The Role of the Physical Environment in the Hospital of the 21st Century: A Once-in-a-Lifetime Opportunity

Abstracts Table Supplement

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Abstracts Table

Reduce Staff Stress

No.	Study	Environmental variable(s) studied	Outcome measure(s)	Research design	Sample description	Major findings	Grade
1	**Alexandre, N. M., de Moraes, M. A., Corrêa Filho, H. R., & Jorge, S. A. (2001).** Evaluation of a program to reduce back pain in nursing personnel. *Revista de Saude Publica, 35*(4), 356-361.	Intervention program: set of exercises and educational component stressing ergonomic aspect (included ergonomic orientation about workplace: work surface height, workspace, and height of reach)	Intensity of pain before and after ergonomic intervention program using a visual analog scale	Before-after study; intervention administered twice a week for four months	Nonprobabilistic sample of nursing aides less than 50 years: control group (n = 29) and intervention group (n = 27)	There was a statistically significant decrease in the frequency of cervical pain in the last two months and in the last seven days in the intervention group. There was also a reduction in cervical pain intensity in the two periods (two months, seven days) and lumbar pain intensity in the last seven days.	B+
2	**Annis, J. F., Case, H. W., Clauser, C. E., & Bradtmiller, B. (1991).** Anthropometry of an aging work force. *Experimental Aging Research, 17*(3), 157-176.	Changes in weight and body dimensions from third to eighth decade of life	Age-associated changes in workspace dimensions	Literature review	Longitudinal and cross-sectional studies	Several body characteristics such as weight, volume, stature, depths, breadths, and circumferences change with age. While acknowledging the need for flexibility in future workplace designs, the authors conclude that age-related changes in body size are insufficient in themselves to justify the resizing of existing ergonomically designed workplaces.	Review

3	**Caboor, D. E., Verlinden, M. O., Zinzen, E., Van Roy, P., van Riel, M. P., & Clarys, J. P. (2000).** Implications of an adjustable bed height during standard nursing tasks on spinal motion, perceived exertion and muscular activity. *Ergonomics, 43*(10), 1771-1780.	Adjustable bed heights	Three main outcomes: spinal motion (changes in posture and shape), muscular activity, and perceived exertion	Experimental	18 right-handed nurses from two Belgian hospitals	Quality of spinal motion enhanced when the opportunity of adjusting the bed height is offered.	A
4	**Daraiseh, N., Genaidy, A. M., Karwowski, W., Davis, L. S., Stambough, J., & Huston, R. L. (2003).** Musculoskeletal outcomes in multiple body regions and work effects among nurses: The effects of stressful and stimulating working conditions. *Ergonomics, 46*(12), 1178-1199.	Work demands (six categories: physical-task demands, mental-task demands, sensory demands, physical environmental demands, social demands, organizational demands) and work stimuli	Six general categories: 1) effort extended, 2) perceived risk of injury or illness, 3) work satisfaction and dissatisfaction, 4) energy state at end of workday, 5) psychosomatic outcomes, 6) musculoskeletal outcomes	Questionnaire; prospective study	34 registered female nurses from hospitals in U.S. Midwest	Effort was significantly associated with physical factors and organizational demands. Perceived risk was statistically positively correlated with task as well as physical-organizational environment demands; it was negatively correlated with social stimuli. Psychosomatic outcomes were positively correlated with environmental demands.	B

5	**Garg, A., & Owen, B. (1992).** Reducing back stress to nursing personnel: An ergonomic intervention in a nursing home. *Ergonomics, 35*(11), 1353-1375.	Ergonomic intervention strategy: training nursing assistants in use of patient transferring devices, modifying toilets and shower rooms, and applying techniques to patient care	Injury rates, intervention acceptability rates; biomechanical stresses; ratings of perceived exertion; mean task performance times	Prospective epidemiologic study; before-after study	57 nursing assistants from two units of nursing home	Biomechanical evaluation showed that the mean compressive force on the L5/S1 disc, the mean hand force required to make a transfer, and the strength requirements all decreased after intervention. Mean rating of perceived exertion was less than "very light" after intervention as compared to "somewhat hard" and "hard" before intervention. Acceptability rates were high (more than 80%) for assistive devices used. Incidence of back injuries decreased.	B+
6	**Jiang, S., Huang, L., Chen, X., Wang, J., Wu, W., Yin, S., et al. (2003).** Ventilation of wards and nosocomial outbreak of severe acute respiratory syndrome among healthcare workers. *Chinese Medical Journal*, *116*(9), 1293-1297.	Four types of isolation ward with different volume and window ventilation area	Incidence of Severe Acute Respiratory Syndrome (SARS) among healthcare workers	Prospective		Isolating SARS cases in wards with good ventilation could reduce the viral load of the ward and might be the key to preventing outbreaks of SARS among healthcare workers along with strict personal protection measures in isolation units.	B
7	**Petzall, K., & Petzall, J. (2003).** Transportation with hospital beds. *Applied Ergonomics, 34*, 383-392.	Four types of tests beds with principally different wheel arrangements	Perception of effort (Borg's category ratio scale) and perceived level of difficulty (visual analog scale)	Experimental; four common transport conditions were studied (transporting hospital bed along a 48m straight corridor, transport bed around corner, maneuver the bed into patient room, maneuver the bed	22 registered nurses and enrolled nurses working at an ear, nose, and throat ward at Sahlgrenska University Hospital at Goteberg	Standard small-diameter castor wheels made the bed easier to maneuver in limited spaces, while larger wheels on fixed axles made the beds more comfortable for long-distance transportation.	A

				into a bed space in a patient room)			
8	**Smedbold, H., Ahlen, C., Unimed, S., Nilsen, A., Norbaeck, D., & Hilt, B. (2002).** Relationships between indoor environments and nasal inflammation in nursing personnel. *Archives of Environmental Health*, *57*(2), 155-161.	Ventilation system	Nasal inflammation in nursing personnel	Retrospective study	Clinical data of 115 females working in 36 geriatric nursing departments in Norway	Nasal patency due to fungal contamination of the air-supply ducts. The findings illustrate the significance of maintaining the ventilation systems and lowering room temperatures.	C
9	**Smith, H., MacKintosh, P., Sverisdottir A, & Robertson C. (1993).** Improved coordination makes for faster work: Ergonomic analysis of a trauma resuscitation room. *Professional Nurse, 8*(11): 711-715.	Work environment in trauma resuscitation room: location of equipment and personnel (nodes), links between equipment and work areas	Time spent on individual tasks as percentage of overall workload	Video recordings of activities in trauma resuscitation rooms were analyzed independently by three observers; two aspects examined: tasks of each individual, utilization of space, and staff movement for tasks in relation to room layout	First 15 minutes of resuscitation process on 19 occasions	During 19 resuscitations, 2,760 internodal movements were performed by nursing and medical staff. Nurse moved significantly greater number of times than medical staff. Specific problem areas were identified and strategies developed for more efficient performance.	A-

Improve Patient Safety

No.	Study	Environmental variable(s) studied	Outcome measure(s)	Research design	Sample description	Major findings	Grade
1	**Adeniran, A., Shakespeare, P., Patrick, S., Fletcher, A. J., & Rossi, L. A. (1995).** Influence of a changed care environment on bacterial colonization of burn wounds. *Burns, 21*(7), 521-525.	Air conditioning in specialized burn unit vs. traditional open ward with no specialized air conditioning	Bacterial colonization of burn wounds	Retrospective study of clinical and laboratory records in two phases; during period 1, patients managed on an 'open ward;' period 2, patients managed on the permanent unit	224 patients admitted to the permanent unit in 1992. 231 patients admitted to the temporary burn unit.	No significant difference in wound colonization rates was found between the two groups. Authors conclude that, a conditioned care environment per se does not influence bacterial colonization rates of burn wounds.	B
2	**Albert, R. K., & Condie, F. (1981).** Hand-washing patterns in medical intensive-care units. *New England Journal of Medicine, 304*(24), 1465-1466.	Hand washing by staff category	Hand-washing compliance (number of patient contacts followed by hand washing/total number of contacts)	Descriptive; hand-washing behavior observation (disguised)	1,212 direct contacts observed in 10 four-hour periods during morning working rounds in a university hospital; 297 during 20 hours in a private hospital	The overall hand-washing compliance rates were 41% for the university hospital and 28% for the private hospital. In the university hospital, physicians' compliance rate was lower than nurses. Compliance rates by physicians were 28% (university) and 14% (private), by nurses were 43% and 28%, by respiratory therapists were 76% and 48%, and by radiology technicians were 44% and 25%. The same pattern appeared in both hospitals.	B
3	**Alcee, D. A. (2000).** The experience of a community hospital in quantifying and reducing patient falls. *Journal of Nursing Care Quality*, *14*(3), 43-54.	Location of patient falls	Patient falls	Retrospective review of patient fall data: data were collected about number of falls, percentage of falls by nursing unit, location of falls, number of repeat	209 falls were documented in an eight-month period	Majority of patients fell during the night shift (8 p.m. to 8 a.m.); greatest percentage of falls occurred on the medical/oncology unit followed by the medical/orthopedic unit. Thirty percent of patients who fell were attempting to use the bathroom. As a result of this study, several organizational, staffing, and physical	B-

				falls		changes were made to address the problem of patient falls.	
4	**Anderson, R. L., Mackel, D. C., Stoler, B. S., & Mallison, G. F. (1982).** Carpeting in hospitals: An epidemiological evaluation. *Journal of Clinical Microbiology, 15*(3), 408-415.	Carpet	Microorganism contamination; colonization; infection rate	Experimental; randomization; prospective; hypotheses; microbial surveillance; chart records	Six pools of carpet plugs (3 plugs per pool) and 6 samples of bare floor in each sampling period (total 58 periods); 23 patients in carpeted rooms and 36 in noncarpeted rooms.	Higher microorganism counts were found on carpeted floor than on bare vinyl-tile floor. Patients were colonized with the same types of organisms as those initially recovered from the carpet in patient rooms. No difference was found, however, regarding infection rate and disease between carpeted and noncarpeted rooms.	A-
5	**Archibald, L. K., Manning, M. L., Bell, L. M., Banerjee, S., & Jarvis, W. R. (1997).** Patient density, nurse-to-patient ratio and nosocomial infection risk in a pediatric cardiac intensive care unit. *Pediatric Infectious Disease Journal, 16*(11), 1045-1048.	Patient density measured as patient days; nurse-to-patient ratio measured as nursing-hours to-patient-day ratio	Nosocomial infection rate (NIR)	Quasi-experimental; regression analysis; retrospective; hypotheses; chart records	Administrative, patient, and microbiology records of 782 admissions to a pediatric cardiac intensive care unit in Philadelphia during the period between December1994 and December 1995	There was a very strong linear correlation between the monthly NIR and patient days ($r = 0.89$, $P = 0.0001$). There was an inverse correlation between the monthly NIR and nursing-hours-to-patient-day ratio ($r = -0.77$). These factors may influence the infection rate via breaks in healthcare worker aseptic technique or decreased hand washing.	B

6	**Arlet, G., Gluckman, E., Gerber, F., Perol, Y., & Hirsch, A. (1989).** Measurement of bacterial and fungal air counts in two bone marrow transplant units. *Journal of Hospital Infection*, *13*(1), 63-69.	Laminar airflow rooms, conventional rooms, and ultraclean rooms in new and old units	Bacterial and fungal air counts	Air samples were taken from the different types of rooms in the old and new units	42 samples taken from old unit from different sites and 78 samples taken from new unit from different sites at the bone marrow transplant unit of the Saint-Louis Hospital (Paris)	Bacterial air contamination was least in laminar airflow rooms and reduced in ultraclean rooms in comparison with conventional rooms. Similar results were obtained with culture of air for fungi.	B
7	**Aygun, G., Demirkiran, O., Utku, T., Mete, B., Urkmez, S., Yilmaz, M., et al. (2002).** Environmental contamination during a carbapenem-resistant Acinetobacter baumannii outbreak in an intensive care unit. *Journal of Hospital Infection, 52*(4), 259-262.	Environmental surface contamination with pathogens in a multibed intensive care unit (ICU)	Pathogenic bacteria (*Acinetobacter baumannii*) contamination of environmental surfaces	Epidemiological survey; microbial surveillance	56 swab samples from a 16-bed ICU in Turkey	*Acinetobacter baumannii* was found in 22 (39.3%) of 56 environmental samples obtained by swabbing. Environmental contamination is an important reservoir of *Acinetobacter baumannii* in ICUs. Appropriate antibiotic treatment, isolation precautions, and infection-control education of the staff failed to halt the outbreak of *Acinetobacter baumannii*.	B-
8	**Babb, J. R., Lynam, P., & Ayliffe, G. A. (1995).** Risk of airborne transmission in an operating theatre containing four ultraclean air units. *Journal of Hospital Infection, 31*(3), 159-168.	Air quality in a single large operating theatre (barn) containing four ultraclean operating units (cabins)	Number of airborne bacteria in the operating fields with and without activity	Prospective study; bacteriological air sampling of air in the cabins using two Casella slit samplers	Air sampled in four ultraclean units	The airflows and bacterial counts during operations within the cabins met the prevalent standards for ultraclean systems, and there was no evidence for mixing of air between cabins. However, bacterial air counts were found to be high in one of the empty cabins when the ventilation was off indicating that contaminated air had entered from other cabins.	B

9	**Barnes, R. A., & Rogers, T. R. (1989).** Control of an outbreak of nosocomial aspergillosis by laminar airflow isolation. *Journal of Hospital Infection, 14*(2), 89-94.	Normally ventilated bone marrow transplantation (BMT) ward with adjacent laminar airflow (LAF) unit construction vs. BMT ward with LAF system post-construction	Incidence of invasive pulmonary aspergillosis	Before-after study; prospective air sampling: the BMT unit, a control ward on a different floor of the hospital, and outside from a small park approximately 200m from the hospital	38 children undergoing BMT were studied	Six of the 19 children undergoing BMT in the area adjacent to the construction site for the new LAF unit died of invasive pulmonary aspergillosis (IPA). Ward air samples confirmed that heavy fungal air contamination had occurred. No cases of IPA were detected in patients nursed exclusively in the LAF unit.	C
10	**Bauer, T. M., Ofner, E., Just, H. M., Just, H., & Daschner, F. D. (1990).** An epidemiological study assessing the relative importance of airborne and direct contact transmission of microorganisms in a medical intensive care unit. *Journal of Hospital Infection, 15*(4), 301-309.	Pathogen contamination in air and on hands in an intensive care unit (ICU)	Pathogenic bacteria contamination	Epidemiological survey; prospective; microbial surveillance; DNA typing	Specimens from 53 patients; 326 hand-washing samples from 39 staff members; 97 air samples in a seven-bed ICU	The spectrum of bacteria recovered from patients and air was generally different, whereas strains recovered from patients and their attendants' hands were indistinguishable on multiple occasions. The results confirm that direct contact by hand is the principal pathway of microbial transmission.	B-
11	**Ben-Abraham, R., Keller, N., Szold, O., Vardi, A., Weinberg, M., Barzilay, Z., et al. (2002).** Do isolation rooms reduce the rate of nosocomial infections in the pediatric intensive care unit? *Journal of Critical Care, 17*(3), 176-180.	Conversion of open-bay pediatric intensive care unit (PICU) to single rooms with separate sinks	Nosocomial infection rates	Quasi-experimental; before-after comparison; retrospective and prospective; hypotheses; chart records	78 children hospitalized for more than 48 hours in 1992 and 115 children hospitalized for more than 48 hours in 1995 in a six-bed PICU	The average number of nosocomial infections per patient was significantly higher in 1992 in the open-space unit (3.62) than 1995 with single rooms with separate sinks (1.87). Similarly, the average length of stay was significantly longer in 1992 than 1995 (25 +/- 6 and 11 +/- 6 days, respectively). There was a significant reduction of respiratory, urinary tract, and catheter-related infections in the separate-room arrangement.	B

12	**Bjorn, E., & Nielsen, P. V. (2002).** Dispersal of exhaled air and personal exposure in displacement ventilated rooms. *Indoor Air, 12*(3), 147-164	Human exhalation, respiration, and movement	Contaminant distribution	Experimental and numerical investigation	Three typical situations are modeled	A moving person significantly alters the ambient air within a space. A very good and unique study on the relationship between the ventilation system and "activity" within the room.	A
13	**Booker, J. M., & Roseman, C. (1995).** A seasonal pattern of hospital medication errors in Alaska. *Psychiatry Research*, *57*(3), 251-257.	Length of daylight	Number of medication errors	Retrospective analysis of medication error data and daylight and darkness hours each month of the year	Data was analyzed retrospectively	Fifty-eight percent of all medication errors occurred during the first quarter of the year. Medication errors were 1.95 times more likely in December than in September. The best statistical prediction was for errors associated with levels of darkness two months earlier.	B
14	**Boyce, J. M., Potter-Bynoe, G., Chenevert, C., & King, T. (1997).** Environmental contamination due to methicillin-resistant Staphylococcus aureus: Possible infection control implications. *Infection Control and Hospital Epidemiology, 18*(9), 622-627.	Methicillin-resistant *Staphylococcus aureus* (MRSA) contamination of environmental surfaces	Occurrence of MRSA contamination of environmental surfaces, and types of surfaces contaminated in rooms of patients with MRSA	Epidemiological survey; microbial surveillance	38 consecutive patients (20 women) colonized or infected with MRSA; 350 environmental-surface samples in patient rooms	Environmental surfaces near affected patients very commonly become contaminated with MRSA. The body site at which patients are colonized or infected affects the frequency of environmental contamination. Personnel may contaminate their uniforms and gowns when caring for patients. Personnel may contaminate their gloves (or possibly their hands) by touching contaminated surfaces.	B-

15	**Brandis, S. (1999).** A collaborative occupational therapy and nursing approach to falls prevention in hospital inpatients. *Journal of Quality in Clinical Practice, 19*(4), 215-221.	Intervention: fall program; environmental factors modified during intervention phase: bathroom and ward design and equipment standardization	Patient falls	Retrospective audit of inpatient falls followed by a falls prevention program, followed by a second audit	During first audit: 270 falls reports by 201 hospital inpatients	After first audit, it was found: 51.85% of falls occurred in the bedroom, 24.4% in the bathroom areas, 12.96% in other areas, 6.3% in halls, and 2.2% in other departments. Transfers to and from bed were reported in 42.2% of the incidents, while 30% involved activities related to toileting. Of the 61 patients who fell in or out of bed, 29.5% reported that bed rails were up at the time. Design faults identified in the bathroom and bedroom areas included slippery floors, inappropriate door openings, poor placement of rails and accessories, and incorrect toilet and furniture heights. At second audit (after two years), there was an overall decrease of 17.3% in patient falls.	B-
16	**Buchanan, T. L., Barker, K. N., Gibson, J. T., Jiang, B. C., & Pearson, R. E. (1991).** Illumination and errors in dispensing. *American Journal of Hospital Pharmacy, 48*(10), 2137-2145.	Three levels of illumination: Level 1: 45 foot candles (ftc) (baseline) Level 2: 102 ftc Level 3: 146 ftc	Prescription-dispensing error rate	Within-subjects (repeated measures) design; random assignment; direct, undisguised observation and retrospective prescription review; illumination level was measured daily before 0800 using a photometer	10,888 prescriptions dispensed by five pharmacists	An illumination level of 146 ftc was associated with a significantly lower error rate (2.6%) than the baseline level of 45 ftc (3.8%). There was a linear relationship between each pharmacist's error rate and that pharmacist's corresponding daily prescription workload for all three illumination levels. The effect of the observer was minimal. The rate of prescription-dispensing errors was associated with the level of illumination.	A-

17	**Bures, S., Fishbain, J. T., Uyehara, C. F., Parker, J. M., & Berg, B. W. (2000).** Computer keyboards and faucet handles as reservoirs of nosocomial pathogens in the intensive care unit. *American Journal of Infection Control, 28*(6), 465-471	Computer keyboards and faucet handles in an intensive care unit (ICU)	Pathogenic contamination	Epidemiological survey; swab sampling; microbial surveillance; DNA typing	144 swab samples from 10 computer keyboards and 8 faucet handles; 33 environmental isolates; 14 patients isolated in a medical intensive care unit	The colonization rates for computer keyboards and faucet handles were 24% and 11%, respectively, which were greater than the colonization rates of other well-studied environmental surfaces in rooms with patients positive for methicillin-resistant *Staphylococcus aureus* (MRSA). The typing of MRSA sampled from two patients was indistinguishable with MRSA on the keyboards and faucet handles in their respective rooms, and on other keyboards throughout the ICU, including the doctors station. These surfaces may serve as reservoirs of nosocomial pathogens.	B
18	**Chang, V. T., & Nelson, K. (2000).** The role of physical proximity in nosocomial diarrhea. *Clinical Infectious Diseases, 31*(3), 717-722.	Physical proximity of patients	Nosocomial acquisition of *Clostridium difficile*-associated diarrhea (CDAD) and antibiotic-associated diarrhea (AAD)	Epidemiological; regression analysis; retrospective; hypotheses; chart records	2,859 patients in a community hospital	Physical proximity to a patient with CDAD, exposure to clindamycin, and the number of antibiotics taken were significant risk factors for acquisition of nosocomial CDAD. For patients with nosocomial AAD, exposure to a roommate with AAD, a stay in an intensive care unit or cardiac care unit, and the number of antibiotics taken were significant risk factors. Physical proximity is an independent risk factor for acquisition of nosocomial CDAD and AAD.	B
19	**Chen, Q., Jiang, Z., & Moser, A. (1992).** Control of airborne particle concentration and draught risk in an operating room. *Indoor Air*, *2*, 154-167.	Location of airborne particle source, ventilation rate, air inlet size, supply-air velocity, air-outlet location, and heat source	Air quality and comfort: particle concentrations, draught risk, air velocity and temperature distributions	Numerical simulation Computational Fluid Dynamics – (CFD) of operating rooms followed by five parametric studies — each with one changed parameter; the	Five hypothetical scenarios for studying effects of individual design variables	Particle concentration in the operating area is controlled only by supply air. In the recirculating area, it is strongly dependent on the location of particle sources. High inflow rates reduce particle concentration in the recirculating zone, however, results in high draught rate in the room. Lower supply velocity better for comfort. Uniform velocity profile of supply air	C

				algorithms used for computing air quality and distribution have been derived from earlier studies		seems to be better for avoiding recirculation within the operating area. No significant influence of heat source.	
20	**Cheng, V. C., Lo, W. K., Woo, P. C., Chan, S. B., Cheng, S. W., Ho, M., et al. (2001).** Polymicrobial outbreak of intermittent peritoneal dialysis peritonitis during external wall renovation at a dialysis center. *Peritoneal Dialysis International, 21*(3), 296-301.	Bacterial air counts	Incidence of peritonitis in intermittent peritoneal dialysis patients	Outbreak investigation and retrospective case-control study	10 episodes of peritonitis were documented in eight patients	Air sampling of the environment detected a median of 110 colony-forming units of bacteria per cubic meter of air, 10% of which were found to be *Acinetobacter baumanii*. The source of this polymicrobial outbreak was attributed to the bamboo scaffolding structure covering the external wall of the hospital during renovation.	B
21	**Cohen, B., Saiman, L., Cimiotti, J., & Larson, E. (2003).** Factors associated with hand hygiene practices in two neonatal intensive care units. *Pediatric Infectious Disease Journal, 22*(6), 494-499.	Dispensers with alcohol-based hand rub vs. sinks with antimicrobial soap in two neonatal intensive care units (NICUs)	Hand-washing compliance: ratio of hand touches with cleaned hands/total hand touches	Quasi-experimental; comparison between nursing units; prospective; hypotheses; observation in clinical setting	1,472 hand touches in two NICUs in New York (44 and 50 beds)	Only 22.8% of all touches were with cleaned and/or newly gloved hands. The mean ratio of direct touches by staff members with cleaned hands was significantly greater in the NICU using an alcohol-based hand rub than in the NICU using antimicrobial soap and sinks.	B

22	**Conly, J. M., Hill, S., Ross, J., Lertzman, J., & Louie, T. J. (1989).** Hand-washing practices in an intensive care unit: The effects of an educational program and its relationship to infection rates. *American Journal of Infection Control, 17*(6), 330-339.	Educational programs (feedback, posters, policy changes) in an intensive care unit (ICU)	Hand-washing compliance rate; nosocomial infection rate	Quasi-experimental; sequential before-after comparison; prospective; hypotheses; observation in clinical setting	455 observations of hand washing, and 53 nosocomial infections in 245 discharges, recorded on four occasions (before and after two educational programs) in a 16-bed ICU (three two-bed cubicles observed for four hours on each occasion) in August to September 1978, and January to August 1983)	Hand-washing compliance rate and nosocomial infection rate are negatively related. Hand-washing compliance and nosocomial infection rate improved immediately after the educational programs; but the improvement was not maintained in the long term.	B+
23	**Cotterill, S., Evans, R., & Fraise, A. P. (1996).** An unusual source for an outbreak of methicillin-resistant Staphylococcus aureus on an intensive therapy unit. *Journal of Hospital Infection, 32*(3), 207-216.	Air quality	Incidence of methicillin-resistant *Staphylococcus aureus* (MRSA)	All cases of MRSA were identified from hospital records; investigation of the environment included microbiological sampling and assessment of the ventilation system for the side room (adjacent to ward)	Six patients nursed on the same bed on an intensive therapy unit	The source of MRSA may have been the exhaust ducting of the adjacent isolation room ventilation system that allowed the organisms to enter the unit via a partially open window positioned above the particular bed. The cycle was broken once the ventilation system was repaired, the window above the bed was repaired, and the window above the window was properly sealed.	B

24	**Davidson, A. I., Smylie, H. G., Macdonald, A., & Smith, G. (1971).** Ward design in relation to postoperative wound infection. *British Medical Journal, 1*(740), 72-75.	Nightingale open ward (1964-6) vs. racetrack surgical ward (1966-8) with 40% beds in single rooms and controlled ventilation	Postoperation wound infection rate	Quasi-experimental; before-after comparison of two units; hypotheses; microorganism surveillance; observation; chart records	1,000 general surgical operations in two surgical wards in a UK hospital (493 surgery patients in Nightingale unit, 507 in newer racetrack unit)	The cross-infection was significantly lower after the Nightingale open ward was changed to a racetrack unit with 40% single rooms and controlled ventilation.	B
25	**Dettenkofer, M., Scherrer, M., Hoch, V., Glaser, H., Schwarzer, G., Zentner, J., et al. (2003).** Shutting down operating theater ventilation when the theater is not in use: Infection control and environmental aspects. *Infection Control and Hospital Epidemiology, 24*(8), 596-600.	Shutting down and restarting air-conditioning system in operating theater	Presence of suspended articles near operating table	Experimental; the ventilation system was switched off and restarted after 10 hours. Particles suspended in the air near the operating table were counted, operating-room (OR) temperature was measured and settle plates were exposed and incubated	13 investigations were conducted in operating theater of neurological OR of a German university hospital	Shutting down OR ventilation during off-duty periods does not appear to result in an unacceptably high particle count of microbial contamination of the OR air shortly after the system is restarted.	A-
26	**Devine, J., Cooke, R. P., & Wright, E. P. (2001).** Is methicillin-resistant Staphylococcus aureus (MRSA) contamination of ward-based computer terminals a surrogate marker for nosocomial MRSA transmission and handwashing compliance? *Journal*	Computer terminal contamination	Nosocomial MRSA transmission rates; hand-washing compliance	Quasi-experimental; comparison of two hospitals; hypotheses; chart records; microorganism surveillance	25 computer terminals and 66,065 admissions (during 1999) in wards in two acute general hospitals (456 and 526 beds)	Five of 12 computer terminals in hospital A and 1 of 13 computer terminals in hospital B were contaminated with MRSA. The nosocomial MRSA transmission rate was significantly greater in A. The rate of hand-hygiene towel use in hospital B was 44% higher. Computer terminals pose a low risk of MRSA cross-infection. This risk can be reduced if all staff washes their hands before and after patient contact.	B-

	of Hospital Infection, 48(1), 72-75.						
27	**Dorsey, S. T., Cydulka, R. K., & Emerman, C. L. (1996).** Is handwashing teachable? Failure to improve handwashing behavior in an urban emergency department. *Academy of Emergency Medicine, 3*(4), 360-365.	Brightly colored signs with Centers for Disease Control recom-mendations for hand washing posted at all sinks in an emergency department (ED); a publication on hand washing	Hand washing compliance rate	Quasi-experimental; before-after comparison; prospective; hypotheses; observation in natural setting	252 situations requiring hand washing observed in ED in a 742-bed urban hospital	Hand-washing compliance showed tendencies toward improvement after the signs and publications were placed in the ED, but the increase was not significant.	B+
28	**Dubbert, P. M., Dolce, J., Richter, W., Miller, M., & Chapman, S. W. (1990).** Increasing ICU staff handwashing: Effects of education and group feedback. *Infection Control and Hospital Epidemiology, 11*(4), 191-193.	Educational classes; feedback to staff about hand-washing errors on the previous day	Hand-washing compliance rate	Quasi-experimental; repeated measurements; prospective; hypotheses; observation in natural setting; descriptive statistical analyses	591 patient contacts by 12 nurses in a 12-bed intensive care unit during a 14-week period (six baseline, four with education, followed by four weeks with feedback)	The average hand-washing compliance rates were 81%, 86%, and 92% for the three consecutive periods. During baseline, the hand-washing compliance rate increased by the end of the period. During the education period, it increased at the beginning then declined to the baseline level. During the feedback period, it increased to 97% by the second week and was maintained to the end of the period.	B

29	**Farquharson, C., & Baguley, K. (2003).** Responding to the severe acute respiratory syndrome (SARS) outbreak: Lessons learned in a Toronto emergency department. *Journal of Emergency Nursing, 29*(3), 222-228.	Changes made to an emergency department environment during a SARS outbreak	Environmental measures implemented to control infection and spread of SARS	Retrospective report; case study of one hospital	A Toronto emergency department with 26 beds in open-bay rooms before SARS outbreak, converted to 16 single rooms and seven negative-pressure isolation rooms during the outbreak	Nineteen probable cases were reported in this emergency department during the SARS outbreak. 77% percent of SARS cases in the Toronto area were the result of exposure within hospitals. Direct contact and airborne transmission were potential modes of transmission. Strategies of SARS control in the hospital included: a triage screening tool, restricting visitation, eliminating beds in hallways and beds separated by curtains, replacing curtains with wall barriers, one bed to each room, and a strict infection-control protocol that included hand washing and masks.	C
30	**Friberg, B., Friberg, S., & Burman, L. G. (1999).** Correlation between surface and air counts of particles carrying aerobic bacteria in operating rooms with turbulent ventilation: an experimental study. *Journal of Hospital Infection, 42*(1), 61-68.	Operating room (OR) turbulent ventilation systems (either upward air displacement system or a conventional plenum pressure system)	Bacterial air and surface contamination rates (measured by sedimentation rates)	Experimental: the relationship between bacterial air and surface contamination rates at different sampling sites was studied during rigidly standardized sham operations performed by the same six-member team wearing either disposable or cotton clothing in an OR ventilated by two different turbulent systems	During one week, 10 sham operations (five disposable clothing, five cotton clothing) were studied in the displacement ventilation system in the conventional system	Airborne contamination in the wound and instrument areas was related to the surface contamination rate in the same areas, and, in addition, on the patient chest and in the periphery of the OR. With the exception of the periphery of the OR, the surface and air contamination rates were highly correlated in both ventilation systems.	A

31	**Gardner, P. S., Court, S. D., Brocklebank, J. T., Downham, M. A., & Weightman, D. (1973).** Virus cross-infection in paediatric wards. *British Medical Journal, 2*(5866), 571-575.	Ward design: single cubicles vs. open ward with some cubicles	Cross-infection rate	Quasi-experimental; concurrent comparison; hypotheses; chart records; epidemiological survey; swab sampling	219 children hospitalized for respiratory syncytial infection, 61 hospitalized for influenza A, 134 hospitalized for parainfluenza in eight pediatric wards (four open wards, four wards with single cubicles)	There was a clear pattern for cross-infection rates to be lower in wards with single cubicles than wards combining an open area with some cubicles. Among sampled children, 16 were due to nosocomial cross-infection of respiratory syncytial, 15 were due to cross-infection of influenza A, and 19 were due to cross-infection of parainfluenza.	B-
32	**Goldmann, D. A., Durbin, W. A., Jr., & Freeman, J. (1981).** Nosocomial infections in a neonatal intensive care unit. *Journal of Infectious Diseases, 144*(5), 449-459.	Old neonatal intensive care unit (NICU) vs. new NICU with more nurses, increased space per infant, convenient sinks, and isolation facilities	Nosocomial infection rates	Quasi-experimental; before-after comparison; hypotheses; microbial surveillance; chart records	642 discharges in the old NICU (January 1974 to February 1977) and 542 in the new NICU (February 1977 to December 1978) in a hospital in Boston	In the old unit, 5.2% of infants had at least one major nosocomial infection. By contrast, in the new unit, 0.9% of infants had a major nosocomial infection (relative risk [old nursery/new nursery] = 5.06; $p < 0.00001$).	B
33	**Graham, M. (1990).** Frequency and duration of handwashing in an intensive care unit. *American Journal of Infection Control, 18*(2), 77-81.	Intensive care unit with vs. without an antiseptic hand-rub dispenser positioned near each bed	Hand-washing compliance rate	Quasi-experimental; interrupted time series (before-after comparison); prospective; hypotheses; observation	884 patient contacts by staff members observed during two (before) and eight (after) weeks in an 18-bed intensive care unit in Australia	A total of 440 contacts and 140 hand washes (32% compliance) were observed in stage one (without antiseptic hand-rub dispensers), and 444 contacts and 201 hand washes (45% compliance) in stage two with hand-rub dispensers. There were significant differences in hand-washing compliance rate and hand-washing duration among the staff groups. Compared to physicians, nurses had a higher hand-washing rate but with shorter duration.	B

34	**Hamrick, W. B., & Reilly, L. (1992).** A comparison of infection rates in a newborn intensive care unit before and after adoption of open visitation. *Neonatal Network, 11*(1), 15-18.	Family visiting: restricted vs. unrestricted hours	Infection rate	Quasi-experimental; before-after; retrospective; chart records	118 patients in a neonatal intensive care unit with 65 patients before implementation of open visiting hours, 53 after	Open visiting hours were not associated with increased infection rates. Increased family visitation of neonates had no adverse effects in regard to infection.	B-
35	**Hanger, H. C., Ball, M. C., & Wood, L. A. (1999).** An analysis of falls in the hospital: Can we do without bedrails? *Journal of the American Geriatrics Society., 47*(5), 529-531.	Bedrails on hospital beds	Total number of falls, falls around the bed, and minor and serious injuries before and after policy change	Fall and injury rates were quantified before and after the implementation of a policy introduced to discourage overuse of bedrails; the presence of bedrails physically attached to beds was checked throughout the year and both major and minor falls were counted; nonrandom assignment of patients to beds with or without bedrails	All patients admitted during 1994 calendar year to any of the five assessment, treatment, or rehabilitation wards of a New Zealand hospital	The number of beds with bedrails attached decreased from a mean of 40.0 before the policy change to 18.5 after the change. There was no significant change in the fall rate after the policy change. Serious injuries, however, were significantly less common after bedrail use was reduced. Minor injuries did not appreciably change.	B
36	**Hopkins, C. C., Weber, D. J., & Rubin, R. H. (1989).** Invasive aspergillus infection: possible non-ward common source within the hospital environment. *Journal of Hospital*	Air quality (measured by air sampling)	Incidence of invasive Aspergillosis	Epidemiological investigation: investigation of hospital records to identify cases and trends; air sampling (though exact methods and	Six immuno-compromised patients housed in widely separated portions of a hospital campus	The cause for the cluster of cases was traced to a common source related to construction activity in a central radiology suite serving the hospital.	C

	Journal of Hospital Infection, 13(1), 19-25.			location of air samples is not described			
37	**Iwen, P. C., Davis, J. C., Reed, E. C., Winfield, B. A., & Hinrichs, S. H. (1994).** Airborne fungal spore monitoring in a protective environment during hospital construction, and correlation with an outbreak of invasive aspergillosis. *Infection Control and Hospital Epidemiology, 15*(5), 303-306.	Contamination of air during construction	Incidence of invasive aspergillosis (IA)	Prospective air sampling for molds was done using the gravity air-settling plate method	Five neutropenic patients developed IA	Four of the five patients with IA were housed in rooms adjacent to a construction staging area. Aerobiological monitoring detected an increase in the number of airborne fungal spores including *Aspergillus* species in these rooms.	B
38	**Jernigan, J. A., Titus, M. G., Groschel, D. H., Getchell-White, S., & Farr, B. M. (1996).** Effectiveness of contact isolation during a hospital outbreak of methicillin-resistant Staphylococcus aureus. *American Journal of Epidemiology, 143*(5), 496-504.	Contact isolation room vs. open bay in a neonatal intensive care unit	Methicillin-resistant *Staphylococcus aureus* (MRSA) transmission rate	Quasi-experimental; comparison between patients; hypotheses; microbial surveillance; chart records	331 neonates in a 33-bed neonatal intensive care unit (NICU) in Virginia (one two-bed isolation room, one open bay)	The rate of transmission of MRSA among patients in the contact isolation room was substantially lower than the rate for patients not in isolation.	B

39	**Kaplan, L. M., & McGuckin, M. (1986).** Increasing handwashing compliance with more accessible sinks. *Infection Control, 7*(8), 408-410.	Units with different bed-to-sink ratios: 1:1 vs. 4:1	Hand-washing compliance rate (hand washes/contacts)	Quasi-experimental; concurrent comparison; prospective; hypotheses; observation	137 contacts and 106 contacts observed in a 7-bed, seven-sink open medical ICU and a 12-bed, three-sink open surgical unit	The nurses in the unit with one sink per bed had significantly higher hand-washing compliance (76%) rate than those in the unit with fewer sinks (51%). Physicians had a lower hand-washing compliance rate than nurses.	B
40	**Kim, M. H., Mindorff, C., Patrick, M. L., Gold, R., & Ford-Jones, E. L. (1987).** Isolation usage in a pediatric hospital. *Infection Control, 8*(5), 195-199.	Number and availability of single-bed isolation rooms compared to multibed rooms	Isolation-room demand and usage	Descriptive; survey; hypotheses; observation; chart records	One pediatric hospital in Canada with 585 beds between November1, 1984, and October 30, 1985	The mean number of isolation days was 153 per 1,000 pediatric patient days or 15.3% of all bed days. During one-third of the 365-day year, the hospital was unable to provide an adequate number of single rooms. The shortage of single rooms ranged from 1 to 20 per day. Hospitals with multibed rooms and an inadequate number of single rooms may be unable to meet current isolation guidelines.	B
41	**Kumari, D. N., Haji, T. C., Keer, V., Hawkey, P. M., Duncanson, V., & Flower, E. (1998).** Ventilation grilles as a potential source of methicillin-resistant Staphylococcus aureus causing an outbreak in an orthopaedic ward at a district general hospital. *Journal of Hospital Infection, 39*(2), 127-133.	Ventilation system	Incidence of methicillin-resistant *Staphylococcus aureus* (MRSA)	Screening of patients and staff for MRSA; environmental sampling	Six patients and one nurse in an orthopedic ward were involved in the outbreak	The ventilation grilles in bays 1 and 2 were found to be harboring EMRSA-15. The ventilation system at that time was working on an intermittent cycle from 4 p.m. to 8 a.m. Daily shutdown of the system temporarily created a negative pressure, sucking air in from the ward environment into the ventilation system and probably contaminating the outlet grilles. It is likely that contaminated air was blown back into the ward when the ventilation system was started.	B

42	**Langley, J. M., Hanakowski, M., & Bortolussi, R. (1994).** Demand for isolation beds in a pediatric hospital. *American Journal of Infection Control, 22*(4), 207-211.	Number and availability of single-bed rooms	Demand and usage of single-bed rooms	Survey; repeated measurements; prospective; questionnaire; chart records	1,634 patients in 89 rooms in six units in a 218-bed Canadian pediatric hospital (point prevalence survey); also, questionnaire survey of 10 Canadian pediatric hospitals	Use of isolation rooms in the 218-bed hospital varied seasonally, with 71% between November and April. Demand for single-bed isolation exceeded supply by 2 to 22 beds throughout the year. Children younger than 24 months comprised 28% of admissions and 57% of the isolation bed use. Respiratory and enteric infections requiring contact isolation accounted for 80% of isolation-room use. Among 10 questionnaire-surveyed hospitals, those built after 1965 had more single rooms. Hospitals with less than 33% single-bed pediatric rooms reported this percentage to be inadequate.	B
43	**Larson, E. (1988).** A causal link between handwashing and risk of infection? Examination of the evidence. *Infection Control, 9*(1), 28-36.	Hand washing	Infection	Review of research literature	423 articles related to hand washing published from 1879 to 1986	Fourteen articles linked hand washing to risk of infection. Nine retrospective studies reported that improved hand washing contributed to the interruption of the spread of an infection outbreak. Five prospective studies established the cause-effect relationship between hand washing and infection. Except for specificity, all the elements for causality, including temporality, strength, plausibility, consistency of the association, and dose response, were present.	Review

44	**Larson, E. L., Bryan, J. L., Adler, L. M., & Blane, C. (1997).** A multifaceted approach to changing handwashing behavior. *American Journal of Infection Control, 25*(1), 3-10.	Intensive care units (ICUs) with conventional sinks vs. automated sinks, and/or with educational interventions vs. without educational interventions	Hand-washing compliance rate; self-reported practices and opinions about hand washing	Quasi-experimental; comparison between nursing units and staff across phases—baseline (two months), automated sink interventions, (each for three months), and follow-up (for three months; prospective; hypotheses; observation; questionnaire	301 hours of observation, 2,624 hand-washing indications recorded in two ICUs, one as experimental with interventions, one as control, in a 350-bed health center	Differences were found between the experimental and control medical units with proportions of observed hand washes significantly higher initially when automated sinks were present. These increases, however, were only transient; hand-washing rates returned to baseline rates by the follow-up phase.	A-
45	**Larson, E., McGeer, A., Quraishi, Z. A., Krenzischek, D., Parsons, B. J., Holdford, J., et al. (1991).** Effect of an automated sink on handwashing practices and attitudes in high-risk units. *Infection Control and Hospital Epidemiology, 12*(7), 422-428.	Automated sinks vs. conventional sinks	Hand-washing compliance rate and quality; attitudes of staff to the automated sinks	Quasi-experimental; crossover design; hypotheses; observation in natural setting; automated programmable counting controller; questionnaire	1,610 hand washes by 55 patient care staff in two acute care units (a six-bed postanesthesia recovery room with three sinks, and one 15-bed neonatal intensive care unit with four sinks) in two tertiary hospitals	For both sites at both hospitals, hands were washed better or more thoroughly but significantly less often with the automated sink. Staff expressed negative attitudes about certain features of the automated sink (e.g., they avoided washing their hands when busy because of a 15-second water-flow interruption programmed in the automated sinks). These negative attitudes toward the automated sinks increased over the study period.	A-

46	**Laurel, V. L., Meier, P. A., Astorga, A., Dolan, D., Brockett, R., & Rinaldi, M. G. (1999).** Pseudoepidemic of Aspergillus niger infections traced to specimen contamination in the microbiology laboratory. *Journal of Clinical Microbiology, 37*(5), 1612-1616.	Air and surface contamination in a laboratory during construction	Specimen contamination resulting in pseudo-epidemic of *Aspergillus niger*	A series of air-sampling experiments were conducted using settle plates in a microbiology laboratory after 14 inpatients were classified as infected based on cultures; however, they did not manifest clinical manifestations of the disease	Varying number of settle plates were exposed in each experiment	The source of the pseudo-outbreak was traced to a construction that had occurred a floor below the laboratory to revise the ventilation system for a pediatric clinic. No barriers were erected during this period to minimize dust production, and the specimen processing continued as usual.	B
47	**Loo, V. G., Bertrand, C., Dixon, C., Vitye, D., DeSalis, B., McLean, A. P., et al. (1996).** Control of construction-associated nosocomial aspergillosis in an antiquated hematology unit. *Infection Control and Hospital Epidemiology, 17*(6), 360-364.	Environmental interventions to control airborne pathogens (portable HEPA air purifiers, copper-8-quinolinolate paint, nonperforated ceiling tiles, window sealing, and systematic regular cleaning of surfaces)	Incidence of invasive aspergillosis	Quasi-experimental; sequential before-after comparison; retrospective/ prospective; hypotheses; microbial surveillance; chart records	141 patients (231 admissions, January 1988 to September 1993) with bone marrow transplants or leukemia in seven single rooms in a hematology-oncology unit	The incidence of aspergillosis in the preconstruction period was 3.18 per 1,000 patient days at risk. During construction activity—before the implementation of a control strategy—the incidence increased dramatically to 9.88 per 1,000 days at risk. With environmental measures implemented as construction continued, the incidence decreased to 2.91 per 1,000 days at risk, comparable to the preconstruction baseline rate.	B

48	**Lutz, B. D. J., Rinaldi, J., Wickes, M. G., Huycke, B. L., Mark M. (2003).** Outbreak of invasive Aspergillus infection in surgical patients, associated with a contaminated air-handling system. *Clinical Infectious Diseases, 37*(6), 786-793.	Operating theater air quality: particle counts were measured as surrogate measures for *Aspergillus conidia*	Outbreak of *Aspergillus* infection among surgery patients	Retrospective study: cases were identified over a two-year period by hospital records and analysis of pathology databases and microbiology laboratory records; environmental contamination measured using settle plates and multichannel portable counter; a confined-space color camera with a wide-angle lens and video recorder was used to survey ductwork that could not be directly visualized	Six patients met the case definition	A confined-space video camera identified moisture and contamination of insulating material in ductwork and variable airflow volume units downstream of final filters. No additional invasive *Aspergillus* wound infections were identified after the operating theater air-handling systems were remediated, suggesting that this unusual outbreak was due to the deterioration of insulating material in variable airflow volume units.	B
49	**Mahieu, L. M., De Dooy, J. J., Van Laer, F. A., Jansens, H., & Ieven, M. M. (2000).** A prospective study on factors influencing aspergillus spore load in the air during renovation works in a neonatal intensive care unit. *Journal of Hospital Infection, 45*(3), 191-197.	Introduction of mobile air-filtration devices in a medium-care area undergoing renovation in a neonatal intensive care unit (NICU)	*Aspergillus* spore air concentrations in a high-care area close to the medium-care unit undergoing renovation; nasopharyngeal colonization in the neonates	Quasi-experimental; before-after comparison; regression analysis; retrospective/ prospective; hypotheses; air sampling; chart records	Weekly air samples in three locations over several months in a NICU in Belgium; 311 neonates in a high-care area with 17 beds; no physical barrier between the high-care unit and the medium-care unit undergoing renovation	Renovation works and air concentration of *Aspergillus* spores in the medium-care area resulted in a significant increase in the concentration in the high-care area. Use of a mobile HEPA air-filtration system caused a significant decrease in *Aspergillus* spore concentration. No relationship was found between *Aspergillus* spore air concentration and nasopharyngeal colonization in the neonates.	B

50	**Malamou-Ladas, H., O'Farrell, S., Nash, J. Q., & Tabaqchali, S. (1983).** Isolation of Clostridium difficile from patients and the environment of hospital wards. *Journal of Clinical Pathology, 36*(1), 88-92.	Pathogen contamination of environmental surfaces and features	Environmental and patient contamination with *Clostridium difficile*	Microbial surveillance; surface and patient sampling; chart records	Rectal swabs from 122 patients and 497 environmental swabs from several wards in a UK hospital	Items found positive for *C. difficile* were those subjected to fecal contamination such as commode chairs, bedpans, dustpans, discard bins, the sluice, and a disposable bedpan machine. The organism was also found on the hands of a nurse. Similar antibiogram patterns were demonstrated in the strains obtained from patients and their physical environment, indicating the possible occurrence of cross-infection. Environmental contamination is important in the spread of *C. difficile* in hospitalized patients.	B
51	**McDonald, L. C., Walker, M., Carson, L., Arduino, M., Aguero, S. M., Gomez, P., et al. (1998).** Outbreak of Acinetobacter spp. bloodstream infections in a nursery associated with contaminated aerosols and air conditioners. *Pediatric Infectious Disease Journal, 17*(8), 716-722.	Staff contact; air-conditioner condensate	*Acinetobacter* bloodstream infection (A-BSI)	Quasi-experimental; retrospective cohort study; hypotheses; chart records; microbiologic surveillance	33 infants in a nursery in the Bahamas	Patients with peripheral IV catheters were more likely to develop A-BSI. Among those with IV catheters, only exposure to one nurse was an independent risk factor for developing A-BSI. Nursery settle plates were more likely to grow *Acinetobacter*. than were settle plates from other hospital areas. Cultures from nursery air conditioners also grew *Acinetobacter*. Environmental conditions that increase air-conditioner condensate may promote airborne dissemination via contaminated aerosols and increase the risk of nosocomial A-BSI.	B
52	**McKendrick, G. D., & Emond, R. T. (1976).** Investigation of cross-infection in isolation wards of different design. *Journal of Hygiene (Lond), 76*(1), 23-31.	Different multibed ward designs: large with ventilation to corridors, small with no ventilation to corridors, doors open and closed	Rate of cross-infection of *varicella-zoster* (chicken pox) and measles	Microbial surveillance; prospective; chart records	Seven isolation wards of different size and design in seven hospitals; detailed architectural descriptions provided	Higher incidence of cross-infection of both chicken pox and measles was recorded in large wards with ventilation to corridors. Small wards with no ventilation to corridors had lower incidence of cross-infection. Door opening and staff shortage were also related to higher incidence.	B

53	**McManus, A. T., Mason, A. D., Jr., McManus, W. F., & Pruitt, B. A., Jr. (1992).** Control of *pseudomonas aeruginosa* infections in burned patients. *Surgical Research Communications, 12*, 61-67.	Open multibed ward vs. unit with single-bed rooms	Pathogen colonization rate; postburn day of colonization; mortality	Quasi-experimental; before-after; retrospective; hypotheses; chart records	2,316 burn patients admitted in an open ward (1980-1983) or a single-room unit (1984-1990)	Regarding *Pseudomonus aeruginosa* (PA) colonization, the unit with single-bed rooms had the same incidence rate as the open ward, but had a more delayed postburn day of colonization. Regarding *Pseudomonus bacteremia,* pneumonia, and invasive burn-wound infection, the single-room unit had a lower frequency and later day of postburn colonization. Predicted mortality increased with PA infection in the open ward unit but did not increase with PA infection in the single-bed room unit.	B
54	**McManus, A. T., Mason, A. D., Jr., McManus, W. F., & Pruitt, B. A., Jr. (1994).** A decade of reduced gram-negative infections and mortality associated with improved isolation of burned patients. *Archives of Surgery, 129*(12), 1306-1309.	Burn unit with open multibed ward vs. unit with single-bed rooms	Colonization rate of gram-negative bacteremia (GNB); mortality	Quasi-experimental; before-after; retrospective; hypotheses; chart records	2,519 consecutive patients with large burns in an army burn center	In the single-room environment, incidence of GNB was lower and the post-injury time of first GNB was delayed. Increased mortality was present in the open ward, but not in the single-room unit.	B+
55	**McManus, A. T., McManus, W. F., Mason, A. D., Jr., Aitcheson, A. R., & Pruitt, B. A., Jr. (1985).** Microbial colonization in a new intensive care burn unit. A prospective cohort study. *Archives of Surgery, 120*(2), 217-223.	Renovated burn unit with more single-bed rooms (unit A, nine single bed room, seven beds in four rooms, more sinks) vs. unit B, an interim eight-bed open burn unit	Infection rates	Quasi-experimental; before-after comparison; prospective; hypotheses; microbial surveillance; chart records	50 patients in the two units (25 from each unit)	A significantly lower incidence of *Providencia stuartii* and *Pseudomonas aeruginosa* (type 15) endemics occurred in unit A (single-bed rooms) than in unit B (eight-bed open ward). No evidence of bacterial cross-contamination was observed between A and B. A new unit with more single rooms may prevent cross-contamination with the endemic flora.	B

56	**Mehta, G. (1990).** Aspergillus endocarditis after open heart surgery: An epidemiological investigation. *Journal of Hospital Infection, 15*(3), 245-253.	Air contamination	Incidence of aspergillus endocarditis after open- heart surgery	Retrospective outbreak investigation; the ventilation system, air-conditioning plant, air and inanimate sources in the operating theater were investigated	Four patients developed aspergillus endocarditis after open heart surgery within a period of 10 months in a hospital in New Delhi, India	With the exception of the operating room, which was fitted with laminar airflow, it was possible to isolate *Aspergillus spp.* from all rooms in the operating suite. Air-conditioner cooling coils and pigeon droppings on the ledges outside the suite were found to harbor *Aspergillus* spores in large amounts.	B
57	**Merriman, E., Corwin, P., & Ikram, R. (2002).** Toys are a potential source of cross-infection in general practitioners' waiting rooms. *British Journal of General Practice, 52*(475), 138-140.	Soft surface toys vs. hard surface toys in waiting room	Bacteria counts on surfaces of toys	Quasi-experimental; prospective; hypotheses; bacteria counting	10 soft and 22 hard toys from six general practitioners' surgeries in New Zealand	Soft toys had far higher bacteria counts than hard toys; 90% of soft toys showed evidence of coliform contamination, while only 13.5% of hard toys showed evidence of such contamination. There was little difference, however, in the percentage of hard and soft toys contaminated (100% vs. 91%); soft toys were more likely to have moderate to high contamination rates. Soft toys are harder to disinfect and tend to rapidly become re-contaminated after cleaning; therefore, soft toys may pose an infection risk.	B-
58	**Morawska, L., Jamriska, M., & Francis, P. (1998).** Particulate matter in the hospital environment. *Indoor Air, 8*, 285-294.	Detergent-cleaned surfaces, ventilation system, air filters	Particle concentrations of airborne infectious agents	Experimental study: measurements were performed at the Royal Children's and Royal Brisbane Hospitals; the ventilation and filtration systems were investigated	Outdoor and indoor air samples were taken about every two hours to monitor changes to ambient air characteristics	No affect of detergent-cleaned surfaces; low particle concentration where high-efficiency NEPA or HEPA filters are used. High concentration in areas that used dry media filters and return air ventilation.	B

59	**Morgan, V. R., Mathison, J. H., Rice, J. C., & Clemmer, D. I. (1985).** Hospital falls: A persistent problem. *American Journal of Public Health, 75*(7), 775.	Variables analyzed: age, sex, admission diagnosis, location, hour, reported activity	Falls	Retrospective study: information on inpatient falls was abstracted from patient incident reports for a 152-private room acute-care specialty hospital without pediatric or obstetrical care	229 patients accounted for 250 falls over a consecutive 22-month period; among the 229 falls, 18 patients experienced two or more falls	Sixty-five percent of the falls occurred within the patients' room, most near the bed. Twenty-nine percent occurred in the private bathroom attached to each room, two-thirds of them near the toilet. Of the 167 falls in the patients' rooms, 57 occurred on the way to or from the bathroom. At least half of the total falls were bathroom related.	B
60	**Mulin, B., Rouget, C., Clement, C., Bailly, P., Julliot, M. C., Viel, J. F., et al. (1997).** Association of private isolation rooms with ventilator-associated Acinetobacter baumanii pneumonia in a surgical intensive-care unit. *Infection Control and Hospital Epidemiology 18*(7), 499-503.	Isolation rooms with hand-washing facility in each room vs. multibed open rooms in a surgical intensive care unit (SICU)	Infection rates of ventilator-associated *Acinetobacter baumanii* pneumonia	Quasi-experimental; comparison between two groups of patients cared before-after renovation; prospective; hypotheses; specimen collection and bacteriological analysis	314 patients hospitalized and mechanically ventilated for more than 48 hours in the 15-bed SICU at a university hospital in France	Infection rates were respectively 28.1% and 5.0% in the old open-bay ICU and the new private-room ICU with hand-washing facility in each room. Bronchopulmonary colonization rates were respectively 9.1 and 0.5 per 1,000 patient days of mechanical ventilation.	B
61	**Muto, C. A., Sistrom, M. G., & Farr, B. M. (2000).** Hand hygiene rates unaffected by installation of dispensers of a rapidly acting hand antiseptic. *American Journal of Infection Control, 28*(3), 273-276.	Medical intensive care unit (MICU) and step-down unit with vs. without alcohol-based hand-rub dispensers installed in hall next to every door	Hand-washing compliance rate	Quasi-experimental; before-after comparison; prospective; hypotheses; observation in natural setting	239 hand-washing indications observed in two wards—the medical intensive care unit and its step-down unit—in a university hospital	The baseline hand-washing rate was 60%. After hallway installation of an alcohol-based hand antiseptic rub dispensers and a brief educational campaign, overall hand-hygiene rates did not change.	B+

62	**Neely, A. N., & Maley, M. P. (2001).** Dealing with contaminated computer keyboards and microbial survival. *American Journal of Infection Control, 29*(2), 131-132.	Computer keyboards at bedside: before vs. after contact control procedure (hand washing and glove change between patients)	Bacteria transfer rate; bacteria survival on keyboards	Brief article (letter to editor); before-after; prospective; hypotheses; microbial surveillance	Computer keyboards	Bacteria survival might be a component of the keyboard-contamination problem. After introduction of the contact-control procedure, the transfer rate was at or below the rate before the use of bedside computers.	B-
63	**Noskin, G. A., Bednarz, P., Suriano, T., Reiner, S., & Peterson, L. (2000).** Persistent contamination of fabric-covered furniture by Vancomycin-resistant Enterocci: Implication for upholstery selection in hospitals. *American Journal of Infection Control, 28*(4), 311-313.	Furniture cover materials (fabric and vinyl)	Contamination and disinfection of vancomycin-resistant *Enterocci* (VRE)	Quasi-experimental; comparison of two materials; hypotheses; chart records; microorganism surveillance; simulated experiment	10 seat cushions in five randomly chosen hospital rooms; five simulated samples	VRE was found on 3 of 10 sampled seat cushions. The contamination was associated with patients being or having been in the rooms. In the simulated experiment, VRE was found at 72 hours and seven days after inoculation on fabric and vinyl upholstered chairs. Routine disinfection was successful in removing VRE from vinyl surfaces but not from fabric surfaces. Staff hands were colonized after contact with a contaminated chair.	B
64	**Obbard, J. P., & Fang, L. S. (2003).** Airborne concentrations of bacteria in a hospital environment in Singapore. *Water Air and Soil Pollution, 144*(1), 333-341.	Occupant density, temperature, and humidity	Airborne concentrations of bacteria	Prospective study: measured concentrations of airborne bacteria in different locations within a general hospital in Singapore	Airborne bacteria were collected in each selected location using Anderson Particle Impactors at a specific air-sampling rate for a total of five minutes	Occupant density and humidity were identified as important factors affecting concentrations of airborne bacteria.	C

65	**Opal, S. M., Asp, A. A., Cannady, P. B., Jr., Morse, P. L., Burton, L. J., & Hammer, P. G., (1986).** Efficacy of infection control measures during a nosocomial outbreak of disseminated aspergillosis associated with hospital construction. *Journal of Infectious Diseases, 153*(3), 634-637.	Environmental interventions, e.g.,construction of airtight plastic and drywall barriers about the construction sites, HEPA filters, etc.	Incidence of disseminated aspergillosis	Prospective study: cases of disseminated aspergillosis were identified from hospital records; environmental interventions were put into place, and a six-stage microbial air sampler was used to determine spore counts in different areas of the hospital during the construction phase	Eleven patients in Fitzsimmons Army Medical Center, a military teaching hospital, contracted disseminated aspergillosis during the construction period	High spore counts were found within and outside construction sites in the hospital. After control measures were instituted, no further cases of disseminated aspergillosis were identified. The combination of the four control measures reduced the dissemination of airborne conidia near the construction sites. The barriers were effective only when extending from ceiling to the floor. The use of HEPA filters in patient rooms reduced the number of airborne spores.	B
66	**Oren, I., Haddad, N., Finkelstein, R., & Rowe, J. M. (2001).** Invasive pulmonary aspergillosis in neutropenic patients during hospital construction: Before and after chemoprophylaxis and institution of HEPA filters. *American Journal of Hematology, 66*(4), 257-262.	Air counts of *Aspergillus* organisms on a regular ward vs. on a ward with HEPA filters	Infection rate of invasive pulmonary *Aspergillus* (IPA) in acute leukemia patients	Before and after study with nonconcurrent and concurrent comparison groups; comparison of infection rates among acute leukemia (AL) patients during three different periods when extensive hospital construction and renovation were taking place	Period 1: 12 AL patients Period 2: 28 AL patients Period 3: 71 AL patients (45 treated on a regular ward and 26 were hospitalized in the new ward)	When patients were treated in the new hematology ward (period 3), none of the AL or Bone Marrow Transplant (BMT) patients who were hospitalized exclusively in the new ward developed IPA, although 29% of the AL patients who were housed in the regular ward (due to space shortage) still contracted IPA. The reduced incidence of IPA among patients in the new ward was attributed solely to the HEPA filters (other treatment measures did not result in significant reduction in infection rates).	B

67	**Palmer, R. (1999).** Bacterial contamination of curtains in clinical areas. *Nursing Standard, 14*(2), 33-35.	Bed and window curtains	Bacteria contamination of bed and window curtains	Microbial surveillance; prospective; chart records	28 bed and window curtains sampled from seven surgical, medical, and orthopedic wards	Recently cleaned curtains had the lowest levels of contamination. Bed curtains had much higher counts of bacteria than window curtains. Ward bed curtains are a source of contaminants and bacteria, including methicillin-resistant *Staphylococcus aureus*.	B-
68	**Panagopoulou, P., Filioti, J., Petrikkos, G., Giakouppi, P., Anatoliotaki, M., Farmaki, E., et al. (2002).** Environmental surveillance of filamentous fungi in three tertiary care hospitals in Greece. *Journal of Hospital Infection, 52*(3), 185-191.	Environmental fungal load from air, surfaces and water	No health outcome measured.	Prospective study: the environmental fungal load (FL) of three hospitals in Greece was studied; air, surfaces, and tap water from high-risk departments were sampled monthly during one year	Three hospitals from representative regions of Greece; air, surface, and tap water samples were taken	No correlation between fungal species, season, hospital, or departments was observed. Sixty percent of all surfaces examined yielded filamentous fungi and/or blastomycetes. The highest Air Fungal Load (AFL) recorded was in wards located in direct proximity to renovation works. Special protection measures implemented, such as the plastic coverage of opening, were found inadequate.	B
69	**Passweg, J. R., Rowlings, P. A., Atkinson, K. A., Barrett, A. J., Gale, R. P., Gratwohl, A., et al. (1998).** Influence of protective isolation on outcome of allogeneic bone marrow transplantation for leukemia. *Bone Marrow Transplant, 21*(12), 1231-1238.	Conventional isolation (single room, glove, hand washing, mask, and gown) vs. HEPA/LAF (isolation in rooms designed to lower exposure to airborne infectious agents using high-efficiency particulate air filtration with or without	Graft vs. host disease; fungal pneumonia; one-year transplant-related mortality (TRM); one-year survival	Quasi-experimental; analysis using existing data; retrospective; hypotheses	5,065 patients receiving allogeneic bone marrow transplants between 1988 and 1992 and reported to the International Bone Marrow Transplant Registry by 222 teams	Among patients receiving alternative donor transplants, the probability of fungal pneumonia was lower in the HEPA/LAF isolation. TRM was lower and one-year survival higher for patients treated with HEPA/LAF isolation, whether the transplant was from an HLA (human leukocyte antigen)-identical sibling or alternative donor. Patients treated with HEPA/LAF had lower relative risks of TRM and overall mortality in the first 100 days post-transplant.	B

		laminar airflow equipment)					
70	**Pegues, D. A., & Woernle, C. H. (1993).** An outbreak of acute nonbacterial gastroenteritis in a nursing home. *Infection Control and Hospital Epidemiology, 14*(2), 87-94.	Having roommate vs. no roommate in a nursing home	Nosocomial infection rates	Quasi-experimental; risk analysis; retrospective/ prospective; hypotheses; chart records; questionnaire	120 residents and 49 employees in a nursing home	The risk of becoming ill one to two days after a roommate became ill was significantly greater than that of becoming ill at other times during the outbreak. The risk of developing illness was greater for female residents and for employees who reported handling residents' soiled linen, stools, or vomit more frequently.	B

71	**Pettinger, A., & Nettleman, M. D. (1991).** Epidemiology of isolation precautions. *Infection Control and Hospital Epidemiology, 12*(5), 303-307.	Occupation and gender of persons entering the room; time spent in the room; number of persons entering the room at a time;type of patient isolation	Isolation-precaution compliance rate	Survey; prospective; hypotheses; observation; chart records	467 persons entering the isolation room of a 24-bed surgical intensive care unit in a 900-bed university hospital	Visitors were much more compliant than staff with strict isolation precautions (88% vs. 41%; $p < .01$). Spending more time in the room was associated with improved compliance. Compliance was higher for persons entering with a group compared with those entering alone. The compliance rate for nurses tended to improve as the nurse-patient ratio increased. Compliance was independent of severity of illness. The amount of time spent in the room and being a visitor were independent predictors of compliance with isolation precautions.	B
72	**Pittet, D., Hugonnet, S., Harbarth, S., Mourouga, P., Sauvan, V., Touveneau, S., et al. (2000).** Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. *Lancet, 356*(9238), 1307-1312.	Promotion posters; bedside, alcohol-based hand-disinfection solution	Hand-washing compliance rate; nosocomial infection rates; rates of methicillin-resistant *Staphylococcus aureus* (MRSA); consumption of hand-rub disinfectant	Quasi-experimental; before-after comparison; prospective; hypotheses; observation in natural setting; chart records	A large acute care teaching hospital in Geneva, Switzerland	After the installation of posters and hand-disinfection dispensers, the hand-washing compliance rate improved from 48% in 1994 to 66% in 1997. Frequency of hand disinfection increased substantially, nosocomial infection decreased (16.9% in 1994 to 9.9% in 1998), MRSA transmission rates decreased (2.16 to 0.93 episodes per 10,000 patient days; $p < 0.001$), and the consumption of alcohol-based hand-rub solution increased from 3.5 to 15.4 L per 1,000 patient-days between 1993 and 1998.	B+

73	**Preston, G. A., Larson, E. L., & Stamm, W. E. (1981).** The effect of private isolation rooms on patient care practices, colonization and infection in an intensive care unit. *American Journal of Medicine, 70*(3), 641-645.	Renovation of an intensive care unit from a six-bed open unit with two sinks to 14 single-bed rooms, each with one sink	Number of persons in the vicinity of patients; staff hand-washing behavior; colonization and infection	Quasi-experimental; before-after comparison; prospective; hypotheses; observation; microbial surveillance; chart records	410 open-unit patients and 1,022 single-room unit patients in an intensive care unit (for infection rates comparison); 168 patient-hours (99 patients) observation/air sampling during nine months in open unit and 113 patient-hours (68 patients) in single-room units during 12 months	Single rooms with more sinks tended to have higher observed-to-expected ratio of hand washing (30%) than open unit (16%, $p = 0.06$). Respiratory tract infection rate was lower in single-bed room units (3.6 per 100 patients vs. 5.4 per 100) than in the open unit. No differences were found in other types of infections and nosocomial acquisition of the six surveillance organisms. Numbers of persons interacting with a patient in an hour averaged 6.1 in the open units and 4.9 in the isolation rooms ($0.05<P<0.10$).	B
74	**Resnick, B. (1999).** Falls in a community of older adults: Putting research into practice. *Clinical Nursing Research, 8*(3), 251-266.	Location of falls in a retirement community	Falls	Descriptive study: over a two-year period, a fall data form was completed for each reported and witnessed fall; the fall data form included the time, location, associated activity, and use of alcohol or sedative hypnotics within four hours of the fall as well as the outcome of the fall based on examination	Convenience sample of 220 older adults living in a continuing care retirement community; mean age of participants was 86 and majority were Caucasian (99%) and women (81%)	There were 154 falls, most of which occurred between noon and midnight, within the residents' apartments, when walking or transferring. No association is mentioned between any environmental variable (location) and number of falls.	B

75	**Roberts, S. A., Findlay, R., & Lang, S. D. (2001).** Investigation of an outbreak of multi-drug resistant Acinetobacter baumannii in an intensive care burns unit. *The Journal of Hospital Infection, 48*(3), 228-232.	Interventions: cleaning of environmental surface, review of hand-washing practice	Isolates of *Acinetobacte baumannii*	Quasi-experimental; before-after comparison; retrospective/ prospective; hypotheses; microbial surveillance; DNA typing; chart records	15 patients (12 from burns intensive care unit) involved in an outbreak of a multidrug resistant *A. baumannii* infection; environmental surfaces; 21 healthcare workers in a burns intensive care unit	Before interventions, the room environment was contaminated with the *A. baumannii*, as was the handle of the door leading from the antechamber between both rooms. This allowed the hands of healthcare workers to be contaminated by *A. baumannii* despite appropriate hand-washing procedures prior to leaving the rooms. Two staff members were colonized with *A. baumannii.* After interventions, no isolates of *A. baumannii* were found among patients in the burns intensive care unit.	B-
76	**Rountree, P. M., Beard, M. A., Loewenthal, J., May, J., & Renwick, S. B. (1967).** Staphylococcal sepsis in a new surgical ward. *British Medical Journal, 1*(533), 132-137.	Old open ward vs. new ward with more single rooms (6 four-bed rooms, 1 two-bed room, and 4 single rooms)	Infection; contamination	Quasi-experimental; before-after comparison; retrospective/ prospective; hypotheses; microbial surveillance; DNA typing; chart records	1,337 patients; 1,811 air samples; 613 curtain samples; 2,004 blanket samples from the new surgical ward in a British hospital	The sepsis rate of *Staphylococcus* in the patients' wounds was 9% in the new ward (10% for men, 7% for women), which was lower than the rate of 14% in the old ward. 28% of these were due to multiple antibiotic-resistant "hospital" strains, which was less than the rate of 56% in the old ward. There was a reduction in the contamination of air and bedding.	B

77	**San Jose-Alonso, J. F., Velasco-Gomez, E., Rey-Martinez, F. J., Alvarez-Guerra, M., & Pelaez, C. G. (1999).** Study on environmental quality of a surgical block. *Energy and Buildings, 29*(2), 179-187.	Ventilation design and maintenance	Indoor air (CO, CO2, TVOC gases, anaesthetic gases); thermal comfort	Retrospective: serious deficiencies of indoor air quality in a hospital in Spain—symptom reports were collected from 118 hospital workers	Measurements of ventilation and contaminants were made of indoor air at six different points simultaneously and also of outdoor air	Indoor air quality was affected by the state of the installations crossing surgical and other areas of health center. Cleanliness of air filters, ducts, etc., is highly important.	B
78	**Sanderson, P. J., & Weissler, S. (1992).** Recovery of coliforms from the hands of nurses and patients: Activities leading to contamination. *Journal of Hospital Infection, 21*(2), 85-93.	Nurses' and patients' hands	Coliform contamination	Microbial surveillance	In preliminary study: 65 hand prints from nurses from both units; in main study: 462 hand prints of nurses, 170 finger cultures from patients, skin cultures from 24 patients in general surgical ward; 450 hand prints of nurses, 282 finger cultures from patients, skin cultures from 12 patients in spinal injuries ward	Coliforms were frequently recovered from nurses' hands after touching patients' washing materials and clothing as well as after bed making, sluice-room activities, and handling clean or dirty linen and curtains. The recovery rates were higher in wards for spinally injured patients than in the surgical wards. Coliforms were recovered with similar frequencies from the hands of patients in both types of wards. Hands might be a media of cross-infection.	B

79	**Sherertz, R. J., & Sullivan, M. L. (1985).** An outbreak of infections with Acinetobacter calcoaceticus in burn patients: Contamination of patients' mattresses. *Journal of Infectious Diseases, 151*(2), 252-258.	Wet mattresses	Burn wound colonization with *Acinetobacter*	Quasi-experimental; before-after comparison; prospective; hypotheses; microbial surveillance; chart records	63 patients infected with *Acinetobacter* in a burn intensive care unit in a hospital in Florida (1981-1982)	Wet mattresses served as environmental reservoirs of *Acinetobacter*. Discarding each patient's mattress on the day of the patient's discharge led to a reduced risk of burn wound colonization with *Acinetobacter* ($P < 0.05$) and, ultimately, resulted in the complete elimination of the organism from the burn unit.	B
80	**Shirani, K. Z., McManus, A. T., Vaughan, G. M., McManus, W. F., Pruitt, B. A., Jr., & Mason, A. D., Jr. (1986).** Effects of environment on infection in burn patients. *Archives of Surgery, 121*(1), 31-36.	Old unit vs. new unit with separate bed enclosures	Infection rate; mortality	Quasi-experimental; before-after comparison; prospective; hypotheses; prediction model; chart records	173 patients in the old open intensive care unit, 213 patients in the new intensive care unit with separate bed enclosures	Infection rate was significantly reduced in the new unit with separate bed enclosure (from 28.9% to 19.2%). Reduction in observed mortality compared with predicted mortality (calculated on the basis of burn size and age alone), was not apparent in the early group, but was apparent in the new unit (reduction from 48.7% to 28.3%) and was restricted to the subgroup of patients with predicted mortality of 25% to 75%. The overall proportion of patients with bacteremia was reduced from 20.1% to 9.4% in new unit. The incidences of both pneumonia and burn wound invasion remained unchanged. *Providencia* and *Pseudomonas* species, endemic in the early cohort, were eliminated in the new unit.	B

81	**Skoutelis, A. T., Westenfelder, G. O., Beckerdite, M., & Phair, J. P. (1994).** Hospital carpeting and epidemiology of Clostridium difficile. *American Journal of Infection Control, 22*(4), 212-217.	Carpet	Microorganism (*Clostridium difficile*) contamination; colonization; infection	Microbial surveillance; quasi-experimental; prospective; chart records	Seven areas (three cultures per area) in each room (total 64 rooms); 59 patients	Carpeted floors were significantly more contaminated for prolonged periods with clinical strains of *C. difficile* than were noncarpeted floors. Contamination of carpeting was not associated with significantly increased frequency of pseudomembranous enterocolitis infection. Room carpeting should be considered a potential reservoir of this organism.	B
82	**Smedbold, H., Ahlen, C., Unimed, S., Nilsen, A., Norbaeck, D., & Hilt, B. (2002).** Relationships between indoor environments and nasal inflammation in nursing personnel. *Archives of Environmental Health, 57*(2), 155-161.	Ventilation system	Nasal inflammation in nursing personnel	Retrospective study following complaints about the indoor climate among staff at geriatric hospitals in Norway (63 degN)	Clinical data of 115 females working in 36 geriatric nursing departments in Norway	Nasal patency due to fungal contamination of the air-supply ducts. The findings illustrate the significance of maintaining the ventilation systems and lowering room temperatures.	C
83	**Smylie, H. G., Davidson, A. I., Macdonald, A., & Smith, G. (1971).** Ward design in relation to postoperative wound infection. *British Medical Journal, 1*(740), 67-72.	Before (1964-6): Nightingale open ward; after (1966-8): racetrack surgical ward with 40% beds in single rooms and controlled ventilation	Postoperation wound infection rate	Quasi-experimental; before-after; prospective; hypotheses; microorganism surveillance; observation; chart records	1,477 (before) and 1,737 (after) patients, all staff members, air samples from a surgical ward in UK	In the new unit with more single rooms and controlled ventilation, postoperative wound-infection rate was lowered by 55% compared to the old open unit. After transferring to the new unit, infection rate of staphylococcal was reduced by 72%. The air samples in the new unit were significantly less contaminated, which was attributed to the improved air hygiene due to more separations and controlled ventilation.	B

84	**Thompson, J. T., Meredith, J. W., & Molnar, J. A. (2002).** The effect of burn nursing units on burn wound infections. *Journal of Burn Care Rehabilitation, 23*(4), 281-286.	Burn isolation unit vs. other area without isolation, where burn patients were treated during renovation of the burn unit	Nosocomial infection rates	Quasi-experimental; sequential before-after comparison; retrospective; hypotheses; chart records	75 patients in burn unit in a hospital in North Carolina—37 in group A cared in burn unit, before renovation; 17 in group B cared in other area during renovation of the burn unit; 21 in group C cared in burn unit, after renovation	Incidence of infection differed significantly ($P < 0.005$), with 47% of patients in group B (cared in other area) having developed infection, compared with 11% and 23% for groups A (cared in burn unit, before renovation) and C (cared in burn unit, after renovation), respectively. Influential variables contributing to the lower infection rates in A and C included: control of traffic, control of dietary habits, and control of dressing, which are made possible by isolation.	B
85	**Utrup, L. J., Werner, K., & Frey, A. H. (2003).** Minimizing pathogenic bacteria, including spores, in indoor air. *Journal of Environmental Health, 66*(5), 19-26, 29.	Picking up of pathological bacteria by coagulated particulates introduced in the room electric field	Protection against pathogenic bacteria, including spores	Assessment/tests to demonstrate that bacteria of different shapes and sizes—vegetative cells and spores—respond like particulate contaminants to the primary forces that control the distribution of small particulates in a room.	Five experiments in a dedicated aerosol physics test facility that has previously yielded highly reliable data with particulates and chemicals; culture-based measurements at timed intervals in a test facility	Acceleration of "coagulation" can enhance the effectiveness. The results indicate that the organisms do respond like particulate contaminants to typical electrical forces in a room.	A-
86	**Vernon, M. O., Trick, W. E., Welbel, S. F., Peterson, B. J., & Weinstein, R. A. (2003).** Adherence with hand hygiene: Does number of sinks matter? *Infection Control and Hospital Epidemiology, 24*(3),	Sink-to-bed ratio	Hand-washing compliance rate by all healthcare workers in intensive care unit (ICU)	Quasi-experimental; comparison between nursing units; prospective; hypotheses; unobtrusive observation in natural setting	14 randomly selected nursing units (seven ICUs, seven non-ICUs) in four facilities (sink-to bed ratio 1:1 in single rooms to 1:6 in open wards, 1,487 hand-washing	In non-ICU wards, hand-washing compliance was similar in wards with a ratio of 1:6 to 1:1. In ICUs there existed a statistically insignificant trend toward improved compliance with increased ratios: 1:4, 33%; 1:3, 36%; 1:2, 20%; 1:1, 41%.	B

	224-225.				indications)		
87	**Williams, H. N., Singh, R., & Romberg, E. (2003).** Surface contamination in the dental operatory: A comparison over two decades. *Journal of the American Dental Association, 134*(3), 325-330.	Improvements in clinic design and equipment (reduce the number of surface areas, mobile countertops, central sterilization facility, autoclavable handpieces, foot-pedal controlled sinks); more stringent infection control procedures	Surface contamination	Quasi-experimental; before (1976)/after (1998) comparison; retrospective/ prospective; hypotheses; microbial surveillance	30 randomly selected dental operatories in a dental clinic (>200 chairs) in Maryland	Improvements in clinic design and equipment, as well as infection control during procedures and practices, resulted in a lower level of surface bacterial contamination in 1998 than in 1976.	B
88	**Wong, S., Glennie, K., Muise, M., Lambie, E., & Meagher, D. (1981).** An exploration of environmental variables and patient falls. *Dimensions in Health Service, 58*(6), 9-11.	Environmental factors associated with fall	Falls	Two-stage study: pilot study of incident reports followed by a questionnaire used by the hospital staff to collect fall-related data; data were collected about patient falls during a one-month period	24 patients from 19 to 88 years old at a psychiatric hospital in Nova Scotia	41% of the falls involved 'low beds,' 12% high beds, 25% a chair, 14% the bedside table, and 8% wheelchairs. Floor conditions and lighting had no significant effect on falls. Most falls (50%) occurred near the bed with the patient possibly attempting to ambulate. Falls were associated with activities requiring a change of posture (e.g., getting out of bed after having been in a recumbent position).	B

Reduce Stress and Improve Outcomes

No.	Study	Environmental variable(s) studied	Outcome measure(s)	Research design	Sample description	Major findings	Grade
1	**Aaron, J. N., Carlisle, C. C., Carskadon, M. A., Meyer, T. J., Hill, N. S., & Millman, R. P. (1996).** Environmental noise as a cause of sleep disruption in an intermediate respiratory care unit. *Sleep, 19*(9), 707-710.	Noise measured by sound meter	Sleep disruption measured by polysomnography	Quasi-experimental; hypotheses; sound meter; polysomnography (diagnostic test involving measurement of number of physiologic variables during sleep)	Six patients in an intermediate respiratory care unit (IRCU) recorded in 61 half-hour segments	There was a strong positive correlation ($r = 0.57$) between the number of sound peaks of ≥80 dBA and arousals from sleep. When the periods were classified as quiet, moderately loud, and very loud based on the number of sound peaks, there were significantly fewer arousals during quiet periods than during very loud periods. Environmental noise may be an important cause of sleep disruption in the IRCU.	B
2	**Ackerman, B., Sherwonit, E., & Fisk, W. (1989).** Reduced incidental light exposure: Affect on the development of retinopathy of prematurity in low birth weight infants. *Pediatrics, 83*(6), 958-962.	Incidental lighting within the newborn intensive care unit	Development of retinopathy of prematurity	Experimental study with historical control group: data obtained retrospectively for control group	Control group: 129 infants admitted to the newborn special care unit at Yale-New Haven Hospital; experimental group: 161 infants admitted to the same unit	There was no difference in the incidence and severity of retinopathy of prematurity between the two groups.	C

3	**Allaouchiche, B., Duflo, F., Debon, R., Bergeret, A., & Chassard, D. (2002).** Noise in the postanaesthesia care unit. *British Journal of Anaesthesia, 88*(3), 369-373.	Noise sources and dBA levels/peaks in a postanesthesia care unit (PACU)	Noise levels; patient perceptions of noise; self-reported discomfort	Quasi-experimental; prospective; decibel recordings; observation of noise peaks; questionnaire assessing patient discomfort	26 patients in an open ward, five-bed PACU in a 35-bed surgical department; 20,187 measurements of noise	The mean dBA level (over 5s intervals) was 67.1, the maximum (over 5s intervals) was 75.7, and the minimum 48.6. The average of peak noises using a linear scale was 126.2 dBL. Five percent of noises exceeded 65 dBA. Staff conversation in open ward caused 56% of sounds greater than 65 dB. Other noise sources (alarm, telephone, and nursing care) each comprised less than 10% of these sounds. Five patients reported disturbance from noise, and there was no significant difference in average levels measured for patients who found the PACU noisy and those who did not.	B
4	**Astedt-Kurki, P., Paunonen, M., & Lehti, K. (1997).** Family members' experiences of their role in a hospital: A pilot study. *Journal of Advanced Nursing, 25*(5), 908-914.	Location in hospital of visits by family members with patients	Family members' experience	Survey questionnaire	50 family members of patients in a neurological ward in a Finnish hospital	Family members spent a lot of time at their relative's bedside, most of them up to several hours a day. Almost half of all visits (49%) took place in the patient's room, 20% were in the ward lounge, and 21% in the hospital café. Family members sought out spaces where they could spend time alone with the patient. The most important way in which the hospital supported families was to keep them informed about the patient's care and treatment.	C
5	**Baker, C. F. (1984).** Sensory overload and noise in the ICU: Sources of environmental stress. *Critical Care Quarterly, 6*(4), 66-80.	Environmental sources of sensory overload with emphasis on noise	Various effects on intensive care unit (ICU) patients	Review of research literature	About 40 articles	The article mainly surveyed studies on noise. It reviewed and discussed the physical properties of noise (loudness, perceived noisiness, response to noise), noise's physiological (blood pressure, heart rate) and psychological effects on patients (sleep deprivation, ICU psychosis, pain), the sources and levels of noise, and noise-control	Review

						measures.	
6	**Baker, C. F. (1992).** Discomfort to environmental noise: Heart rate responses of SICU patients. *Critical Care Nursing Quarterly, 15*(2), 75-90.	Noise levels and sources	Heart rate	Quasi-experimental; correlational; prospective; hypotheses; ECG monitor; sound level meter	28 adult patients in a 14-bed single-room surgical intensive care unit	The lowest sound level experienced by most patients was 59 dBA, due to oxygen ventilators near the patients' heads. Fourteen patients were exposed to 65–69 dBA. Categories of noise sources included conversation in the room, conversation outside the room, nonconversation noise, and ambient noise (listed in the order of average loudness). Patients' heart rates increased with dBA increases (2–12 bpm with a 6-dBA increase), particularly in response to noises from conversation.	B
7	**Baker, C. F., Garvin, B. J., Kennedy, C. W., & Polivka, B. J. (1993).** The effect of environmental sound and communication on CCU patients' heart rate and blood pressure. *Research in Nursing & Health, 16*(6), 415-421.	Environmental noise from equipment; social noise from conversation	Heart rate, blood pressure	Quasi-experimental; correlational; hypotheses; ECG monitor; sound meter; blood pressure monitor; self-reported anxiety	20 patients in a 29-bed coronary critical care unit studied over two days	The loudest sounds exceeded 70 dBA. Maximum heart rates were higher during conversation than during low ambient sounds (quiet). Blood pressure did not significantly change during any of the sound conditions.	B

8	**Barnhart, S. K., Perkins, N. H., & Fitzsimonds, J. (1998).** Behaviour and outdoor setting preferences at a psychiatric hospital. *Landscape and Urban Planning, 42*(2-4), 147-156.	Different outdoor settings	Preferred types of outdoor spaces for different behaviors	Quasi-experimental; prospective; hypotheses; a patient-interactive computer survey located in one of the secure hospital wards	74 subjects (50% staff and 50% patients) in a 312-bed psychiatric hospital in Canada	Both staff and patients selected natural open settings for passive behaviors such as sitting and viewing scenery, and natural enclosed settings for active behaviors, such as walking and talking with others. Few significant differences were found between staff and patients.	B
9	**Bay, E. J., Kupferschmidt, B., Opperwall, B. J., & Speer, J. (1988).** Effect of the family visit on the patient's mental status. *Focus on Critical Care, 15*(1), 11-16.	Family visits; family closeness; anxiety	Patient mental status	Quasi-experimental; before-after; prospective; hypotheses; Adams Mental Status Examination; family self-rated closeness and anxiety; chart records	74 patients and their families in three general intensive care units	Family visits had no consistent effect on patient mental status. Some patients improved after the visit, whereas others experienced a decline in their mental status. Patients who had undergone surgery were more likely to have a negative change in mental status after a visit. Family members who saw themselves as having moderate amounts of mutuality (closeness) with patients had the most positive effects on patient mental status.	B
10	**Bayo, M. V., Garcia, A. M., & Garcia, A. (1995).** Noise levels in an urban hospital and workers' subjective responses. *Archives of Environmental Health, 50*(3), 247-251.	Noise levels and sources	Staff-reported judgments of noise effects on staff and patients	Descriptive; survey of noise distribution; prospective; sound meter; questionnaire	295 staff members in a hospital in Spain	Noise outside the building ranged from 52 to 75 dBA. The main sources were road traffic, human voices, aircraft, and sirens. Noise levels inside the building ranged from 52 to 82 dBA, and the main sources were human voices, vehicles, and equipment. From the staff perspective, noise levels were sufficiently high to interfere with their work and to affect patient comfort and recovery.	B-

11	**Beauchemin, K. M., & Hays, P. (1996).** Sunny hospital rooms expedite recovery from severe and refractory depressions. *Journal of Affective Disorders, 40*(1-2), 49-51.	Sunlight: sunny rooms vs. dull rooms	Length of stay, mortality	Natural experiment	568 cases with a nonfatal outcome processed—272 in the bright rooms (men 209, women 63) and 296 in dark rooms (men 222, women 74)	Patients stayed a shorter time in sunny rooms, but significant difference was confined to women (2.3 days in sunny rooms, 3.3. days in dull rooms). Mortality in both sexes was consistently higher in dull rooms.	A-
12	**Beauchemin, K., & Hays, P. (1998).** Dying in the dark: Sunshine, gender and outcomes in myocardial infarction. *Journal of the Royal Society of Medicine, 91*(7), 352-354.	Sunny (bright) rooms vs. dull (dim) rooms	Length of stay	Retrospective natural experiment: random assignment of patients	174 admissions to two psychiatric wards at a hospital in Edmonton, Alberta, Canada	Patients in sunny rooms had an average stay of 16.6 days compared to 19.5 days for those in dull rooms, a difference of 2.6 days (15%). The difference was more marked for males: bright rooms, 15.3 days vs. dull rooms, 22.1 days.	A-
13	**Benedetti, F., Colombo, C., Barbini, B., Campori, E., & Smeraldi, E. (2001).** Morning sunlight reduces length of hospitalization in bipolar depression. *Journal of Affective Disorders, 62*(3), 221-223.	Sunlight: east-facing room (direct morning sunlight) vs. west-facing rooms	Length of stay	Naturalistic retrospective observation days were analyzed	Consecutively admitted 415 and 187 bipolar depressed inpatients, stratified by diagnosis, rooms of hospitalization, and season of hospitalization	Bipolar patients in east rooms had a mean 3.67-day shorter hospital stay than patients in west rooms. No effect was found in unipolar patients.	A-
14	**Bentley, S., Murphy, F., & Dudley, H. (1977).** Perceived noise in surgical wards and an intensive care area: An objective analysis. *British Medical Journal, 2*(6101), 1503-1506.	Noise in an open Nightingale ward, a cubicle, and a mixed intensive therapy unit (ITU)	Sources and levels of noise	Descriptive survey of noise distribution; sound meters mounted on walls above heads of patients	Five 24-hour periods in an open Nightingale ward, a cubicle of the ward, and an ITU in the UK	Noise levels in all three areas were higher than internationally recommended levels at all times of day. Loud noises above 70 dBA were common in all areas, particularly the ITU. Noise reached levels known to cause annoyance during the day in the ward and cubicle, and during both the day and the night in the ITU. Equipment and staff conversations	B-

						were the main causes of noise in the ITU.	
15	**Berg, S. (2001).** Impact of reduced reverberation time on sound-induced arousals during sleep. *Sleep, 24*(3), 289-292.	Acoustic characteristics of ceiling tiles (sound-reflecting vs. sound-absorbing)	Reverberation time; sleep arousals or fragmentation	Quasi-experimental; within-subjects; prospective; recording of dB levels and reverberation period; sleep recording via EEG	12 healthy student volunteers (six male, six female) studied in a one-bed room over four nights in a refurbished (former) surgical ward	Sound-absorbing ceiling tiles reduced the reverberation time by 0.12 seconds in a frequency range of 200–5,000Hz. At the same time, arousal responses/sleep fragmentations were significantly reduced, indicating improved sleep quality.	A
16	**Blackburn, S., & Patteson, D. (1991).** Effects of cycled light on activity state and cardiorespiratory function in preterm infants. *Journal of Perinatal & Neonatal Nursing, 4*(4), 47-54.	Cycled light (lights turned off for a portion of the 24-hour day) vs. continuous lighting	Heart rate, activity levels, and respiratory rate	Natural experiment	18 infants born at or prior to 34-weeks gestation, admitted to a tertiary neonatal intensive care unit	Heart rates and activity levels were significantly lower for the cycled (lights off) group than the continuous lighting group. Also, infants in the cycled-light group tended to have longer periods of quiescence and inactivity similar to quiet sleep.	B
17	**Blomkvist, V., Eriksen, C. A., Theorell, T., Ulrich, R. S., & Rasmanis, G. (in press, 2004).** Acoustics and psychosocial environment in coronary intensive care. *Occupational and Environmental Medicine.*	Reverberation time (altered by changing the ceiling tiles in a coronary critical care unit (CCU) from sound-reflecting tiles to sound-absorbing tiles of identical appearance)	Reported psychosocial work environment and staff moods; speech intelligibility	Quasi-experimental; repeated measurements; prospective; hypotheses; sound-level recordings; staff questionnaire; Rapid Speech Transmission (RASTI) measure	36 nurses working regularly over three shifts for several weeks in the CCU in a large Swedish teaching hospital	Shorter reverberation times were recorded after ceiling tiles were changed from sound-reflecting ceiling tiles to sound-absorbing ceiling tiles (0.8-0.9 to 0.4 seconds). The staff experienced significantly lower work demands and improved workplace atmosphere (less pressure and strain) during the afternoons. Speech intelligibility improved on the RASTI scale when the sound-reflecting ceiling was changed to sound	A-

				of speech intelligibility		absorbing.	
18	**Brown, B., Wright, H., & Brown, C. (1997).** A post-occupancy evaluation of wayfinding in a pediatric hospital: Research findings and implications for instruction. *Journal of Architectural & Planning Research, 14*(1), 35-51.	Wayfinding aids	Staff involvement in giving directions for wayfinding, influence on work commitments; visitor wayfinding experiences; patient wayfinding experiences	Postoccupancy evaluation; five systematic methods were used to assess problems: staff and visitor interviews, staff-maintained logs to record visitor wayfinding requests, photographed traces, behavior observation and tracking, cognitive maps drawn by patients and parents	66 staff interviews, 47 visitor wayfinding interviews, 46 summaries of one week of direction giving, 193 observations of initial wayfinding, 13 visitors tracked to destination-cognitive maps drawn by 11 inpatients and three parents	Spatial organization and layout often resulted in wayfinding problems. Problems were exacerbated by inadequate or conflicting cues—signs, colors, lighting. Important to understand entire wayfinding system to diagnose and remedy wayfinding problems. Detailed findings related to the specific conditions at the hospital. However, these are commonly occurring situations in hospitals.	D

19	**Callahan, E. J., Brasted, W. S., Myerberg, D. Z., & Hamilton, S. (1991).** Prolonged travel time to neonatal intensive care unit does not affect content of parental visiting: A controlled prospective study. *Journal of Rural Health, 7*(1), 73-83.	Parental visits to a neonatal intensive care unit (NICU)	Observed parent behaviors (closeness to incubator, parent-staff interaction, eye contact between parent and child, physical contact); number and duration of parental visits	Observation	49 set of parents with infants in the NICU separated into three groups: visits in house while mother hospitalized; visits requiring one hour or less travel time; visits requiring more than one hour of travel time	Travel time was found to influence the number of visits, with fewer visits from those parents who lived furthest from the NICU. The duration of these infrequent visits was longer in comparison to those visits from parents living closer to the NICU, therefore, the total duration of visiting time over a two-week period was the same. Observation of behaviors indicated no difference in interaction between parents and infants among the groups.	
20	**Carpman, J., Grant, M., & Simmons, D. (1983-84).** Wayfinding in the hospital environment: The impact of various floor numbering alternatives. *Journal of Environmental Systems, 13*(4), 353-364.	Floor numbering in a multistory hospital with two basement floors	Clarity and desirability of different numbering systems for wayfinding	Prospective study	Stratified random sample: 60 patients (15 inpatients, 15 outpatients) and visitors (15 inpatient visitors and 15 outpatient companions) were interviewed; 350 staff members were interviewed	Patients and visitors preferred SUB1, SUB2 over other options. Staff preferences were different—they preferred naming the floors 1 and 2 based on a concern that B1, B2 and SUB1, SUB2 schemes project a poor image—basement floors had a negative association.	
21	**Carpman, J., Grant, M., & Simmons, D. (1984).** *No more mazes: Research about design for wayfinding in hospitals*. Ann Arbor, Michigan: The University of Michigan Hospitals.	Terminology on hospital signs	Patients' and visitors' understanding of technical and lay hospital-related terms	Patient and visitor interviews	Study 1: random sample of 125 patients and visitors; study 2: random sample of 105 visitors	For the most part, terms suggested most often in study 1 were also selected the 'best' by participants in study 2. Participants preferred simple terms such as *walkway*, *general hospital* to more complex or less familiar terms such as *overhead link, medical pavilion*, or *health sciences complex.*	A-

22	**Carpman, J., Grant, M., & Simmons, D. (1984).** *No more mazes: Research about design for wayfinding in hospitals.* Ann Arbor, Michigan: The University of Michigan Hospitals.	Plan view vs. perspective view in you-are-here maps; use of insets in YAH maps	Clarity of spatial representation	Prospective study; random assignment	70 randomly selected patients and visitors	Perspective view was preferred over the plan view (whether presented with or without inset). Maps with insets were preferred over those without, whether dealing with plan or perspective views.	B
23	**Carpman, J., Grant, M., & Simmons, D. (1984).** *No more mazes: Research about design for wayfinding in hospitals.* Ann Arbor, Michigan: The University of Michigan Hospitals.	Location and spacing of signs; decision points	Travel time; number of hesitations; number of times directions asked; reported level of stress; number of additional signs requested; number of signs available to participant	Experimental design; multiple outcomes measured; random sample	105 randomly selected inpatients and inpatient visitors; 26 participants in each of the experimental groups and 26 in a fourth group without any signs	The number of signs available to the participant had a significant effect on wayfinding along many different measures including travel time, number of hesitations, number of times directions were asked, as well as reported level of stress. Results suggest that directional signs should be placed at or before every major intersection, at major destinations, and where a single environmental cue or a series of such cues (e.g., change in flooring material) convey the message that the individual is moving from one area into another. If there are no key decision points along a route, signs should be placed approximately every 150–250 feet.	A-

24	**Carpman, J., Grant, M. A., & Simmons, D. A. (1985).** Hospital design and wayfinding: A video simulation study. *Environment & Behavior, 17*(3), 296-314.	Alternative locations of entrance doors to parking structure	Turning behavior and wayfinding	Experimental, video simulation study	100 hospital visitors randomly sampled in different public spaces (lobbies and waiting areas throughout the hospital)	Significantly more people said they would turn into the drop-off circle when there was a north entrance to the deck than when there was no north entrance, even when there was signage instructing them to continue ahead to find parking. The results remained similar in crowded and uncrowded situations. The results of this study had a direct impact on subsequent design decisions.	A-
25	**Causey, D. L., McKay, M., Rosenthal, C., & Darnell, C. (1998).** Assessment of hospital-related stress in children and adolescents admitted to a psychiatric inpatient unit. *Journal of Child and Adolescent Psychiatric Nursing, 11*(4), 135-145.	Stressors related to a psychiatric inpatient unit	Reported hospital-related stressors; reported coping efforts, depression, and anxiety; observed behaviors and patient adjustment	Questionnaire; observation	40 child and adolescent patients in an acute, short-term psychiatric unit	Hospital-related stressors identified included: separation from family/friends; loss of autonomy; psychiatric-setting characteristics (e.g., being in a unit with all doors locked); therapeutic/staff interactions; rules and authority; and stigmatization. Higher levels of stress experienced by the patients were associated with higher levels of anxiety and depression.	B
26	**Chang, Y. J., Lin, C. H., & Lin, L. H. (2001).** Noise and related events in a neonatal intensive care unit. *Acta Paediatrica Taiwanica = Taiwan Er Ke Yi Xue Hui Za Zhi, 42*(4), 212-217.	Noise	dBA levels and peaks	Descriptive; recordings of noise distribution, peak noise, and sources at different locations; decibel meter; observation of noise sources	Continuous recording at two areas (one near and one away from the nursing station) for one week in a neonatal intensive care unit (NICU) in a hospital in Asia	Mean noise levels in areas A and B were 62 and 61.4 dBA on average. Sound levels exceeded 59 dBA during more than 70% of the total observation time for both areas. The noise intensity was particularly high between 8 a.m. and 4 p.m.; noise levels on the weekend were lower than on weekdays. During the 48-hour observation period, 4,994 peak noises were recorded; 86% of those peak noises were within ranges of 65–74 dBA, and 90% were human-related. The primary nonhuman-	B-

						related source was monitor alarms. These results imply that modifications of staff behavior, care procedures, and apparatus may reduce the noise levels in the NICU.	
27	**Cheek, F. E., Maxwell, R., & Weisman, R. (1971).** Carpeting the ward: An exploratory study in environmental psychiatry. *Mental Hygiene, 55*(1), 109-118.	Carpet	Patient and staff satisfaction; ease of maintenance	Exploratory; before-after study	Interviews with administrative personnel (A-2, B-3), ward staff (A-6, B-3), and patients (A-4, B-5); questionnaires from ward staff (A-16, B-6) at two psychiatric units located at state mental institutions	While staff members reacted very negatively to the carpet in ward A, administration considered it a success. Patients reacted positively. Carpeting was a success in ward B as it was incorporated into the design before people moved in and efforts were made to have cleaning systems in place from the beginning. All respondents had a favorable opinion.	C
28	**Cmiel, C. A., Karr, D. M., Gasser, D. M., Oliphant, L. M., & Neveau, A. J. (2004).** Noise control: A nursing team's approach to sleep promotion. *American Journal of Nursing, 104*(2), 40-48.	Noise levels as function of changes in staff behavior and equipment modification	Noise levels and peaks in dBA	Quasi-experimental; prospective; a priori hypotheses; sound dosimeter; patient questionnaire	Three empty rooms and one semiprivate room (simulated occupied) before noise-reduction interventions in a surgical thoracic intermediate care nursing unit; one empty room after interventions in the same unit	Before interventions, the average sound level recorded in empty rooms was 45 dBA, and in the simulated occupied semiprivate room, 53 dBA, both exceeding the recommended 35 dBA level. Peak sound level in the empty rooms was 113 dBA. After interventions, sound levels in an empty room averaged 42 dBA, and peaked at 86 dBA. Staff reported efforts to close patient room doors and to advocate awareness of noise level. Patients commented positively on closing of doors.	B-

29	**Cohen-Mansfield, J., & Werner, P. (1999).** Outdoor wandering parks for persons with dementia: A survey of characteristics and use. *Alzheimer Disease and Associated Disorders, 13*(2), 109-117.	Outdoor spaces in long-term care facilities	Residents use and satisfaction reported by staff; perceived impacts on patient functioning, staff, public relations, marketing	Mail survey questionnaire	320 U.S. long-term care facilities with outdoor areas; one questionnaire per facility; 61% of respondents were nursing directors, 13% administrators	Sixty-nine percent of respondents rated outdoor spaces as extremely useful and as having several positive impacts on patients. Higher levels of perceived benefits were linked to the presence of more design features, such as gazebos and benches, and to a greater number of activities offered in the area. Problems cited frequently included lack of benches, absence of shade, difficulty in accessing space from inside facility, and patient safety.	B-
30	**Couper, R. T., Hendy, K., Lloyd, N., Gray, N., Williams, S., & Bates, D. J. (1994).** Traffic and noise in children's wards. *Medical Journal of Australia, 160*(6), 338-341.	Pedestrian traffic volume in two pediatric open-bay units (8 beds and 10 beds)	Noise levels in dBA	Descriptive; observed pedestrian traffic volume, including visits by physicians, nurses, other staff, and family and friends of patients; noise levels measured every 15 minutes at centers of open bays	Eight 24-hour periods (Friday to Saturday) over eight weeks; four periods in each of the two open bay wards—one for infant (eight beds), one for older children (10 beds)	Open bays generate very high traffic volumes and coincident noise. In an average 24-hour period, 5.5 patients in the infants' ward and 9.5 patients in the children's ward received 617 and 683 visits by 104 and 110 individuals, respectively. Maximum noise levels of 57.3 dBA and 64.6 dBA occurred at 10:00 Saturday and 19:00 Friday, which coincided with peak traffic volumes. Consideration should be given either to abolishing or substantially modifying open-bay areas to control noise.	B-
31	**Deep, P., & Petropoulos, D. (2003).** Effect of illumination on the accuracy of identifying interproximal carious lesions on bitewing radiographs. *Journal (Canadian Dental Association), 69*(7), 444-446.	Use of secondary sources of illumination in addition to a primary source (viewbox)	Accuracy of identifying interproximal carious lesions on bitewing radiographs	Experimental	14 dentists, all general practitioners.	There was no significant difference ($p = 0.07$) in the accuracy of identifying simulated interproximal carious lesions on bitewing radiographs in the light mean accuracy (72%+/-12%) and dark (75% +/- 12%) conditions.	A-

32	**Diette, G. B., Lechtzin, N., Haponik, E., Devrotes, A., & Rubin, H. R. (2003).** Distraction therapy with nature sights and sounds reduces pain during flexible bronchoscopy: A complementary approach to routine analgesia. *Chest, 123*(3), 941-948.	Nature scene mural with a tape of nature sounds vs. blank ceiling of procedure room	Patient ratings of pain control and anxiety; satisfaction; ability to breath	Experiment; randomized; prospective; hypotheses; questionnaire	80 adult patients undergoing flexible bronchoscopy with conscious sedation in a hospital in Baltimore	The odds of better pain control were greater in the nature-distraction-intervention patients than in the control patients, after adjustment for age, gender, race, education, health status, and dose of narcotic medication. There was no difference in patient-reported anxiety and satisfaction.	A
33	**Dijkers, M., Yavuzer, G., Ergin, S., Weitzenkamp, D., & Whiteneck, G. G. (2002).** A tale of two countries: Environmental impacts on social participation after spinal cord injury. *Spinal Cord, 40*(7), 351-362.	Environmental barriers (e.g., accessibility of public spaces, buildings, public transportation, businesses)	Patients' independence in activities of daily living; aspects of the physical environment that facilitate or hinder daily living; social integration	Survey questionnaires (Craig Handicap Assessment and Reporting Technique, Craig Hospital Inventory of Environmental Factors)	66 patients with spinal cord injury (SCI) in Turkey; 130 patients with SCI in the U.S.	The patients in the U.S. reported higher social-participation scores and fewer barriers in daily living. However, when age, gender, time since injury, and motor ability were controlled for, there were no significant differences in reported barriers between the two countries. Motor ability was the major influence on social participation. Measurement limitations in the study may have been the reason for the low level of support for the hypothesis that environment affects social participation.	B
34	**Eastman, C. I., Young, M. A., Fogg, L. F., Liu, L., & Meaden, P. M. (1998).** Bright light treatment of winter depression. *Archives of General Psychiatry, 55*(10), 883.	Bright light treatment	Depression (SIGH-SAD questionnaire); measures of sleep; patient expectations	Experimental, random assignment of patients to one of three treatment groups	96 patients with Seasonal Affective Disorders	After three weeks of treatment, morning light produced more of the complete or almost complete remissions than placebo. By one criteria (SIGH-SAD score), 61% of the patients responded to morning light, 50% to evening light, and 32% to placebo after four weeks of treatment.	A

35	**Falk, S. A., & Woods, N. F. (1973).** Hospital noise-levels and potential health hazards. *New England Journal of Medicine, 289*(15), 774-781.	Noise in three different types of patient physical environments	Noise levels in dBA	Descriptive; recordings of noise levels and observation of noise sources at different locations; sound-level meter	Six infant incubators, a 17-bed surgical recovery room, and two rooms in a seven-bed acute-care unit in an 800-bed hospital.	Noise in incubators averaged 57.7 dBA, and was generated mainly by an electric motor and fan. The average noise level in the recovery room was 57.2dBA, and in the acute care unit rooms 60.1 and 55.8dBA; peaks frequently exceeded 70–80 dBA. Noise levels in the recovery room and acute care unit rooms were significantly correlated with the numbers of staff members and patients. Noise levels are given for specific medical equipment and patient care activities.	B-
36	**Firestone, I. J., Lichtman, C. M., & Evans, J. R. (1980).** Privacy and solidarity: Effects of nursing home accommodation on environmental perception and sociability preferences. *International Journal of Aging & Human Development, 11*(3), 229-241.	Single-bed rooms vs. four-bed wards in a large nursing home	Perceptions regarding physical and social aspects of the nursing home environment; satisfaction; preferences with regard to privacy, socializing, noise, etc.	Structured interview	66 residents (39 single-room residents; 27 ward residents) over 60 years of age in a 400-bed nursing home; age range of residents: 60-89 years	Residents of four-bed rooms viewed the nursing home as less secure and lacking privacy in comparison to the single-bed room residents. Single-room residents expressed greater preference for isolation and greater concern for confidentiality.	B
37	**Foss, K. R., & Tenholder, M. F. (1993).** Expectations and needs of persons with family members in an intensive care unit as opposed to a general ward. *Southern Medical Journal, 86*(4), 380-384.	Intensive care units vs. general medical-surgical wards	Family members' needs with respect to being near or with the patient and the physical environment to support the family	Questionnaire	25 family members of patients in general medical and surgical wards; 25 family members of patients in intensive care units (ICU) in a V.A. hospital	Categories of family needs that were considered important or very important by respondents both in general wards and ICUs included: patient information, being near or with the patient (waiting room, overnight accommodations), emotional support, and a physical environment to support personal needs (nearby bathroom, convenient telephone, comfortable furniture in waiting room, food available 24 hours a day). ICU family also assigned high	B

						importance to flexible visiting hours and having a place to be alone.	
38	**Fox, R. A., & Henson, P. W. (1996).** Potential ocular hazard from a surgical light source. *Australasian Physical and Engineering Sciences in Medicine, 19*(1), 12-16.	Surgical light source	Retinal damage to staff	Laboratory measurements made using an Optronics Laboratories Inc. Model 742 spectroradiometer at a distance of 130 mm from the output aperture; total beam power was measured with Scientech 361 thermopile power meter	Number of measurements not specified	Calculation using data on the retinal irradiance required to produce retinal damage indicates that for an accidental exposure at a distance of 500 mm there is a significant possibility of retinal damage. At closer distances, the probability of retinal damage is even higher.	A-
39	**Franck, L. S., & Spencer, C. (2003).** Parent visiting and participation in infant caregiving activities in a neonatal unit. *Birth, 30*(1), 31-35.	Mothers' and fathers' visitation and infant care-giving activities in a multibed-bay neonatal intensive care unit	Frequency and duration of parent visits; parent care-giving activities (social care, cleaning, feeding)	Observation	Parents of 110 infants in a tertiary-level neonatal unit in a London hospital; data were recorded on 12 days during a three-month period	Mothers, compared to fathers, visited infants more frequently and for longer periods. Mothers visited less often if there were siblings to care for and if the infant was over the age of one month. All parents carried out social activities such as talking, stroking, or holding during their visits. More than 75% of the mothers, in comparison to less than 20% of the fathers, performed cleaning and feeding activities. The study did not evaluate possible environmental barriers to	B

						possible environmental barriers to visitation.	
40	**Freedman, N. S., Kotzer, N., & Schwab, R. J. (1999).** Patient perception of sleep quality and etiology of sleep disruption in the intensive care unit. *American Journal of Respiratory and Critical Care Medicine, 159*(Pt 1), 1155-1162.	Perceived environmental sources of sleep disruption in intensive care units (ICUs)	Perceived sleep quality and daytime sleepiness	Patient questionnaire administered on the day of discharge; descriptive	203 patients (121 males and 82 females) from different types of ICUs	Perceived ICU sleep quality was significantly poorer than baseline sleep at home. No significant differences in sleep quality were found among different types of intensive care units (cardiac, medical, surgical). Major sources of perceived sleep disruption were environmental noise, disruption from human interventions, and diagnostic testing.	B-
41	**Friberg, T. R., & Borrero, G. (2000).** Diminished perception of ambient light: A symptom of clinical depression? *Journal of Affective Disorders, 61*(1-2), 113-118.	Lighting levels	Perception	Nonrandomized, uncontrolled pilot study	120 patients (46 males, 74 females)	Two-thirds of the patients categorized as severely depressed responded that their ambient environment appeared dimmer than usual compared to 21% of moderately and 14% of mildly depressed patients. This difference was statistically significant. A patient's perception of the ambient light in the environment being dimmer than usual may be an important symptom of a major depressive disorder.	B

42	**Frumkin, H. (2001).** Beyond toxicity: Human health and the natural environment. *American Journal of Preventive Medicine, 20*(3), 234-240.	Contacts with nature, including plants, landscapes, wilderness, and companion animals	Many outcomes: e.g., stress reduction, blood pressure, cholesterol, pain, length of hospital stay, one-year survival after heart attack	Review of research literature	Approximately 75 studies	Evidence from many studies suggests that contacts with animals and pets, plants, viewing natural landscapes, and active wilderness experiences have positive effects on human health and well-being. Knowledge about health benefits of nature should be applied in ways to directly enhance public health. Examples of clinical applications include: building hospitals in scenic locations, planting gardens in rehabilitation centers, and advising patients to spend time gardening.	Review
43	**Gabor, J. Y., Cooper, A. B., Crombach, S. A., Lee, B., Kadikar, N., Bettger, H. E., et al. (2003).** Contribution of the intensive care unit environment to sleep disruption in mechanically ventilated patients and healthy subjects. *American Journal of Respiratory and Critical Care Medicine, 167*(5), 708-715.	Noise levels in an 18-bed open-plan intensive care unit (ICU), with curtain partitions between beds	Sleep arousals and awakenings measured by polysomnography; questionnaire for assessing perceived sources of sleep disruption	Quasi-experimental; correlational; comparison of normal room and noise-reduced room; hypotheses; polysomnography and sound-meter recordings	Seven mechanically ventilated patients in an ICU and six healthy volunteers	Sound elevations were responsible for 20.9 +/- 11.3% of total sleep arousals and awakenings. Patient care activities (7.8 +/- 4.2 times per hour of sleep) were responsible for 7.1 +/- 4.4% of total arousals and awakenings. Healthy volunteers slept better in the typically loud ICU environment than patients, and experienced improved sleep in a noise-reduced, single-patient ICU room. Participants in the open ICU identified alarms and staff conversation as the most disruptive environmental noises.	B

44	**Gast, P. L., & Baker, C. F. (1989).** The CCU patient: Anxiety and annoyance to noise. *Critical Care Nursing Quarterly, 12*(3), 39-54.	Noisy hour (7 a.m. to 8 a.m.) vs. quiet hour (11 a.m. to 12 p.m.) in single-bed ICU rooms having tile floors, bare walls, and acoustic ceiling tile (room doors were usually left open)	Reported state and trait anxiety; annoyance with noise; noise levels	Quasi-experimental; repeated measures; hypotheses; state-trait anxiety inventory; annoyance to ICU noise questionnaire; sound-level meter	20 patients who were cared for in single rooms in an 18-bed coronary care unit in a large U.S. hospital; data were collected during two one-hour periods (noisy vs. quiet) for each patient	Contrary to the hypotheses and previous studies, the "quiet hour" had higher noise levels than the "noisy hour." Possible explanations included visitors and open doors to patient rooms. Major noise sources reported by patients included alarms, falling objects, equipment such as carts, and staff talking at night and during shift changes. Equipment noise was the most annoying source of noise. Mean annoyance and state anxiety scores were slightly but not significantly higher for the “quiet” hour.	B-
45	**Gershon, J., Zimand, E., Lemos, R., Rothbaum, B. O., & Hodges, L. (2003).** Use of virtual reality as a distracter for painful procedures in a patient with pediatric cancer: A case study. *Cyberpsychology & Behavior, 6*(6), 657-661.	Three environmental conditions: no distraction, nonvirtual reality (VR) distraction on a computer screen, and immersive virtual reality; the distraction was an educational program for children that simulated a visit to a habitat for gorillas	Self-reported pain and anxiety; pain and anxiety reported by parents and nurse; pulse rate; behavioral observations relating to distress; social competence and problem behavior reported by parents	Case study of one patient; outcomes measured during consecutive appointments, each of which exposed patient to a different distraction condition; self-report; observation	One 8-year-old Caucasian male with acute lymphocytic leukemia in an outpatient oncology clinic	The behavioral observations recorded by the researcher indicated the lowest pain was experienced during the VR condition. The nurse and parents likewise evaluated the patient as experiencing less pain and anxiety during the VR condition in comparison to the other conditions. The patient’s pulse was lowest during the VR condition. The patient’s ratings for pain were also lowest during the VR condition; however patient ratings for anxiety were lowest during the non-VR condition.	C

46	**Giacoia, G. P., Rutledge, D., & West, K. (1985).** Factors affecting visitation of sick newborns. *Clinical Pediatrics, 24*(5), 259-262.	Location and distance of homes of newborns' parents relative to the neonatal intensive care unit: group A, located within local city of the hospital, group B, located out of town	Visitation of sick newborns by parents; telephone calls to unit by parents	Structured interviews with parents of infants; examination of records of telephone calls to unit; patient medical information, including birth weight, gestational age, length of stay	Data on visits and telephone calls were collected over a six-month period for 167 infants in a neonatal intensive care unit	Birth weight, gestational age, and length of stay were similar for infants with parents in group A (residents of local city) and group B (from out of town). Group B parents visited fewer times, made fewer telephone calls to the unit, and earned a smaller income in comparison to the parents of group A. Factors that were identified as limiting or reducing visitation were the demands of work, the expenses associated with the trip, the distance traveled, and the responsibility of care for siblings of the infant.	B
47	**Glod, C. A., Teicher, M. H., Butler, M., Savino, M., Harper, D., Magnus, E., et al. (1994).** Modifying quiet room design enhances calming of children and adolescents. *Journal of the American Academy of Child and Adolescent Psychiatry, 33*(4), 558-566.	Standard vs. modified quiet rooms (QR);. one modified room (tea rose paint, carpeting, and a picturesque mural on one wall), the four standard rooms had white walls, grey-speckled vinyl tiles	Aggression: verbal, physical, toward self, toward others, motor excitement and disorganization; use of additional restraint interventions	Experimental design; repeated measures within-subjects design; nonrandom assignment; subjects were blinded, raters were unblinded	19 inpatients: 14 males and 5 females, range 4 to 18, mean age 9.6; subjects had been placed in the modified room 30 times and the quiet room 46 times	Total aggression ratings were 45% lower in the modified QR than in the standard QR ($p < .03$), and initial aggression scores fell by 50% during five minutes of placement in the modified QR, but only after 20 minutes of placement in the standard QR ($p < .0001$). Motor excitement and verbal aggression were the two component factors most strongly influenced by QR design.	A

48	**Grover, P. (1971).** *Wayfinding in hospital environments: UCLA hospital disorientation pilot case study.* Los Angeles, Calif.: Graduate School of Architecture and Urban Planning, University of California, Los Angeles.	Signage	Being able to find the way or disorientation; satisfaction with signs; staff costs associated with giving directions	Before-after intervention study	100 students using the Student Health Services building; staff persons interviewed in phase 1 of study	Students were generally successful in finding their way using signs, fewer students were getting lost and overall satisfaction with the signs was high. Students preferred wall-mounted signs to the earlier 'line' system. Staff preferred the line system and wanted it back. Use of only wall-mounted signs did not work as they were often missed. Also, signs are required at many different decision points along the way.	C
49	**Hagerman, I., Rasmanis, G., Blomkvist, V., Ulrich, R. S., Eriksen, C. A., & Theorell, T. (in press).** Influence of coronary intensive care acoustics on the physiological states and quality of care of patients. *International Journal of Cardiology.*	Acoustics were altered during the study period by changing the ceiling tiles from sound-reflecting (bad acoustics) to sound-absorbing tiles (good acoustics) of similar appearance	Blood pressure; pulse amplitude; heart rate; heart-rate variability; intake of intravenous beta-blockers; patient ratings of care quality	Quasi-experimental; prospective; before-after; hypotheses; sound level recordings; physiological monitoring; drug-intake data; rehospitalization data; patient questionnaire	94 patients in the coronary intensive care unit at a university hospital in Sweden	Compared to the sound-reflecting ceiling tiles, the sound absorbing tiles decreased both dBA levels and reverberation time. Patients with sound-absorbing tiles (good acoustics), compared to those with sound-reflecting tiles, had lower pulse amplitude, less need for intravenous beta-blockers, a lower incidence of rehospitalization at both one and three months, and reported they were much more satisfied with the staff attitude and care. A bad acoustics environment during acute illness can have important detrimental physiological effects on rehabilitation.	A-

50	**Haq, S., & Zimring, C. (2003).** Just down the road a piece: The development of topological knowledge of building layouts. *Environment & Behavior, 35*(1), 132-160.	Uninterrupted visibility lines decision points (using space syntax measures such as connectivity, integration, intelligibility, etc.)	Wayfinding behavior and cognitive understanding	Experiment: Participants performed open exploration and directed searches between four destinations at three big hospitals in a major U.S. city	128 participants (62 male, 66 female students), mostly aged from 17 to 25 (mean = 19.5); in total, 128 research participants carried out 508 directed searches	During initial exploration, participants relied more on local topological qualities, such as how many additional nodal decision points could be seen from a given node. As they got to know the setting better (within 10 to 15 minutes), their wayfinding behavior was better predicted by more global qualities such as space-syntax integration of a node.	A
51	**Harris, R. W., & Reitz, M. L. (1985).** Effects of room reverberation and noise on speech discrimination by the elderly. *Audiology*, *24*(5), 319-324.	Effects of quiet vs. noisier environment (+10 dB) under two levels of reverberation time (RT = 0.6 s and 1.6 s) [RT defined as the time required for a noise signal to decay 60 dB upon termination of the noise]	Speech-discrimination performance	Experiment; comparisons between acoustic conditions and subjects of different ages; hypotheses; Speech-discrimination test; hearing test	10 young normal-hearing nonpatient volunteers, 10 elderly normal-hearing nonpatient volunteers, and 10 elderly hearing-impaired persons	Elderly normal-hearing subjects performed much poorer than the young normal-hearing subjects under the reverberant noisier condition (longer RT + 10 dB). There was a drastic 48% decline in speech discrimination among the elderly hearing-impaired from the best acoustic condition (quiet + shorter RT) to poorest (noise + longer RT). The findings imply for healthcare design that consideration should be given to providing sound-absorbing ceilings and other measures that shorten RT and reduce noise propagation, thereby increasing speech discrimination among elderly patients and possibly older staff.	A-

52	**Heath, Y., & Gifford, R. (2001).** Post-occupancy evaluation of therapeutic gardens in a multi-level care facility for the aged. *Activities, Adaptation & Aging, 25*(2), 21-43.	Eight courtyard therapeutic gardens—each with a different design theme and goal—in a large care facility for the elderly in western Canada	Reported use of gardens; preference for garden features; and perceived effectiveness or safety of features by patients, staff, volunteers, and family members	Postoccupancy study, which focused on functionality and effectiveness of the gardens for users; family members, staff, and volunteers filled out a questionnaire; residents were interviewed	190 participants responded to a questionnaire (80 staff, 36 volunteers, 57 family members); 17 residents participated in interviews	The vast majority (84%) of the family, volunteers, and residents reported they had visited at least one of the gardens. The largest percentage of respondents visited the gardens weekly, during the afternoon, and for less than 30 minutes at a time. Three major activities that took place in the gardens were sitting, walking, or visiting with others. Ninety-seven percent of the respondents liked the gardens, and more than 80% reported that the gardens had successfully achieved the design goals. However, many respondents thought the designs could be improved; the most frequent suggestion was to provide more shade. More than 70% reported that the gardens were a wise financial investment.	D
53	**Hilton, B. A. (1976).** Quantity and quality of patients' sleep and sleep-disturbing factors in a respiratory intensive care unit. *Journal of Advanced Nursing, 1*(6), 453-468.	Sources of noise that disturb sleep in a multibed respiratory intensive care unit	Patient sleep quantity and quality	Descriptive; continuous polygraphic sleep recordings (EEG, EMG, EOG); observation and recording of sleep disturbing factors; patient interview	10 patients in a respiratory intensive care unit, each monitored continuously for 48 hours	Quality of sleep in the unit was poor for all patients; no complete sleep cycles were experienced. Deprivation was evident in stage 3, 4, and REM sleep. Sleep-disturbing factors occurred an average of 20 minutes per hour. Sources of disturbance were mainly therapeutic procedures, staff talking, and environmental noises. Most disturbances were linked to the presence of other patients in the multibed unit.	B-

54	**Hilton, B. A. (1985).** Noise in acute patient care areas. *Research in Nursing & Health, 8*(3), 283-291.	Noise in multibed and single-bed intensive care units (ICUs) and general care units	Noise levels in dBA; patient perceptions of noise	Descriptive; continuous noise-level recordings made at several locations in each unit; observation of sound sources; structured patient interview	Four intensive care and two general care units in three hospitals (one large with multibed rooms, two smaller hospitals with single-bed ICUs); 25 patients; sound measured for 24 hours at head of each patient's bed	Continuous noise levels were high in the larger hospital's multibed recovery room and ICU (48.5–68.5 dBA); lower levels were measured in the smaller hospitals' single-bed ICUs (32.5–57 dBA), and general ward areas (34.25–62.5 dBA). Noise peaks from equipment reached 90 dBA. The difference in noise levels between the large hospital ICU and the two smaller ICUs was related to the number of beds per room. Patients' perceptions of noise were strongly negative in the large hospital's eight-bed recovery room. Closing doors reduced sounds from outside rooms by 10–15 dBA.	B-
55	**Hodge, B., & Thompson, J. F. (1990).** Noise pollution in the operating theatre. *Lancet, 335*(8694), 891-894.	One major operation in an operating theatre	Noise levels and sources	Descriptive; recordings of noise levels, distribution, and sources; sound-level meters placed at ear-level height of surgical team	A typical major operation in an operating theatre in an Australian hospital	Very loud intermittent noises (up to108 dBA) were emitted frequently from sources such as suckers, intercoms, alarms on anesthetic monitoring devices, clanging metal bowls, and gas escaping from outlets during disconnection. Noise levels during surgery were much higher than levels of normal speech between staff, which disrupted communication and sometimes made it impossible. Noise greatly exceeded previously established speech-interference levels.	B-

56	**Hoffman, H. G., Doctor, J. N., Patterson, D. R., Carrougher, G. J., & Furness, T. A., 3rd. (2000).** Virtual reality as an adjunctive pain control during burn wound care in adolescent patients. *Pain, 85*(1-2), 305-309.	Two types of environmental distractions: immersive virtual reality (VR) vs. video game; VR was an interactive "kitchen" with countertops, window, cabinets that could be opened, etc; video game was jet ski race	Self-reported pain, anxiety, estimates of time spent thinking about pain; nausea as a result of VR	Case study of two patients, each exposed to two different distraction conditions; hypotheses; self-report	Two patients: one 16-year-old male and one 17-year-old male with severe painful burns	In this preliminary study, both patients reported significantly less pain and anxiety and spending less time thinking about pain during the immersive VR distraction than the video game. Immersive VR did not produce nausea in these patients. The patients' inability to see the burn and wound care during immersive VR may have contributed to the reduction in pain.	**C**
57	**Holahan, C. (1972).** Seating patterns and patient behavior in an experimental dayroom. *Journal of Abnormal Psychology, 80*(2), 115-124.	Various structured and mixed seating arrangements, and an unstructured setting where psychiatric patients arranged seating themselves in an experimental hospital dayroom	Observed patient behaviors, including social and nonsocial, and nonaggressive and aggressive; patient-reported preference, satisfaction; length of time patients remained in room; amount of coffee consumed	Experiment with random assignment of patients to six-member groups; five groups assigned to each of four environmental or seating conditions; hypotheses; observation of patients; patient questionnaire; patient drawings of preferred seating arrangements on room pictures	120 male psychiatric inpatients in a V.A. hospital	The various seating patterns exerted powerful control over the amount and quality of social interaction among patients in the dayroom. As predicted, an arrangement with chairs shoulder-to-shoulder along the dayroom walls strongly suppressed social interaction. By contrast, arranging chairs around small tables in the middle of the room increased interaction, especially among socially inclined patients. Unstructured or free arrangements did not increase interaction. Seating arrangements had no effects on nonsocial activities such as reading. More coffee and cigarettes were consumed when seating was arranged around tables and in mixed arrangements, than in the free/unstructured and shoulder-to-shoulder-along-walls arrangements. Patients preferred seating around tables.	A

58	**Holahan, C., & Saegert, S. (1973).** Behavioral and attitudinal effects of large-scale variation in the physical environment of psychiatric wards. *Journal of Abnormal Psychology, 82*(3), 454-462.	Remodeled psychiatric admissions ward (repainted, new furniture, bedspreads, partitions in bedroom areas) vs. an identical unchanged admissions ward	Social and active behavior attitudes toward ward environment	Experimental design; post-test-only control group design; a priori hypotheses.	25 patients were randomly selected on each of the two wards; 13 males and 12 females were studied on each ward	Significantly more socializing and less passivity occurred on the remodeled than on the control ward, and patients of the remodeled ward demonstrated more positive attitudes toward the ward's physical environment. Also, patients on the remodeled ward viewed their environment more positively than the patients on the control ward.	A
59	**Hook, W. F., Sobal, J., & Oak, J. C. (1982).** Frequency of visitation in nursing homes: Patterns of contact across the boundaries of total institutions. *Gerontologist, 22*(4), 424-428.	Visitation of nursing home residents	Frequency of visitation; attributes of the visitor, resident, and their shared relationship	Survey; visitor questionnaire; hypotheses	629 visitors in three nursing homes in central Pennsylvania on three consecutive Sundays: home A (90 residents), home B (102 residents), home C (157 residents)	Fifty-four percent of all residents received at least one visitor during the study. Greater frequency of visitation occurred when the distance traveled by the visitor to the nursing home was shorter. (Mean distance traveled by all visitors was 18 miles.) Visitation also was more frequent when the relationship between the visitor and resident was close. More than three-fourths of visitors came in groups. Males and females (sons and daughters of residents) were equal in the percentage reporting weekly visits.	B
60	**Hutton, A. (2002).** The private adolescent: Privacy needs of adolescents in hospitals. *Journal of Pediatric Nursing, 17*(1), 67-72.	Ward environmental characteristics for fostering privacy and control	Privacy requirements of adolescents in two-bed rooms	Patient drawings of a ward design; interview with patients about their ward designs	Seven adolescent patients (five with cystic fibrosis, two with chronic asthma); each patient had three admissions in an Australian hospital with a total stay of at least 10 days	The patients displayed in their ward drawings and reported in interviews a strong need for privacy with respect to the bathroom (using the toilet, showering, grooming). Patients wanted a private bathroom attached to their bedroom, not a corridor bathroom. It was also important to have convenient access to a telephone and privacy when talking. Patients reported that having a telephone in a side-room of their two-bed ward	B-

						room would provide adequate privacy.	
61	**Janssen, P. A., Klein, M. C., Harris, S. J., Soolsma, J., & Seymour, L. C. (2000).** Single room maternity care and client satisfaction. *Birth, 27*(4), 235-243.	Single-room maternity care vs. care in a traditional setting	Client satisfaction	Comparative study with historical and concurrent comparison groups	205 women in single-room maternity care (study group); 221 women in historical comparison group; 104 women in concurrent comparison group	Study-group women were more satisfied than comparison groups in all areas evaluated, including provision of information and support, physical environment, nursing care, patient education, assistance with infant feeding, respect for privacy, and preparation for discharge. Noise was less of an issue for the study group. The physical layout of the single-room maternity care room was found to be superior by the study group with respect to spaciousness, availability of supplies, comfort of the support person, and lighting.	A-
62	**Johnson, A. N. (2001).** Neonatal response to control of noise inside the incubator. *Pediatric Nursing, 27*(6), 600-605.	Presence vs. absence of acoustical foam placed in each corner of incubators	Noise levels (dBA) measured inside incubators; infant oxygen saturation; infant behavioral states	Experiment; within-patients repeated measures; hypotheses; sound-level recordings; infant behavioral observation; cardiorespiratory monitoring	65 premature neonates in a neonatal intensive care unit in a large suburban hospital in the Mid-Atlantic region; each patient monitored for 40 minutes	Findings demonstrated a significant treatment effect of the use of acoustical foam for decreasing environmental noise measured inside the incubator (average decrease = 3.3 dBA). When the acoustical foam was in place, and incubator noise lessened, neonates experienced improved oxygen saturation and sleep state.	A

63	**Katcher, A., Segal, H., & Beck, A. (1984).** Comparison of contemplation and hypnosis for the reduction of anxiety and discomfort during dental surgery. *American Journal of Clinical Hypnosis,* 27(1), 14-21.	Experimental dental surgery waiting room with five interventions: aquarium, poster of natural scene, aquarium + hypnosis, poster + hypnosis, or control (no aquarium, poster, or hypnosis)	Comfort and anxiety reported by patient; compliance during surgery evaluated by the dentist; blood pressure; heart rate	Experiment with random assignment; hypotheses; questionnaire; observation; blood pressure and heart-rate monitoring; test for hypnotic susceptibility	42 patients prior to and during elective dental surgery (eight patients in each treatment group, 10 in control group)	Compared to the control and poster treatments, both aquarium treatments (aquarium only, aquarium + hypnosis) produced greater relaxation evident during the subsequent surgery phase, as indicated by reduced anxiety and increased comfort. Hypnosis did not improve relaxation induced by aquarium contemplation, but did significantly enhance relaxation effects of poster contemplation. It is suggested that consideration be given to placing an aquarium so that viewing and distraction can continue during surgery.	A-
64	**Keep, P., James, J., & Inman, M. (1980).** Windows in the intensive therapy unit. *Anaesthesia, 35*(3), 257-262.	An intensive therapy unit (ITU) with windows (translucent but not transparent) vs. another ITU without windows	Patient-reported memory accuracy of ITU stay, time orientation during stay, sleep quality, incidence of hallucinations and delusions	Quasi-experimental; retrospective; comparison of patients in two ITU wards in two hospitals; hypotheses; patient questionnaire administered after discharge	A total of 150 patients in two multibed ITUs in two UK hospitals: 72 patients in a unit with windows, 78 comparable patients in a windowless ITU	The findings confirmed previous studies showing that most ITU patients are conscious of their surroundings and retain some long-term memory of their stay. Patients in the present study who received care in the windowless ITU, compared to those in the ITU with windows, had a less accurate memory of the length of their stay, and were less well-orientated in time during their stay. The incidence of hallucinations and delusions reported by patients was more than twice as high in the windowless unit.	B-

65	**Kent, W. D., Tan, A. K., Clarke, M. C., & Bardell, T. (2002).** Excessive noise levels in the neonatal ICU: Potential effects on auditory system development. *Journal of Otolaryngology, 31*(6), 355-360.	Noise levels in multibed rooms in a neonatal intensive care unit (NICU) and inside infant incubators	Noise levels and peaks in dBA	Descriptive; sound-level meter recordings of noise levels, peaks, and distribution	Six 12-hour and four 24-hour periods measured inside incubators and in three rooms (six patients in each room) in the NICU in a Canadian hospital	Mean hourly noise levels inside the incubator (61 dBA) were significantly higher than outside (55 dBA); both values exceeded the recommended level of 50 dB. Noise levels were also higher in a higher-acuity room where staff activity was greatest (59 dB). In addition, peak noise levels of 120 dB were measured in incubators, indicating that noise levels in the NICU are greatly excessive.	B-
66	**Leather, P., Beale, D., Santos, A., Watts, J., & Lee, L. (2003).** Outcomes of environmental appraisal of different hospital waiting areas. *Environment & Behavior, 35*(6), 842-869.	Traditional vs. nouveau waiting areas in outpatient clinic	Multiple outcome measures: patients' affective appraisal of environment, self-reported stress and arousal, satisfaction ratings, pulse readings	Two-sample comparative design with data being collected pre and post-relocation to a neurology outpatient clinic; a priori hypotheses	145 neurology patients interviewed in two groups: 81 (traditional), 64 (nouveau) waiting area	Convergent evidence that the nouveau waiting area is associated with more positive environmental appraisals, improved mood, altered physiological state, and greater reported satisfaction.	A-
67	**Leather, P., Pyrgas, M., Beale, D., & Lawrence, C. (1998).** Windows in the workplace: Sunlight, view, and occupational stress. *Environment & Behavior, 30*(6), 739-762.	Windows in private and shared offices: level of illumination; view accessibility and quality; sunlight penetration (max floor area that could be covered in direct sunlight)	Reported job strain; job satisfaction; intention to quit; well-being, including fatigue and tension	Questionnaire-based survey of employees	100 white-collar and blue-collar employees (66 males, 34 females; mean age 41.8 years) of a large organization in a region of Southern Europe	Employees experienced a wide range of window conditions, ranging from very dim to very bright illumination levels, no sun patches (no penetration) to total coverage of floor, and from no view of nature to a full nature view. There was a positive impact for the level of sunlight penetration on job satisfaction, intention to quit, and general well-being. Window views of nature helped to buffer the impact that job stress had on the intention to quit, and had a positive effect on general well-being of the employees. There were no effects for the level of	B

						illumination.	
68	**Lee, D. W., Chan, A. C., Wong, S. K., Fung, T. M., Li, A. C., Chan, S. K., et al. (2004).** Can visual distraction decrease the dose of patient-controlled sedation required during colonoscopy? A prospective randomized controlled trial. *Endoscopy, 36*(3), 197-201.	Environmental distractions in a Hong Kong hospital: visual distraction (home movies mainly of scenic views), and visual distraction in combination with audio distraction (classical music)	Sedative required; pain; hypotensive episodes; oxygen desaturation; satisfaction; recovery time	Experiment with random assignment; blind observation; hypotheses; patient-controlled sedation doses (PCS); reported pain; satisfaction; recovery time assessed by recovery nurse	157 elective colonoscopy patients (age range: 16-75 yrs), each assigned to one of three environmental conditions: visual distraction and PCS; music, visual distraction, and PCS; or only PCS.	No decrease in PCS was observed during visual distraction alone. The combination of visual and audio distraction produced a significant decrease in PCS required and reported pain. Both visual distraction alone and the combination of visual-audio distraction improved patient satisfaction and increased tolerance and acceptability of elective colonoscopy.	A
69	**Levine, M., Marchon, I., & Hanley, G. (1984).** The placement and mis-placement of you-are-here maps. *Environment & Behavior, 16*(2), 139-157.	Alignment of you-are-here maps (the YAH arrow pointed in different directions)	Experiment 1: being able to predict direction of destination correctly; experiment 2: time spent examining map and time spent in finding the physical destination	Experimental	Experiment 1: 47 undergraduate students (32 female, 15 males) from SUNY, Stony Brook; experiment 2: 20 volunteers (11 female and 9 male)	Experiment 1: When the YAH arrow was aligned so that "forward is up," participants gave correct direction-finding responses more often than in any other alignment. Experiment 2: People viewing the aligned map found their destinations more often than those viewing misaligned maps. Also, those viewing misaligned maps spent significantly more time viewing the map and significantly more time searching for	A

						the destination than those viewing the aligned map.	
70	**Lewy, A. J., Bauer, V. K., Cutler, N. L., Sack, R. L., Ahmed, S., Thomas, K. H., et al. (1998).** Morning vs. evening light treatment of patients with winter depression. *Archives of General Psychiatry, 55*(10), 890-896.	Exposure to bright light either in the morning or evening	Depression (SIGH-SAD questionnaire); melatonin levels; measures of sleep; patient expectations of whether the morning or evening bright light treatment would be effective	Experimental; patient matching; crossover design	51 patients and 49 matched controls	Established that morning light was at least twice as effective as evening light in the treatment of Seasonal Affective Disorder. Dim-light melatonin onsets were generally delayed in the patients compared with the controls.	A
71	**Love, H. (2003).** Noise exposure in the orthopaedic operating theatre: A significant health hazard. *ANZ Journal of Surgery, 73*(10), 836-838.	Noise produced during orthopedic operations	Noise levels in dBA and exposure experienced by operating surgeon	Descriptive; recordings of noise distribution, peak noise; sound dosimeter worn near ear by operating surgeon	Noise exposure of one surgeon during three total hip replacements and two knee replacements in orthopedic operating theatres in a New Zealand hospital	Noise exposure averaged 4.5%–5.7% (1.5–7.4%) of the allowed daily dose (average duration 70, 77 minutes). Maximum sound levels (108 dBA) approached but did not exceed limits of 110 dBA recommended by the New Zealand Health and Safety Employment Act of 1992. However, transient sound peaks exceeded 140 dBA on multiple occasions during surgeries. This constitutes a noise hazard and carries a significant risk for noise-induced hearing loss.	B-

72	**Madi, B. C., Sandall, J., Bennett, R., & MacLeod, C. (1999).** Effects of female relative support in labor: A randomized controlled trial. *Birth, 26*(1), 4-8.	Presence of a female relative vs. absence of a relative during labor and delivery in multibed labor rooms	Labor outcomes: pain drugs; percent vaginal deliveries; drugs to augment labor; oxytocin; vacuum extractions; cesarean sections	Prospective experiment with random assignment of patients; hypotheses; several labor outcomes	109 women in uncomplicated spontaneous labor in a hospital and maternity clinics in Botswana	Patients with a female relative, compared to those with no relative present, had reduced need for obstetric interventions and a higher frequency of normal deliveries. When a female relative was present, patients had a higher rate of spontaneous vaginal delivery, needed less analgesia, less oxytocin, fewer amniotomies to augment labor, required vacuum extraction less often, and had fewer cesarean sections.	A
73	**McLaughlin, A., McLaughlin, B., Elliott, J., & Campalani, G. (1996).** Noise levels in a cardiac surgical intensive care unit: A preliminary study conducted in secret. *Intensive Critical Care Nursing, 12*(4), 226-230.	Noise levels in a multibed open-plan cardiac surgical intensive care unit (CSICU)	Noise levels	Descriptive; recordings of noise levels, peaks, and distribution in environment; concealed sound-level meter	Six 16-hour recordings of sound levels in a 12-bed open-plan cardiac surgical intensive care unit in the UK	Maximum sound levels occurring in one-minute periods ranged from 61 to 101 dBA. Peaks frequently exceeded 80 dBA. Continuous background noise (one minute continuous-sound pressure levels) ranged from 57 to 77 dBA. Noise in the CSICU was consistently and far above the World Health Organization recommended levels (35 dBA at night and 40 dBA during the day).	B-
74	**Meyer, T. J., Eveloff, S. E., Bauer, M. S., Schwartz, W. A., Hill, N. S., & Millman, R. P. (1994).** Adverse environmental conditions in the respiratory and medical ICU settings. *Chest, 105*(4), 1211-1216.	Noise, light, and interruptions in an intensive care unit (ICU)	Noise levels in dBA; light levels in foot candles; patient interruption by doctors, nurses, therapists	Descriptive; recordings of noise distribution, peak noise, noise sources; light levels; staff interruptions; decibel meter; observation by staff	24 hours of observation of patient interruptions; more than one week of recordings of sound and light on a general medical floor	Peak noise levels were much higher than those recommended in all areas. The number of sound peaks greater than 80 dBA was especially high in the intensive and respiratory care areas. Light levels in all areas had a day-night rhythm. Patient interruptions by staff tended to be erratic, leaving little time for condensed sleep.	B-

75	**Miller, A. C., Hickman, L. C., & Lemasters, G. K. (1992).** A distraction technique for control of burn pain. *Journal of Burn Care and Rehabilitation, 13*, 576-580.	Distraction-relaxation technique (Muralvision)	Intensity of pain; quality of pain; anxiety	Experiment; randomized; questionnaire	17 patients (16 males, 1 female) with burns	There was a significant decrease in pain intensity, pain quality, and anxiety reported by patients who experienced the treatment with the distraction technique.	A-
76	**Minckley, B. B. (1968).** A study of noise and its relationship to patient discomfort in the recovery room. *Nursing Research, 17*(3), 247-250.	Noise levels	Use of narcotic and sedative medications	Quasi-experimental; correlational; prospective; hypotheses; observation; sound-level meter	100 half-hour intervals in a 10-bed recovery room in a large hospital	The median noise level was 50–60 dBA. The number of patients given medication was significantly and positively related to the dBA level. Doctors' presence was associated with higher sound levels.	B
77	**Mlinek, E. J., & Pierce, J. (1997).** Confidentiality and privacy breaches in a university hospital emergency department. *Academic Emergency Medicine, 4*(12), 1142-1146.	Emergency room patient rooms with curtain walls vs. glass walls vs. solid walls; reception desk	Confidentiality breaches	Quasi-experimental; prospective; observation; interview	Visual and auditory confidentiality breaches observed during six one-hour periods in waiting/triage and 18 one-hour periods in emergency department patient rooms	Breaches in the triage/waiting area occurred for > 53% of the patients. Overhearing at the reception desk was the main problem in this area. Breaches near the physician/nursing station (overheard by patients in nearby room) ranged from 3 to 24 per hour and 1.5 to 3.4 per patient hour. Overhearing and visual breaches occurred in rooms separated by curtain walls and glass walls, but not in rooms with solid walls.	B

78	**Moeser, S. D. (1988).** Cognitive mapping in a complex building. *Environment & Behavior, 20*(1), 21-49.	Building plans	Formation of cognitive mapping systems	Experimental	Student nurses attending the General Hospital School of Nursing	Student nurses failed to form a 'survey' map of the building even after traversing it for two years. Naïve subjects performed significantly better on objective measures of cognitive mapping than did nurses with two years' experience working in the hospital. The conclusion was that the building was too complex to enable formation of survey map by simply traversing it. Conscious training was required for development of the knowledge of the configuration.	A-
79	**Montello, D. (1991).** Spatial orientation and the angularity of urban routes: A field study. *Environment & Behavior, 23*(1), 47-69.	Route angularity of urban routes	Spatial orientation (measured by pointing errors); response time	Experimental	60 pedestrians (18 female, 42 male), most were between 19 and 26 years of age; 50 were staff, students, or faculty at Arizona State University	Pointing error on four of the five targets was greater on both oblique streets than on the orthogonal streets, especially for the cardinal directions. Length of residency was related to both accuracy and response speed. Results demonstrate that environmental orientation depends in part on the angularity of route structure, the disorienting effects of oblique routes being due to memory distortion or imprecision associated with oblique routes.	A
80	**Moore, M. M., Nguyen, D., Nolan, S. P., Robinson, S. P., Ryals, B., Imbrie, J. Z., et al. (1998).** Interventions to reduce decibel levels on patient care units. *American Surgeon, 64*(9), 894.	Interventions: education of nursing and physician staff on controlling noise; closing patient room doors	Noise level	Quasi-experimental; repeated measurements; prospective; hypotheses; decibel meter	Three 24-hour periods in three locations in a surgical patient acute care unit and an intensive care unit in a university health system	Noise was identified as the most important stressor for surgical inpatients. Educating staff had little effect in reducing noise. Closing patient doors on surgical floors decreased noise levels by an average of 6 dBA, a change that patients can readily perceive. Conversely, in the intensive care unit, closing doors increased noise levels, presumably because most noise emanates from equipment within the room.	B

81	**Morrison, W. E., Haas, E. C., Shaffner, D. H., Garrett, E. S., & Fackler, J. C. (2003).** Noise, stress, and annoyance in a pediatric intensive care unit. *Critical Care Medicine, 31*(1), 113-119.	Noise levels in dBA	Heart rate; salivary amylase; self-reported stress and annoyance	Quasi-experimental; prospective; hypotheses; regression analysis; decibel meter; self-report; physiological measures	11 nurses in a pediatric intensive care unit	The average daytime sound level was 61 dBA, while the average nighttime level was 59 dBA. Higher average sound levels significantly predicted higher heart rates, and greater self-reported stress and annoyance, but did not predict amylase measurements.	B
82	**Morse, J. M., & Pooler, C. (2002).** Patient-family-nurse interactions in the trauma-resuscitation room. *American Journal of Critical Care, 11*(3), 240-249.	Trauma resuscitation room	Family-nurse-patient interactions	Observation	193 patients and family members in a trauma-resuscitation room	The patient's condition and behavior determined when the family members entered the room. Family usually entered after the patient was stabilized. Persons who were considered emotionally enduring were silent and their movement was minimal. Persons classified as emotionally suffering tended to cry or speak frequently and stood close to others. Whether the family or patients were considered enduring or emotionally suffering affected the focus of the nurse.	B
83	**Murthy, V. S., Malhotra, S. K., Bala, I., & Raghunathan, M. (1995).** Auditory functions in anaesthesia residents during exposure to operating room noise. *Indian Journal of Medical Research, 101*, 213-216.	Noise simulated by playing pre-recorded audio tape of operating room noise	Speech reception threshold; speech discrimination	Quasi-experimental; simulation; repeated measurements; Prospective; hypotheses; audio tape playing; audiometer; speech-repeating task	20 anaesthesia residents tested in the audiology department in a research institute	During exposure to operating room noise, speech-reception threshold increased substantially by 23.75 +/- 6.86 dBA for the right ear and 26.25 +/- 6.90 dBA for the left ear. Speech discrimination sharply decreased by 23.3 +/- 4.82% for the right ear and 23.5 +/- 3.89%for the left ear. This implies that speech communication during operating room noise may be possible only by raising the voice, and the ability to discriminate spoken words sharply declines.	B+

84	**Nelson-Shulman, Y. (1983-84).** Information and environmental stress: Report of a hospital intervention. *Journal of Environmental Systems, 13*(4), 303-316.	Signs in waiting area	Knowledge of admitting procedures; familiarity with admitting environment; number of patient-initiated interactions with staff; patient's evaluation of hospital anxiety (heart rate); perceived crowding; estimates of waiting time	Before-after intervention study with non-concurrent comparison groups; a priori hypothesis.	Pretest (uninformed group): 86 patients, post-test (informed group): 94 patients; 51% female sample, mean age 46	Informed patients were found to be more knowledgeable about admitting procedures and available amenities. They were more self-reliant and made fewer demands on staff. In contrast, uninformed patients rated the hospital less favorably and were found to have elevated heart rates. Patients admitted under conditions of high density gave more negative responses than those admitted under conditions of low density.	B+
85	**Nott, M. R., & West, P. D. (2003).** Orthopaedic theatre noise: A potential hazard to patients. *Anaesthesia, 58*(8), 784-787.	Noise produced by orthopedic surgery	Noise levels in dBA	Descriptive; recordings of noise distribution; sound meter	39 patients undergoing 59 routine procedures in an orthopedic surgery theatre	Peak noise level exceeded 100 dBA. This noise level may result in significant inner-ear damage and permanent tinnitus. Ear protectors or disposable earplugs might be used to reduce possible ear damage.	B-
86	**Novaes, M. A., Aronovich, A., Ferraz, M. B., & Knobel, E. (1997).** Stressors in ICU: Patients' evaluation. *Intensive Care Medicine, 23*(12), 1282-1285.	Stressors in an intensive care unit (ICU)	Patient perception of stress	Descriptive; cross-sectional survey; questionnaire	50 randomly selected patients in the general ICU of a Brazilian hospital	Being in pain, being unable to sleep due to noise, and having tubes in the nose and/or mouth were reported as the major physical stressors. Loss of control and lack of understanding about the attitudes and procedures were the main psychological stressors.	B

87	**Nystrom, K., & Axelsson, K. (2002).** Mothers' experience of being separated from their newborns. *Journal of Obstetric, Gynecologic, and Neonatal Nursing, 31*(3), 275-282.	Separation of mothers from their newborns in a neonatal intensive care unit (NICU)	Mothers' reported feelings and perceptions about the separation experience	Descriptive; interview; no comparison group	Eight females with full-term newborn infants who were treated in a NICU	The mothers reported they experienced considerable emotional strain and anxiety while being separated from their newborn infants. The mothers experienced lack of personal control and felt like an outsider in relation to the infant, staff, the infant's father, the environment, other mothers, and themselves.	C
88	**Ogilvie, A. J. (1980).** Sources and levels of noise on the ward at night. *Nursing Times, 76*(31), 1363-1366.	Noise in Nightingale ward vs. newer racetrack ward	Noise levels in dBA and noise sources	Quasi-experimental; prospective; hypotheses; sound meter; observation	Four days of continuous recordings at two ends of each of two male wards: ward A (26-bed modernized Nightingale), and ward B (a 30-bed racetrack ward)	The comparatively modern racetrack ward was significantly quieter than the older Nightingale ward. Mean noise levels exceeded recommended limits, often by as much as 15 dBA. Human activities were the cause of the most frequent noises. The loudest noises came from equipment and other aspects of the physical environment or building structure.	B

89	**Parthasarathy, S., & Tobin, M. J. (2004).** Sleep in the intensive care unit. *Intensive Care Medicine, 30*(2), 197-206.	Intensive care unit (ICU) noise and other environmental factors	Sleep abnormalities	Review of research literature	87 articles	Polygraphic recordings, as opposed to observations or inspections, are more reliable measurements of sleep quantity and quality in ICUs. Critically ill patients exhibit increased sleep fragmentation (arousals and awakenings in sleep and decreases in rapid eye movement and slow-wave sleep). About 20% of arousals and awakenings are related to noise, and 10% to patient care activities. Other possible sources include severity of underlying disease, mechanical ventilation, and sedation. Sleep abnormality can induce sympathetic activation and elevation of blood pressure, delirium, agitation, patient morbidity, decrease immune function, and promote negative nitrogen balance. Effective measures to improve sleep include single rooms, decreasing noise, earplugs, and sedative agents.	Review
90	**Peponis, J., Zimring, C., & Choi, Y. K. (1990).** Finding the building in wayfinding. *Environment & Behavior, 22*(5), 555-590.	Spatial configuration	Intelligibility; ability to reach destinations	Experimental	15 graduate and undergraduate students from the schools of architecture and psychology	Search patterns are strongly shaped according to the degree of integration of each space and each choice node of the circulation system within the overall layout. Participants tended to move along more integrated routes and it may be important to locate key integration cores in the plan while placing important facilities and key points such as the entrance.	A

91	**Peterson, R., Knapp, T., Rosen, J.. & Pither, B. F. (1977).** The effects of furniture arrangement on the behavior of geriatric patients. *Behavior Therapy, 8*, 464-467.	Different furniture arrangements in a geriatric ward	Frequency of talking and other patient behaviors	Experiment; observation	Number of patients ranged from 20 to 34 for each session, with an average of 28	Frequency of talking was the only observed behavior that changed during the different furniture arrangement conditions, indicating that furniture arrangement can influence the verbalizations of patients in a geriatric ward.	A
92	**Powers, K. S., & Rubenstein, J. S. (1999).** Family presence during invasive procedures in the pediatric intensive care unit: A prospective study. *Archives of Pediatrics & Adolescent Medicine, 153*(9), 955-958.	Presence vs. absence of parents of patients in a pediatric intensive care unit (PICU)	Procedure-related anxiety reported by parents	Quasi-experimental; prospective, hypotheses; questionnaire; chart records	23 patients (16 in experimental group, parents present), six in control, parents absent) and their parents in a 12-bed PICU	Parental presence significantly reduced parental anxiety related to the procedure, but did not change condition-related anxiety. Both parents and nurses perceived parental presence as positive to parents and children.	B
93	**Ray, C. D., & Levinson, R. (1992).** Noise pollution in the operating room: A hazard to surgeons, personnel, and patients. *Journal of Spinal Disorders, 5*(4), 485-488.	Noise from spinal operations	Noise levels in dBA	Descriptive; recordings of noise levels and distribution; sound-level meter; observation of sources	Four spinal operative procedures	Noise peak levels were very high during surgery (95–118 dBA) and were potentially damaging to hearing. Peaks notably occurred during the use of high-speed gas turbine bone-cutting drills.	B-

94	**Rice, C. G., Talbott, J. A., & Stern, D. (1980).** Effects of environmental agents on social behavior of patients in a hospital dining room. *Hospital & Community Psychiatry, 31*(2), 128-130.	Three environmental conditions on patients' dining tables: flowering plant vs. no plant and Chianti bottle with candle vs. no flower and no Chianti bottle with candle	Observed vocalization; social gazing; seating location; duration of stay; amount of food consumed	Quasi-experimental design; observation	14 patients in the dining room of a locked psychiatric facility	There was an increase in social gazing, duration of stay in the dining space, and food consumption after the introduction of flowering plants. After the plants were removed, there was a decrease in the duration of stay and amount of food consumed. There was an increase in vocalizations, social gazing, duration of stay, and amount of food consumed after introduction of the Chianti bottles with candles. When the bottles were removed, social gazing decreased. Vocalizations, social gazing, duration of stay, and food consumed all increased more after the introduction of Chianti bottles/candles in comparison to the flowering plants.	A-
95	**Robertson, A., Cooper-Peel, C., & Vos, P. (1998).** Peak noise distribution in the neonatal intensive care nursery. *Journal of Perinatology, 18*(5), 361-364.	Noise in a neonatal intensive care unit (NICU)	Peak noise levels (short duration sounds) in dBA	Descriptive; recordings of noise levels and distribution; sound-level meter	80,640 minutes of sound recordings in four locations in a 12-bed room in a NICU	Thirty-one percent of the noise peaks exceeded 90 dBA. The proportion exceeding 90 dBA varied as a function of time of day, day of week, week, and location within the NICU. Three daily periods (9 a.m –12 p.m., 3–6 p.m., and 10–11 p.m.) were associated with increased frequency of noise exceeding 90 dBA. During physician rounds, there was a 16% increase in noises exceeding 90 dBA.	B

96	**Routhieaux, R. L., & Tansik, D. A. (1997).** The benefits of music in hospital waiting rooms. *Health Care Supervisor, 16*(2), 31-40.	Presence vs. absence of music in a large surgical intensive care waiting room in a hospital	Visitor-reported stress levels; perceptions of customer service	Quasi-experimental; hypotheses; questionnaire	279 nonpatient visitors who were in a waiting room (which could accommodate 75 people) in a large hospital	The presence of music significantly reduced stress levels compared to when there was no music in the waiting room. Persons who had lower stress levels reported greater satisfaction with customer service. However, there was no significant link found between the ratings of customer service and the presence of music.	B
97	**Schneider, S. M., Ellis, M., Coombs, W. T., Shonkwiler, E. L., & Folsom, L. C. (2003).** Virtual reality intervention for older women with breast cancer. *Cyberpsychology & Behavior, 6*(3), 301-307.	Immersive virtual reality (VR) distraction vs. no VR distraction; VR displayed underwater scenes and walking through an art museum	Effects of chemotherapy on self-reported ratings of fatigue, anxiety, and symptoms	Experiment; randomized; within-subjects; anxiety inventory; fatigue scale; symptom distress scale	16 women (15 Caucasian, one African American) aged 50–77 diagnosed with breast cancer	Patients reported significantly decreased anxiety after receiving treatment with the VR distraction, compared to when they had no VR. No significant changes were reported in regards to symptom distress or fatigue after the use of VR. However, after a 48-hour period, improvement in symptom distress was reported.	A
98	**Schneider, S. M., Prince-Paul, M., Allen, M. J., Silverman, P., & Talaba, D. (2004).** Virtual reality as a distraction intervention for women receiving chemotherapy. *Oncology Nursing Forum, 31*(1), 81-88.	Immersive virtual reality (VR) distraction vs. no VR distraction during chemotherapy for breast cancer; VR displayed underwater scenes and a walk through an art museum	Self-reported symptom distress, fatigue, and anxiety	Experiment; cross-over design; within-subjects	20 women (16 Caucasian, three African American, one other) aged 18–55 receiving chemotherapy for breast cancer	The patients reported decreased symptom distress and fatigue following treatment with the VR distraction, compared to when they had no VR distraction. Reported anxiety was slightly but not significantly lower after the VR intervention.	A

99	**Schnelle, J. F., Ouslander, J. G., Simmons, S. F., Alessi, C. A., & Gravel, M. D. (1993).** The nighttime environment, incontinence care, and sleep disruption in nursing homes. *Journal of the American Geriatrics Society, 41*(9), 910-914.	Noise; light; interruptions for incontinence care in a nursing home	Nighttime awakenings	Cross-sectional survey; bedside monitoring equipment; observation	118 residents in four nursing homes	Noise, light, and incontinent nursing care practices were associated with 50% of all waking episodes of four minutes or longer and 35% of all waking episodes of two minutes or shorter. Eighty-seven percent of all incontinence nursing care practices were associated with episodes of awakening.	B-
100	**Schofield, P., & Davis, B. (2000).** Sensory stimulation (Snoezelen) vs. relaxation: A potential strategy for the management of chronic pain. *Disability & Rehabilitation, 22*(15), 675-682.	Exposure to Snoezelen multisensory environment (lights, colors, sounds, textures) intended to induce relaxation vs. no Snoezelen exposure in a pain clinic	Self-reported pain intensity and quality; anxiety; depression; self-efficacy, sickness impact, and coping	Experiment; random assignment; questionnaires	73 pain patients assigned either to an experimental group (with Snoezelen room exposure) or a control group with Snoezelen exposure in a UK pain clinic	The control group (no Snoezelen) reported significant improvement in regard to the sickness impact profile. The group exposed to the Snoezelen environment reported significantly lessened pain and improvements in terms of disability (physical, psychosocial, recreational), sleep, coping, and sickness impact profile.	A-
101	**Schulte, D. A., Burrell, L. O., Gueldner, S. H., Bramlett, M. H., Fuszard, B., Stone, S. K., et al. (1993).** Pilot study of the relationship between heart rate and ectopy and unrestricted vs. restricted visiting hours in the coronary care unit. *American*	Unrestricted vs. restricted visiting hours in a coronary care unit	Cardiac performance (as measured by heart rate and ectopy)	Quasi-experimental; repeated measurements; hypotheses; cardiac measures	25 patients (13 in unrestricted visiting group, 12 in restricted visiting group) in a coronary care unit	Patients with unrestricted visiting hours had a significantly lower heart rate after visits than patients with restricted visits.	B

	Journal of Critical Care, 2(2), 134-136.						
102	**Shankar, N., Malhotra, K. L., Ahuja, S., & Tandon, O. P. (2001).** Noise pollution: A study of noise levels in the operation theatres of a general hospital during various surgical procedures. *Journal of the Indian Medical Association, 99*(5), 244, 246-247.	Noise in operating theatres during surgery	Noise levels in dBA	Descriptive; recording of noise levels and distribution; sound-level meter; observation of noise sources	Four operations in four operation theatres in a general hospital in India	Sound levels (47–80 dBA) were found to be higher than the recommended international standards. Noise was produced mainly by doors, trolleys, equipment, alarms, and the incessant conversation among the operation theatre staff.	B-
103	**Sherman, S. A., Varni, J. W., Ulrich, R. S., Malcarne, V. L. (in press).** Post occupancy evaluation of healing gardens in a pediatric cancer center. *Landscape and Urban Planning.*	Three varied healing gardens	Observed behaviors of garden users; length of stay of garden users; observed window use in patient rooms; reported present health-related functioning by patient parents	Postoccupancy evaluation; hypotheses; observation; self-report	1,400 observed users of three gardens at a pediatric cancer center at San Diego Children's Hospital: Garden of Dreams (6,279 square feet), Friendship Garden (4,625 square feet), and Buggy Garden (1,102 square feet)	The garden that was the largest and most accessible to patients was used the most. Major types of staff activities in the gardens included walking, sitting, and eating. Staff activities did not utilize garden features intended for active participation. Most garden visitors were adults who participated in passive or sedentary activities. Compared to adult visitors, children who visited the gardens interacted with the garden features in more active ways. An inverse relationship	D

						was found between patient-room window use and the number of visitors in the gardens. Preliminary data suggested that emotional distress were lower for patients, parents, and staff members when they were in a garden in comparison to being inside the hospital.	
104	**Shertzer, K. E., & Keck, J. F. (2001).** Music and the PACU environment. *Journal of Perianesthesia Nursing, 16*(2), 90-102.	Effects of music vs. no music on pain in a pediatric intensive care unit (PACU)	Pain intensity; comfort with aspects of the PACU stay	Quasi-experimental; hypotheses; reported pain and comfort	97 pediatric patients undergoing same-day surgery	The group exposed to music experienced a reduction in pain during the PACU stay, while there was no reduction experienced by the control group (no music). Also, the group with music reported less noise from both the staff and equipment, perceived the nurses as more available, and reported a more positive stay experience in the PACU.	B
105	**Simpson, T., & Shaver, J. (1991).** A comparison of hypertensive and nonhypertensive coronary care patients' cardiovascular responses to visitors. *Heart Lung, 20*(3), 213-220.	Family visit vs. an interview by an investigator	Blood pressure (systolic and diastolic), heart rate, and premature ventricular contractions	Quasi-experimental; repeated measurements; hypotheses	24 patients (12 with hypertension, 12 without) in a coronary critical care unit in a hospital in the U.S. Northwest	Group means for systolic blood pressure and heart rate were higher for patients with hypertension than for patients without hypertension. Cardiovascular data indicated for both groups of patients (those with hypertension and those without hypertension) that family visits were no more physiologically stressful than a comparative interaction condition consisting of an interview.	B

106	**Slevin, M., Farrington, N., Duffy, G., Daly, L., & Murphy, J. F. (2000).** Altering the NICU and measuring infants' responses. *Acta Paediatrica, 89*(5), 577-581.	Quiet period (reduced light, noise, alarm events, staff conversation, staff activity, and infant handling) vs. period without quieting in a neonatal intensive care unit (NICU)	Blood pressure; heart rate; oxygen saturation; infants' observed movements	Quasi-experimental; before-after; within-subjects; hypotheses; decibel meter; light meter; video camera; physiology monitor; observation	10 preterm infants in a NICU in Ireland	During the quiet period (reduced light, noise, alarm events, staff conversation, staff activity, and infant handling), infants' diastolic blood pressure and mean arterial blood pressure declined significantly (2 mm Hg), and infants' movements dropped from 84 to 14.5.	B
107	**Sommer, R., & Ross, H. (1958).** Social interaction on a geriatrics ward. *The International Journal of Social Psychiatry, 4*(2), 128-133.	Different furniture arrangements in a geriatric ward	Verbal interactions among patients (sustained and transient)	Experiment; within-subjects; observation	83 female subjects (mean age 74); 57 diagnosed as arteriosclerotic; 24 diagnosed as schizophrenic or manic depressive; 2 diagnosed as GPI (general paralysis of the insane).	Both transient and sustained verbal interactions almost doubled after the implementation of the new furniture arrangement. There were no recorded verbal interactions that occurred between more than three subjects.	A
108	**Soutar, R. L., & Wilson, J. A. (1986).** Does hospital noise disturb patients? *British Medical Journal (Clinical Research Ed.), 292*(6516), 305.	Noise in a general medical ward, acute admission ward, and psychiatric ward	Noise levels in dBA; sleep quality	Descriptive; survey of noise distribution; hypotheses; sound-level meter; sleep quality reported by patients and staff	91 patients and 21 nursing staff members in a general medical ward, an acute admission ward, and a psychiatric ward	The average noise levels in the general medical ward, the acute admission ward, and the psychiatric ward were respectively 68, 66, and 49 dBA. The psychiatric unit was quieter than the other units. In comparison to sleep at home, 39 patients reported unaltered sleep, 28 reported worse sleep, and 24 reported better sleep when in the hospital. Staff reported noise was sufficient to disturb 40% of patients.	B-

109	**Southwell, M. T., & Wistow, G. (1995).** Sleep in hospitals at night: Are patients' needs being met? *Journal of Advanced Nursing, 21*(6), 1101-1109.	Sources of sleep disturbance in different hospital environments	Patient sleep quality	Descriptive; survey; questionnaire	454 patients and 129 nurses in four hospitals in the UK	Patients reported they had insufficient sleep in the hospital at night and experienced discomfort, worries, and pain. Sleep was disrupted by a variety of sources of disturbance, including inadequately dimmed lights at night and that staff awakened patients early in the morning. Major sources of noise disturbance were other patients, nurses attending other patients, phone rings, and patients' and nurses' conversations.	B
110	**Starks, M. A. (2003).** Restoring attention in pregnancy: The natural environment. *Clinical Nursing Research, 12*(3), 246-265.	Activities in nature vs. no activities in nature	Test errors	Quasi-experimental; pre/post-test with control group; hypotheses; test performance accuracy	57 women attending prenatal classes (29 in group exposed to nature, 28 in control group)	After the nature intervention, women in the experimental group (spending 120 minutes each week in restorative activities involving nature) had fewer errors compared to the control group without nature experience. Other measures did not reveal differences.	B
111	**Stoneham, J., & Jones, R. (1997).** Residential landscapes: Their contribution to the quality of older people's lives. *Activities, Adaptation & Aging, 22*(1-2), 17-26.	Gardens or landscapes in sheltered houses	Residents' self-reported behaviors and perceptions with respect to gardens and landscapes	Descriptive; survey; hypotheses; questionnaire; interview	106 residents (aged 60–94 years old) in six sheltered houses in the UK	The main reported uses of landscapes were passive. Most residents viewed landscapes to be important and of high value.	B-

112	**Thomas, K. A. (1990).** Design issues in the NICU: Thermal effects of windows. *Neonatal Network, 9*(4), 23-26.	Location of incubators near windows vs. interior walls	Incubator air temperature, incubator exterior wall temperature, and temperature of window and wall surfaces as estimates of gradients supporting convective and radiant heat loss	Natural experiment	A total of 10 single-walled, manually operated incubators (Isolette C-86) were studied, five located adjacent to exterior windows and five adjacent to interior walls	Incubators in the wall location evidenced slightly warmer wall temperatures and slightly cooler indoor air temperatures than those in window locations. Gradient driving heat loss was larger in the window location, the incubators located adjacent to exterior windows appeared to have greater convective and radiant heat loss.	A-
113	**Topf, M., & Davis, J. E. (1993).** Critical care unit noise and rapid eye movement (REM) sleep. *Heart Lung, 22*(3), 252-258.	Audiotaped critical care unit noise (noisy vs. quiet conditions) played in a sleep laboratory	REM (rapid eye movement) sleep	Experiment; randomized assignment to noisy and quiet conditions; hypotheses; audiotape played; polysomnography	70 healthy (nonpatient) females attempting to sleep in a sleep laboratory	During the noisy condition, participants showed poorer REM sleep on 7 of 10 measures. They had lower REM activity and shorter REM durations throughout the night, during the first and second halves of the night, as well as a longer interval between the first and second REM cycles.	A-
114	**Topf, M., & Dillon, E. (1988).** Noise-induced stress as a predictor of burnout in critical care nurses. *Heart Lung, 17*(5), 567-574.	Noise in critical care units	Staff life-event stress; occupational stress; sensitivity to noise; noise-induced stress; burnout	Survey; hypotheses; correlational; Jones's Staff Burnout Scale for Health Professionals; Maslach's Burnout Inventory; other self-reports	100 critical care nurses (91% female) in two large U.S. hospitals	The three noise sources listed by nurses as most important were telephones, alarms, and beepers. Reported noise-induced occupational stress was positively related to reported burnout. Nurses more sensitive to noise were not at more risk of burnout due to noise-induced stress.	B

115	**Topf, M., & Thompson, S. (2001).** Interactive relationships between hospital patients' noise-induced stress and other stress with sleep. *Heart Lung, 30*(4), 237-243.	Noise and other environmental stressors (e.g., light)	Self-reported sleep quality, stress, anxiety, pain	Secondary analysis using existing data; hypotheses; self-report inventories; regression analysis	97 cardiac patients in a general unit	Regression analysis suggested that reported noise, an uncomfortable bed, pain, and anxiety worsened sleep quality. These stressors interacted to account for 12% of the variance in sleep.	B
116	**Topf, M., Bookman, M., & Arand, D. (1996).** Effects of critical care unit noise on the subjective quality of sleep. *Journal of Advanced Nursing, 24*(3), 545-551.	Audiotaped critical care unit noise (noisy vs. quiet conditions) in a sleep laboratory	Self-reported sleep quality	Experiment with random assignment; comparison between noisy and quiet condition; prospective; hypotheses; audiotape; self-reports	60 females attempting to sleep in a laboratory (33 of them listened to an audiotape of noise in a critical care unit)	Participants (nonpatient volunteers) in the noise condition reported taking longer to fall asleep, sleeping less, having more awakenings, poorer quality of sleep compared to home, and listed fewer positive and more numerous negative adjectives descriptive of sleep.	A-
117	**Tse, M. M. Y., Ng, J. K. F., Chung, J. W. Y., & Wong, T. K. S. (2002).** The effect of visual stimulation via the eyeglass display and the perception of pain. *Cyberpsychology & Behavior, 5*(1), 65-75.	Exposure to soundless video display of natural scenery vs. exposure to a blank display (control)	Self-reported ratings of anxiety level, simulation sickness, and degree of simulation immersion; pain threshold; pain tolerance	Experiment; random assignment; cross-over; reported pain; behavioral measure of pain tolerance; pain produced by modified tourniquet	72 (36 female, 36 male) Chinese students (nonpatients) with the average age of 20.97 +/- 1.97 years, in good health, and with normal or corrected vision	Participants (nonpatient volunteers) assigned the display of natural scenery evidenced significantly greater pain tolerance and higher pain thresholds (the time when they reported the first detectable pain). There was no correlation between the increase in pain tolerance with the level of immersion in the distraction reported by the participants.	A

118	**Tse, M. M., Ng, J. K., Chung, J. W., & Wong, T. K. (2002).** The effect of visual stimuli on pain threshold and tolerance. *Journal of Clinical Nursing, 11*(4), 462-469.	Exposure to soundless video display of natural scenery vs. exposure to a blank display (control)	Pain threshold (time when participants reported the first detectable pain); pain tolerance (time that pain was reported as intolerable)	Experiment; randomized; cross-over; hypotheses; pain was produced by a modified tourniquet	46 healthy volunteers assigned to two groups: with video nature display or with blank display	Nonpatient volunteers exposed to the nature scenery, compared to participants assigned the blank display, had higher pain thresholds and greater pain tolerance. Gender and the sequence of visual stimuli did not influence the effect of the nature display on pain threshold and pain tolerance.	A
119	**Tsiou, C., Eftymiatos, D., Theodossopoulou, E., Notis, P., & Kiriakou, K. (1998).** Noise sources and levels in the Evgenidion Hospital intensive care unit. *Intensive Care Medicine, 24*(8), 845-847.	Noise in a multibed intensive care unit (ICU)	Noise levels in dBA	Descriptive; recordings of noise levels; distribution; sound-level meter; questionnaire	10 patients (six male, four female); nine eight-hour sound recording periods in a six-bed ICU in Greece	Human activity, operating equipment, and construction engineering of the hospital building were identified as major noise sources. Average noise levels in the ICU ranged from 60.3–67.4 dBA and exceeded recommended hospital levels by 27 dBA.	B
120	**Ulrich, R. S. (1984).** View through a window may influence recovery from surgery. *Science, 224*(4647), 420-421.	Views through windows: natural view vs. view of brick wall	Length of stay; number and strength of analgesic doses; number and strength of anti-anxiety doses; minor complications; nurses' notes	Quasi-experimental design; random-like assignment; retrospective; clinical data from patient records	46 patients grouped into 23 matched pairs (15 female and 8 male) who had undergone cholecystectomy	Patients with the window view of nature (trees) had shorter postoperative stays, took fewer potent pain drugs, and received more favorable comments about their conditions in nurses' notes, than matched patients in similar rooms with windows facing a brick building wall. There was a nonsignificant tendency for patients with the window view of trees to develop fewer minor complications.	A-

121	**Ulrich, R. S. (1999).** Effects of gardens on health outcomes: Theory and research. In C. Cooper Marcus & M. Barnes (Eds.), *Healing gardens* (pp. 27-86). New York: Wiley.	Gardens in healthcare facilities	Health outcomes	Review of research literature	More than 100 studies	According to research reviewed from the behavioral sciences and health-related fields, gardens that foster control, social support, physical exercise, and exposure to nature can reduce stress among patients, family, and staff. There is increasing evidence that simply viewing gardens can mitigate pain. Certain negative distractions in healthcare gardens, including urban or mechanical noise and ambiguous design or art features, can worsen stress and other outcomes. In addition to reducing stress and pain, gardens can heighten satisfaction and facilitate wayfinding or navigation in healthcare buildings by patients and visitors.	Review
122	**Ulrich, R. S., & Gilpin, L. (2003)**. Healing arts: Nutrition for the soul. In S. B. Frampton, L. Gilpin & P. Charmel (Eds.), *Putting patients first: Designing and practicing patient-centered care* (pp. 117-146). San Francisco: Jossey-Bass.	Visual art	Various outcomes, for example, blood pressure, heart rate, intake of pain drugs, reported pain and anxiety	Review of research literature	Approximately 20 studies	Certain types of psychologically appropriate artwork, including representational images with themes relating to waterscapes, natural landscapes, flowers, and gardens, and figurative art with emotionally positive gestures and facial expressions, can reduce stress and improve outcomes such as pain. However, there is increasing evidence that emotionally inappropriate art styles and subject matter can worsen patient stress and other outcomes. Abstract or ambiguous images or emotionally challenging subject matter can evoke dislike or other distinctly negative reactions in many patients. The limited amount of art research supports the conclusion that art selection for healthcare facilities should be evidence-based.	Review

123	**Ulrich, R. S., Simons, R. F., & Miles, M. A. (2003).** Effects of environmental simulations and television on blood donor stress. *Journal of Architectural & Planning Research, 20*(1), 38-47.	A blood donor clinic waiting room with a television monitor that displayed either: a nature videotape, a tape of urban settings, daytime television, or a blank monitor	Donor stress measured by blood pressure, pulse rate, fainting episodes, and reported anxiety	Experiment; semi-randomized; prospective; hypotheses; physiological measures; self-reported anxiety; fainting episodes recorded by staff	872 blood donors in a U.S. clinic	Blood pressure and pulse rate recordings converged to indicate that donor stress was lower during no television (blank monitor) than daytime television, and during low-stimulation (nature tape + no TV) than high-stimulation conditions (urban tape + TV). Pulse rates were much lower during exposure to nature rather than urban tapes. There were no differences in the number or severity of fainting episodes during phlebotomy or in anxiety reported after the phlebotomy phase.	A
124	**Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991).** Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology, 11*(2), 201-230.	Videotapes of different natural environments vs. different urban environments	Electrocardiogram; pulse transit time; skin conductance; muscle tension; self-reported affective states	Experiment with random assignment; hypotheses; physiological measures; self-reported emotional states; movie to elicit stress	120 healthy undergraduate students (60 males, 60 females)	Findings from all physiological and self-report measures converged to show that recovery from stress was faster and more complete when persons were exposed to the natural rather than urban environments. During the first four minutes of exposure, participants assigned to view a nature tape achieved recovery from stress approaching baseline (pre-stressor) levels in autonomic and somatic activity. Also, participants reported less anger/aggression and fear and higher levels of positive affects after exposure to the natural settings in comparison to the urban settings.	A

125	**Verderber, S. (1986).** Dimensions of person-window transactions in the hospital environment. *Environment & Behavior, 18*(4), 450-466.	Hospital rooms with windows vs. without windows; different types of window-view content	Patient and staff preferences; self-ratings of satisfaction with/without windows; behaviors associated with/without windows	Questionnaire; interview	250 subjects: 125 staff (62% female), and 125 inpatients (50% female); 58% of patients were wheelchair-dependent and the average age was 62 years	The most preferred windows views were of vegetation, the surrounding neighborhood, people, vistas, and views that provided information about outside activities. Window views of architectural features (i.e., concrete building) or monotonous views were not preferred. If artificial substitutes for window views were necessary due to lack of windows, patients and staff preferred representations of nature. Respondents were not satisfied with: views in the hospital; the degree of personal control over windows, screens, and curtains; and the poor views from treatment rooms or the lack of windows. Spaces that had windows with sills high from the floor, that were not close to the viewer, or were obscured by walls or other architectural features were considered not adequately windowed.	B
126	**Verderber, S., & Reuman, D. (1987).** Windows, views, and health status in hospital therapeutic environments. *Journal of Architectural & Planning Research, 4*(2), 120-133.	Windows, view quality, and other window-related factors	Staff-reported well-being, occupational outlook, and job satisfaction; staff-reported patient health status and well-being	Staff questionnaire	137 hospital staff; 100 inpatient respondents	Patients, in comparison to staff, were more negatively affected by poorly windowed rooms. Staff who commuted daily more than two miles to work or worked in spaces without windows or far from windows, reported lower levels of well-being compared to other staff members.	B

127	**Vessey, J. A., Carlson, K. L., & McGill, J. (1994).** Use of distraction with children during an acute pain experience. *Nursing Research, 43*(6), 369-372.	Kaleidoscope distraction vs. no kaleidoscope	Children's pain and behavioral distress during routine blood draws	Experiment; randomized; hypotheses; self-reported pain; staff observation of patient behaviors	100 children, ages 3.5–12 years	The experimental group (encouraged to use a kaleidoscope) perceived less pain and demonstrated less behavioral distress than the control group (no kaleidoscope, but comforted by physical touch and voices).	A
128	**Vogelsang, J. (1988).** Effect of visitors on patient behavior in the postanesthesia period. *Dimensions of Critical Care Nursing, 7*(2), 91-100.	Family visitor vs. special nurse visitor	Frequency of social interaction between patients and visitors	Quasi-experimental; hypotheses; observation of social interaction	40 post-anesthesia patients (20 with family visitor, 20 with nurse visitor)	Patients who had family visitor exhibited more frequent social interactions than those having nurse visitors.	B
129	**Walder, B., Francioli, D., Meyer, J. J., Lancon, M., & Romand, J. A. (2000).** Effects of guidelines implementation in a surgical intensive care unit to control nighttime light and noise levels. *Critical Care Medicine, 28*(7), 2242-2247.	No guidelines vs. guidelines to decrease light and sound levels in an intensive care unit (ICU) (closing doors, lowering alarm sound, limiting nursing interventions, limits on conversation, phone, radio, direct light in	Light levels; sound levels; patient sleep quality perceived by nurses	Quasi-experimental; before-after; hypotheses; sound-level meter; light meter; questionnaire	17 patients in an 18-bed surgical ICU (nine patients in period 1 and eight in period 2)	Night-light levels were low during both periods, and lowering the light levels induced a greater variation of light, which may impair sleep quality. Noise levels remained high during both periods (with and without guidelines), which could contribute to sleep disturbance. Implementation of the guidelines decreased the mean noise level (51.3 dB to 48.3 dB), peak noise level (74.9 dB to 70.8 dB), and the number of identified alarms.	B

		room)					
130	**Walker, J. S., Eakes, G. G., & Siebelink, E. (1998).** The effects of familial voice interventions on comatose head-injured patients. *Journal of Trauma Nursing, 5*(2), 41-45.	Familial voice vs. no familial voice in intensive care unit (ICU)	Physiologic measures (intracranial pressure, blood pressure, pulse, respiratory rate, oxygen saturation level); restlessness	Quasi-experimental; repeated measurements; hypothesis; taped familial voice; physiologic measures and behavior observation	10 comatose head-injured patients in two ICUs	No significant changes were recorded in physiologic criteria after introduction of the tapes of a familial voice. This implied that family interactions would not have negative effects on comatose patients.	B
131	**Wallace-Guy, G., Kripke, D., Jean-Louis, G., Langer, R., Elliott, J., & Tuunainen, A. (2002).** Evening light exposure: Implications for sleep and depression. *Journal of the American Geriatrics Society, 50*(4), 738-739.	Illumination level in the evening and over 24-hour period	Sleep amount, sleep efficiency, sleep latency, wake within sleep, or mood	Prospective trial; nonrandomized	154 menopausal women, mean age 66.7; data were selected from a larger study of participants in the Women's Health Initiative	Illumination in the four hours before bedtime was quite dim; median 24 lux. Nevertheless, evening light exposure was not significantly related to sleep amount (in bed or out of bed), sleep efficiency, sleep latency, wake within sleep, or mood. In contrast, the overall amount of light throughout the 24 hours was negatively correlated with sleep latency, wake within sleep, and depressed mood.	A-

132	**Warren, N. A. (1993).** Perceived needs of the family members in the critical care waiting room. *Critical Care Nursing Quarterly, 16*(3), 56-63.	Family members of patients in a critical care unit waiting room	Family members' needs	Descriptive; questionnaire	94 family members (mean age 50 years; 24 males and 70 females) of critically ill patients	The study indicated that social support, assurance, and physical comfort were identified as important needs that were being met. Information (regarding communication with the staff about the patient) was also perceived as being important, however, this need was not being met. Comfort items considered very important/important included having a telephone near the waiting room, having a bathroom near the waiting room, and being assured by staff that it was all right to leave the hospital for a while. The presence of caring persons was very important and overlapped both support and comfort needs.	B
133	**Whall, A. L., Black, M. E., Groh, C. J., Yankou, D. J., Kupferschmid, B. J., & Foster, N. L. (1997).** The effect of natural environments upon agitation and aggression in late stage dementia patients. *American Journal of Alzheimer's Disease and Other Dementias,* 216-220	Five shower rooms for Alzheimer's patients either without nature distraction or with nature distractions (recorded bird songs, sound of babbling brooks, bird pictures)	Patient agitation and aggression during showering	Quasi-experimental; prospective; hypotheses; observation by clinical staff of patient behaviors indicating aggression and agitation	31 patients (in five nursing homes) diagnosed with late-stage Alzheimer's disease (4 males, 27 females); 15 were assigned to nature condition, 16 to control group with usual care but no nature	There was a significant decrease in agitated behaviors during showering when natural elements were present, but not during showering without nature. There was a nonsignificant tendency for aggression (e.g., hitting) to be lower for the nature shower condition than the control condition.	A-

134	**Whitehouse, S., Varni, J. W., Seid, M., Cooper-Marcus, C., Ensberg, M. J., Jacobs, J. R., et al. (2001).** Evaluating a children's hospital garden environment: Utilization and consumer satisfaction. *Journal of Environmental Psychology, 21*(3), 301-314.	An outdoor garden planned as a soothing healing space for patients, families, and staff in a large children's hospital	Perceived benefits of garden for patients' parents and staff; satisfaction; utilization; user-recommended changes for improving garden	Postoccupancy evaluation; hypotheses; behavioral observation of garden users; questionnaire; interviews with staff, parents of patients, patients, and patients' siblings	28 adult garden visitors and 55 adult family members and staff (17 males and 66 females) in a large children's hospital in San Diego; 52 adult respondents had been to the garden; also, 12 children and adolescents in the garden and 10 in the hospital (12 males and 10 females)	Most adults who were surveyed spent time in the garden to relax and rest and to improve their mood, while children mostly explored and actively played. The garden was perceived as a place of restoration and healing, and use was associated with increased general satisfaction with the hospital. The garden, however, was not used as often or as effectively as intended. Most visits by adults and children were of short duration. Changes for the garden recommended frequently by staff, parents, and children included adding more greenery and trees (suggested by 50% of parents), and more interactive features for children's activities or "things for kids to do" (18% of adults, 66% of children).	D
135	**Whitis, G. (1994).** Visiting hospitalized patients. *Journal of Advanced Nursing, 19*(1), 85-88.	Hospital visiting policies for different patient groups (including implementation of the policies)	Visiting policies in hospitals; visitor provisions; implementation of visiting policies by nurses	Descriptive; questionnaire survey of nurse managers	49 accredited hospitals in 10 southeastern states in the U.S.	Most of the hospitals surveyed had more liberal visiting policies for pediatric patients than for adult patients (86% allowed 24-hour visitation of pediatric patients in general medical units). However, 64% of the hospitals prohibited visitation by children 12–14 years or younger. Visiting policies for intensive care units were more restrictive or limiting for both pediatric and adult patients. Factors affecting implementation of visiting policies by nurses (and exceptions made for those visiting adult patients) included the acuity and prognosis of the patients, other patient or family requirements, and staff workload. Factors influencing exceptions made for visitors of pediatric patients	B

						included the prognosis and condition of patients and other patient or family needs.	
136	**Wilson, L. M. (1972).** Intensive care delirium: The effect of outside deprivation in a windowless unit. *Archives of Internal Medicine, 130*(2), 225-226.	Intensive care units (ICUs) with windows vs. without windows	Delirium and depression	Quasi-experimental; retrospective; not randomized; hypotheses; chart data. ICUs were in different hospitals; unknown differences between ICUs (e.g., nurses) may effect findings	100 patients in two ICUs in two hospitals; 50 patients (23 males) in ICU with windows, 50 (19 males) in windowless ICU	The number of patients who experienced delirium in the windowless ICU (20) was more than twice as high as in the ICU with windows (9). It is concluded that the presence of windows is highly desirable in ICUs to prevent deleterious effects of sensory deprivation.	B
137	**Wright, P., Hull, A. J., & Lickorish, A. (1993).** Navigating in a hospital outpatients' department: The merits of maps and wallsigns. *Journal of Architectural and Planning research, 10*(1), 76-89.	Handheld sketch maps; wall signs	Navigation adequacy; how often people retraced steps, speed	Experimental	24 paid women volunteers recruited from the volunteer panel of the applied psychology unit	People moving without the map were faster, though they retraced their steps more often to check they were going in the right direction. During subsequent debriefing, those using the map found it helpful, and half the group without the map thought it would have been useful.	

138	**Yinnon, A. M., Ilan, Y., Tadmor, B., Altarescu, G., & Hershko, C. (1992).** Quality of sleep in the medical department. *British Journal of Clinical Practitioners, 46(*2), 88-91.	Home vs. hospital	Sleep quality (duration of sleep, number of awakenings, need for sleeping pills); reasons for impaired sleep quality	Comparison of reported preadmission/ postadmission sleep quality; hypotheses; patient interview sleep-quality scales	134 patients in two medical departments and a coronary critical care unit in two Jerusalem hospitals	Compared to sleeping at home, 51% of 134 patients had a lower total sleep score in the hospital. Deterioration of sleep was found in number of awakenings (37%), reported quality of sleep (32%), duration of sleep (31%), and the need for using sleeping pills (26%). Reported reasons for impaired quality of sleep were noise made by other patients or by the medical staff (47%), and the patient's own disease (30%). Differences existed in the quality of sleep between the two medical departments located in different hospitals.	B
139	**Zahr, L. K., & de Traversay, J. (1995).** Premature infant responses to noise reduction by earmuffs: Effects on behavioral and physiologic measures. *Journal of Perinatology, 15*(6), 448-455.	Noise in neonatal intensive care unit (NICU) incubators for infants with vs. without earmuffs	Physiological responses (respiratory rate, heart rate, oxygen saturation); behavioral responses (behavior-state scale)	Experiment; within-subjects; treatment/control and crossover design; prospective; hypotheses; physiological monitoring; observation	17 premature infants in one hospital (randomly assigned to treatment and control groups) and 13 in another hospital (served as their own controls with crossover design)	Earmuffs reduced noise for infants by 7 –12 dB. In the NICU where infants served as their own controls, they had higher mean oxygen saturation levels, less fluctuation in oxygen saturation, less frequent behavioral state changes, spent more time in the quiet sleep state, and had longer episodes of sleep, when they wore the earmuffs. In the hospital where two concurrent groups were compared, no significant results were found, possibly because of individual variability. It is imperative that noise be reduced in NICUs.	A

Improve Overall Health-Care Quality

No.	Study	Environmental variable(s) studied	Outcome measure(s)	Research design	Sample description	Major findings	Grade
1	**Devlin, A. S. (1992).** Psychiatric ward renovation: Staff perception and patient behavior. *Environment & Behavior, 24*(1), 66-84.	Environmental improvements including new day-hall furniture, plants, wallpaper, brighter lighting	Staff response to design changes (higher staff morale hypothesized)	Before-after study (methods: staff surveys and behavior mapping)	Before phase: 37 staff; after phase: 24 staff; study conducted at a 40-year-old state psychiatric facility	Results indicate significant pre-post improvements in the ratings of day-hall furnishings and plants. Behavioral data showed a significant decrease in patient stereotypy and a preference for more private seating areas in the day hall following renovation.	D
2	**Holahan, C., & Saegert, S. (1973).** Behavioral and attitudinal effects of large-scale variation in the physical environment of psychiatric wards. *Journal of Abnormal Psychology, 82*(3), 454-462.	Remodeled psychiatric admissions ward (repainted, new furniture, bedspreads, partitions in bedroom areas) vs. an identical unchanged admissions ward	Social and active behavior attitudes toward ward environment	Experimental design; post-test-only control group design; a priori hypotheses	25 patients were randomly selected on each of the two wards; 13 males and 12 females were studied on each ward	Significantly more socializing and less passivity occurred on the remodeled than on the control ward, and patients of the remodeled ward demonstrated more positive attitudes toward the ward physical environment. Also, patients on the remodeled ward viewed their environment more positively than the patients on the control ward.	A
3	**Shepley, M. M. (1995).** The location of behavioral incidents in a children's psychiatric facility. *Children's Environments, 12*(3), 352-361.	Ward environment: redesign phase, antiquated dormitory style buildings, post-occupancy phase, new structures with semiprivate and private rooms housing 22 patients each	Location and incidence of negative behaviors in a children's psychiatric facility	Two-phase study: Predesign and post occupancy phase; a priori hypotheses present	Phase 1: seven workshops with staff, 25 interviews with children, 20 drawings by children; phase 2: 37 staff questionnaires, 10 drawings by children	The location for negative behaviors changed from the previous building and the number of behaviors dropped significantly following initial building occupation. The data indicated that more negative behaviors occurred in the new semiprivate patient rooms than in the dormitories of the old building, although staff supported continued use of semiprivate rooms.	D

4	**Shepley, M. M., Bryant, C., & Frohman, B. (1995).** Validating a building prototype: A post-occupancy evaluation of a women's medical center. *Journal of Interior Design, 21*(2), 15-29	Inpatient unit, neonatal intensive care unit (NICU), administration/support spaces, and surgery suite in a women's medical center.	Human factors such as social interaction, family-centered care, staff morale, and general building factors related to appearance, ambience, and functionality were assessed	Multimethod postoccupancy evaluation: questionnaire, interviews, and behavior-mapping techniques	22 questionnaire responses from staff; eight staff interviews; two behavior-mapping studies	Findings describe positive and negative aspects of the different departments studied from the staff perspective. The inpatient unit was reviewed favorably, though specific improvements were suggested such as providing footwall storage in the patient rooms and reexamining the use of the nurses stations. The open plan of the NICU was also positively received by staff.	D
5	**Stahler, G. J., Frazer, D., & Rappaport, H. (1984).** The evaluation of an environmental remodeling program on a psychiatric geriatric ward, *Journal of Social Psychology,* 123(1), 101.	Furniture rearrangement	Activity levels (social and nonsocial), pathological behavior, self-care skills, management problems, attitude toward ward environment	Before-after study with comparison group; methods used included behavior observations, Norristown Behavior checklist (patient behavior assessment checklist), and structured interviews (follow-up stage).	Experimental group: 69 female patients; control group: 67 male patients	Patient-staff interaction increased following the remodeling, but patients also displayed increased hostility and tension as well as decreased sociability and self-maintenance skills. Five weeks later, however, it was found that pathological behavior had decreased below the level found prior to remodeling. None of these changes were observed in the comparison ward. Interviews indicated that environmental enhancement improved morale among patients and staff.	B
6	**Teresi, J. A., Holmes, D., & Monaco, C. (1993).** An evaluation of the effects of commingling cognitively and noncognitively impaired individuals in long-term care facilities. *Gerontologist, 33*(3), 350-358	Living with or next to a demented individual in integrated long-term care facilities	Depression/ demoralization; dissatisfaction measured by scales	Interview	77 non-cognitively impaired residents of a long-term care facility (mean age 81 years)	Those residents living with or next to a demented individual were found to be less cognitively and more physically impaired, had fewer contacts with family, and reported more distress.	B