

# Impact of noise in healthcare

**A research summary**



**Ecophon**<sup>®</sup>  
SAINT-GOBAIN

A SOUND EFFECT ON PEOPLE



# Healthcare facts

## Benefits of a healthy sound environment

*Studies show that a good sound environment dramatically increases the overall quality of care in healthcare facilities. The benefits include:*

- Lowered blood pressure
- Improved quality of sleep
- Reduced intake of pain medication
- Improved communication
- Lowered stress levels
- Improved patient safety
- Enhanced staff wellbeing, performance and job satisfaction



*It is quite astonishing that the acoustic solution can contribute to all this. And in addition to all the human benefits, think of what the benefits mean in terms of saving time and money.*



### Hospitals and outpatient clinic facts

- High sound levels in healthcare facilities are known to: impair sleep, increase stress, delay post-illness rehabilitation, aggravate agitation, cause psychiatric symptoms, escalate restlessness, increase respiratory rates and increase heart rates<sup>1</sup>
- Sleep is fundamental to human health in general and critical to patient recovery. Alertness, mood, behaviour, coping abilities, respiratory muscle function, healing time and length of stay are just a few of the potential impacts of patient sleep disturbance or deprivation<sup>2</sup>
- Noise in emergency departments is regarded by 60.5% of staff as being “very” or “somewhat” burdensome.<sup>3</sup> 83% of all communication with a head nurse in an emergency department is synchronous, e.g. face to face or via telephone.<sup>4</sup> 70% of critical medical errors in emergency departments can be traced back to “communication shortcomings” such as multitasking and interruptions<sup>5</sup>

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<sup>1</sup> Weise, “Investigation of patient perception of hospital noise and sound level measurements: before, during and after renovations of a hospital wing”, Architectural engineering - Dissertations and Student Research, 2010, Paper 4, p7

<sup>2</sup> Hsu, Ryherd, Ackerman, Persson Wayne, “Noise pollution in hospitals: Impacts on patients”, J. Clin. Out. Mgmt. 2012, vol 19, no 7, p301 -309

<sup>3</sup> M. Simon, P. Tackenberg et al., Auswertung der ersten Befragung der NEXt-Studie in Deutschland. Wuppertal University, 2005

<sup>4</sup> Woloshynowych, Davis et al., “Communication patterns in a UK emergency department”, Ann. Emerg. Med., Oct 2007, 50(4), p407-413

<sup>5</sup> Joint Comission. Sentinel Event Data, Root Causes by Event Type, 2010



### **Elderly care facts**

- Age-related hearing loss (presbycusis) causes communication problems for approximately 37% of people between the ages of 61 and 70. This prevalence rises to 60% for people aged 71 to 80<sup>6</sup>
- Impaired hearing adversely affects spatial orientation and increases the risk of falling. Impaired hearing turns communication into a real effort and causes rapid fatigue/exhaustion. Frequent misunderstandings are known to lead to withdrawal, self-doubt, depression and dogmatism<sup>7</sup>
- The severity of hearing loss correlates with reduced cognition and an increased incidence of depression in old age<sup>8,9</sup>
- People who are cut off acoustically from the external world not only lose their hearing, they are at risk of becoming socially and intellectually isolated. The less stimulation the brain receives, the more quickly its capacity diminishes<sup>7</sup>

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<sup>6</sup> Baur et al., Einfluss exogener Faktoren auf Altersschwerhörigkeit, HNO 2009, Springer Medizin Verlag 2009, p1023-1028

<sup>7</sup> Arneborg, E., Deutsche Seniorenliga e.V., Altersschwerhörigkeit - Symptome, Ursachen, Folgen, Diagnostik, Therapie, (Age-related hearing loss - symptoms, causes, consequences, diagnosis, therapy) Ausgabe 2010; Dalton et al., 2003; Chia et al., 2007; Chisolm et al., 2004

<sup>8</sup> Cacciatore, F., Napoli, C., Abete, P., et al., 1999. Quality of Life Determinants and Hearing Function in an Elderly Population: Osservatorio Geriatrico Campano Study Group, Gerontology, 45 (6), p323-328

<sup>9</sup> Dalton, D. S., Cruickshanks, K. J., Klein, B. E., et al., 2003. The Impact of Hearing Loss on Quality of Life in Older Adults. The gerontologist, 43 (5), p661 -668



### **Mental health facts**

- The most widespread and well-documented subjective response to noise is annoyance, which may include fear and mild anger, related to a belief that one is being avoidably harmed<sup>10</sup>
- Noise may reduce helping behaviour, increase aggression and reduce the processing of social cues<sup>10</sup>
- Overcrowding is a factor that can contribute to fear and tension on a ward. Staff perform better in environments that feel safe, calm and spacious<sup>11</sup>
- Designs that have good acoustics, minimise the risk of crowding and have natural light and ventilation are important in helping to create a positive therapeutic atmosphere<sup>11</sup>
- A therapeutic environment is one where noise levels are adjusted to meet the needs of the people living there<sup>11</sup>

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<sup>10</sup> Stansfeld et al., Noise pollution: non-auditory effects on health, British Medical Bulletin 2003; 68: p243-257

<sup>11</sup> United Kingdom Department of Health, "Health Building Note 03/01: Adult acute mental health units", 2013, p6-11

# Common sound levels

## and how they are perceived

### Typical sound levels in decibels<sup>12</sup>

Four-engine jet aircraft at 100 m	120 dB
Riveting of steel plate at 10 m	105 dB
Pneumatic drill at 10 m	90 dB
Circular wood saw at 10 m	80 dB
Heavy road traffic at 10 m	75 dB
Telephone bell at 10 m	65 dB
Male speech, average, at 10 m	50 dB
Whisper at 10 m	25 dB

**+ 10 db**

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An increase of 10 dB is perceived by people as twice as strong/high.

### Measuring decibels

Depending on what you want to measure, the sound strength at different frequencies can be weighted differently.

- dB(A) is used when you want to measure general sound strength as perceived by the human ear.
- Whenever dB is mentioned in this brochure, it refers to dB(A).

<sup>12</sup> Appendix 12B: Description of noise and vibration units, <https://www.blaby.gov.uk/EasySiteWeb/GatewayLink.aspx?allid=3120>

# Effect of noise

## on intellectual performance

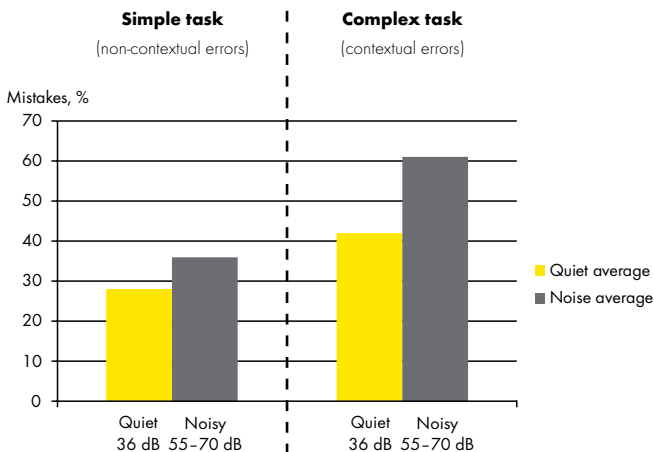
Weinstein, University of California, Berkeley, *Journal of applied psychology*, 1974, vol 59, no 5, p548-554

The study aimed to establish the difference in performance between working in a quiet environment and one with irregular bursts of background noise. 33 college students were divided into groups and performed tasks in two settings, one less demanding (finding spelling and typographical errors) and one more complex (finding grammatical errors, missing words and incorrect words).

When interviewed the subjects did not believe that the noise had interfered significantly with their proofreading. Most of them also thought they did a lot better than they actually did.

### Conclusions

- There was not a significant difference between the two environments when performing the easier task. But when it comes to the complex task, the performance in the noisy space was 50% less accurate.



# WHO guidelines

## for sound in healthcare

Berglund et al., "Guidelines for community noise", Technical Report 1999, World Health Organization

The World Health Organization has released facts about, and recommendations for, noise in specific environments.

### **In general:**

- Half of all European Union citizens are estimated to live in zones that do not ensure acoustic comfort for residents. At night more than 30% of citizens are exposed to equivalent sound levels exceeding 55 dB, which are disturbing to sleep
- Worldwide, the medical and social cost associated with indoor noise-induced illnesses, and the related reduction in human productivity, can result in substantial economic losses
- For full intelligibility in listeners with normal hearing, the speech level needs to be 15 dB higher than the background noise. For vulnerable groups, even lower background levels are needed, and a reverberation time below 0.6 s is desirable for adequate speech intelligibility, even in a quiet environment
- For a good night's sleep, continuous background noise should not exceed 30 dB, and individual noise events exceeding 45 dB should be avoided
- Noise above 80 dB may reduce helping behaviour and increase aggressive behaviour. It may also increase the susceptibility of schoolchildren to feelings of helplessness

### **And specifically for hospitals:**

- For ward rooms, the equivalent sound levels should be 30 dB
- The noise peaks during the night should not exceed 40 dB
- Since patients have less ability to cope with stress, the average sound levels should not exceed 35 dB in most rooms in which patients are being treated or observed
- Sound inside incubators may result in health problems, including sleep disturbance, and may lead to hearing impairment in neonates

**WHO**  
recommends  
**30-35**  
**dB**  
in hospitals



# Actual sound levels

## in hospitals

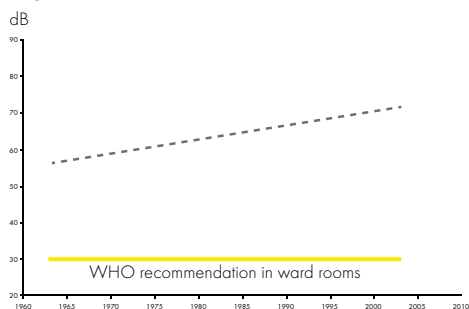
Busch-Vishniac et al., "Noise Levels in John Hopkins Hospital", *Journal of the Acoustical Society of America*, Dec 2005, 118(6), p3629-3645

The study looks at noise data from research in hospitals across the world, between 1960 and 2005. A second part of the study focuses on measurements at John Hopkins Hospital.

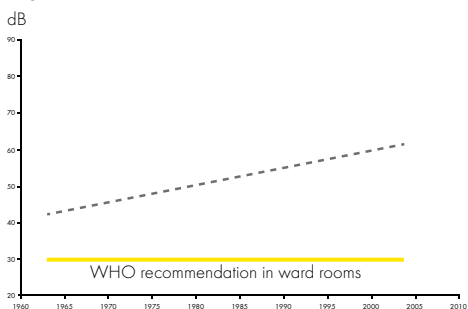
### Conclusions

- Not one hospital complied with WHO guidelines
- From 1960 to 2005 the sound pressure levels have increased on average 15 dB during the day and 18 dB during the night
- Sound levels exceed the typical speech level for communication between two people, which is 45–50dB. This suggests that staff and patients constantly need to raise their voices to be heard
- The sound pressure levels are sufficiently high to interfere with sleep, affect speech intelligibility and create a level of background noise that will annoy and affect most people

#### Daytime sound levels



#### Night-time sound levels



# Sleep disruption

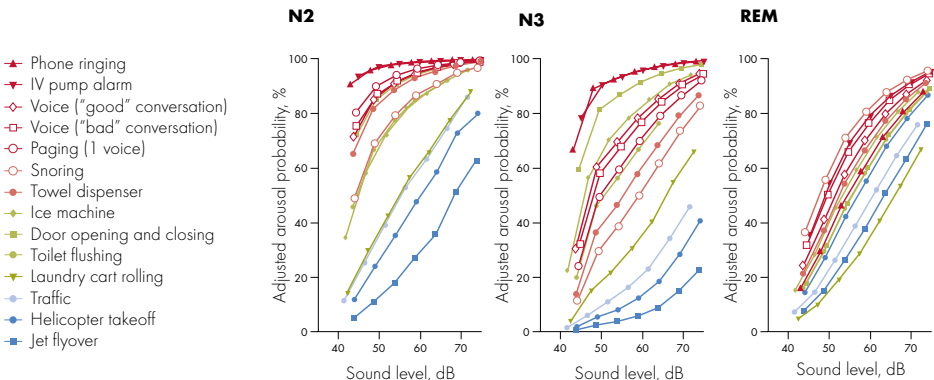
## due to noise

Buxton et al., "Sleep disruption due to hospital noises", *Ann. Intern. Med.*, 2012, vol 157(3), p170-179

The study was a three-day polysomnographic lab study with 12 healthy subjects exposed to 14 noise stimuli. Noises lasting 10 seconds were introduced during sleep stages N2, N3 and REM to evaluate their propensity to disturb sleep.

### Conclusions

- Electronic sounds were consistently more arousing than other sounds at the same noise dose. Staff conversations and voice paging were also found to be highly alerting, producing a 50% chance of arousal at 50 dB in N2 and REM sleep
- The arousal effects of noise on sleep include heart rate elevations, even when disruptions are brief and frequent
- Preservation of patients' sleep should be a priority for contributing to improved clinical outcomes for patients who are hospitalised
- Protecting sleep from acoustic assault in hospital settings is a key goal in advancing the quality of care for in-patient medicine
- Improving the acoustics in healthcare facilities will be critical to ensuring that these environments enable the highest quality of care and the best clinical outcomes



# Improved acoustics

## reduce sleep disruption

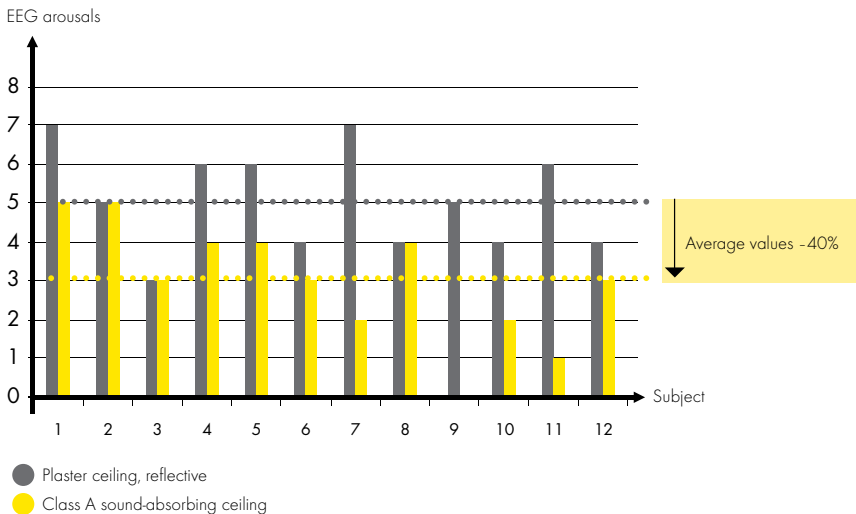
Berg, "Impact of reduced reverberation time on sound-induced arousals during sleep", *Sleep*, 2001, vol 24, no 3, p289-292

The study was conducted during three nights with 12 people (6 women and 6 men), 20–25 years old. 12 different sounds were played during sleep to investigate arousal. The subjects were ignorant of the purpose of the study.

The ceiling in the bedrooms was made of plaster on the first two nights, and class A sound absorbers on the third night. The results of the first night were excluded from the results.

### Conclusions

- EEG arousals resulting from specific sound stimuli were significantly reduced from 5.1 to 3 when the sound-absorbing ceiling was installed



# Medication

## increases with noise

Minckley, "A study of noise and its relationship to patient discomfort in the recovery room", *Nursing Research*, 1968, vol 17, no 3, p247-250

The study was done in a 10-bed recovery room on five random working days. The number of narcotic/sedative medication doses that were given was recorded.

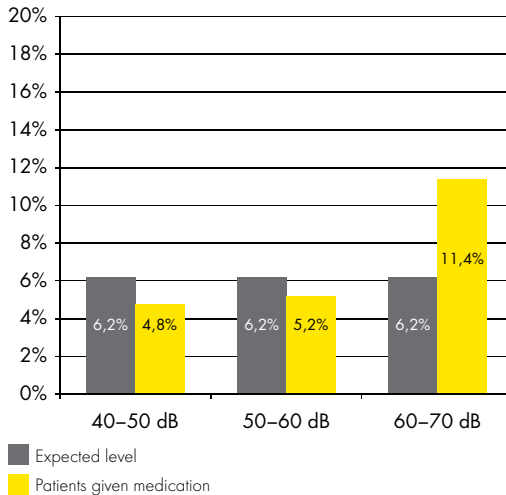
Periods of heightened activity, presence of a large number of staff, overcrowding of patients, certain sounds such as crying, laughing, groaning, snoring, and ringing of telephones produced noise levels between 60 and 70 dB.

### Conclusions

- Significant difference in the number of patients given medication at times when noise levels were high

#### Medication given at different sound levels

% of patients



# Lower noise levels

## reduce medication

Hagerman et al., "Influence of intensive coronary care acoustics on the quality of care and physiological state of patients", *International Journal of Cardiology*, Feb 2005, 98(2), p267-270

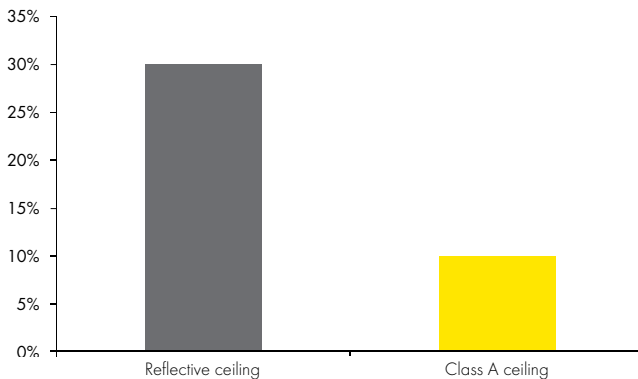
The study took place over eight weeks in a hospital in Huddinge, Sweden, with 94 patients suffering from chest pain. For the first four weeks the ceiling was a reflective type, and for the last four weeks the ceiling consisted of class A sound absorbers.

### Conclusions

- The sound level dropped by 5–6 dB in the patient rooms and 1 dB in the main working area
- Reverberation time dropped from 0.9 to 0.4 in the patient rooms and from 0.8 to 0.4 in the main working area
- There was a significant rise in the need for extra intravenous beta-blockers in the group during the period with poor acoustics
- Patients during the period with good acoustics considered the staff attitude to be much better than during the period with poor acoustics

*During the period with good acoustics, patients felt that the staff attitude was much better than during the period with poor acoustics*

### Percentage of patients needing extra intravenous beta-blockers



# 83% of communication

## in the emergency department is speech-related

Woloshynowych, Davis et al., "Communication patterns in a UK emergency department", *Ann. Emerg. Med.*, Oct 2007, 50(4), p407-413

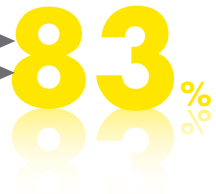
Observational study carried out in an inner-city hospital emergency department in London, UK. The nurse in charge of the ED was observed and the following factors were studied: the level of communication, interruptions and simultaneous events; the channel and purpose of communication; interaction types; unresolved communications and annoying aspects of the observed periods.

Data collection took place during a 6-month period. Eleven nurses were observed during 18 observation periods over a total of 20 hours.

### Conclusions

- A total of 2,019 distinct communication events were identified
- This means that on average there were 100.9 communication events per hour, or 1.68 per minute
- Communication multitasking was evident on 286 (14%) occasions
- The communication load can disrupt memory and lead to mistakes. Improving communication between healthcare staff by reducing the levels of interruptions and minimising the volume of irrelevant or unnecessary information exchange could therefore have important implications for patient safety

Type of communication channel	Number of communication events (%)
Face to face	1,528 (76)
Telephone	144 (7)
Computer	107 (5)
Whiteboard	104 (5)
Pager	35 (2)
Patient records	35 (2)
4-h Target	19 (1)
Tannoy	7 (<1)
Paper source, e.g., patient transport form, staff allocation sheet, booking request form, incident reporting form	40 (2)



# Hospital noise

## impedes speech communication

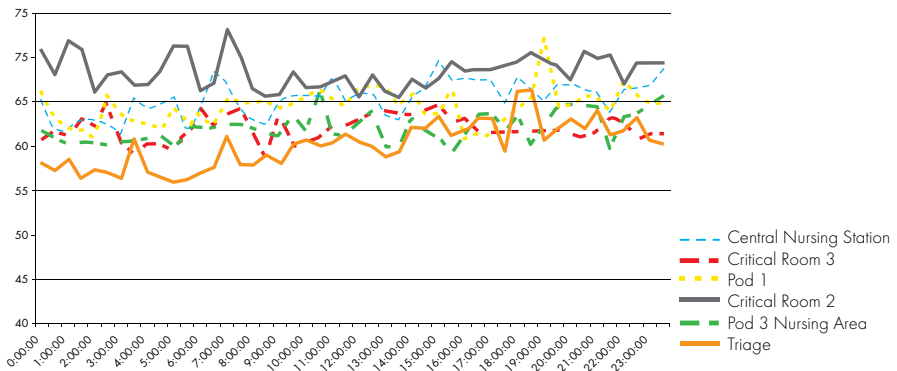
Orellana, Busch-Vishniac, West, "Noise in the adult emergency department of Johns Hopkins Hospital", *Journal of the Acoustical Society of America*, Apr 2007, 121(4), p1996-1999

The study collected 24-hour measurements throughout the adult emergency department of Johns Hopkins Hospital, the top-ranked hospital in the United States for 16 years running.

### Conclusions

- The average sound level throughout the emergency department is about 5–10 dB higher than in in-patient units at the same hospital
- The sound levels are high during the day and night and they are particularly high in the speech frequency band
- Within the emergency department the triage area at the entrance to the department has the highest average sound level, 65 to 73 dB
- Sound levels in the emergency department are on average between 61 and 69 dB
- The sound levels raise concerns regarding the possibility of speech communication without errors
- The main concern is for patient safety, which could be compromised by less than perfect speech communication. Additionally, medical staff fatigue is an issue since speaking in a raised voice is tiring

24 hour sound levels



# Noise leads to

## communication errors ...

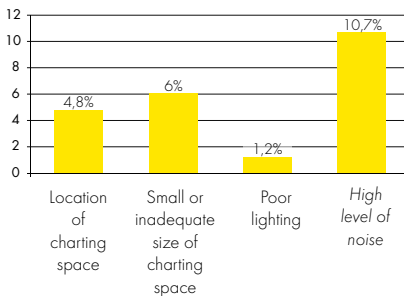
Mahmood et al., "Nurses' perception of how physical environment affects medication errors in acute care settings", *Applied Nursing Research*, 2011, vol 24, issue 4, p229-237

In this study, a cross-sectional survey was conducted with 84 nurses in four hospitals in the Pacific Northwest region of the United States. The survey included questions on nursing unit design, medication room configurations, perceived incidence of errors, and adverse events.

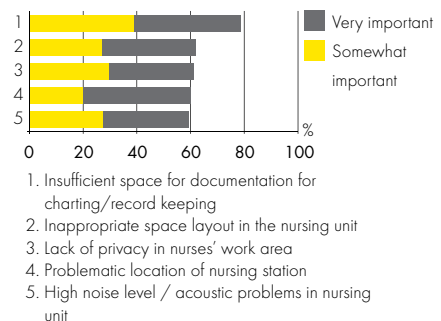
### Conclusions

- Respondents noted several physical environmental factors that are potentially problematic in the nursing station area and can lead to medication, documentation, and other types of nursing errors
- A few non-environmental factors (e.g., overwork, stress, or fatigue of staff, higher number of patients per nurse) were identified as the most frequent causes leading to errors
- But the role of environmental factors in latent causes of error (e.g., fatigue, stress, tiredness) should not be overlooked while planning for interventions to reduce errors in acute care settings
- Effective strategies and meaningful interventions to reduce medication errors should be considered when designing or modifying the physical environment

**Number of times frequent factors contribute to documentation errors, %**



**Top 5 physical environmental factors leading to nursing errors**





## ... that can have critical consequences

Pennsylvania patient safety authority, "Improving the safety of telephone or verbal orders", PA-PSRS Patient Safety Advisory, Jun 2006, vol 3, no 2, p1-7

An advisory report based on healthcare staff reporting to the PAPSRS, Pennsylvania Patient Safety Reporting System (USA). The report contains many examples of real-life medical errors due to mishearing.

### Conclusions

- Interpreting speech is inherently problematic because of different accents, dialects, and pronunciations
- Background noise, interruptions, and unfamiliar drug names and terminology often compound the problem
- Once received, a verbal order must be transcribed as a written order, which adds complexity and risk to the ordering process
- The only real record of a verbal order is in the memories of those involved

“

*"A nurse thought that the nursing student stated the patient's blood sugar as 257 when it was 157. The patient was given 6 units regular insulin instead of 2 units regular insulin."*

*"A phone order mistaken for Toradol 50 mg was administered prior to the pharmacy review, when the intended dose was 15 mg."*

*"An emergency room physician verbally ordered 'morphine 2 mg IV' but the nurse heard 'morphine 10 mg IV'. The patient received a 10 mg injection and developed respiratory arrest."*

*"A physician called in an order for '15 mg' of hydralazine to be given IV every 2 hours. The nurse, thinking that he had said '50 mg' administered an overdose to the patient who developed tachycardia and had a significant drop in blood pressure."*

# Noise

## induces stress ...

Blomkvist et al. "Acoustics and psychosocial environment in intensive coronary care", *Occup Environ Med*, Mar 2005, 62(3):e1

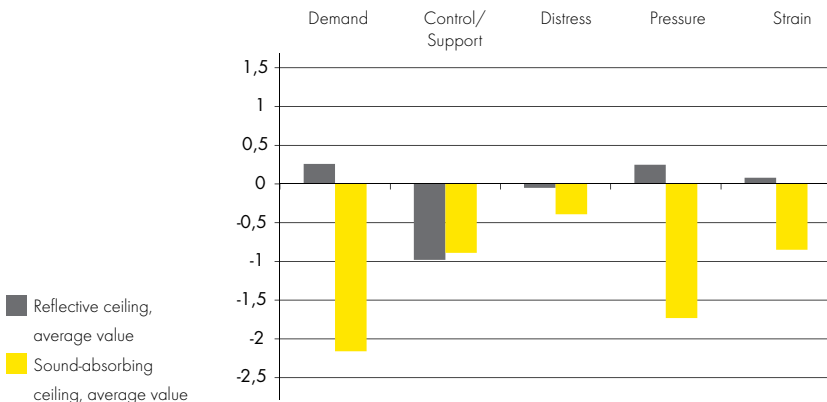
The study took place over eight weeks in an intensive coronary care unit (CCU) at Huddinge University Hospital, Sweden. For the first four weeks the ceiling was of a reflective type and for the last four weeks a class A sound absorbing ceiling was installed.

36 nurses at the CCU answered questionnaires of a psychological nature at the start of their shift and at the end.

### Conclusions

- The sound level dropped by 5–6 dB in the patient rooms and 1 dB in the main working area
- Reverberation time dropped from 0.9 to 0.4 in the patient rooms and from 0.8 to 0.4 in the main working area
- Important gains in the psychosocial healthcare environment can be achieved by improving room acoustics
- Improvements in healthcare acoustics will be inadequate if they only focus on reducing sound levels
- There was a highly significant improvement in *Demand*, *Pressure* and *Strain*

### Mood states, perceived by nurses on the afternoon shift



## ... and raises epinephrine levels

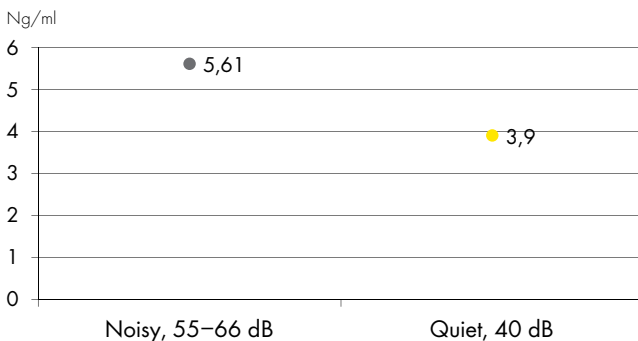
Evans Johnson, Cornell University, 2000, "Stress and Open-Office Noise", *Journal of Applied Psychology*, 2000, vol 85, no 5, p779-783

The study tested 40 clerical workers for elevated levels of hormones in the urine after three hours exposure to low-intensity noise, in comparison to hormone levels in quiet office conditions.

### Conclusions

- The two groups of subjects did not differ in perceived stress
- Levels of the stress-indicator epinephrine differed between the two groups
- So called motivational after-effects, such as fewer attempts at unsolvable puzzles and a lower likelihood of making ergonomic postural adjustments were found
- The inability to control sound rather than its intensity is what makes it stressful. Even low-intensity sound levels can induce performance after-effects, indicative of diminished task motivation

### Increased epinephrine level



# Sound levels

## affect critical care ...

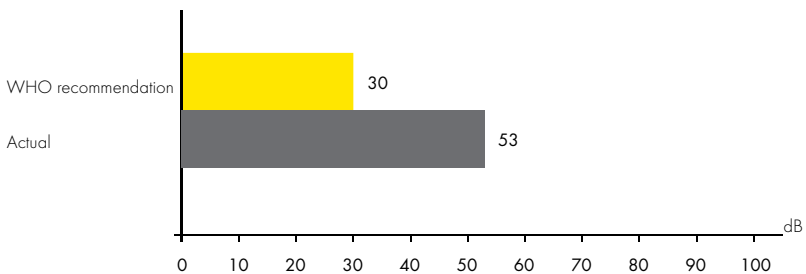
Johansson et al., "The sound environment in an ICU patient room - a content analysis of sound levels and patient experiences", *Intensive and Critical Care Nursing Journal*, Oct 2012, 28(5), p269-279

The study describes the sound environment in an ICU patient room at a regional hospital in south-western Sweden.

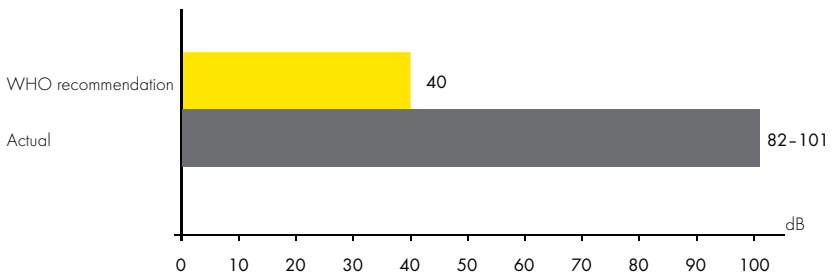
### Conclusions

- Average sound level in the ICU was 53 dB
- Sound level peaks exceeded 55 dB 68–79% of the time
- Sounds from neighbouring patients and from advanced medical treatments and equipment are perceived as disturbing and can create feelings of helplessness and make it difficult to find the peace and calm that are essential for recovery and wellbeing

#### Sound levels, average



#### Sound levels, peaks



## ... and can impair your hearing

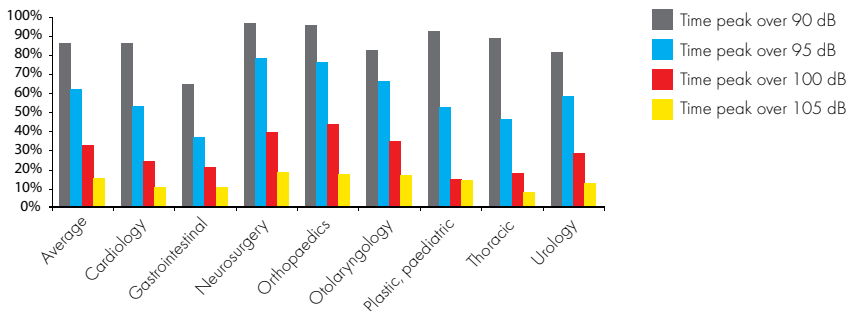
Kracht, Busch-Vishniac et al., "Noise in the operating rooms of Johns Hopkins Hospital", *Journal of the Acoustical Society of America*, May 2007, 121(5 pt1), p2673-80

Sound pressure levels in the operating rooms at Johns Hopkins Hospital, USA, were monitored before, during, and after operations. The duration of noise was recorded during each surgical procedure, permitting the association of sound levels with particular types of surgery.

### Conclusions

- Sound levels were found to average between 55 and 70 dB with significant sound peaks, some of great intensity during surgical procedures
- The concerns raised by high sound levels in ORs are twofold: the potential for hearing loss, and the disruption to clear speech communication
- The majority of the surgical departments experienced sound peaks of at least 110 dB. Levels over 120 dB were not uncommon
- In general, clear speech communication requires at least a 15 dB signal-to-noise ratio. Given the sustained sound levels in the OR during surgery, that would suggest normal speech levels at 70–85 dB
- Medical staff are confronted with the choice of either speaking loudly in the OR in order to ensure good communication, or running the risk of somewhat compromised communication clarity. Given the nature of surgery, the latter of these options is clearly unacceptable

Sound level peaks, % of the time



# The helpless

## suffer the most

Johannes van der Berg, *Care for Sound, Sound Environment, Healing & Health Care, Publications from Sound Environment Center at Lund University* n. 12, 2014, p27-429



*Studies from NICUs report average sound levels ranging from around 55 dB to 89 dB*

These results are a summary of present research in neonatal intensive care unit (NICU) sound environments, their impact on the infant and preventative strategies.

### Conclusions

- In neonatal sound environments, the American Academy of Pediatrics has recommended that the sound level should be lower than 45 dB. But numerous studies from NICUs report average sound levels ranging from around 55 dB to 89 dB
- Sound spectral analysis in NICUs has shown that the sounds are mostly in the high-frequency (1–8 kHz) bands and exist close to the infant care area. But there are also sounds in the low-frequency band, for instance from the incubator
- The effect of sound can be observed as changes in physiological and behavioural signs. High sound levels (70–80 dB) have been reported to increase the infant's heart rate and respiration rate, and also lower the infant's oxygenation level
- Increased blood pressure was found when infants were exposed to intermittent sounds at a level of 79–88 dB, but not when exposed to continuous sound of 50–60 dB
- When using EMG recordings and behaviour assessment to study infants exposed to sound levels ranging from 70 to 90 dB, a significant reaction in both these measures was shown, that prevented the infants from returning to baseline
- Sleep is important for neurodevelopment and there are studies indicating that high sound levels affect preterm infants negatively, altering sleep states or behavioural states
- A review of hearing loss among infants with very low birth weight (VLBW) reported that hearing impairment in infants and young children are 0.1% to 0.2%, while hearing loss among infants discharged from NICUs is 0.7–1.5%, i.e. around seven times higher

# The helpless

## suffer the most

Johansson et al., *Meanings of Being Critically Ill in a Sound-Intensive ICU Patient Room - A Phenomenological Hermeneutical Study*, *The Open Nursing Journal*, 2012, 6, p108-116

The aim of the study was to illuminate the meanings of being critically ill in a sound-intensive ICU patient room, as disclosed through patients' narratives. Thirteen patients were asked to narrate their experiences of the sound environment in ICU patient rooms.

“

### A night in the ICU

*“There are three of us in this room, three patients with different disorders and each of us seems to be in the same bad condition. This means it is never quiet. Every minute there are unexpected noises from different directions which make it very hard to relax or sleep. Moreover, I feel helpless hearing these frightening noises from my roommates. One patient has severe pneumonia I think, because he coughs all the time and breathes very strangely. Another patient screams a lot. I also heard him throw up once and that was awful. Nor can I see any of them. A thin fabric curtain divides our beds so I just hear the different sounds and noises and that means that I am never prepared for them. Every time I fall asleep an unexpected noise wakes me up again. Last night I woke up because of an unexpected noise beside me and something unpleasant happened. Gradually I understood that the patient beside me had become severely ill and needed some kind of treatment. Three physicians had come into the room and I heard everything they said very clearly. I became paralyzed when I realized that I had to stay in the room and listen to all that. I was too tired to get up and leave. I did not even have enough strength to tell the staff about how I felt or ask for help. I just lay there scared and terrified but quiet and calm on the outside. The conversations among the physicians and nurses lasted for what I thought was hours. After a while they started some kind of treatment and I understood that the man might not survive. I was exhausted but I did not know what to do. That night I didn't sleep at all and it was one of the longest nights of my life.”*



# Hearing loss

## reduces quality of life ...

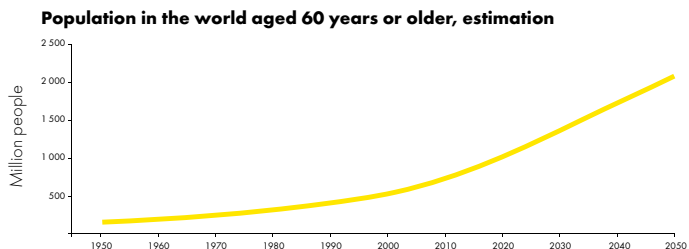
Dalton, D. S., Cruickshanks, K. J., Klein, B. E., et al., 2003. *The Impact of Hearing Loss on Quality of Life in Older Adults. The Gerontologist, 43 (5), p661-668.*

A five-year follow-up epidemiology of hearing loss study, a population-based longitudinal study of age-related hearing impairment conducted in Beaver Dam, USA, between March 1998 and July 2000. The study covered 2,688 people with an age range of 53–97. 42% were male and 58% female.

### Conclusions

- Of the participants, 28% had mild hearing loss and 24% had moderate to severe hearing loss
- Severity of hearing loss was significantly associated with having a hearing handicap and with self-reported communication difficulties
- Individuals with moderate to severe hearing loss were more likely than individuals without hearing loss to have impaired ADLs and IADL (Activities of Daily Living and instrumental ADLs)
- Overall, 52% of the study participants reported having problems with communication
- Participants with moderate to severe hearing loss were almost eight times as likely as those without hearing loss to have self-reported difficulties with communication
- Participants with mild hearing loss were nearly three times as likely as those without hearing loss to report difficulties with communication

United Nations, Department of Economic and Social Affairs, Population Division, *World Population Prospects: The 2015 Revision*, 2015





## ... for older adults

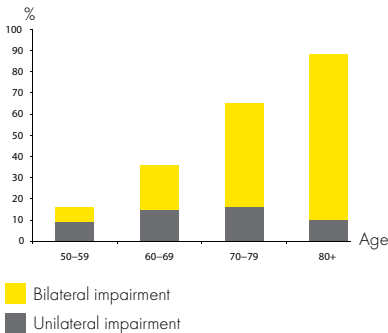
Chia et al., "Hearing Impairment and Health-Related Quality of Life: The Blue Mountains Hearing Study", *Ear & Hearing*, 2007, vol 28 no 2, p187-195

The study aimed to assess the association between hearing impairment and health-related quality of life (HRQOL) in an older population, using the self-administered 36-item Short-Form Health Survey (SF-36). 2956 participants in the Blue Mountains Hearing Study attended a comprehensive interview and hearing examination in which both self-reported and measured hearing impairments were assessed.

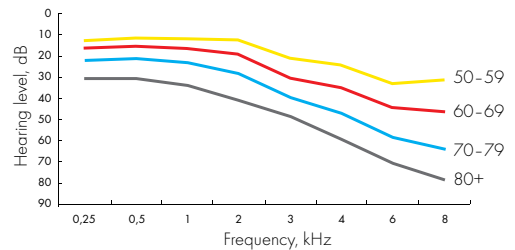
### Conclusions

- Of the 2431 participants with complete data, 1347 (55.4%) did not have measured hearing loss, whereas 324 (13.3%) had unilateral (285 mild, 22 moderate, 17 severe) and 760 (31.3%) had bilateral hearing impairment (478 mild, 207 moderate, 75 severe)
- Bilateral hearing impairment was associated with poorer SF-36 scores in both physical and mental domains
- Persons with self-reported hearing loss had significantly poorer health-related quality of life (HRQOL) than corresponding persons without

**Hearing impairment, % of population by age**



**Average hearing threshold audiogram by age group**



# A sound investment

Sadler et al., "Fable Hospital 2.0: The Business Case for Building Better Health Care Facilities," *Hastings Center Report*, 2011, vol 41, no 1, p13-23

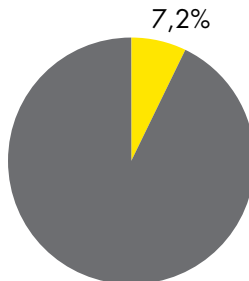
This is a business case to estimate benefits of evidence-based design (EBD) hospitals. Preventable errors and preventable harm are mentioned as important.

In this case, high-performance acoustic ceilings and sound-absorbing wall materials were used in patient rooms. High-performance acoustic ceilings were used in all patient care areas.

## Conclusions

- The payback time for EBD at this hospital is estimated at 3 years
- The premium for EBD is estimated at 7.2% of total building cost
- Noise reduction contributed to less sleep deprivation, quicker recovery and decreased stress
- In the business case, less noise is considered to contribute to less adverse drug effects and reduced nursing turnover
- Building designs that help reduce preventable harm are becoming key elements in a hospital's survival strategy
- Medicare will no longer reimburse for the incremental costs incurred by certain preventable errors (USA)

**Evidence Based Design, % of total building cost**



# Enhance wellbeing

Salonen, Heidi et al., "Design approaches for promoting beneficial indoor environments in healthcare facilities: a review". *Intelligent Buildings International* (2013), 5(1), p 26-50.

This is a review of the implications of key indoor physical design parameters, in relation to their potential impact on human health and wellbeing. In addition, the findings were discussed within the context of the relevant guidelines and standards for the design of healthcare facilities. A total of 810 abstracts that met the inclusion criteria, were identified through a Pubmed search, and these covered journal articles, guidelines, books, reports and monographs in the studied area. Of these, 231 full publications were selected for this review.

## **Conclusions**

- According to the literature, the most beneficial design elements were: single-bed patient rooms, safe and easily cleaned surface materials, sound-absorbing ceiling tiles, adequate and sufficient ventilation, thermal comfort, natural daylight, control over temperature and lighting, views, exposure and access to nature, and appropriate equipment, tools and furniture
- The effects of some design elements, such as lighting and layout, on staff and patients vary, and "the best design practice" for each healthcare facility should always be formulated in co-operation with different user groups and a multi-professional design team
- The relevant guidelines and standards should also be considered in future design, construction and renovations, in order to produce more favourable physical indoor environments in healthcare facilities



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*Ecophon efforts are guided by a vision of earning global leadership in room acoustic comfort through sound-absorbing systems, enhancing end-user performance and wellbeing. Ecophon maintains an ongoing dialogue with government agencies, working environment organisations and research institutes, and is involved in formulating national standards in the field of room acoustics where Ecophon contributes to a better working environment wherever people work and communicate.*

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