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Evaluation of Critical Care Space Requirements for Three Frequent and High-Risk Tasks

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Many investigators have identified that staff and patient safety can be compromised if insufficient space is provided [1–5]. Even if sufficient space is available, the layout and ergonomic design of workspace may restrict activities and contribute to adverse events [6,7]. In the United Kingdom (UK), there are health and safety laws that, for example, require "every room [to] have sufficient floor area, height and space for the purposes of health and safety" [8]. This is a cross-industry regulation that applies mostly to employee activities but also to all users of a space, including patients and visitors.

Many guidance publications are available to assist designers (architects) in planning hospital spaces; they include topics on health and safety, hospital design, and clinical guidance. The recommendations for bed space (single rooms or cubicles in shared rooms) have increased since 1992, but little empiric evidence is published to support the proposed dimensions.

To test the space requirements for critical care tasks, three frequent or space-critical tasks were simulated in a full-size mock-up. The mock-up was based on the measured dimensions from four UK critical care units built since 2000. The selected tasks were determined by a previous field study [9]: washing and dressing patients and moving them from a bed to wheelchair using a lifter (bed wash/lifter task); transferring patients from bed to another bed (bed-to-bed task); and resuscitating patients (resuscitation task).

Background

Patient bed space (room or cubicle) is the most important and largest repeating space envelope in a health care facility because it is the center of nursing activity [10,11]. The design of hospitals has been viewed as an important and integral part of the therapeutic environment since the time of Florence Nightingale, with the effectiveness of health care delivery determined, in part, by the design of the physical environment and the spatial organization of work [12,13].

The first ICUs were built in the early to mid-1950s, with open wards and no partitions except curtains or screens. The second- and third-generation ICUs (1970s and 1980s) had individual rooms, moving from walled cubicles to folding or sliding doors with increased level of control. It is predicted that the future ICUs will have individual rooms with increased privacy [14]. The challenge is to design critical care units that facilitate the provision of care and also provide a low stress environment for patients and their families or significant others [15,16]. In the United States of America (USA), there are recommendations to decrease patient transfers through the use of adaptable acuity design [17–20]. This allows patients to be accommodated in the same single room throughout their stay with the room adjusted for the requirements of care and treatment. The dimensions and configuration of the room include a patient area, family area (including recliner bed

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and so forth), caregiver area, and hygiene area [15,17]. The critical care bed space needs to have working space for staff, appropriate clinical equipment and furniture, and movement space for routine and emergency care [17].

There is a difference in professional space recommendations in the USA and the UK. In the USA, the recommended space envelope has increased from 13.94 m^2 (rooms) [21] in 1996 to 16.72 m^2 (rooms or cubicles) [22] in 2001 and 36 m^2 for universal (acuity adaptable) rooms (Fig. 1) [18]. In the UK, the recommended space has increased from 20.25 m^2 (cubicles) [23] in 1992 to 26 m^2 (rooms or cubicles) [24] in 2003. No empiric research was located to support the space recommendations shown in Fig. 1.

The development of evidence-based health care has paralleled the availability of information, with technology increasing the availability of research findings. These concepts are starting to be seen in

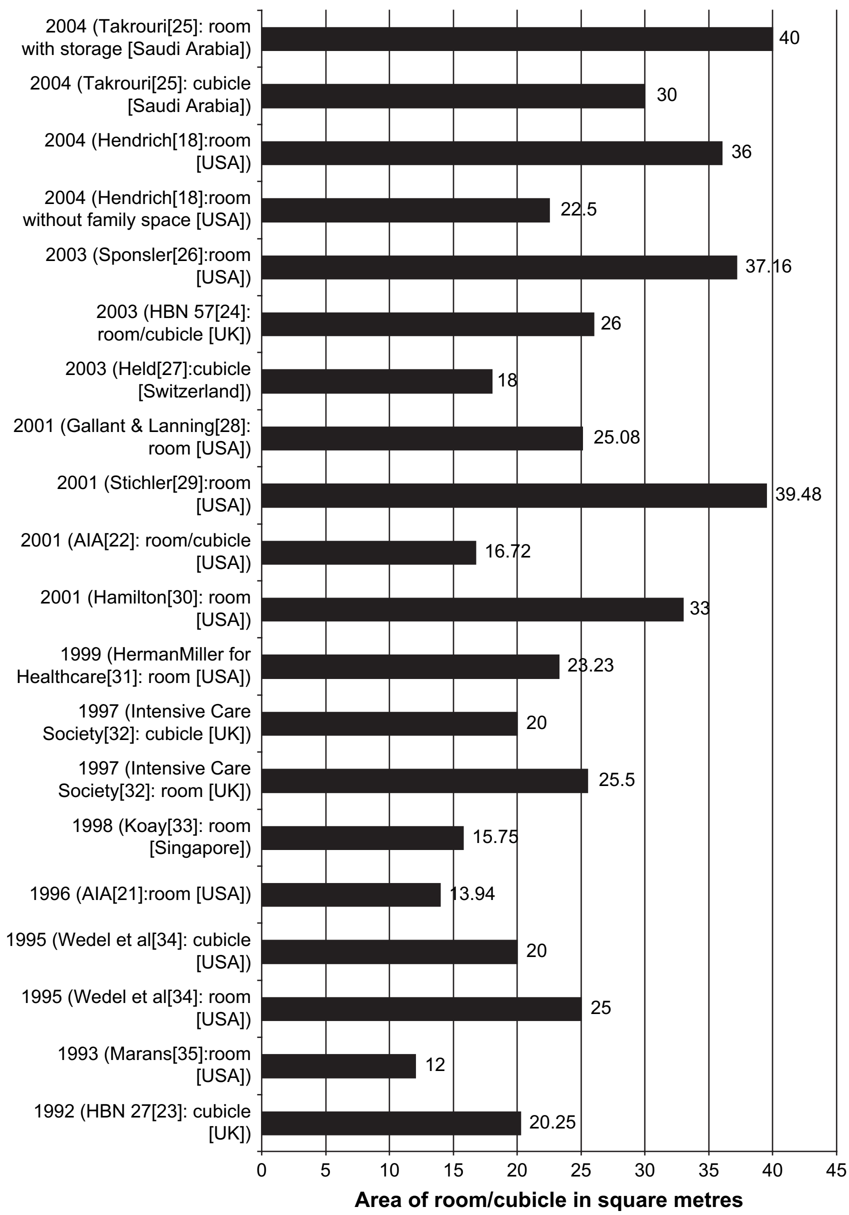

Fig. 1. Recommendations for bed space in ICUs (m^2). Data from Refs. [26–35].

health care architecture, where it is recognized that health care architects must aim to achieve the same high standards as clinical evidence-based practice [36,37]. There are several narrative reviews summarizing the literature [38–43] but no systematic reviews looking at health care design. As health care treatment and care procedures predominantly are evidence based, the lack of a systematic review to present a critical appraisal of design research limits the usability of this research for clinicians and designers (architects).

Aim

The aim is to determine the space requirements for critical care bed space envelope (rooms or cubicles) for three space-critical high-risk tasks: (1) washing and dressing patients and then moving them from bed-to-wheelchair using a lifter, (2) transferring patients from bed to another bed, and (3) resuscitating patients.

Method

Functional space experiments (FSEs) were developed to test the space required. This method of space testing originally was used in 1955 [44] and has been used to recommend minimum patient handling space requirements in bed spaces [11] and shower or toilet rooms [45].

The importance of clinical staff participating in health care building design is highlighted by several investigators [7,10,46–48]. The use of mock-ups as part of the participatory design process is recommended by several investigators to enable staff to experience all aspects of the design, including getting the feel of the space, evaluating various aspects, and providing feedback [10,49–53].

The templates for the FSEs were derived from four UK hospitals built or refurbished since 2001. The bed spaces (defined by boundaries of walls or cubicle curtains) were measured in each ICU, as shown in Table 1. As more recent guidance recommends that rooms and cubicles need the same amount of space for clinical activities [22,24]; no allowance is made for room and cubicle space envelopes in these experiments.

Table 1
Critical care unit bed space templates

Layout	Date	Width (m)	Length (m)	Area (m^2)
1 (room)	2002	5.28	5.10	26.93
2 (room)	2001	6.12	4.10	25.09
3 (room)	2002	4.64	4.37	20.28
4 (cubicle)	2001	3.30	4.00	13.20

Participants

Participants were recruited from the cardiac ICU of a large regional hospital (with more than 11,500 total staff on three sites). A poster advertising the FSE and seeking participation was displayed on the cardiac ICU notice board for several weeks before the start of the FSEs. Eighteen nurses were recruited, including seven registered nurses, eight health care assistants, and three student nurses. Their experience working in critical care ranged from 6 months to 20 years, with an average of 5.3 years. Participating nurses were given an information sheet and signed a consent form at the FSE.

Tasks

Patient rooms are described in terms of four zones: patient area, family area, hygiene area, and caregiver area [15,17]. This experiment looked at the patient (bed, bedside table, and chair) and caregiver areas but excluded the family and hygiene areas and in-room storage.

Data from a previous observational study was used to determine the tasks to be used in the FSEs [9]. Three task scenarios were chosen: (1) washing and dressing patients and then moving them from bed to wheelchair using a lifter (bed wash/lifter), (2) transferring patients from bed to another bed (bed to bed), and (3) resuscitating a patient; the techniques and equipment used for the three tasks were based on recommendations for practice by the Royal College of Nursing [54].

The task scenarios were reviewed with the help of expert nursing staff in prepilot and pilot stages to determine, for example, how many participants were needed for a task, what equipment would be used, the start and end points of the task, the mock-up design, and camera locations.

Six groups of nurses tested the layouts by performing the three tasks repeatedly. Different colored tapes were used to mark the laboratory floor to represent the boundaries of the bed space templates with additional parallel lines at 20-cm intervals on both sides of a boundary line to record and measure the exact space required for nursing tasks (Fig. 2). The mock-up used in this FSE used a module rail (gantry), as the bed space templates had gantry systems rather than headwall services.

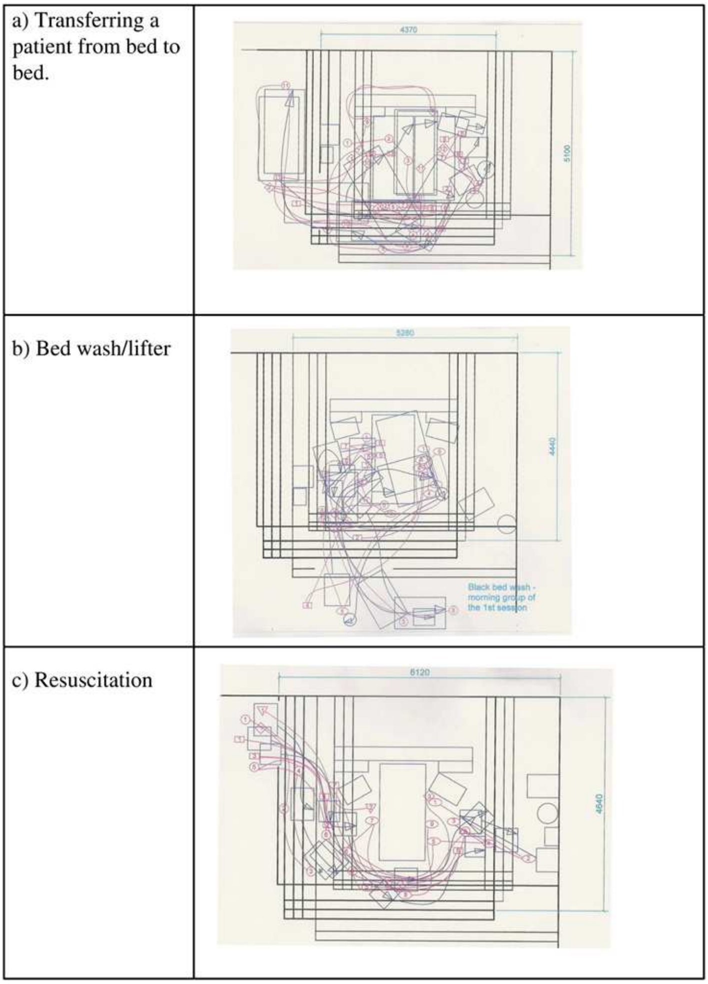

Fig. 2. Link analyses for bed-to-bed transfer (*a*), bed wash/lifter (*b*), and resuscitation (*c*).

A 17-kg fully articulated mannequin was used as the patient in all the FSEs.

Data were collected using video recording for detailed frame-by-frame analysis. Link analysis was used to record the movements of components (ie, nursing staff, equipment or device, and furniture) and the participants' (nurses') movements between equipment or device, furniture, and patient. Links were defined as movements of position and components [55,56]. AutoCAD was used to draw the link diagrams as output to convey spatial information.

Ethical issues

Ethical approval for this study was granted by Loughborough University and National Health Service (MREC 04/MRE09/31 and LCPRA 05/Q2501/45). Research governance was granted by the participating NHS Trusts and honorary contracts were issued to both researchers.

Results

The multidirectional video data (from four cameras) were analyzed frame by frame using link analysis. The movement of each nurse was plotted individually and then overlaid with that of their colleagues for each task and template to give 48 data sets of the composite link analyses; Fig. 2a shows the bed-to-bed transfer, Fig. 2b the bed wash/lifter, and Fig. 2c resuscitation. The average space occupied was measured for each trial and an average calculated for each task; Fig. 3 shows the area, Fig. 4 the width, and Fig. 5 the length.

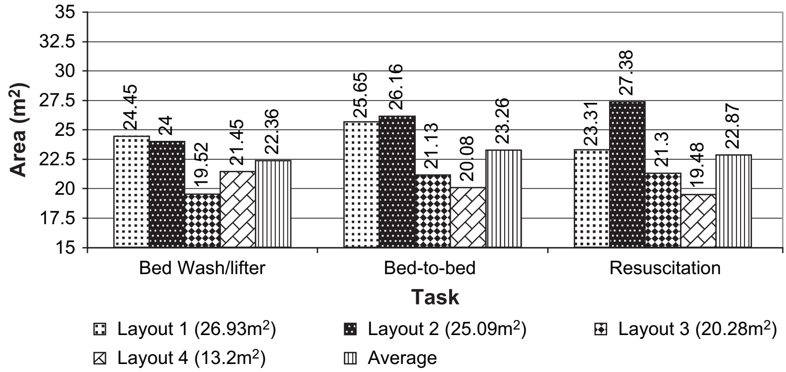

Fig. 3. Bed space envelope dimensions: area (m^2).

The complexity of the task scenarios was emphasized during the link analysis where the movement of individual nurses could be plotted from the multidirectional data before combination with the data for the other nurses. The overlaid diagrams (see Fig. 2) are detailed but give a true reflection of the complexity of the working activities.

The bed-to-bed transfer task occupied the most space, with an average area of 23.26 m^2 (see Fig. 3), followed by the resuscitation task (22.87 m^2) and the bed wash/lifter task (22.36 m^2). Only layout one (26.93 m^2) accommodated all the average spatial requirements for all the tasks. Layout two (25.09 m^2) was exceeded for the bed-to-bed task but accommodated the bed wash/lifter and resuscitation tasks. Layout three (20.28 m^2) accommodated the bed-to-bed and resuscitation tasks but not the bed wash/lifter task. Layout four (13.2 m^2) was exceeded for all the tasks. To investigate the spatial requirements further, the average dimensions for width and length also were determined.

The results of width analysis found that the resuscitation task needed an average of 4.89 m (see Fig. 4), followed by the bed-to-bed transfer task (4.87 m) and the bed wash/lifter task (4.81 m). Again, layouts one (5.28 m) and three (4.64 m) accommodated all the tasks. Layout two (6.12 m) just accommodated the tasks, with the full width used for the resuscitation task. There was concern that the data from layout two might skew the results. This was checked in detail from the video recording and it was concluded that nursing task behavior was unchanged when compared with the other three layouts. Layout four (3.3 m) was exceeded for all three tasks.

The results of length analysis (see Fig. 5) found that the bed-to-bed transfer task needed an average

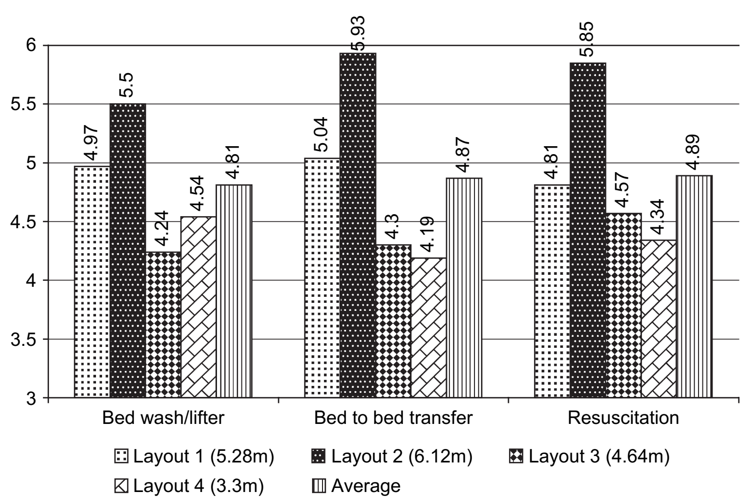

Fig. 4. Bed space envelope dimensions: width (m).

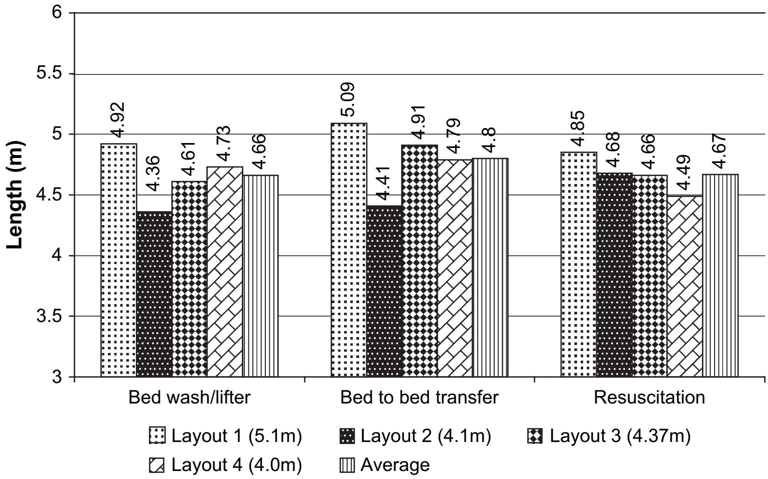

Fig. 5. Bed space envelope dimensions: length (m).

of 4.80 m, followed by the resuscitation task (4.67 m) and the bed wash/lifter task (4.66 m). Most of the resulting dimensions approximated to square shapes. Layout one (5.1 m) accommodated all the tasks. Layouts two (4.1 m), three (4.37 m), and four (4.0 m) all were exceeded for all three tasks.

Discussion

The average spatial requirement from all the FSEs was 22.83 m^2 (average width of 4.68 m and length of 4.71 m), similar to the recommendation from Hendrich and colleagues [18] for a room area of 22.5 m^2, excluding family space. The result is within the current UK recommendation (26 m^2) but greater than the guidance [23] that would have been used for all the benchmark sites (20.25 m^2). One of the limitations of the FSEs was the exclusion of space considerations for family, hygiene, and in-room storage areas and it is likely that an additional 3 m^2 would be needed to accommodate these areas. In comparison, recommendations for adaptable acuity rooms usually include storage and services, giving space recommendations of 36 m^2 (of which 13.5 m^2 is family space) [18] and 40 m^2 (of which 10 m^2 is storage space) [25]. The shape of the bed space envelope was important. The average spatial dimensions for the three tasks differed. The limiting factor was found to be the length for layouts two (bed-to-bed transfer task) and three (bed wash/lifter task) where the average area was insufficient for the specified tasks. The shape of the layout for all the tasks resulted in a greater width than length, with the resuscitation task needing 20 cm more width than length and the bed wash/lifter task 15 cm more width than length.

The three tasks offered frequent (bed wash/lifter and bed-to-bed transfer) and safety critical (resuscitation) challenges to the spatial requirements. The resuscitation task required the greatest width to accommodate the increased number of staff (up to six were available for the FSEs) and the equipment and circulatory space around the bed. It was anticipated that the bed-to-bed transfer and bed wash/lifter might require greater space than the resuscitation task because of the additional equipment (second bed and lifter). The length requirements are less surprising, with the bed-to-bed transfer requiring the largest dimension to accommodate the access and egress of the second bed. It was expected that the resuscitation task might require a greater length than the bed wash/lifter task. A previous pilot study on adult acute ward bed space envelopes identified that width was the critical spatial factor when using a lifter, whereas length was the critical factor for resuscitation (bed-to-bed transfer spatial requirements were not investigated) [11]. The results from the critical care environment suggest that width is equally important for the resuscitation task and requires more space than when using a lifter. This presents a challenge to hospital designers: Should a bed space envelope be designed for the safety critical task, giving a larger envelope (23.80 m^2)? Or for the frequent tasks, 23.23 m^2 or 22.27 m^2? The location of openings (doorways) within a layout was found to affect the results. For example, in layout two, the doorway was close to the patient bed head and services (electrical points, oxygen, air, and so forth) and perpendicular to the bed. When the nurses wanted to move the mobile lifter, the resuscitation trolley, second patient bed, or any other big equipment or furniture into the bed space from outside, a lot of space was needed between the door and bed to maneuver the equipment without difficulty. It is suggested that this might be the reason the architect had to design the width of 6.12 m and why the data from this layout seemed to skew the results.

It was important to give the results with specific dimensions (length and width) and floor areas. For example, a 24-m^2 room could be 4 m in width with 6 m in length (or 4 m in length × 6 m in width) or 3 m in width by 8 m in length (or 3 m in length by 8 m in width), depending on the functionality and usability. This might be a problem, as architects and clients could talk about the floor area of a room without taking account of the shape. This approach might work when designing buildings, such as shops, museums, libraries, and even residential buildings, because professional knowledge, personal experience, and common sense can inform the architect. But hospital building design presents different challenges and architects need to know that the lack of 0.5 m in the length or width of a room could affect the safety and efficiency of care and treatment.

A limitation of this research was the lack of evaluation for the design of the provision of services (electrical, vacuum, air, and oxygen). There are two principal systems for the delivery of these services, a modular rail or power column [57,58]. A rail system has the intravenous lines, tubes, and so forth fanning out from patients. The benefits of the rail system (gantry) include minimal tangling, adjustability for different patients, access for right- and left-handed caregivers, and freeing floor space with everything hanging from the rail but must work from both sides of the bed [7,49]. The power column (pendant) has the lines, tubes, and so forth leaving a patient and converging in one area. This can facilitate 360° access to patients, decrease the amount of walking, and increase efficiency with controls at fingertips and equipment congregated in one area, but the lines can get tangled [17,49,59].

The choice to provide care in rooms or cubicles needs to be considered in more detail to look at the risk balance for safety and social issues. Two studies report that isolated patients (in single rooms) were visited half as often as nonisolated patients (5.3 versus 10.9 visits per patient) [60] and were twice as likely to have adverse events (31 versus 15 events per 1000 patient days) [61]. Two studies looking at patient stressors in ICUs (with six bed units) found that lack of privacy was not considered a priority [62] and ranked only fourteenth as a stressor [16].

Summary

The provision of functional space in a critical care environment is recognized as important for patient and staff safety. This research provides empiric data to support a spatial requirement of 22.83 m^2, as the average task space based on the average length (bed-to-bed transfer) and width (resuscitation) dimensions are given as 4.8 m and 4.89 m. The method of link analysis was found effective for plotting the movements of the nurses and accounting for the complexity of the tasks. This method, in combination with observational field studies, provides a simple but effective way of determining the functional space requirements for nursing activities.

Summary of important points

- There has been a gradual increase in the recommended dimensions for critical care bed spaces since 1992.
- Empiric data are lacking to support the recommendations from professional guidelines for critical care bed space envelopes.
- The use of mock-ups with systematic FSEs provides a simple but effective method for determining the spatial requirements.
- An average bed space envelope requirement of 22.83 m^2 is recommended to accommodate frequent and safety critical tasks in ICU environments.

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References

[1] Stanton G. The development of ergonomics data for health building design guidance. Ergonomics 1983; 26(8):375–93.

[2] Ljungberg AS, Kilborn A, Hägg G. Occupational lifting by nursing aides and warehouse workers. Ergonomics 1989;32(1):59–78.
[3] Rogers R, Salvage J. The hazards. In: Nurses at risk: a guide to health and safety at work. Oxford (UK): Heinemann Nursing; 1988. p. 125–6.
[4] Chard C. Planning a safe area. In: Health and safety for nurses. London: Chapman and Hall; 1993. p. 167–80.
[5] Hignett S, Richardson B. Manual handling human loads in a hospital: an exploratory study to identify nurses' perceptions. Applied Ergonomics 1995; 26(3):221–6.
[6] Garg A, Owen B. Reducing back stress in nursing personnel: an ergonomic intervention in a nursing home. Ergonomics 1992;35(11):1353–75.
[7] Dyson M. Modern critical care unit design. Nurs Crit Care 1996;1(4):194–201.
[8] Workplace (Health, Safety and Welfare) Regulations. 1992. [S.1.1992 No. 3004]. Available at: www.legislation.hmso.gov.uk/si/si1992/Uksi_19923004_en_1.htm. Accessed April 29, 2005.
[9] Lu J, Hignett S. Ergonomics methods applied to healthcare architecture. In: 6th International Postgraduate Research Conference of International Built & Human Environment Research Week, 6–7 April 2006. Delft, The Netherlands: 2006. p. 379–88.
[10] Swaim TJ. Staff involvement in critical care construction. Crit Care Nurs Q 1991;14(1):63–70.
[11] Hignett S, Keen E. How much space is needed to operate a mobile and an overhead patient hoist? Prof Nurse 2005;20(7):40–2.
[12] Reizenstein JE. Hospital design and human behaviour—a review of recent literature (1969–1979). In: Baum A, Singer JE, editors. Advances in environmental psychology, vol. 4. Environment and Health. Hilsdale (NJ): Lawrence Erlbaum Associates; 1982.
[13] Gadbois C, Bourgeoiu P, Goed-Akue-Gad MM, et al. Hospital design and the temporal and spatial organisation of nursing work. Work Stress 1992; 6(3):277–91.
[14] Fontaine DK, Briggs LP, Pope-Smith B. Designing humanistic critical care environments. Crit Care Nurs Q 2001;24(3):21–34.
[15] Jastremski CA, Harvey M. Making change to improve the intensive care experience for patients and their families. New Horiz 1998;6:99–109.
[16] Novaes MAFP, Aronovich A, Ferraz MB, et al. Stressors in ICU: patients' evaluation. Intensive Care Med 1997;23:1282–5.
[17] Hamilton DK. Design for flexibility in critical care. New Horiz 1999;7(2):205–17.
[18] Hendrich AL, Fay J, Sorrells AK. Effects of acuity-adaptable rooms on flow of patients and delivery of care. Am J Crit Care 2004;13(1):35–45.
[19] Garvey T, Allison D. Adaptable patient room takes top prize. 2004. Available at: http://www.ingenious.carleton.ca/2005-01/40pf.htm. Accessed December 30, 2005.
[20] Runy LA. The patient room: universal rooms. Hosp Health Netw 2004;78(5):36–40.
[21] AIA. Guidelines for design and construction of hospital and healthcare facilities. 1st edition. Washington, DC: The American Institute of Architects; 1996.
[22] AIA. Guidelines for design and construction of hospital and healthcare facilities. 2nd edition. Washington, DC: The American Institute of Architects; 2001.
[23] NHS Estates. Health building note no. 27. Intensive therapy unit. London: The Stationary Office; 1992.
[24] NHS Estates. Health building note no. 57. Facilities for critical care. London: The Stationary Office; 2003.
[25] Takrouri MSM. Intensive care unit. The Internet Journal of Health 2004; 3(2). Available at: http://www.ispub.com/ostia/index.php?xmlFilePath=journals/ijh/vol3n2/icu.xml. Accessed June 12, 2006.
[26] Sponsler S. The universal ICU. Healthcare Design Magazine; 2004. Available at: http://www.healthcaredesignmagazine.com/Dispstpg.htm?ID=1646. Accessed June 13, 2006.
[27] Held J. Analysis of an intensive care unit. In: Tagungsband der 49. Munchen (Germany): Jahrestagung Der Gesellschaft fur Arbeitswissenschaft; 2003;S673–76.
[28] Gallant D, Lanning K. Streamlining patient care processes through flexible room and equipment design. Crit Care Nurs Q 2001;24(3):59–76.
[29] Stichler JF. Creating healing environments in critical care units. Crit Care Nurs Q 2001;24(3):1–20.
[30] Hamilton K. Design for critical care: impact of the ICU 2010 report. In: Dilani A, editor. Design & health—the therapeutic benefits of design. Stockholm (Sweden): AB Svensk Byggtjänst; 2001.
[31] HermanMiller for Healthcare. Critical care. 1999. Available at: www2.hermanmiller.com/healthcare/government/pdf/ccgs0699.pdf. Accessed June 16, 2004.
[32] The Intensive Care Society. Standards for intensive care units. 1997. Available at: http://www.ics.ac.uk/downloads/ICSstandards4302.pdf. Accessed June 13, 2006.
[33] Koay CK. Planning and design of a surgical intensive care unit in a new regional hospital. Ann Acad Med Singapore 1998;27(3):448–52.
[34] Wedel S, Warren J, Harvey M, et al. Guidelines for intensive care design. Crit Care Med 1995;23:582–8.
[35] Marans RW. A multimodal approach to full-scale simulation: evaluating hospital room designs. In: Marans RW, Stokols D, editors. Environmental simulation: research and policy issues. New York: Plenum Press; 1993. p. 113–31.
[36] Hamilton DK. Design for patient units. 2003 Available at: http://www.muhc-healing.mcgill.ca/english/Speakers/hamilton_p2.html. Accessed April 19, 2005.
[37] Hamilton DK. The four levels of evidence-based practice. Healthcare Design 2003;(November): 18–26.
[38] Rubin HR, Owens AJ, Golden G. An investigation to determine whether the built environment affects

patients' medical outcomesStatus report. Baltimore (MD): The Center for Health Design; 1998.
[39] Lawson B, Phiri M. The architectural healthcare environment and its effect on patient health outcomes: a report on an NHS estates funded research project. London: The Stationary Office; 2003.
[40] Ulrich R, Quan X, Zimring C, et al. The role of the physical environment in the hospital of the 21st century: a once-in-a-lifetime opportunity. Houston (TX): The Centre for Health and Design; 2004. Available at:http://www.rwjf.org/publications/publicationsPdfs/Role%20of%20the%20Physical%20Environment.pdf. Accessed December 20, 2004.
[41] Chaudhury H, Mahmood A, Valente M. The use of single patient rooms vs. multiple occupancy rooms in acute care environments: a review and analysis of the literature. 2003. Available at: www.aia.org/SiteObjects/files/04_Review_and_Anal_Literature.pdf. Accessed December 30, 2005.
[42] Chaudhury H, Mahmood A, Valente M. Advantages and disadvantages of single-versus-multiple-occupancy rooms in acute care environments. Environ Behav 2005;37(6):760–86.
[43] van den Berg AE. Health impacts of healing environments. A review of evidence for benefits of nature, daylight, fresh air and quiet in healthcare settings. Groningen (Netherlands): The Architecture of Hospitals; 2005. Available at: www.thearchitectureofhospitals.org/conferences/pdfs/Healing_Environments.pdf. Accessed November 9, 2005.
[44] Nuffield Provincial Hospitals Trust. Studies in the functions and design of hospitals. London: Oxford University Press; 1955.
[45] Hignett S, Evans D. Spatial requirements for patient handling in hospital shower/toilet rooms. Nurs Stand 2006;21(3):43–8.
[46] Hardesty T. Knowledge that nurses need to participate on a design team. Nurs Manage 1988;19(3):49–57.
[47] Harrell JW. User driven design process. Crit Care Nurs Q 1991;14(1):21–9.
[48] Munn EM, Saulsbery PAH. Facility planning: a blueprint for nurse executives. J Nurs Adm 1992;22(1):13–7.
[49] Harrell MF. Designing critical care units: an overview. Crit Care Nurs Q 1991;14(1):1–8.
[50] Gregory M. Concepts in headwall selection and design. Crit Care Nurs Q 1993;16(3):51–5.
[51] Vincent DR, Taslan DH, Stromberg D. Beyond the mock-up: the value of temporary occupancy and evaluation. The Academy Journal; V4: 2001. Available at: www.aia.org/static/journal/ARTICLES/v4_04/article04asp. Accessed November 24, 2005.
[52] Zilm F. Four key decisions in the evolution of a critical care unit. Crit Care Nurs Q 1991;14(1):9–20.
[53] Haugh R. The patient room: administrative. standardizing where things to in a room and other fairly simple ideas pay off. Hosp Health Netw 2004;78(5):34–6.
[54] Smith J. The guide to the handling of patients. 5th edition. Teddington (UK): BackCare; 2005.
[55] Kirwan B, Ainsworth LK. A guide to task analysis. London: Taylor & Francis; 1992.
[56] Stanton NA, Young MS. A guide to methodology in ergonomics. London: Taylor and Francis; 1999.
[57] Harrell MF. Headwall considerations for critical care unit designs. Crit Care Nurs Q 1991;14(1):50–3.
[58] Lee S. Designing and developing a new high dependency unit. Nurs Crit Care 1996;1(4):198–201.
[59] Moore S. Critical care unit design: a collaborative approach. Crit Care Nurs Q 1993;16(3):15–26.
[60] Evans HL, Shaffer MM, Hughes MG, et al. Contact isolation in surgical patients: a barrier to care? Surgery 2003;134:180–8.
[61] Stelfox HT, Bates DW, Redelmeier DA. Safety of patients in isolation for infection control. JAMA 2003;290:1899–905.
[62] Elpern EH, Patterson PA, Gloskey D, et al. Patients' preferences of intensive care. Crit Care Med 1992;20:43–7.