impact of the built environment into health outcomes has not been following some of the main aspects related to the development of an evidence-base. Some of the main problems relate to the fact that the meaning of health outcomes has not been made explicit and/or does not establish to which level of health improvement the outcome relates. The same problem exists in relation to what is meant by built environment and which are its constituent parts. Also, disparities between different research results have not been made explicit. In respect to patients' information, in general the studies do not specify to which kind of patient the results refer to (e.g. making explicit cultural background and historical and current health condition). Finally and mostly important, the relationships between causes and effects have generally not been clearly set.

Acknowledgement:
The authors would like to thank Professor Rachel Cooper who contributed to this paper through her helpful comments.

References:

Beaney, M. (2003). Analysis. E. N. Zalta, The Stanford Encyclopedia of Philosophy.

CABE (2006). Designed with care: design and neighbourhood healthcare buildings, CABE. 2006.

Chaudhury, H., Mahmood, A. and Valente, M. (2005). "Advantages and disadvantages of single versus multiple-occupancy rooms in acute care environments: a review and analysis of the literature." Environment and Behavior 37(6): 760-786.

Chow, T.-T. Y., Xiao-Yu (2003). "Performance of ventilation system in a non-standard operating room." Building and Environment 38: 1401 - 1411.

Cook, D. J., Greengold, N. L., Ellrodt, A. G. and Weingarten, S. R. (1997a). "The Relation between Systematic Reviews and Practice Guidelines." Ann Intern Med 127(3): 210-216.

Cook, D. J., Mulrow, C. D. and Haynes, R. B. (1997b). "Systematic Reviews: Synthesis of Best Evidence for Clinical Decisions." Ann Intern Med 126(5): 376-380.

Daykin, N. and E. Byrne (2006). The impact of visual arts and design on the health and wellbeing of patients and staff in mental health care: A systematic review of the literature. Bristol, Centre for Public Health Research in the University of the West of England,: 87.

Devlin, A. S. and Arneill, A. B. (2003). "Health care environments and patient outcomes: a review of the literature." Environment and Behavior 35(5): 665-694.

Dictionary of Economics (2002). "environment" John Black. Oxford University Press, 2002. Oxford Reference Online. Oxford University Press. Salford University. 10 January 2007 http://www.oxfordreference.com/views/ENTRY.html?subview=Main&entry=t19.e1010

DOH (2004). The NHS improvement plan: putting people at the heart of public services. London, Department of Health: 80.

Eddy, D M (1990) Clinical decision making: from theory to practice. Anatomy of a decision. JAMA; 263:441-3.

Fleming, T. R. and DeMets, D. L. (1996). "Surrogate end points in clinical trials: are we being misled?" Annals of Internal Medicine 125: 605-613.

Glass, P., Avery, G., B., Subramanian, K., N., Keys, M., P., Sostek, A., M., and D., M., Friendly Effects of bright light in hospital nursery on the incidence of retinopathy of maturity, The New England Journal of Medicine, Vol., 313, No. 7, August, 15 1985 401- 404

Goodare H, Smith R. (1995) The rights of patients in research [Editorial]. BMJ; 310:1277-8.

Kendall, S. (2005). Open building: an architectural management paradigm for hospital architecture. CIB W096 Architectural Management, Lyngby, Denmark, TU Denmark.

Laditka, J. N.; Laditka, S. B.; Cornman, C. B. (2005) “Evaluating hospital care for individuals with Alzheimer’s disease using inpatient quality indicators”, American Journal of Alzheimer’s Disease and Other Dementias, Vol. 20, No 1, 27-36.

Malkin, J. (2003). The business case for creating a healing environment. Business briefing: hospital engineering and facilities management: 32-36.

Lawson, B. (2001). The language of space. Oxford, Elsevier.

Lawson, B. and Phiri, M. (2004). Providing single rooms for patients: a study of the benefits to patients and staff within the NHS in England. Sheffield, The University of Sheffield, School of Architecture: 60.

Meade, M. O. and W. S. Richardson (1997). "Selecting and Appraising Studies for a Systematic Review." Ann Intern Med 127(7): 531-537.

Mulrow, C. D. and Cook, D. J. (1997). "Formulating questions and locating primary studies for inclusion in systematic reviews." Annals of Internal Medicine, Academia and Clinic, Systemtic Review Series 127(5): 380-387.

Mulrow, C. D., Cook, D. J. and Davidoff, F. (1997b). "Systematic Reviews: Critical Links in the Great Chain of Evidence." Ann Intern Med 126(5): 389-391.

Mulrow, C., Langhorne, P. and Grimshaw, J. (1997a). "Integrating Heterogeneous Pieces of Evidence in Systematic Reviews." Ann Intern Med 127(11): 989-995.

NHS Estates. (2005). "Safer Environment Database - efm-evidence." Lawson, B Phiri, M.

Nuffield Provincial Hospitals Trust (1960). Studies in the functions and design of hospitals, Oxford University Press.

Oxford Dictionary of Sports Science & Medicine (2007) "psychological well-being" Oxford University Press, 2007. Oxford Reference Online. Oxford University Press. Salford University. 1 February 2007 http://www.oxfordreference.com/views/ENTRY.html?subview=Main&entry=t161.e5636

Pignone, M., et al. (2005). "Challenges in Systematic Reviews of Economic Analyses." Ann Intern Med 142(12_Part_2): 1073-1079.

Proshansky, H. M., Ittelson, W. H. and Rivlin, L. G. (1976). Environmental psychology : people and their physical settings. London, New York : Holt, Rinehart and Winston.

Reed, D., et al. (2005). "Challenges in Systematic Reviews of Educational Intervention Studies." Ann Intern Med 142(12_Part_2): 1080-1089.

Smith R. (1996) What clinical information do doctors need? BMJ; 313:1062-8.

Sundstron, E., Bell, P. A., Busby, P. L. and Asmus, C. (1996). "Environmental Psychology 1989-1994." Annual Review Psychology 47: 485-512.

The Concise Oxford English Dictionary (2006), "environment n."Eleventh edition revised . Ed. Catherine Soanes and Angus Stevenson. Oxford University Press, 2006. Oxford Reference Online. Oxford University Press. Salford University. 4 February 2007 http://www.oxfordreference.com/views/ENTRY.html?subview=Main&entry=t23.e18499

The Concise Oxford English Dictionary, (2006), "well-being n." Eleventh edition revised . Ed. Catherine Soanes and Angus Stevenson. Oxford University Press, 2006. Oxford Reference Online. Oxford University Press. Salford University. 10 January 2007 http://www.oxfordreference.com/views/ENTRY.html?subview=Main&entry=t23.e64384

Tranfield, D., Denyer, D. and Smart, P. (2003). "Towards a methodology for developing evidence-informed management knowledge by means of systematic review." British Journal of Management 14: 207-222.

Tzortzopoulos, P. et al., (2005). “Fuzzy front-end of design in the NHS MaST LIFT primary healthcare projects.” Research report. Available at: http://www.scri.salford.ac.uk/publications/Pubs/MaSTLIFT.pdf. Last access, July, 2006.

Ulrich, R. S. (2000). Evidence-based environmental design for improving medical outcomes. An Event Held by McGill University Health Centre, Montreal, Swiss.

Ulrich, R. and Zimring, C. (2004). The role of the physical environment in the hospital of the 21st century: a once-in-a-lifetime opportunity, Center for health design for the designing the 21st century hospital project: 69.

WHO (1946). Constitution of the World Health Organization. New York, World Health Organization: 19.

Wikipedia (2006). Evidence-based design, Wikipedia, The Free Encyclopedia. 2006.

Wikipedia (2006b) "Built environment," Wikipedia, The Free Encyclopedia, http://en.wikipedia.org/w/index.php?title=Built_environment&oldid=93901273 (accessed February 4, 2007).

Wilson, I.B., Cleary, P.D. (1995) Linking clinical variables with health-related quality of life. A conceptual model of patient outcomes Journal of American Medical Association; 273, 59-65

Zeisel, J., Silverstein, Nina M., Hyde, Joan, Levkoff, Sue, Lawton, M.P., Holmes, William (2003). "Environmental Correlates to Behavioral Health Outcomes in Alzheimer's Special Care Units." The Gerontologist 43(5): 697-711.