



## EVIDENCE SPACE

### Benefits of sound absorbing ceiling tiles in healthcare

Hospitals are loud places with numerous sources of noise, and historically they have been designed with sound-reflecting surfaces that worsen acoustic conditions and enable noises to echo and propagate over large areas. Research has found that the use of noise-reducing finishes such as high-performance sound-absorbing ceiling tiles can reduce the noise in hospitals and benefit both patients and staff.

#### Noise in healthcare environments



The World Health Organization (WHO) recommends average noise levels are no more than 35 dBA in rooms where patients are treated or observed and no more than 30 dBA in ward rooms <sup>(2&3)</sup>, although a recent landmark study showed that no hospital noise results published since 1960 meet these guidelines <sup>(2&4)</sup>. Many studies have demonstrated noise levels far exceeding these guidelines, with ranges cited from 45 to 90dB, with peaks frequently exceeding 85-90dB and some as high as 120dB <sup>(5&6)</sup>. There is also a concerning trend where hospital noise levels have increased over time by 5dB per decade <sup>(7)</sup>. In evaluating these noise levels, it should be noted that the decibel scale for quantifying loudness or sound pressure intensity is logarithmic; each 10 dBA increase therefore represents a sound pressure level that is 10 times higher <sup>(1)</sup>.

#### Hospital noise levels have increased over time by 5dB per decade

Well-documented examples of noise sources include staff voices, paging systems, alarms, bedrails moved up or down, telephones, ice machines, pneumatic tubes and trolleys <sup>(1)</sup>. Second, many environmental surfaces (e.g., floors, ceilings, walls) are hard and sound-reflecting, not sound-absorbing; this creates poor acoustic conditions (long reverberation times) that enable noise to echo, linger, and propagate over large areas and into patient rooms <sup>(1&8)</sup>. Finally, hospitals are noisy because many patients are housed in multi-bed rooms where noise originates from other patients <sup>(1)</sup>.

#### Effect of noise on patient health

Studies have shown that noise in hospitals has several effects on patient health and recovery including disturbed sleep. Although the percentage slightly varies, it has generally been shown that roughly 11% to 20% of arousals and awakenings are due to noise <sup>(2&9)</sup>. Sleep is fundamental to human health in general and critical to patient recovery. Alertness, mood, behaviour, coping abilities, respiratory muscle function, ventilatory control and healing time are just a few of the potential impacts of patient sleep disturbance or deprivation <sup>(5)</sup>. In addition to worsening sleep quality, noise elevates psychological and physiological stress in patients, as indicated by negative feelings such as anxiety and annoyance, and detrimental physiological changes such as elevated heart rate and blood pressure <sup>(1)</sup>. There is some evidence that noise may even contribute to increased lengths of hospital stay <sup>(10)</sup>. Certain sub groups are also more vulnerable to noise, such as those with hearing or visual impairment, the young, the elderly, the depressed, and those who have particular medical conditions <sup>(5)</sup>.





## EVIDENCE SPACE

### Benefits of sound absorbing ceiling tiles in healthcare

#### Effect of noise on staff productivity and wellbeing



Excessive noise affects staff as well as patients, with noise implicated in staff stress levels, burnout and emotional exhaustion <sup>(5 & 6)</sup>. Another study revealed that noise induced stress could account for 6% of headaches at work, as self-reported by nurses in critical care areas. When noise levels were reduced, staff report less stress and overall better working environments <sup>(5 & 11)</sup>.

#### Noise induced stress could account for 6% of headaches at work

Among staff, reduced noise levels in healthcare facilities has been associated with reduced stress, reduced emotional exhaustion and burnout, reduced fatigue, increased satisfaction, increased effectiveness, increased productivity <sup>(1, 12-17)</sup>, improved communication and decreased medical errors <sup>(12, 17-19)</sup>. In addition, improved acoustical conditions have been linked to a reduction in pressure and strain at work <sup>(8 & 12)</sup>.



#### Solutions to minimise noise



The use of noise-reducing finishes such as high-performance sound-absorbing ceiling tiles can reduce the noise in hospitals and benefit both patients and staff <sup>(1)</sup>. It is one of the most frequently recommended interventions for sound reduction in wards, with a number of authors endorsing such a strategy <sup>(1, 5, 20-24)</sup>.

The positive effect of installing sound absorbing ceiling tiles has been demonstrated in three separate studies as follows:

A study by Berg, which took place in a refurbished former surgical ward, focused on the effects of Reverberation Time on noise-induced sleep arousals using EEG (electroencephalogram) for 12 subjects <sup>(25)</sup>.

#### Reverberation Time was reduced by an average 26% after the installation of sound absorptive ceiling tiles.

Noise ranged from 27 to 58 dB(A), originating from both continuous and impulsive sources such as dropped plates, traffic noise, fan noise, machine noise, doors closing and radios. Results showed that even if the noise level (dB) remains almost the same, the reduction in reverberation time achieved by sound-absorbing ceiling tiles can improve sleep quality <sup>(1)</sup>.

In another well-cited pre/post study by Blomkvist et al, sound-reflecting ceiling tiles were replaced by sound-absorbing tiles in a coronary care unit. Pre/post questionnaires to 36 nursing staff and pre/post acoustic measurements revealed that reverberation times were reduced, and that staff experienced less strain and pressure, overall positive effects on their work environment and improved speech intelligibility. The authors speculated that the improvement in acoustics and the communication environment could lead to reduced errors and conflict <sup>(5 & 8)</sup>.



**EVIDENCE SPACE**

## **Benefits of sound absorbing ceiling tiles in healthcare**



In the most recent study by Hagerman et al, a controlled clinical trial also conducted in a coronary care unit with 94 patients, physiological differences were demonstrated for those patients exposed to the sound-reducing ceiling tiles. There were positive differences in heart rate, blood pressure and sleep fragmentation, with a decreased need for certain medications. Added to these outcomes was a patient perception of higher quality of care as well as reduced rates of re-hospitalisation for the experimental group<sup>(5, 26 & 27)</sup>.

### **Conclusions**

Among patients, noise is one of the features of the ambient environment that patients complain about most often<sup>(1 & 12)</sup>. Studies have found that reduced noise levels e.g. by using noise-reducing finishes such as high-performance sound absorbing ceiling tiles, improve sleep, reduce annoyance, improve satisfaction, reduce pain and the use of pain medications, decrease psychological and physiological stress, decrease emotional exhaustion, reduce headaches, improve communication, reduce medical errors, decrease heart and respiratory rate, decrease blood pressure, shorten recovery time and hospital stays, and reduce re-hospitalisation<sup>(1, 12-16, 27)</sup>. There is no doubt that excessive noise is bad for people's health. Sound-absorbing ceiling tiles are an effective means to create a quiet environment that improves people's health<sup>(28)</sup>.



## EVIDENCE SPACE

# Benefits of sound absorbing ceiling tiles in healthcare

### References

- (1) Ulrich R, Zimring C, Xuemei Zhu, DuBose J, Hyun-Bo Seo, Young-Seon Choi, Xiaobo Quan, and Anjali Joseph. A Review of the Research Literature on Evidence based Healthcare Design. *Health Environments Research & Design*, 1(3), 2008.
- (2) T Hsu, E Ryherd, K Persson Waye, and J Ackerman. Noise pollution in hospitals - Impact on patients. *JCOM Vol 19, No 7 July 2012 Pg 301-309*
- (3) Berglund B, Lindvall T, editors. *Guidelines for community noise*. Geneva: World Health Organization; 1999
- (4) Busch-Vishniac IJ, West JE, Barnhill C, et al. Noise levels in Johns Hopkins Hospital. *J Acoust Soc Am* 2005;118:3629-45
- (5) Ampt A, Harris P and Maxwell M. The health impacts of the design of hospital facilities on patient recovery and wellbeing: A review of the literature. 2008 Centre for Primary Healthcare and Equity, University of New South Wales, Sydney
- (6) Ulrich R. and X. Quan. The Role of the Physical Environment in the Hospital of the 21st century: A Once-in-a-Lifetime Opportunity. *Designing the 21st Century Hospital Project*, The Center for Health Design. 2004
- (7) Ulrich R. Evidence Based Design for better buildings. *Welsh Health Estates and IHEEM Conference*, Cardiff, 2006
- (8) Blomkvist V., Eriksen C. A., Theorell T., Ulrich R. S. & Rasmanis G. (2005). Acoustics and psychosocial environment in intensive coronary care. *Occupational and Environmental Medicine*, 62, 132-139.
- (9) Aurell J, Elmqvist D. Sleep in the surgical intensive care unit: continuous polygraphic recording in nine patients receiving postoperative care. *Br Med J* 1985; 290:1029-32
- (10) M Schweitzer, Gilpin L, Frampton S. Healing Spaces: Elements of Environmental Design that make an impact on Health. *The Journal of Alternative and Complementary Medicine*. 2004, Vol 10, Supplement 1, 71-83
- (11) Devlin, A.S. and Arneill, A.B., 2003, 'Health care environments and patient outcomes: A review of the literature', *Environment and Behavior*, 35 (5), 665- 694.
- (12) H Salonen , L Morawska. Physical characteristics of the indoor environment that affect health and wellbeing in healthcare facilities: A review. *Intelligent Buildings International*, 2013
- (13) Bayo, M.V., Garcia, A.M. and Garcia, A., 1995, 'Noise levels in an urban hospital and workers' subjective responses', *Archives of Environmental Health*, 50 247-251.
- (14) Beyea, S.C., 2007, 'Noise: a distraction, interruption, and safety hazard. *AORN Journal*.
- (15) Biley, F.C., 1994, 'Effects of noise in hospitals', *British Journal of Community Nursing*, 3 (3), 110-113.
- (16) Joseph, A., 2010, 'Hospitals that heal'. *Hospital design for the 21st century*. *Asian hospital and healthcare management*.
- (17) Zun, L.S. and Downey, L.V., 2005, 'The effect of noise in the emergency department'. *Acad Emerg Med* 42 (7), 663-666.
- (18) Flynn, E.A., Barker, K.N., Gibson, J.T., Pearson, R.E., Berger, B.A. and Smith, L.A., 1999, 'Impact of interruptions and distractions on dispensing errors in an ambulatory care pharmacy', *American Journal of Health Systems Pharmacy*, 56 (13), 1319-1325.
- (19) Joseph, A. and Ulrich, R., 2007. 'Sound control for improved outcomes in healthcare settings'. *Concord, California, The Center for Health Design*
- (20) Barach, P. (2008). "Strategies to reduce patient harm: understanding the role of design and the built environment." *Studies in Health Technology and Informatics* 132: 14-22.
- (21) White, R. D. (2006). "Recommended standards for newborn ICU design." *Journal of Perinatology* 26(SUPPL. 3).
- (22) Altimier, L. B. (2004). "Healing environments: for patients and providers." *Newborn & Infant Nursing Reviews* 4(2): 89-92.
- (23) Reiling, J. G., B. L. Knutzen, et al. (2004). "Enhancing the traditional hospital design process: a focus on patient safety." *Joint Commission Journal on Quality & Safety* 30(3): 115-124.
- (24) Brown, P. and L. T. Taquino (2001). "Designing and Delivering Neonatal Care in Single Rooms." *Journal of Perinatal and Neonatal Nursing* 15(1): 68-83.
- (25) Berg S. Impact of reduced reverberation time on sound induced arousals during sleep. *Sleep* 2001;24:289-92.
- (26) Dijkstra, K., M. Pieterse, et al. (2006). "Physical environmental stimuli that turn healthcare facilities into healing environments through psychologically mediated effects: Systematic review." *Journal of Advanced Nursing* 56(2): 166-181.
- (27) Hagerman I., Rasmanis G., Blomkvist V., Ulrich R., Eriksen C. A. & Theorell T. (2005). Influence of intensive coronary care acoustics on the quality of care and physiological state of patients. *International Journal of Cardiology*, 98 (2), 267-270.
- (28) A van den Berg, F Jaspers, C Wagenaar (2005). Health Impacts of Healing Environments: A review of evidence of nature, daylight, fresh air, and quiet in healthcare settings. *Foundation 200 years University Hospital Groningen*