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Session: 04 C - Acoustic regulations and quality classes

Acoustic regulation in hospitals – Interior acoustics improving the recovery of patients

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1 Impacts of room acoustics on patients

2 Room acoustic requirements for hospitals in building regulations

3 Conclusions

What determines our state of health?

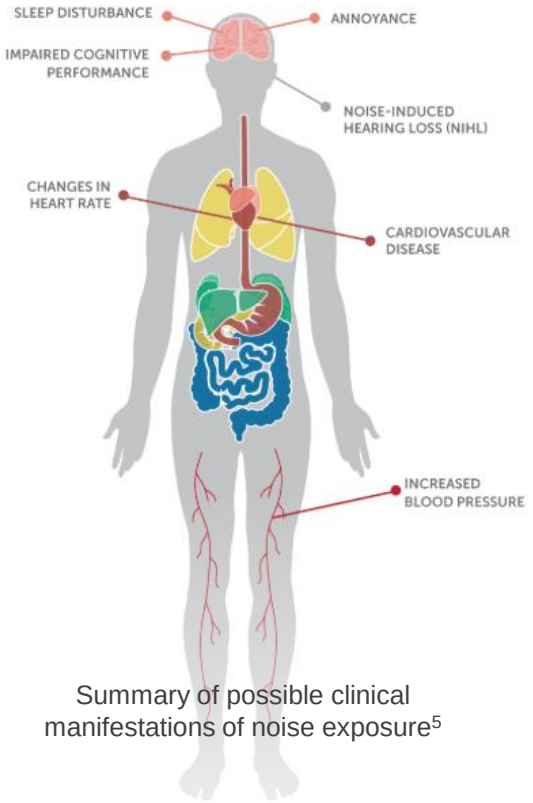
*"Health is a state of complete **physical**, **mental**, and **social well-being**. Not merely the absence of disease or infirmity."*

World Health Organization

Source: Centers for Disease Control and Protection. Frequently Asked Questions. 2014. Available online at: http://www.cdc.gov/nchhstp/socialdeterminants/faq.html

The rampant noise found in hospitals is caused by patients, staff, medical alerts, etc., making hospitals unable to meet the desirable acoustic levels.

An increase of noise levels in a room is directly associated with an increased risk of hypertension[1] (unhealthy blood pressure), diabetes[2], obesity[3], hyperactive[4], etc.

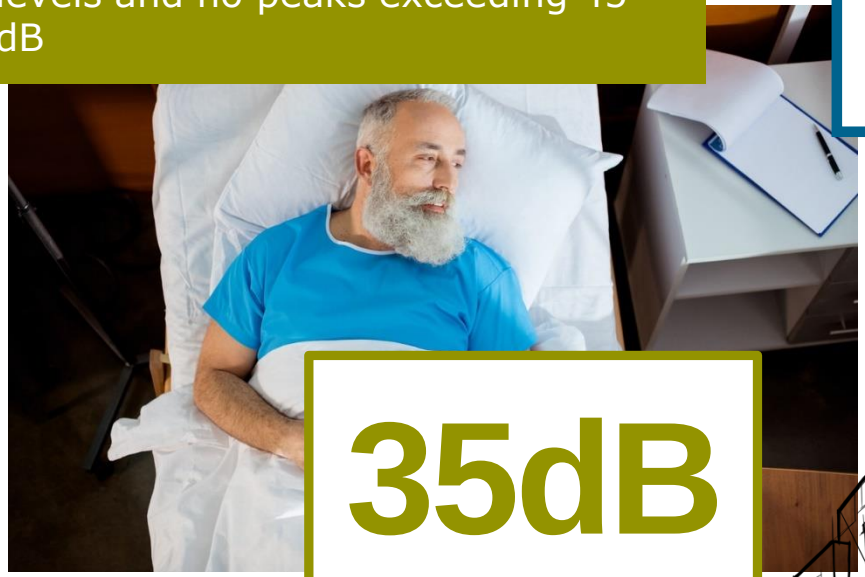


Summary of possible clinical manifestations of noise exposure[5]

Sources: [1] Ettehad et al 2016; Meline et al 2015; Ta-Yuan Chang et al 2013
[2] Sorensen et al 2013, Recio et al 2016; Dzhambov 2015
[3] Dzhambov and Dimitrova 2016; Christensen et al 2016
[4] Dreger et al 2015; Stansfeld and Clark 2015
[5] IWBI, Acoustics WELLography, Figure 12 page 86

Acoustics in hospitals – WHO guidelines

WHO recommends, for a good night sleep, an average of 30dB noise levels and no peaks exceeding 45 dB



30dB

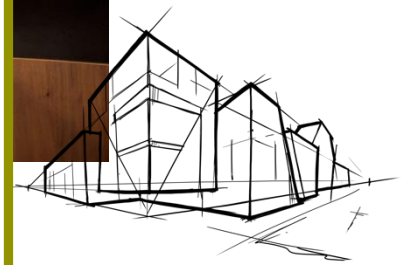
for ward rooms [1]

40dB

max. for noise peaks during the night [1]

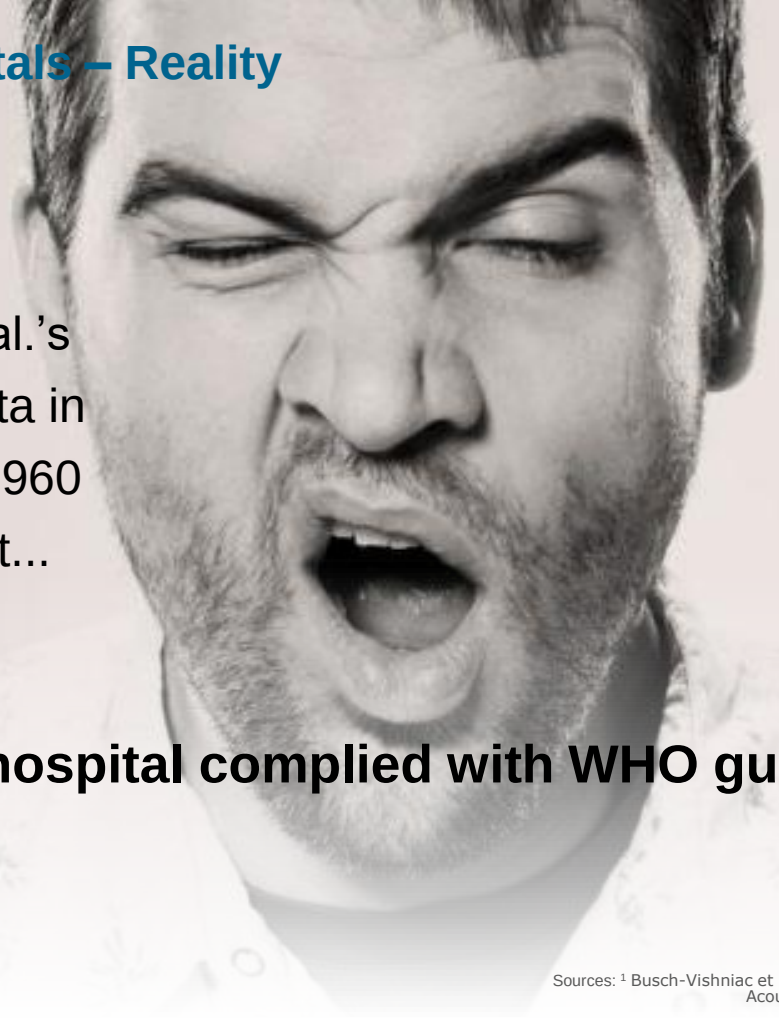
35dB

max. average noise levels in rooms for patient treatment or observation [1]



Sources: [1] Berglund et al., "Guidelines for community noise", Technical Report 1999, World Health Organization

Acoustics in hospitals – Reality



Busch-Vishniac et al.'s analysis of noise data in hospitals between 1960 to 2005 shows that...

"...no hospital complied with WHO guidelines [1]"

Sources: [1] Busch-Vishniac et al., "Noise Levels in John Hopkins Hospital", Journal of the Acoustical Society of America, Dec 2005, 118(6), p3629-3645

Acoustics in hospitals – Insights

''unwanted sound'' can increase heart rate, blood pressure and the respiration rate of patients.[1]

84%

of anesthesiologists reported that the noise levels in their operating rooms negatively affected their work.[2]

Overpopulation can contribute to tension & fear in a hospital unit. Employees performance increase in safe, calm and spacious environments [3]

Sources: [1] UK Government Department of Health: Health Technical Memorandum 08-01: Acoustics (2013)
[2] Katz, J. D, MD, Noise in the Operating Room, The American Society of Anesthesiologists, Inc.; 2014
[3] United Kingdom Department of Health, "Health Building Note 03-01: Adult acute mental health units", 2013, p6–11

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Acoustics in hospitals – Insights

60%

of emergency department staff regard noise in their work environment as “somewhat” or “very” burdensome [1]

70%

of key medical mistakes in the emergency divisions can be traced back to communication shortcomings [2]

83%

of communication in an emergency division is face-to-face or via phone [3]

Sources: [1] M. Simon, P. Tackenberg et al., Auswertung der ersten Befragung der NEXT-Studie in Deutschland. Wuppertal University, 2005
[2] Joint Comission. Sentinel Event Data, Root Causes by Event Type, 2010
[3] Woloshynowych, Davis et al., “Communication patterns in a UK emergency department”, Ann. Emerg. Med., Oct 2007, 50(4), p407–413

Light in hospitals

Designs that have good acoustics, minimize the risk of crowding and having natural light and ventilation are important in helping to create a positive therapeutic atmosphere [2]

15%

reduction in hospitalization time, for patients in southern facing rooms. They had an average stay of 16.9 days compared to 19.5 days for those in northern facing rooms[1]

Access to natural light regulates the body's circadian system and prompts the brain to suppress the production of melatonin, increasing sleep efficiency from 77.5% to 90%,

12,5%

Increase, improving recovery time. [3]

Sources: [1] Kathleen M Beauchemin, Peter Hays, Sunny hospital rooms expedite recovery from severe and refractory depressions, Journal of Affective Disorders 40 (1996) 49-51
[2] United Kingdom Department of Health, "Health Building Note 03-01: Adult acute mental health units", 2013, p6–11
[3] Boyce, P., Hunter, C., & Howlett, O. (2003). The benefits of daylight through windows. Troy, NY: Rensselaer Polytechnic Institute.

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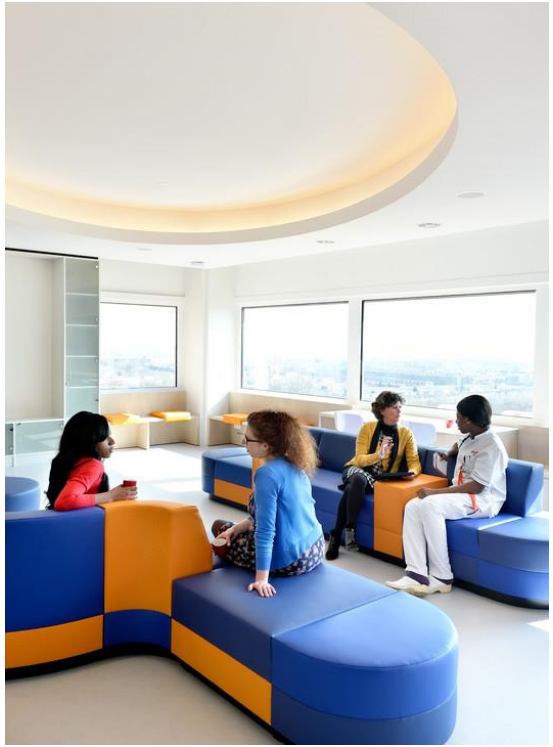
Acoustic classification schemes in hospitals for 8 European countries

Country	Classification scheme	for Healthcare facilities
Finland	SFS 5907:2004	**yes**
Island	IST 45:2016	**yes**
Norway	NS 8175:2012	**yes**
Sweden	SS 25268:2007	**yes**
Lithuania	STR 2.01.07:2003	**yes**
Latvia	LBN 016-15	**yes**
Italy	UNI 11367:2010	**yes**
Turkey	Reg. protection against noise (2017)	**yes**



➔ Without a classification scheme for healthcare facilities:
Denmark, Germany, Austria, Netherlands, France, Poland, Portugal, …

Sources: [1] after B. Rasmussen, 2018: Acoustic classification of buildings in Europe – Main characteristics of national schemes for housing, schools, hospitals and office buildings. Proceedings of EuroNoise 2018.

Room acoustic regulations for hospitals vs schools in 12 countries

Country	Room acoustic regulation		Sources
	for hospitals	for schools	
Belgium	no	yes	for schools: NBN 01-400-2 (2012), for non-residential buildings: NBN 01-400-3 in the works
Netherlands	no	yes	for schools: Programma van Eisen Frisse Scholen 2015, Rijksdienst voor Ondernemend Nederland in opdracht van het ministerie van Binnenlandse Zaken en Koninkrijksrelaties (versie september 2015).
Germany	yes	yes	for schools and hospitals: DIN 18041:2016-03
France	yes	yes	for schools: Arrêté du 25 Avril 2003 relatif à la limitation du bruit dans les établissements d'enseignement and hospitals: … de santé
Italy	no	yes	for schools: UNI 11532-2 2019
Spain	yes*	yes	for schools: Documento Básico HR, Protección frente al ruido; page 10, section 2.2 *for hospitals: generic regulation, for common areas of hospitlas (meaning halls, stairs, communal zones) the same as for treatment rooms
England	no	yes	for schools: Approved Document E BB 93 "Acoustic Design of Schools“ 2014 for hospitals: only a guidance from England Department of Health "Health Technical Memorandum (HTM) 08-01
Denmark	yes	yes	for schools: Bygningsreglementet BR18, Lydforhold (§ 368 - § 376) ➔ Vejledning til undervisningsbygninger for hospitals: ➔ Vejledning til hospitaler laegehuse og klinikker
Norway	yes	yes	for schools and hospitals: Byggteknisk forskrift (TEK 17) ➔ preaccepted rules to NS 8175 class C
Sweden	yes	yes	for schools and hospitals: Boverkets byggregler (BBR, BFS 2015:3) ➔ SS 25268:2007+T1:2017
Finland	yes	yes	for schools and hospitals: 796/2017 Decree of the Ministry of the Environment on sound insulation and noise abatement in buildings
Poland	yes	yes	for schools and hospitals: PN-B-02151-4: 2015-06: Building acoustics - Protection against noise in buildings - Part 4

Example 1: Danish building regulation

➔ 6.4 Rumakustik i hospitaler, lægehuse og klinikker

Tabel 6.4 indeholder forslag til projekteringsværdier for efterklangstid i udvalgte rumtyper i sengestuer og undersøgelses- og behandlingsrum svarende til overholdelse af BR18's generelle bestemmelse om, at brugerne skal sikres tilfredsstillende lydforhold.

Forslag til projekteringsværdier er gengivet fra SBi-anvisning 258, dog med undtagelse af grænseværdien for efterklangstid i sengestuer, hvor værdien ændret til 0,6 s svarende til den angivne efterklangstid for øvrige rumtyper.
Referencer findes i afsnit 1.5.

Supplerende vejledning, der ikke nødvendigvis skal overholdes for at opfylde bygningsreglementets funktionskrav, er anført separat i tabellerne (i kursiv).

Hospitaler, lægehuse og klinikker – Tabel 6.4 Rumakustik – forslag til projekteringsværdier

Efterklangstid [3]	***T*** [1)]	***Frekvensområde***
Sengestuer [2)]	*T ≤ 0,6 s*	*125-4000 Hz*
Undersøgelsesrum, behandlingsrum mv. [2)]	*T ≤ 0,6 s*	*125-4000 Hz*

Noter

1) *Maksimumsværdierne for efterklangstiden gælder for hvert 1/1-oktavbånd i de angivne frekvensområder. Ved 125 Hz kan den angivne maksimumsværdi dog tillægges 20 %.*

2) *Projekteringsværdierne gælder i møblerede rum.*

Sources: http://bygningsreglementet.dk/Tekniske-bestemmelser/17/Vejledninger/Hospitaler-laegehuse-og-klinikker

Example 2: Swedish standard referred to in building regulation

➔ RT_{20} for care facilities

Tabell 5 – Längsta tillåtna efterklangstid, T_{20}, för vårdlokaler

	T_{20} s			
	Ljudklass			
Typ av utrymme	A	B	C	D
5a Utrymme med särskilda krav på dämpad ljudmiljö *exempelvis intensivvård, uppvakningsrum, talträning, storköksutrymme, diskrum*	0,4	0,5	0,5	0,6
5b Små utrymmen för simning och bad *exempelvis bassängrum*	0,6	0,8	0,8	–
5c Övriga utrymmen där människor vistas mer än tillfälligt *exempelvis undersökning, behandling, förlossning, OP-sal inkl. stödjande ytor, sjukgymnastik, patientrum, vårdrum, journum, expedition, kontor, laboratorium, reception, dagrum, väntrum, personalrum, avdelningskorridor, konferensrum, utbildning, matsal, vardagsrum eller samlingssal*	0,5	0,6	0,6	–
5d Utrymmen där människor vistas tillfälligt *exempelvis förbindelsestråk inkl. hisshall, vilrum, entréer*	0,6	0,8	0,8	–
5e – dock i trapphus	1,0	1,2	1,5	–

Intensive care, recovery room, speech therapy, large kitchen space

swimming pool and bathroom

examination, treatment, child delivery, operation, patient room, offices, …

Sources: SS 25268:2007+T1:2017

Example 3: Norwegian standard referred to in building regulation

➔ NS 8175: 2019 version

Tabell 22 – Lydklasser for helsebygninger – Romakustikk

Type brukerområde	Måle-størrelse	Enhet	Klasse A	Klasse B	Klasse C	Klasse D
I fellesareal, TV-stue [a] common areas	$\overline{\alpha} \geq$	–	0,30	0,25	0,20	0,15
I fellesareal, TV-stue	$T_h \leq$	s	$0{,}13 \times h$	$0{,}16 \times h$	$0{,}20 \times h$	$0{,}27 \times h$
I undersøkelsesrom, behandlings-rom, operasjonsstue, senge- eller beboerrom [b] examination-, treatment-, operation-, and bed rooms	$T \leq$	s	0,4	0,5	0,6	0,8

a Med mindre det kan dokumenteres at det er unødvendig, skal det installeres lydutjevningsanlegg (fordelte høyttalere) eller sentrale høyttalere med retningsegenskaper tilpasset dekningsområdet der det er behov for å sikre god taleoppfattelse og kunnskapsformidling. Dette er spesielt aktuelt ved lavt talenivå, forstyrrende støy og lange etterklangstider. Slike anlegg kan kompletteres med teleslynge eller annet tilsvarende trådløst lydoverføringsutstyr. Der det er mange rom med tilnærmet samme størrelse og brukermulighet, er det tilstrekkelig at 1/10 og minst ett av disse rommene har teleslynge eller annet mikrofonbasert, trådløst overføringsutstyr. I noen tilfeller er det også behov for individuelt tilpassede tekniske hjelpemidler i tillegg til at det gjøres bygningsakustiske tiltak slik at kravene til universell utforming blir oppfylt.

b Behovet for god talekommunikasjon og konfidensielle samtaler skal sikres med individuelt tilpassede tekniske hjelpemidler der det er behov for dette, i tillegg til at det gjøres bygningsakustiske tiltak. Se også veiledning i NS 11001-1.

Sources: NS 8175:2019

Example 4: German standard

- Group A: audibility over medium and larger distances.
- Group B: audibility over small distances

Tabelle 3 — Orientierungswerte für das Verhältnis von äquivalenter Schallabsorptionsfläche A zum Raumvolumen V

Nutzungsart	bei Raumhöhen $h \leq 2,5$ m m^2/m^3	bei Raumhöhen $h > 2,5$ m m^2/m^3
B1	ohne Anforderung	ohne Anforderung
B2	$A/V \geq 0,15$	$A/V \geq [4,80 + 4,69 \lg(h/1\,\text{m})]^{-1}$ (7)
B3	$A/V \geq 0,20$	$A/V \geq [3,13 + 4,69 \lg(h/1\,\text{m})]^{-1}$ (8)
B4	$A/V \geq 0,25$	$A/V \geq [2,13 + 4,69 \lg(h/1\,\text{m})]^{-1}$ (9)
B5	$A/V \geq 0,30$	$A/V \geq [1,47 + 4,69 \lg(h/1\,\text{m})]^{-1}$ (10)

examination-, treatment-, operation-, patient room

intensive care, wake-up room, canteen

Dabei ist

A die äquivalente Schallabsorptionsfläche eines Raums in Quadratmeter

V das Raumvolumen in Kubikmeter

h die lichte Raumhöhe in Meter

Sources: DIN 18041:2016

Room acoustic regulation for hospitals in 8 countries

Country	Patient rooms	Treatment rooms	Common areas	Comment
Germany	A/V ≥ 0.20 (room type B3)	A/V ≥ 0.20 (room type B3) and A/V ≥ 0.3 (type B5; intensive care)	A/V ≥ 0.15 (room type B2)	Values for h ≤ 2.5m (A = hypothetical/equivalent absorption area of the room in m2 with sound absorption coefficient = 1)
France	RT ≤ 0.8 s (Staff room: RT ≤ 0.5 s)		Lobby: RT < 1.2 s Hallways: A/FA > 0.25	Room volumes 250 - 512 m3: RT < 1.2s >512 m3: RT < 0,15*(V)^(1/3)
Spain	A/V > 0.2		A/V > 0.2	
England	A/FA > 0.8 (for class C absorber)			Only a guidance from England's Department of Health "Health Technical Memorandum (HTM) 08-01"
Denmark	RT ≤ 0.6 s			
Norway	RT ≤ 0.6 s (class C)		RT ≤ 0.2 x h	Standard updated in 2019
Sweden	RT ≤ 0.6 s (class C)	RT ≤ 0.6 s and ≤ 0.5 s for intensive care (class C)		Standard updated in 2019
Finland	RT ≤ 0.8 s, STI > 0.6			
Poland	RT ≤ 0.8 s		Waiting rooms: A ≥ 0.8 x S Hallways: A ≥ 0.8 x S	(S = rzutu pomieszczenia, floor area)

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Conclusions & call to action

WHO guidance exists for the past 20 years …

… still most hospitals do not reach the recommended levels

Consistent acoustic classification of existing hospitals

Coordinated lobby efforts during the update of national regulations and creation of EU directives (such as EPBD – energy performance of buildings directive).

Ambitious classes in a future ISO acoustic classification standard for hospitals should be the key reference for all national regulation (e.g. TS 19488 for dwellings)

Support of international efforts – overcome “not invented here attitude”

➔ Harmonization of acoustic descriptors and zoning of hospitals

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