Lärm und Lärmwirkungen in Krankeneinrichtungen: Übersicht über einschlägige angelsächsische umwelt- und medizinisch-psychologische Studien

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Thema und Datengrundlage

Quelle: Roger Ulrich, Xiaobo Quan, Craig Zimring u.a. (2004): The Role of the Physical Environment in the Hospital of the 21st Century: A Once-in-a-Lifetime Opportunity,
vgl. <http://www.healthdesign.org/research/reports/>

Die Quellenarbeit stützt sich auf die Auswertung von neueren medizinisch- und umweltpsychologischen Studien in angelsächsischen Fachzeitschriften zur Reduzierung von "Staff stress" (88 Studien), allgemein zur Reduzierung von Stress und Verbesserung von "Outcomes" vor allem bei Patienten (139 Studien) sowie 6 Arbeiten "Improve overall health- care Quality".

Die in der Quellenarbeit berücksichtigten Studien beziehen sich auf heterogene umweltpsychologische Einflußgrößen wie Beleuchtung /Sonnenlicht, Luftqualität, Bodenbeschaffenheit, Weglängen, Orientierungssysteme oder - nicht zuletzt - Natur und Ästhetik im räumlichen Kontext von Krankeneinrichtungen.

In der hier vorgelegten Sekundärzusammenfassung wurden speziell diejenigen 25 Arbeiten betrachtet, die sich mit Lärm und Lärmwirkungen in Krankeneinrichtungen befassen.

Allgemeine Schlußfolgerungen

1. Eine recht stattliche Zahl von systematischen medizinisch- und umweltpsychologischen Untersuchungen in den berücksichtigen angelsächsischen Fachzeitschriften befaßt sich
- in unterschiedlichen Krankenhaus- Funktionsbereichen und heterogenen Zielgruppen (Patienten von Neugeborenen bis zu Senioren, Besucher, medizinisches und pflegerisches Fachpersonal)
- mit der qualitativen und quantitativen Erfassung von Lärmkenngrößen,
- deren unabhängigen Bedingungen,
- physischen, psychosozialen oder arbeitsorganisatorischen Interventionen zur Lärmreduktion,
- der Abschätzung ihrer Auswirkungen (bzw. bei Interventionen der Wirksamkeit) auf Grundlage vielfältiger abhängiger Variablen.

2. Eine der wesentlichen Einschätzungen der Autoren, gestützt auch auf methodisch gut recht kontrollierte Studien (z.B. 49): "A bad acoustics environment during acute illness can have important detrimental physiological effects on rehabilitation."

Kurzübersicht zu den dort erhobenen Vatiablen:

Unabhängige Var./ Interventionen:
ceiling tiles from soundreflecting tiles to soundabsorbing tiles of identical appearance (2 Arbeiten)
Noise levels as function of changes in staff behavior and equipment modification
numbers of staff members and patients
curtain partitions between beds
privacy breaches in emergency rooms
Interventions: education of nursing and physician staff on controlling noise; closing patient room doors

Abhängige Variablen u.a.:
Psychophysiol.:
Heart rate, heart-rate variability;
pulse amplitude; blood pressure
infant oxygen saturation;
infant behavioral states, infants' observed movements
arousals during sleep, Sleep arousals, awakenings
Subjektive Kriterien:
Perceived noise, psychosocial criteria, Perceived environmental sources of sleep disruption
Perceived sleep quality and daytime sleepiness
annoyance with noise
Psychol.
Reported state and trait anxiety
Medikamentenbedarf
intake of intravenous beta-blockers;
Leistungsmaße
Speech-discrimination performance (Senioren)
Speech reception threshold; speech discrimination
Evaluationsindikatoren:
patient ratings of care quality, patient discomfort in the recovery room
workers' subjective responses,

Qualitative Messungen / Erhebungen
recordings of noise distribution, peak noise, and sources at different locations; decibel meter; observation of noise sources
Noise levels in dBA; patient perceptions of noise (auch im OP- Saal, mehrere Studien)

Berücksichtige Studien:

(Vorangestellte Nummer entspr. Originalarbeit)

A Reviews
Lärm und Umweltstress:
5 Baker, C. F. (1984). Sensory overload and noise in the ICU: Sources of environmental stress.
Critical Care Quarterly, 6(4), 66-80. (40 Einzelpubl.)
Hauptergebnis: 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 measures.

Lärmbedingte Schlafstörungen von Patienten auf Intensivstationen:
89 Parthasarathy, S., & Tobin, M. J. (2004): Sleep in the intensive care unit.
Intensive Care Medicine, 30(2), 197-206. (89 Einzelpubl.)
Hauptergebnis: 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

B Berücksichtigte Einzelstudien (Vorangestellte Nummer entspr. Originalarbeit)

6 Baker, C. F. (1992). Discomfort to environmental noise: Heart rate responses of SICU patients. Critical Care Nursing Quarterly, 15(2), 75- 90.
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.
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.
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.
15 Berg, S. (2001). Impact of reduced reverberation time on sound-induced arousals during sleep. Sleep, 24(3), 289-292.
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.
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.
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.
35 Falk, S. A., & Woods, N. F. (1973). Hospital noise-levels and potential health hazards. New England Journal of Medicine, 289(15), 774-781.
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.
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.
44 Gast, P. L., & Baker, C. F. (1989). The CCU patient: Anxiety and annoyance to noise. Critical Care Nursing Quarterly, 12(3), 39- 54.
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.
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.
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.
54 Hilton, B. A. (1985). Noise in acute patient care areas. Research in Nursing & Health, 8(3), 283-291.
55 Hodge, B., & Thompson, J. F. (1990). Noise pollution in the operating theatre. Lancet, 335(8694), 891-894.
62 Johnson, A. N. (2001). Neonatal response to control of noise inside the incubator. Pediatric Nursing, 27(6), 600- 605.
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.
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.
77 Mlinek, E. J., & Pierce, J. (1997). Confidentiality and privacy breaches in a university hospital emergency department. Academic Emergency Medicine, 4(12), 1142- 1146.
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.
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.
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.
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.

Anhang: Kurzbeschreibung der einbezogenen Studien nach Ulrich u.a. 2004

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 measures. Review

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 Quasiexperimental; correlational; prospective; hypotheses; ECG monitor; sound level meter 28 adult patients in a 14-bed singleroom 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 Quasiexperimental; 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

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

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 were the main causes of noise in the ITU. B

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 (soundreflecting vs. soundabsorbing) Reverberation time; sleep arousals or fragmentation Quasiexperimental; 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 onebed 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

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

soundreflecting tiles to soundabsorbing tiles of identical appearance) Reported psychosocial work environment and staff moods; speech intelligibility Quasiexperimental; repeated measurements; prospective; hypotheses; sound-level recordings; staff questionnaire; Rapid Speech Transmission (RASTI) measure of speech intelligibility 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 absorbing. A

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 humanrelated. The primary nonhumanrelated source was monitor alarms. These results imply that modifications of staff behavior, care procedures, and apparatus may reduce the noise levels in the NICU.

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 Quasiexperimental; 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.

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 acutecare 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.

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.

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 openplan intensive care unit (ICU), with curtain partitions between beds Sleep arousals and

awakenings measured by polysomnography; questionnaire for assessing perceived sources of sleep disruption Quasiexperimental; 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 singlebed 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 Quasiexperimental; repeated measures; hypotheses; statetrait 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 onehour 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.

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 soundreflecting (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 Quasiexperimental; prospective; before-after; hypotheses; sound level recordings; physiological monitoring; drugintake 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

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; Speechdiscrimination test; hearing test 10 young normalhearing nonpatient volunteers, 10 elderly normalhearing nonpatient volunteers, and 10 elderly hearingimpaired 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.

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 noiselevel 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

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

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 openplan 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).

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 Quasiexperimental; 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 Quasiexperimental; prospective; observation; interview Visual and auditory confidentiality breaches observed during six onehour 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

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 Quasiexperimental; 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

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 prerecorded audio tape of operating room noise Speech reception threshold; speech discrimination Quasiexperimental; 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.

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

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 bonecutting drills. 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 Quasiexperimental; 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