

Silent Operating Theatre Optimisation System **SOTOS**

A new noise reduction and information
management system

Effects on stress, concentration, well-being
and communication of OT crews

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Herzmedizin 2021

DIGITAL

Offenlegung potentieller Interessenskonflikte

1. Anstellungsverhältnis oder Führungsposition

Martin Friedrich, CEO of the new StartUp

2. Beratungstätigkeit

nein

3. Aktienbesitz

nein

4. Honorare

nein

5. Finanzierung wissenschaftlicher Untersuchungen

nein

6. Gutachtertätigkeit

nein

7. Andere finanzielle Beziehungen

nein

SOTOS

(Silent Operating Theatre Optimisation System)

is a complex

- **innovative noise reduction system** and
- **information management system**

for medical staff in operating theaters,
enhancing focus and reducing fatigue and errors

scalable to the most diverse (high-tech) environments

SXOTOS ... the smallest working world 4.0 environment with a lot of possibilities

Information and Noise Management in Operating Room Environments

Are our operating theatres quiet enough?



Information and Noise Management in Operating Room Environments

**Are our operating theatres
quiet enough?**

a clear No!



Information and Noise Management in Operating Room Environments

Background informations



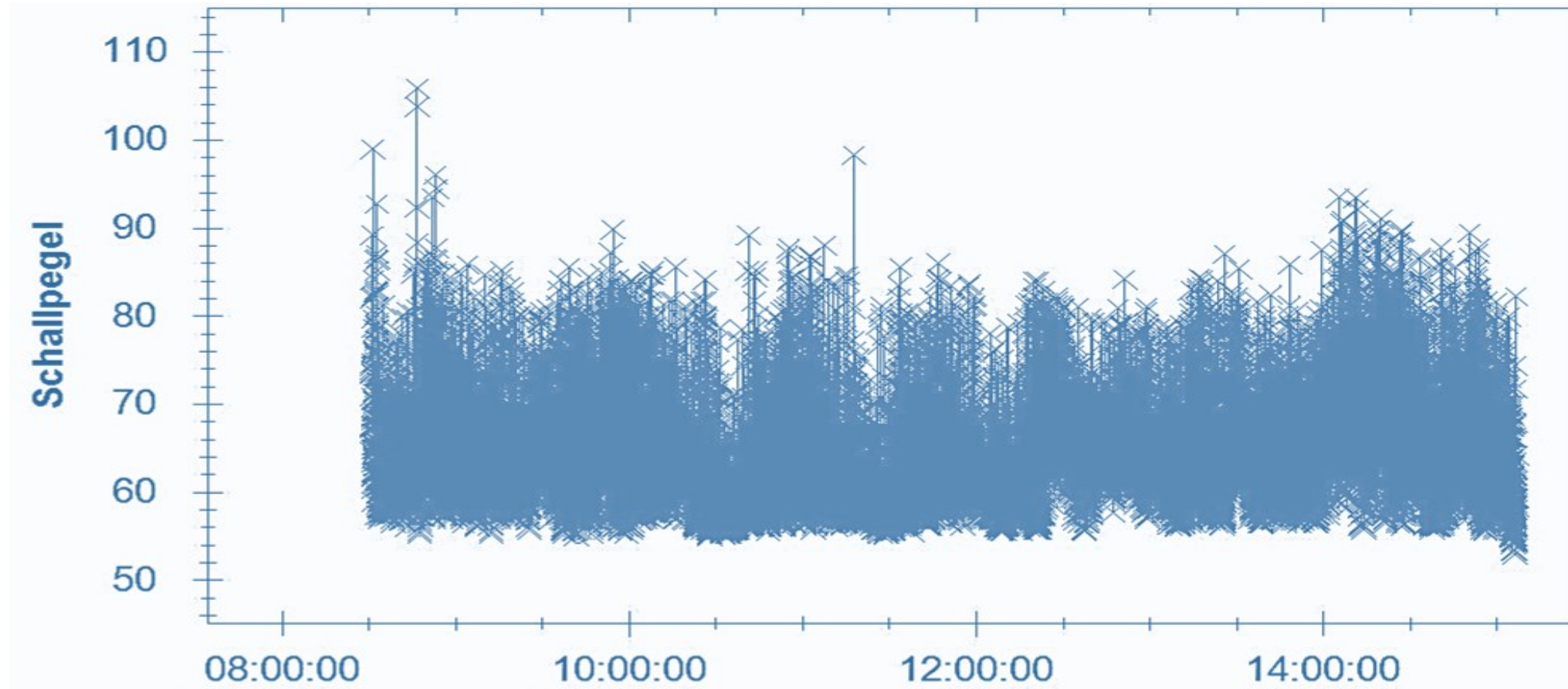
Background Informations



- increasing number of **high-tech equipment**
- **Operating noise levels** have risen up to situation at a highway
- **Qualified staff must communicate** safely (+12 dB)
- increasing number of images, communication packages, technical details, data, procedures - lead to an **information overload**
- **Negative noise effects** on creative, intellectually demanding work
- **no valid solution established**

6 hours cardiac surgery

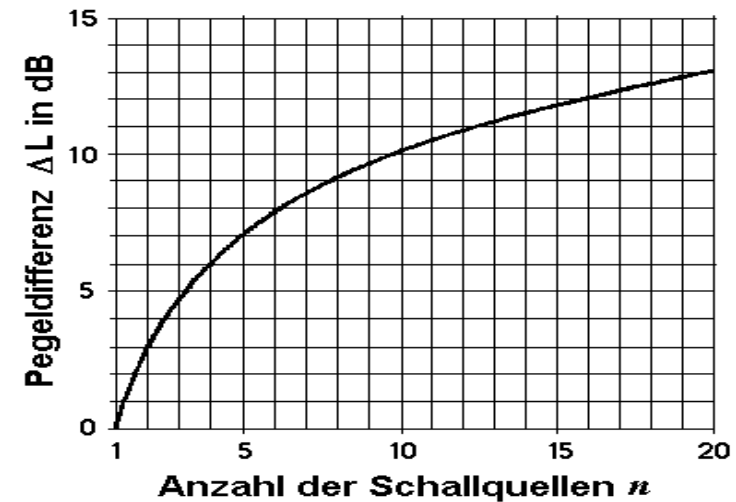
(Measurement on table: 1m to patients heart, 1m to the surgeons ear, A-filtered)



Sum of equal sound sources

- 10 devices with 60dB:
 $10 \times 60\text{dB} = 69,997\text{dB}$

- in other calculation
with every equal device plus 3dB



- Increase of 10dB is perceived twice as loud

speech intelligibility

is directly dependent

- on the background noise level,
- the reverberation time
- the space shape

Consonants play a much greater role in speech intelligibility than vowels.
If consonants are heard clearly,
Voice information can be perceived more secure.



speech intelligibility

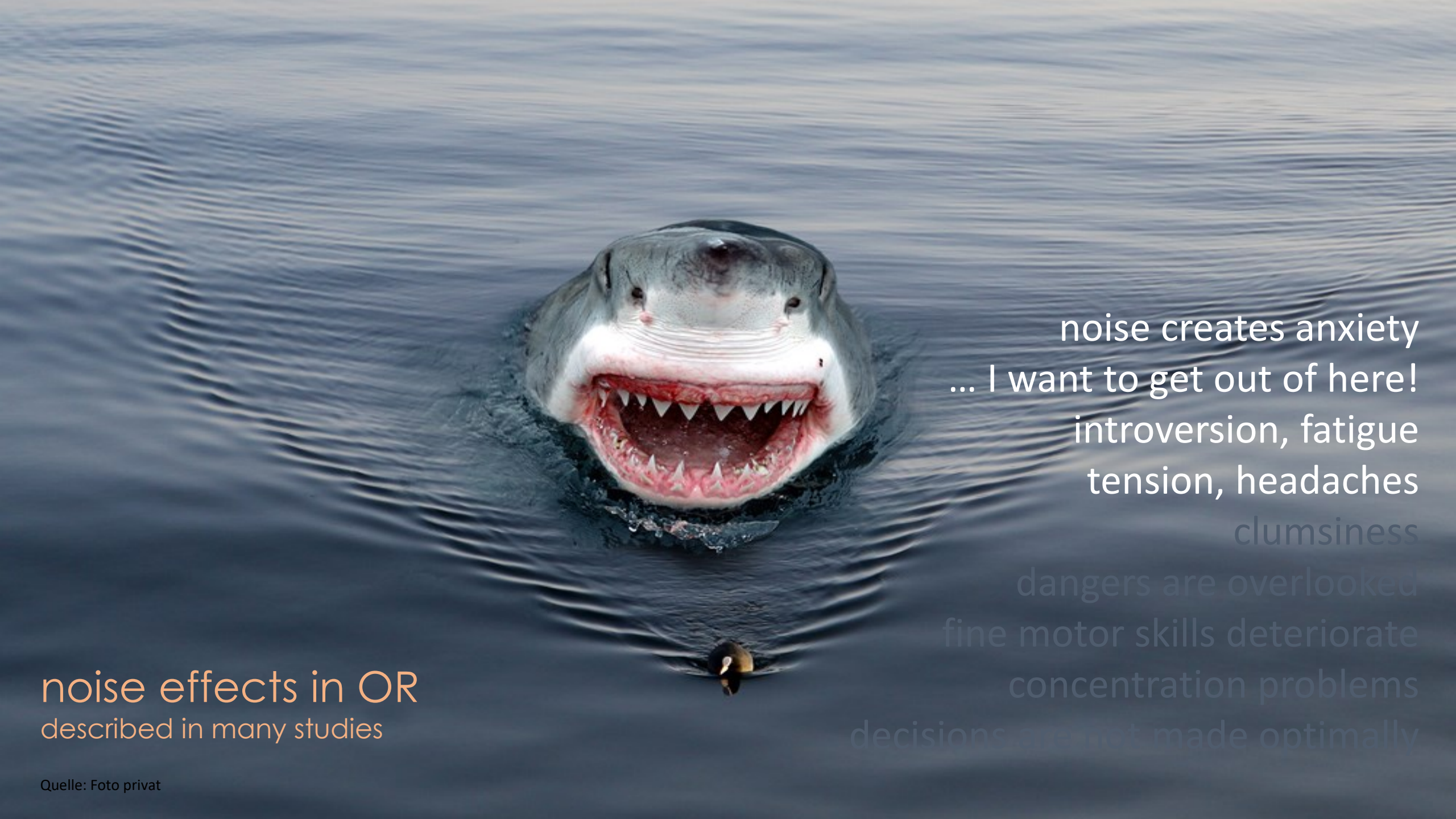
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... with mask it gets even worse

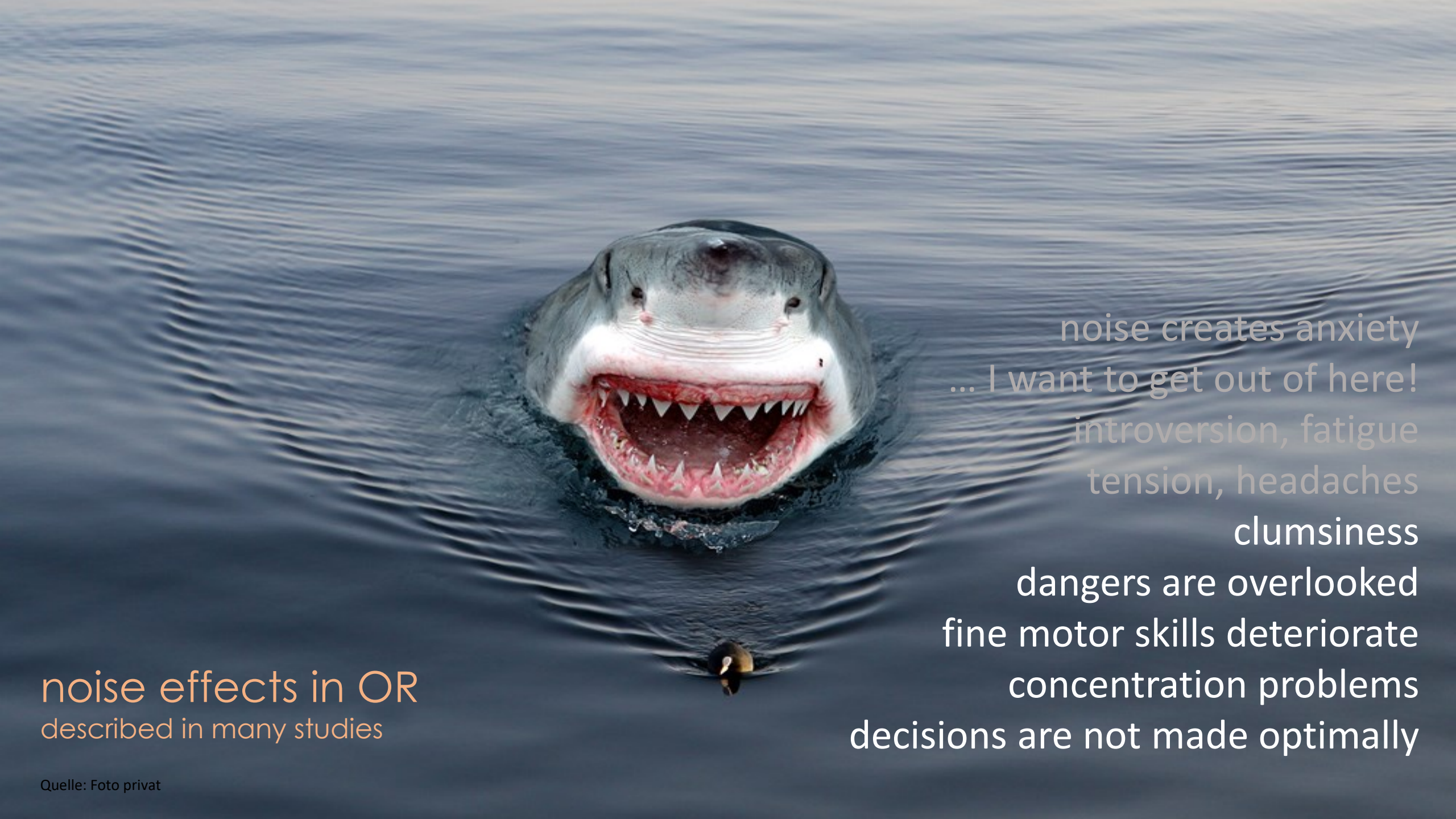




noise effects in OR
described in many studies

Quelle: Foto privat

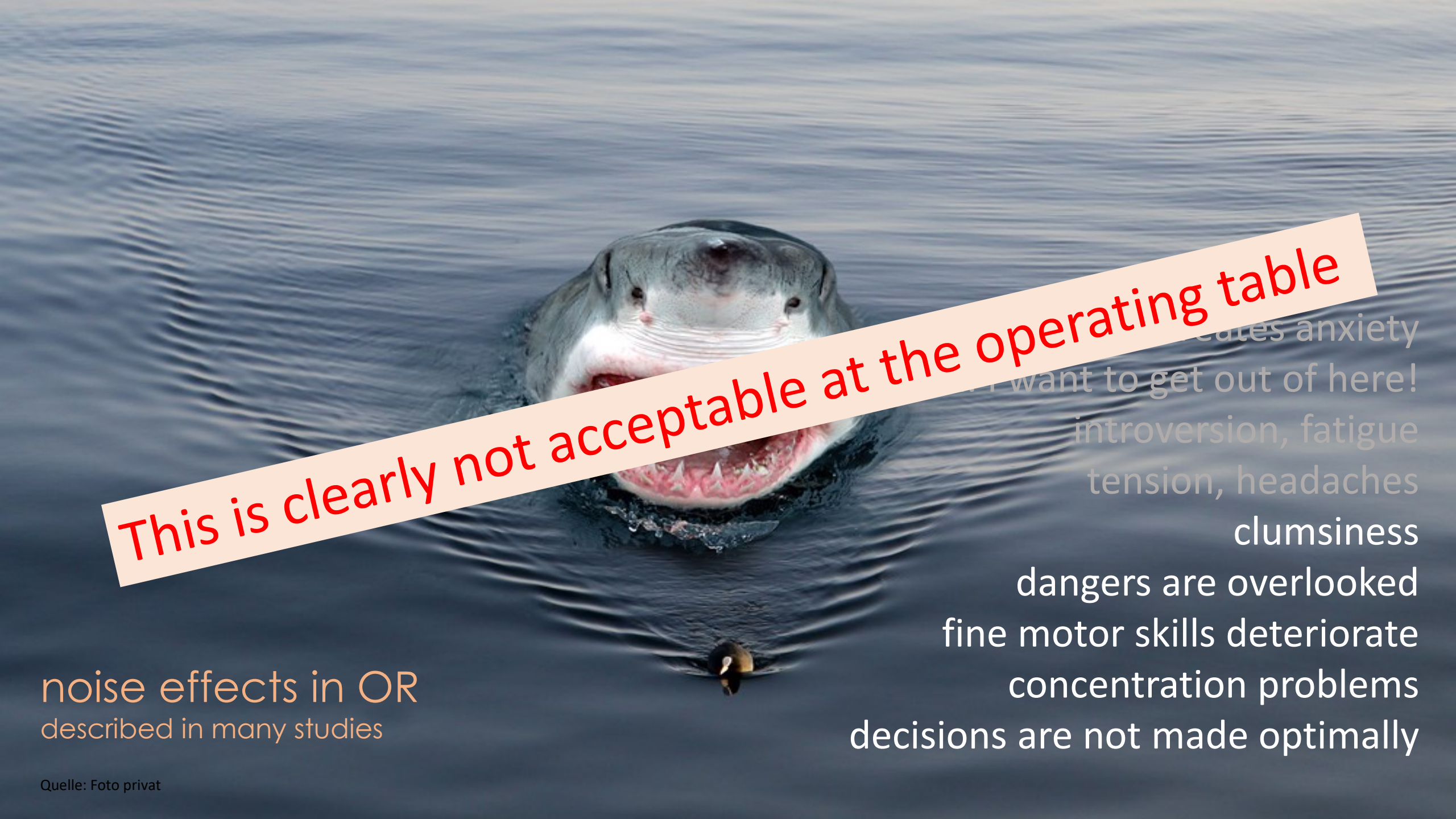
noise creates anxiety
... I want to get out of here!
introversion, fatigue
tension, headaches
clumsiness
dangers are overlooked
fine motor skills deteriorate
concentration problems
decisions are not made optimally



noise effects in OR
described in many studies

Quelle: Foto privat

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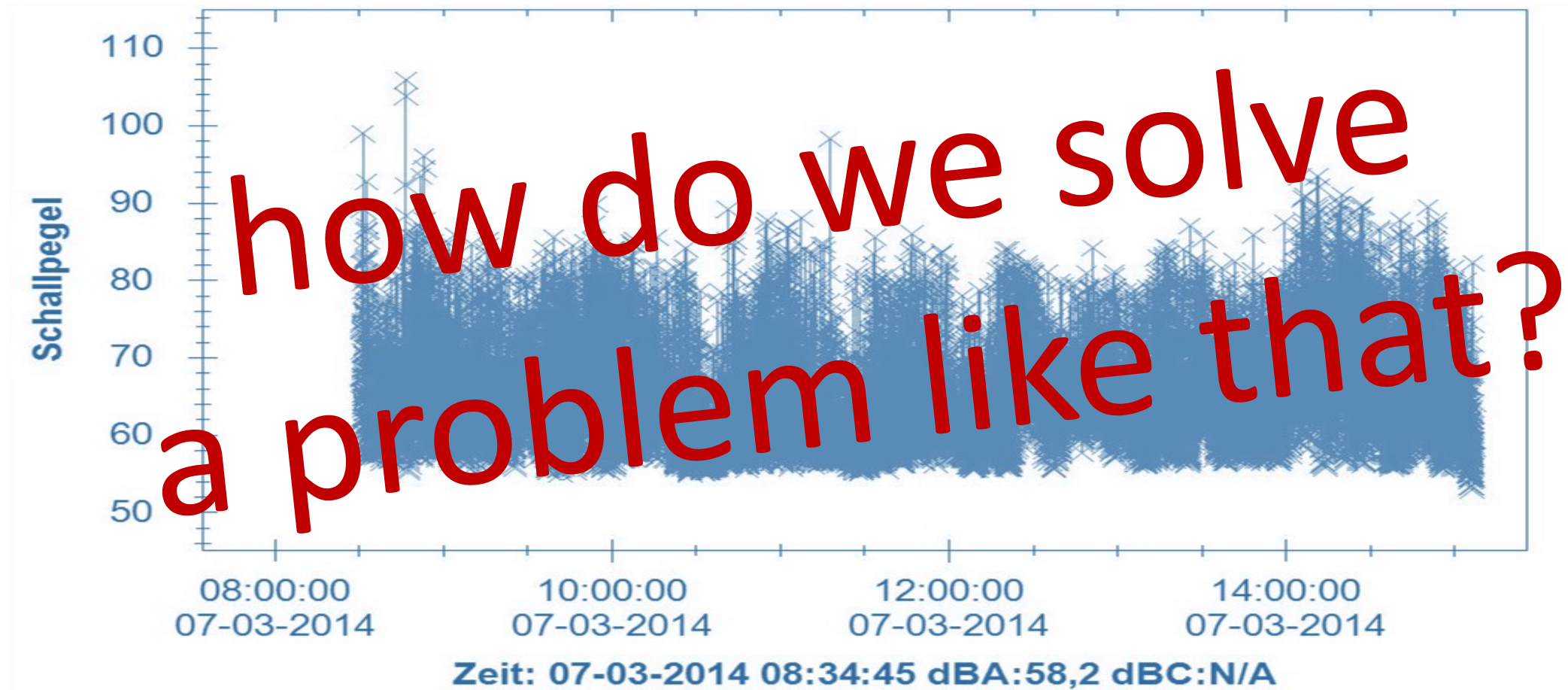


This is clearly not acceptable at the operating table

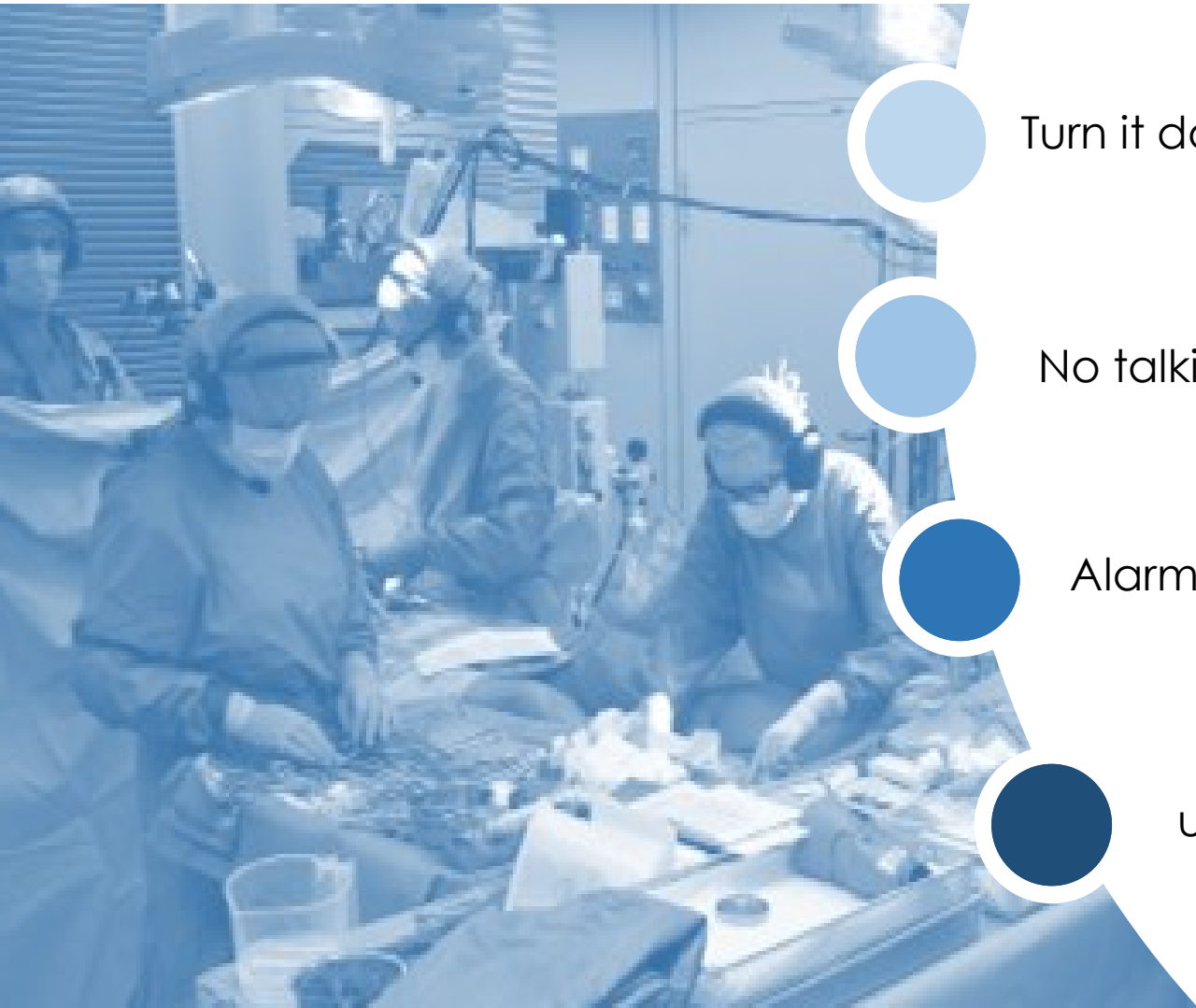
noise effects in OR
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creates anxiety
want to get out of here!
introversion, fatigue
tension, headaches
clumsiness
dangers are overlooked
fine motor skills deteriorate
concentration problems
decisions are not made optimally

6 hours cardiac surgery



What can we do?



Turn it down, radio off

No talking, no phone calls

Alarms to a minimum loudness level

use of silent medical technique

C. R. Engelmann *et al.* A Noise-Reduction Program in a Pediatric Operation Theatre is Associated With Surgeon's Benefits and a Reduced Rate of Complications: A Prospective Controlled Clinical Trial", *Annals of Surgery*, Volume 259, Issue 5, Seiten 1025–1033



Turn it down, radio off

**But noise is not
the only problem!**

No talking, no phone calls

Alarms to a minimum

what else?

Working memory – Modell (Baddeley, 2000)



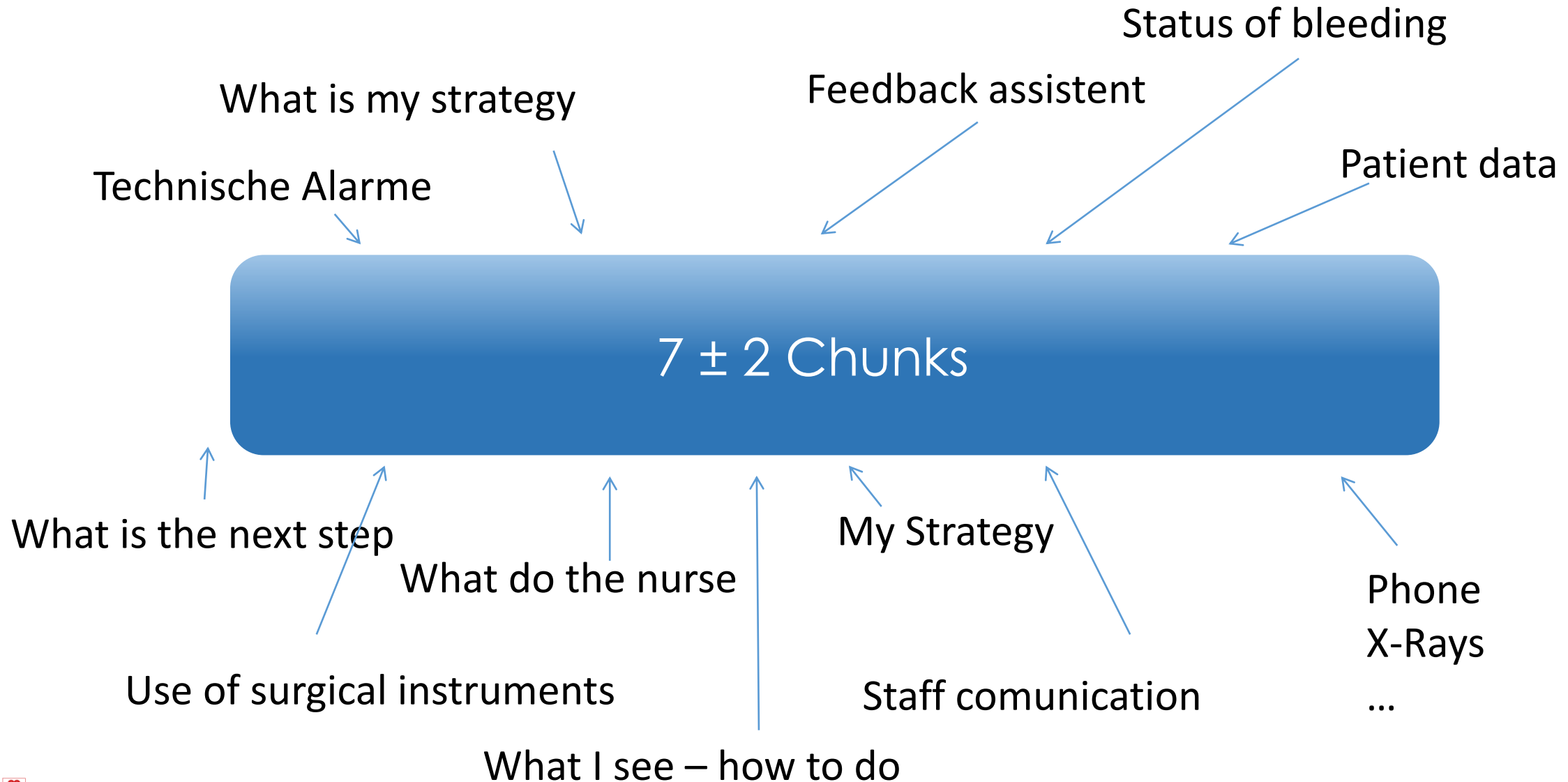
short term memory ... STM
long term memory ... LTM (Neel, 1974)

7 ± 2 Chunks

“The magical number seven, plus or minus two”

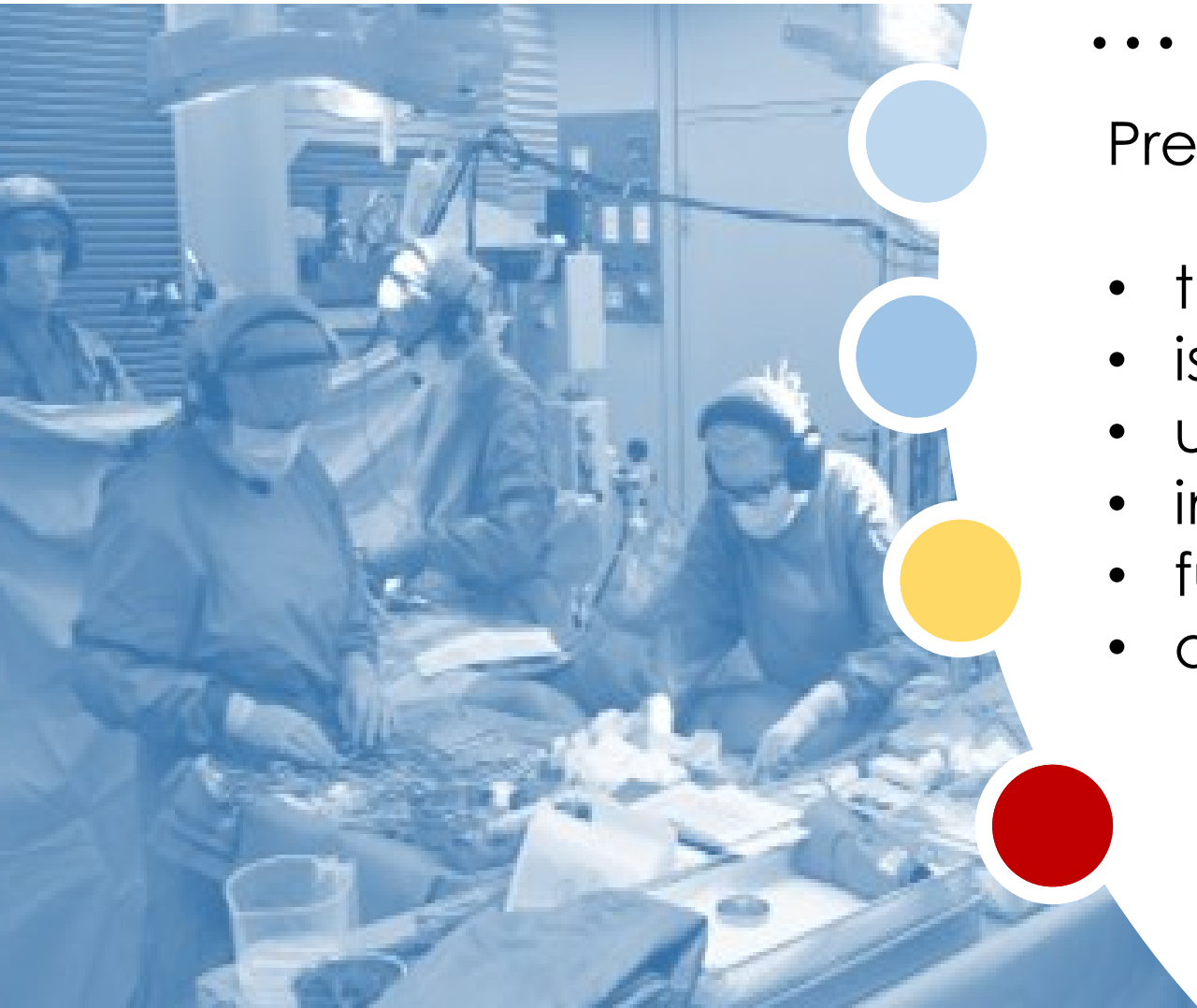
(George Miller, 1956)

Working memory – Modell (Baddeley, 2000)



Working memory – Modell (Baddeley, 2000)

If we overload this system,
we get slower or
we make more mistakes !



... what we need:

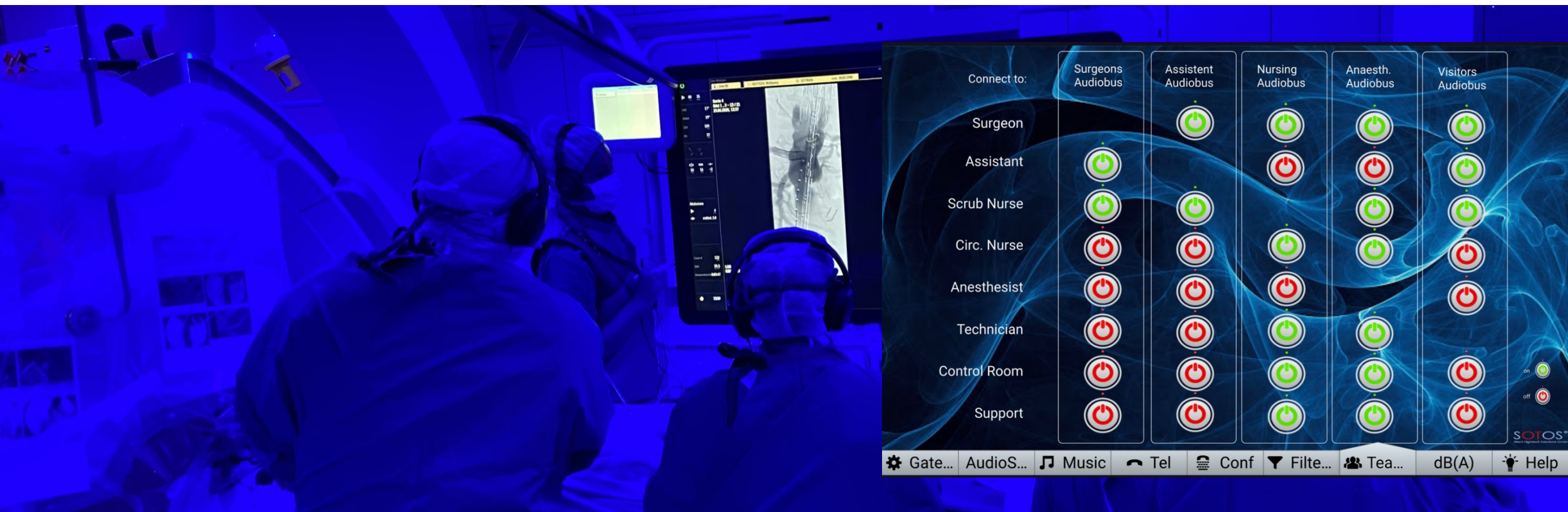
Precise professional communication

- takes place in a quiet atmosphere
- is directly
- undisturbed by nonsense information
- individual
- focusable
- adapt dynamically

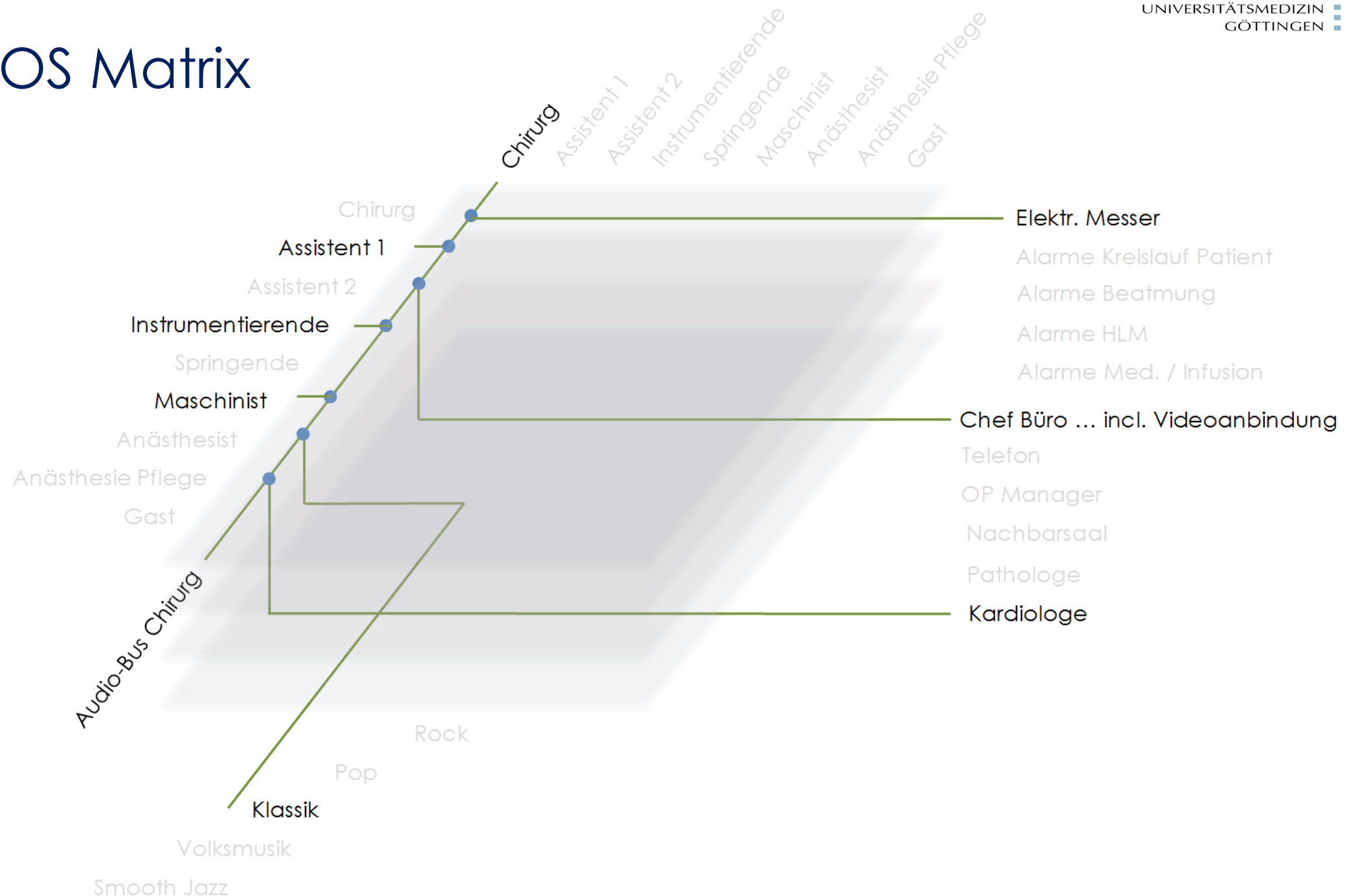
one has unfortunately (in medicine)
"audio" almost completely forgotten

SOTOS technique

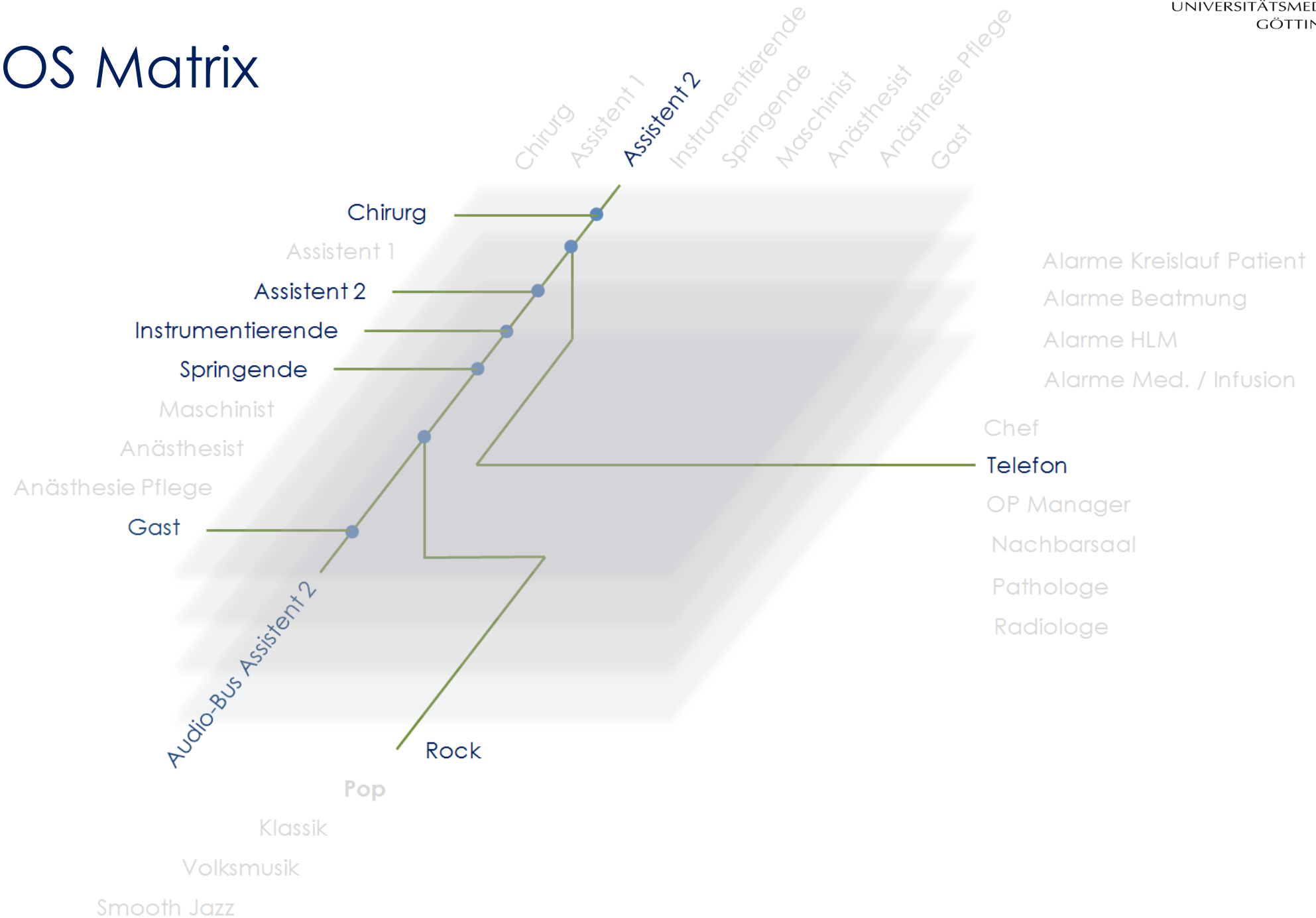
- fully customizable digital matrix for informations
- audio layers for each team member
- including alarms, machine signals
- external parties
- controlled background music



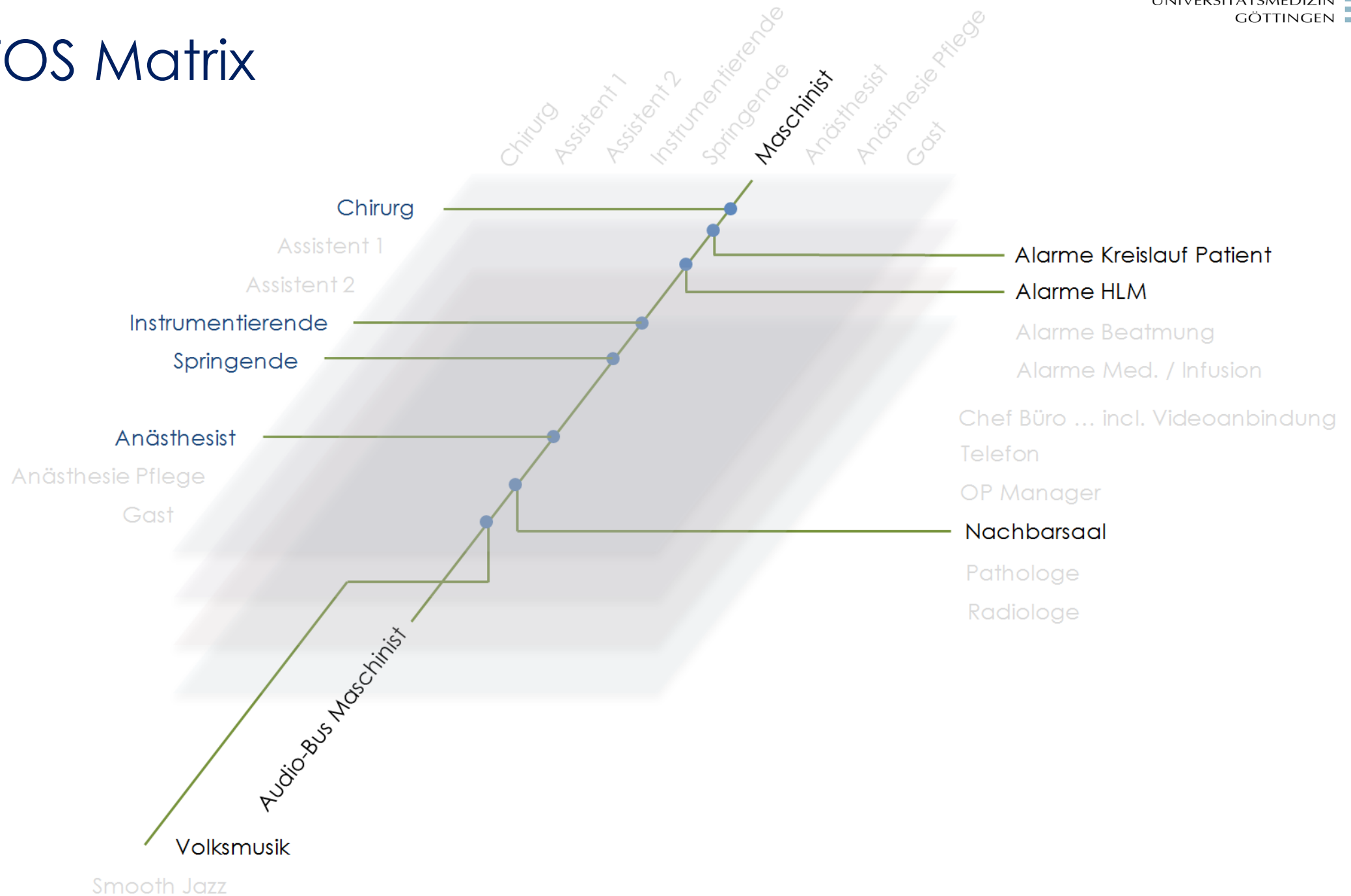
SOTOS Matrix

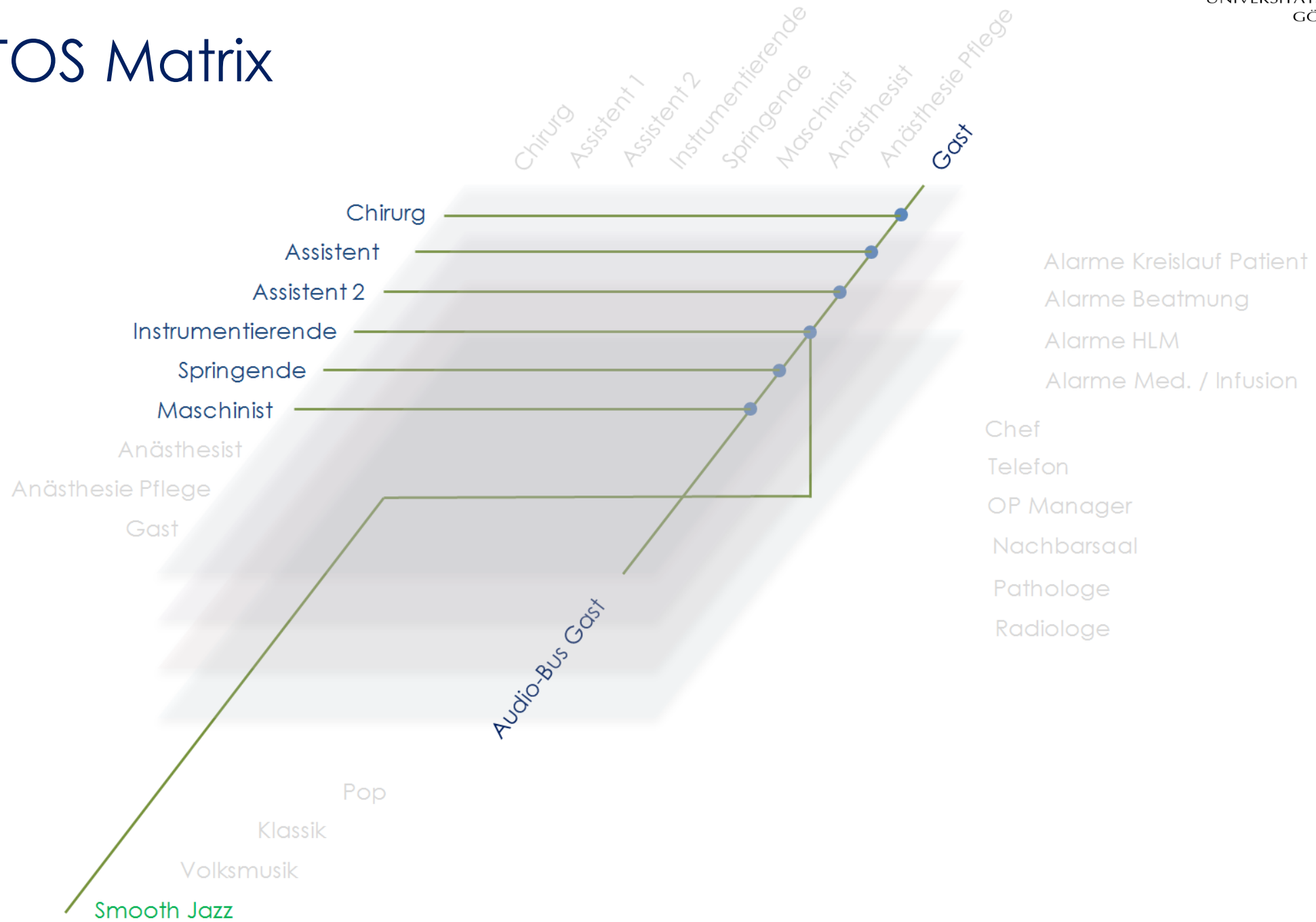


SOTOS Matrix



SOTOS Matrix







SOTOS User Controlled Interfaces

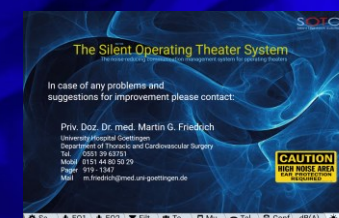
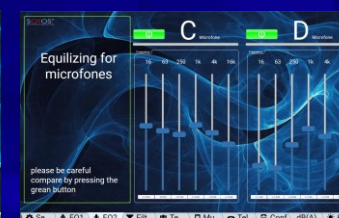
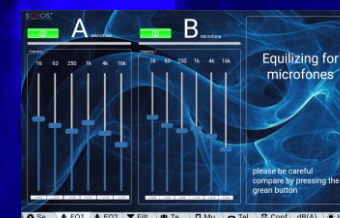
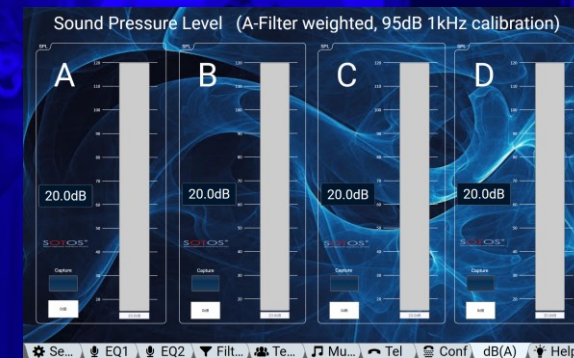
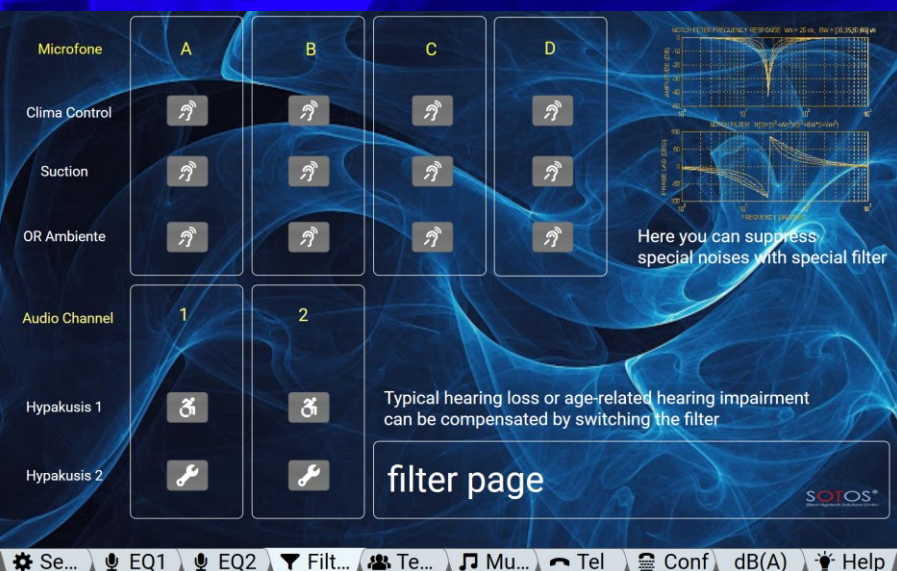
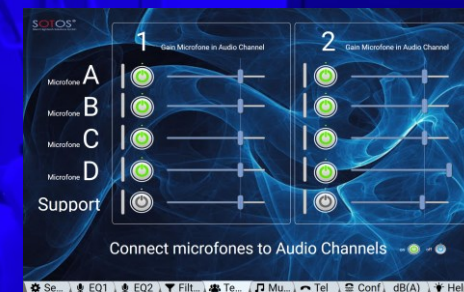
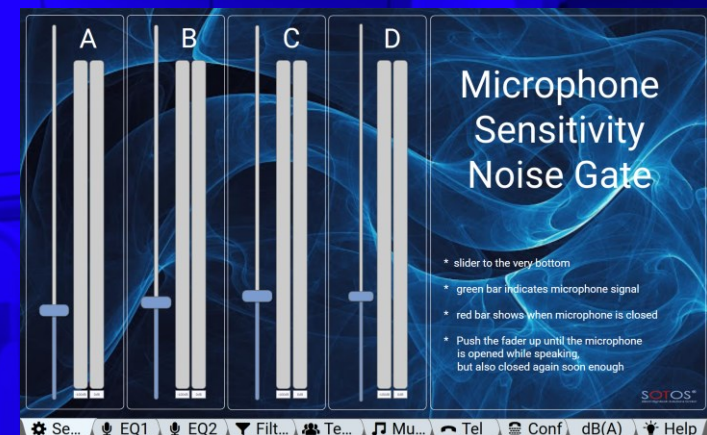
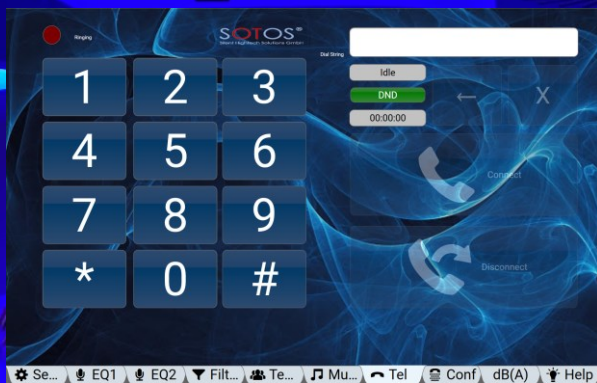
the only necessary personal interface to the SOTOS machine

UCI
at touchscreens,
smartphones and
windows-applications



SOTOS
meets the
Philips Azurion
UMG Hybrid
Operating Room

Apps as personal interfaces



Findings SOTOS – Study

Heart Surgery

22 Surgeries

11 with and 11 without SOTOS



DaVinci Robotic Surgery

32 Surgeries

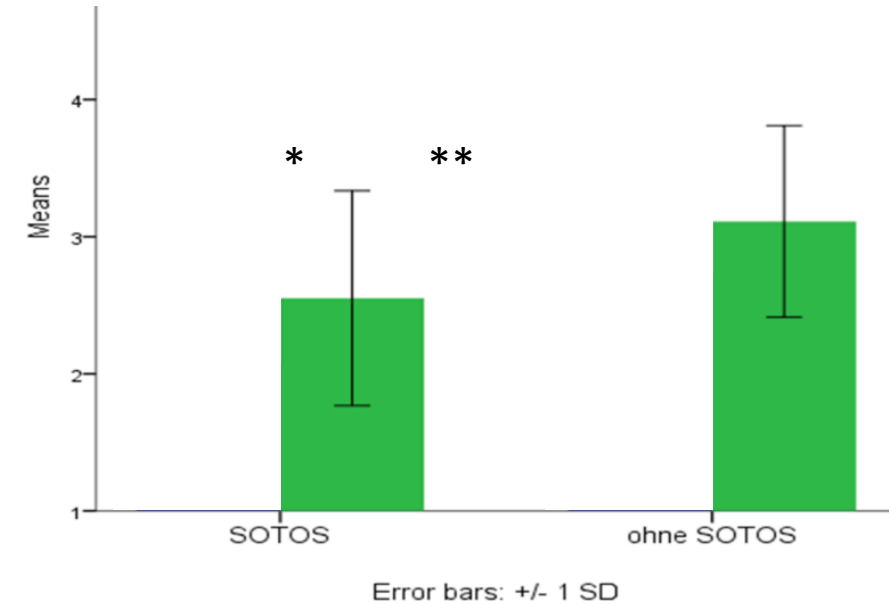
16 with and 16 without SOTOS



Findings SOTOS – Study

with use of SOTOS

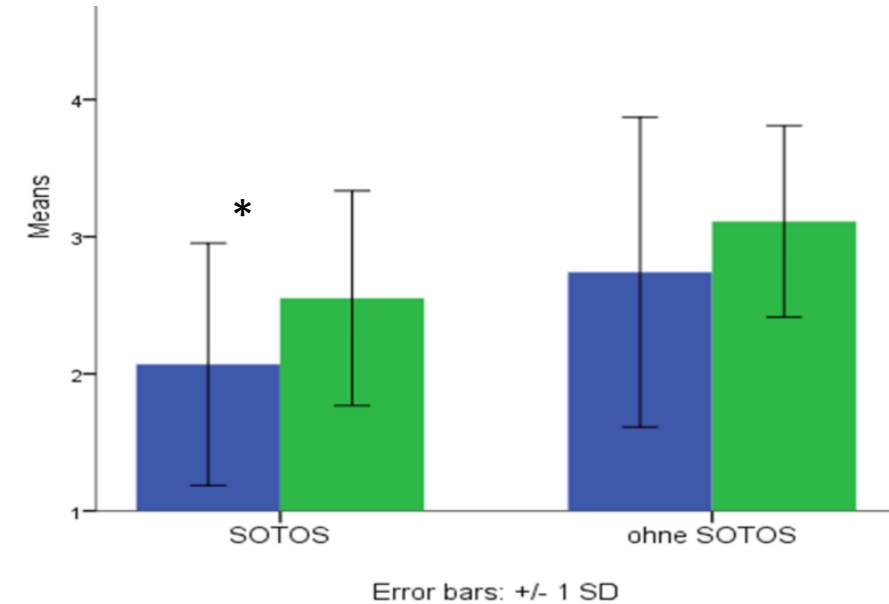
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(heart surgery: $p < 0,05$; DaVinci $p < 0,001$)
- *less stressed right after the surgery*
($p < 0,05$)
- *less tired because of the surgery*
($p < 0,05$)
- *even more active at end of the OR*
($p < 0,05$)
- *less humor acts*
($p < 0,05$)
- *less spoken words*
($p < 0,05$)
- *it is much quieter in OR*
($p < 0,001$)
- *fewer germs in the surgical field*
(n.s.)
- *Heart rate is reduced (because of less stress)*
($p < 0,05$)



Findings SOTOS – Study

with use of SOTOS

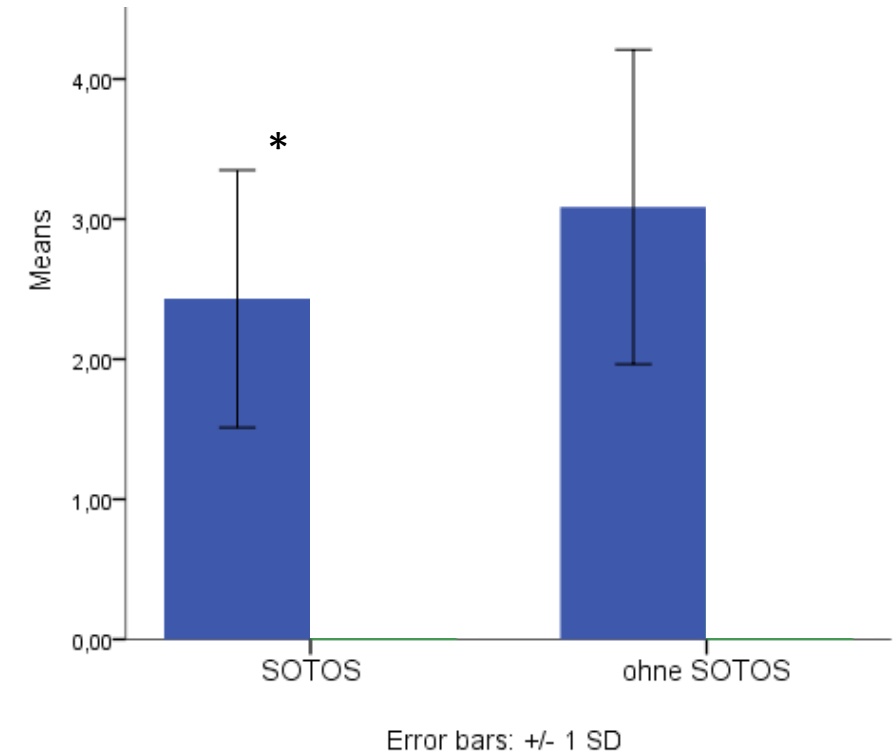
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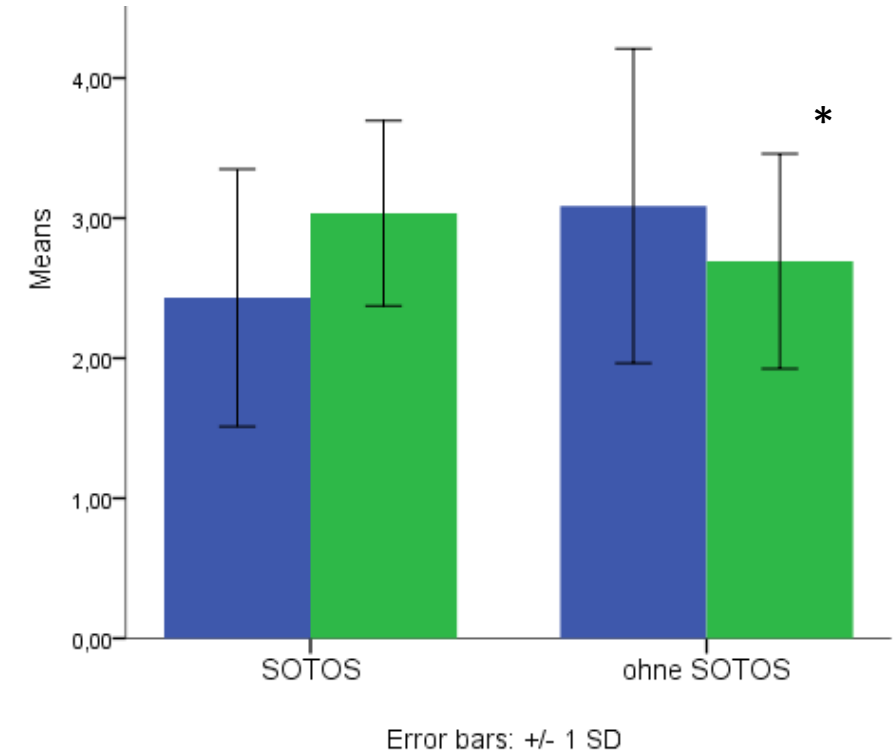
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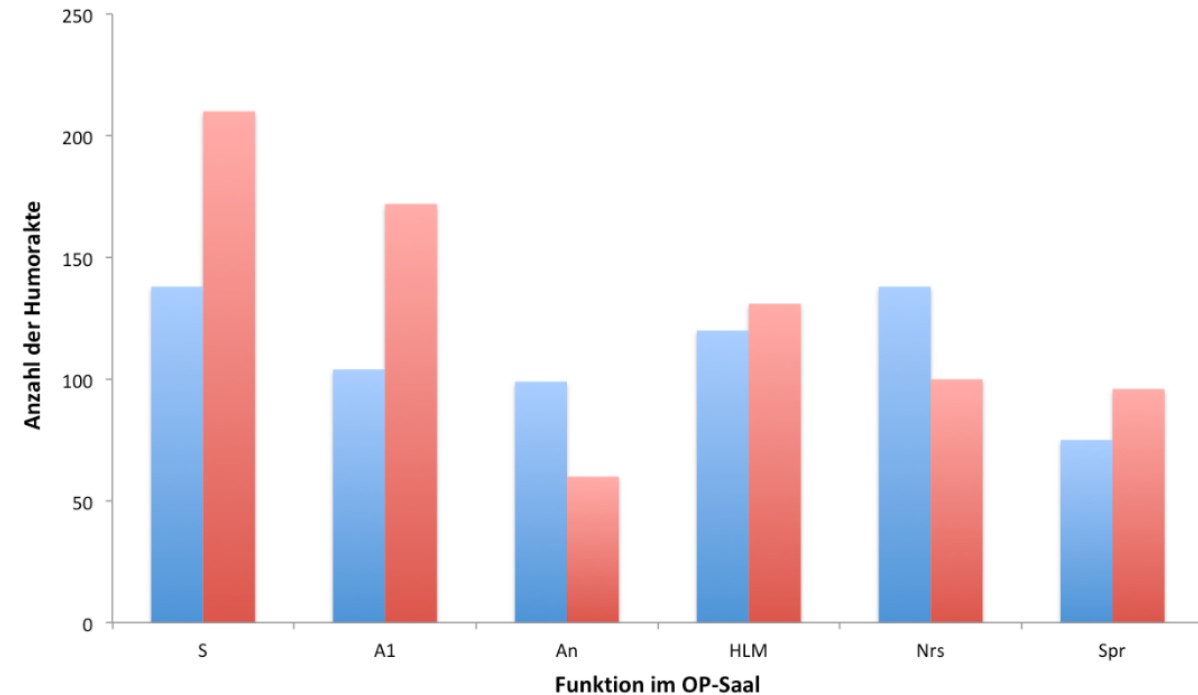
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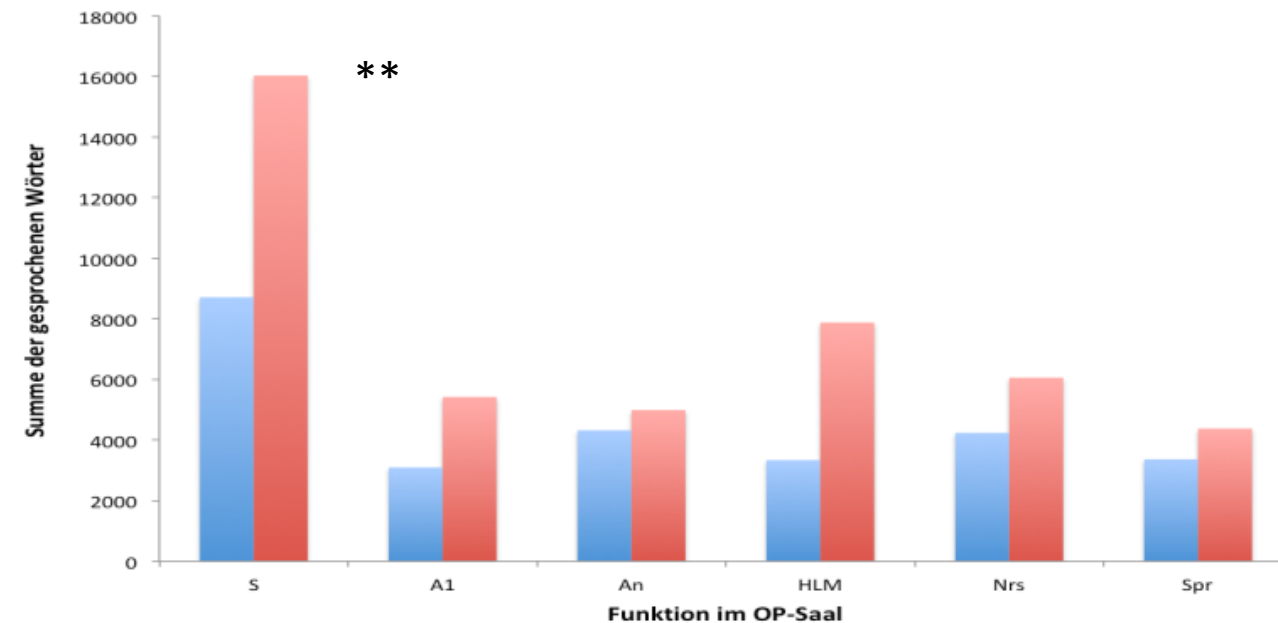
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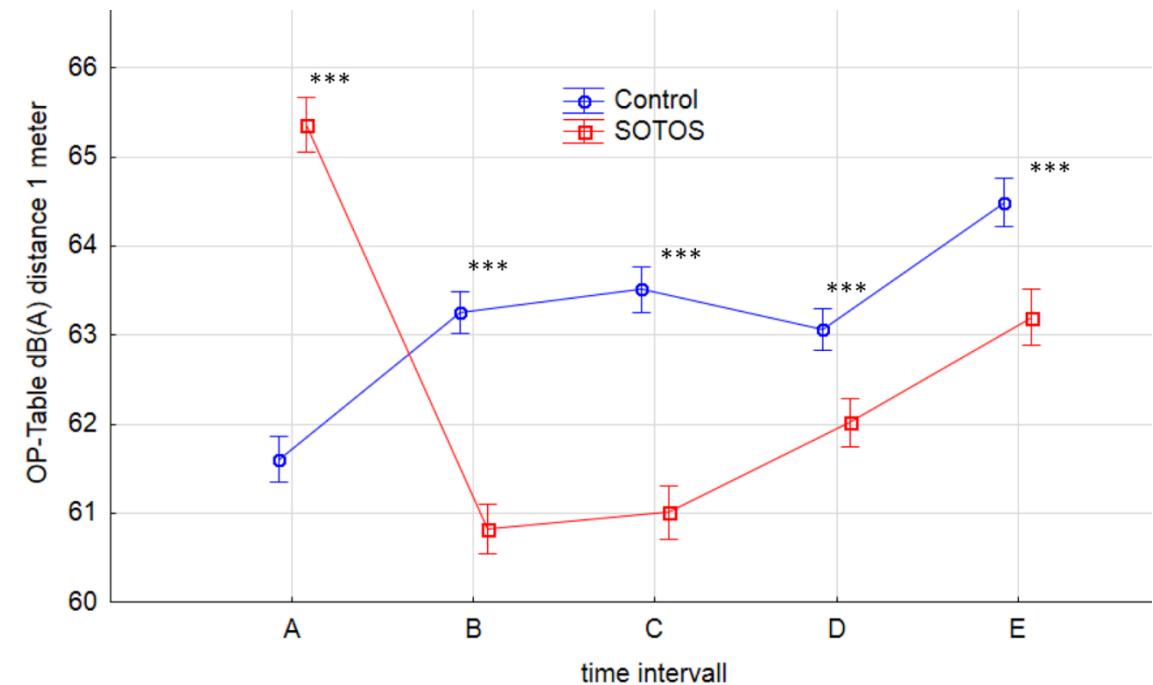
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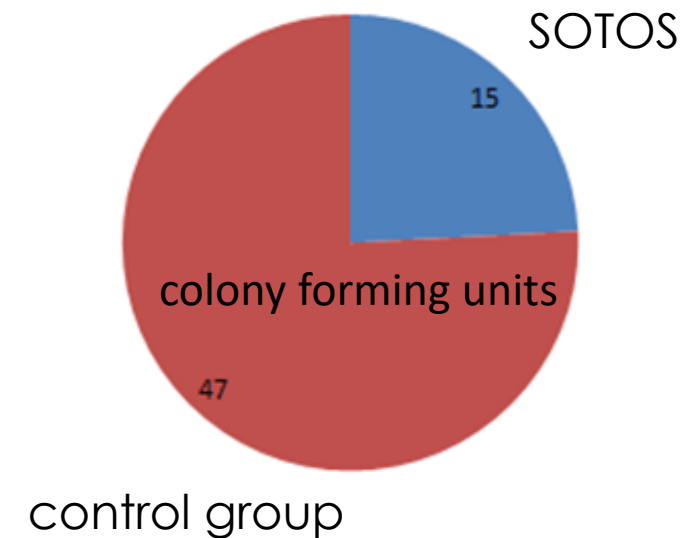
Findings SOTOS – Study



Findings SOTOS – Study

with use of SOTOS

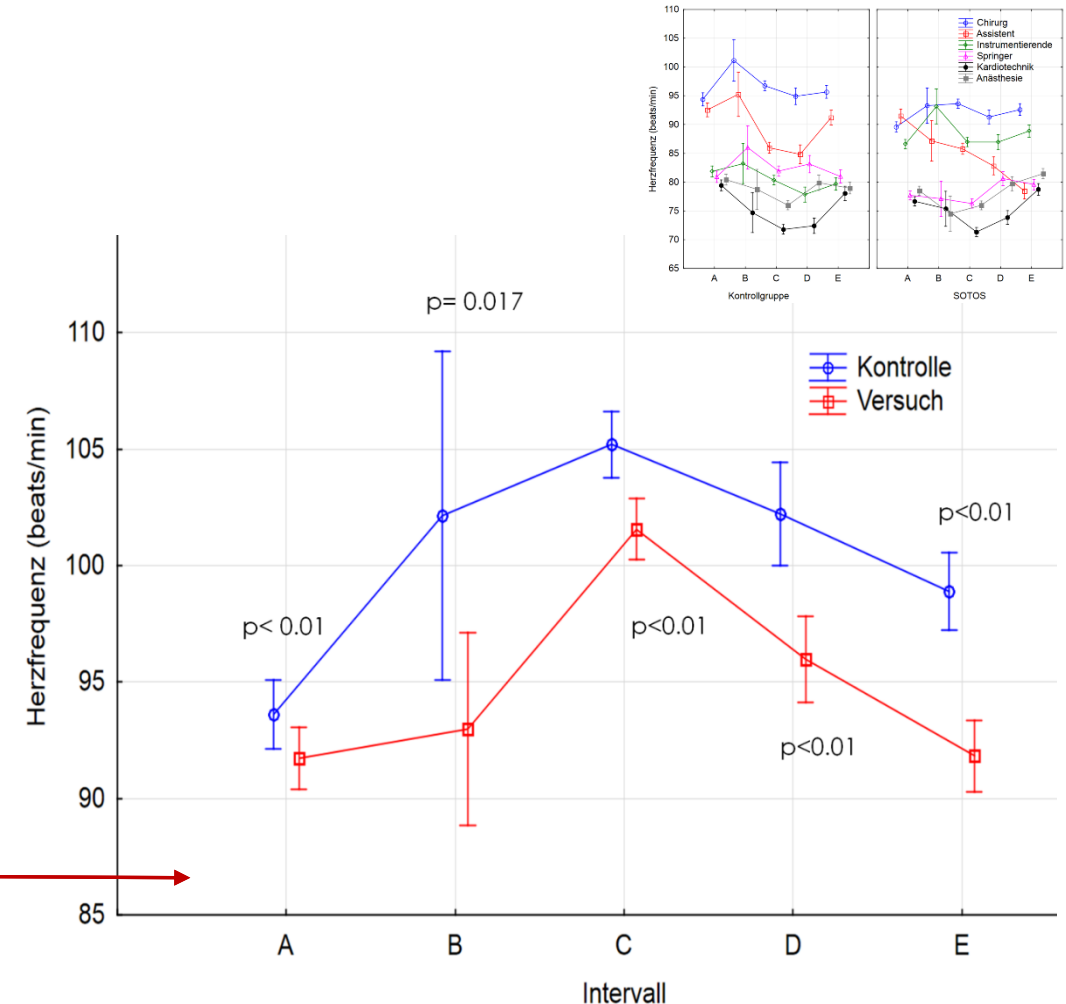
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there are 3 scientific papers published

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ASSISTIVE TECHNOLOGIES

ORIGINAL ARTICLE

New technical solution to minimise noise exposure for surgical staff: the 'silent operating theatre optimisation system'

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Received 20 December 2016
Revised 9 August 2017
Accepted 8 September 2017



CrossMark

To cite: Friedrich MG, Boos M, Pagel M, et al. *BMJ Innov* Published Online First: [please include Day Month Year]. doi:10.1136/bmjinnov-2016-000188

ABSTRACT

The increasing number of technical equipment in the operating room (OR) is resulting in significantly higher noise levels. The more complex and sophisticated the surgical procedure is, the more essential it is for all team members of the OR to work together in a harmonious fashion to process and manage their demanding team tasks. With increasing noise in OR, the risk of more frequent errors also increases. The reduction of noise production in the OR is possible but limited. The aim of this study was to develop a device that reduces ambient noise for the operating team without hindering their ability to communicate. We developed a new communication technology set-up for the OR to meet all needed requirements. All members of the operating team are issued headsets with microphones. The headsets filter out background noises (active and passive noise cancelling) and the microphones enable interactive communication among and between OR subgroups through targeted information selection (signal selection). Any remaining background noise is overshadowed by music, which is queued by direct speech into the microphone (ducking). Information flow is programmed on a digital workstation, providing each team member a selection of acoustic signals from the OR on their bidirectional headset. A complex matrix of connections in this audio technology allows a predefined communication structure. These procedures were assembled in the Silent Operating Theatre Optimisation System (SOTOS). The technical specifications and user interface are described. A pilot study in 2015 using the SOTOS in cardiac surgery showed very positive feedback from the participating operating team members. Further studies focusing on communication psychology

perspective and physiological reaction are recommended.

INTRODUCTION

More complex techniques and equipment are continually added to today's operating room (OR) to assure a more effective, controlled environment for patient health and safety. However, these modern technologies produce noise in the OR that is now comparable to the noise level of a major highway with high traffic density.¹ Persistent, high levels of noise (sound pollution) are known to lead to health problems²⁻⁴ and can affect outcome of surgical procedures^{4,7} and even OR failures.⁸ The volume level and the frequency of noise (sound quality) have negative effects on concentration.⁹⁻¹² Higher volumes of noise correlate directly with higher levels of surgical errors, putting patients at risk.¹³ The more complex the operation procedures are, the more severe the negative effects of noise become.¹⁴

The ill effects of long-sustaining sound pollution are well researched in industrial and occupational medicine.^{15,16} and work environment noises are restricted by national laws and regulations for occupational safety and health.¹⁷ Unfortunately, there are no specific noise level restrictions for the OR. And although the noise pollution problem in OR is inarguable, very little has been invested to find and develop solutions. Engelmann *et al* showed a significant positive effect with lower rate of OR surgical complications by implementing consequent noise hygiene in the OR: no phones, a ban on

Journal of Robotic Surgery
<https://doi.org/10.1007/s11701-020-01135-x>

ORIGINAL ARTICLE



The Silent Operation Theatre Optimisation System (SOTOS[®]) to reduce noise pollution during da Vinci robot-assisted laparoscopic radical prostatectomy

Conrad Leitsmann¹ · Annemarie Uhlig¹ · I. Valentin Popeneanu¹ · Margarete Boos² · Sascha A. Ahyal¹ · Marianne Schmid¹ · Rolf Wachter^{3,4} · Lutz Trojan¹ · Martin Friedrich⁵

Received: 22 May 2020 / Accepted: 3 August 2020
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Abstract

To reduce noise pollution and consequently stress during robot-assisted laparoscopic radical prostatectomy (RALP) the aim of our study was to evaluate the silent operation theatre optimisation system (SOTOS) in its effectiveness. In the operating room (OR) the noise level is between 80 and 85 decibel (dB). Noise corresponds to a major stress factor for surgical teams and especially surgeons. The use of the da Vinci surgical system entails an additional aspect of noise in the OR. The SOTOS surgical team used wired or wireless headphone/microphone combinations to communicate. We measured sound pressure levels in two different locations in the OR and the heart rate of every surgical team member as an indicator of the stress level. We further captured subjective acceptance of SOTOS as well as perioperative data such as surgical time. We prospectively randomised 32 RALP patients into two study arms. Sixteen surgeries were performed using SOTOS and 16 without (control). Overall, the mean sound pressure level in the SOTOS group was 3.6 dB lower compared to the control ($p < 0.001$). The highest sound pressure level measured was 96 dB in the control group. Mean heart rates were 81.3 beats/min for surgeons and 90.8 beats/min for circulating nurses. SOTOS had no statistically significant effect on mean heart rates of the operating team. Subjective acceptance of SOTOS was high. Our prospective evaluation of SOTOS in RALP could show a significant noise reduction in the OR and a high acceptance by the surgical staff.

Keywords SOTOS[®] · Noise pollution · Da Vinci · Prostatectomy · Robotic surgery · Robotic-assisted laparoscopic prostatectomy (RALP) · Health risk

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Published online: 10 August 2020



BMJ

Friedrich MG, et al. *BMJ Innov* 2017;0:1–10. doi:10.1136/bmjinnov-2016-000188

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1

ASSISTIVE TECHNOLOGIES

ORIGINAL RESEARCH

Silent operating theatre optimisation system for positive impact on surgical staff-members' stress, exhaustion, activity and concentration in urological da Vinci surgeries

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³Thoracic and Cardiovascular Surgery, University Medical Center Göttingen, Göttingen, Niedersachsen, Germany

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IM-L and MB contributed equally.

Received 6 December 2019
Revised 8 July 2020
Accepted 16 August 2020



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To cite: Meyer-Lamp I, Boos M, Schugmann LS, et al. *BMJ Innov* Published ahead of print: [please include Day Month Year]. doi:10.1136/bmjinnov-2019-000413

ABSTRACT

Background Noise in the operating room (OR) is a stressor with far-reaching negative consequences. The Silent Operating Theatre Optimisation System (SOTOS) suppresses the noise level in the OR and improves the communication of the OR-staff. This study investigates whether SOTOS has a positive impact on the OR-staff's perceived stress, exhaustion, activity and concentration. **Methods** Data were collected in a quasi-experimental study design of 32 radical prostatectomies using the da Vinci robotic-assisted system. Sixteen randomly chosen surgeries were carried out with SOTOS and 16 without. A total of 34 OR-staff-members took part, each 32 surgeries involving five planned OR-staff-members. Two points of measurement, before and after each surgery, were carried out, with a final sample of n=143 repeated measurements data. Before and after surgery, OR-staff-members completed a concentration test and a questionnaire concerning their perceived stress, exhaustion and activity levels. **Results** The OR-staff felt significantly less stressed, less exhausted and more active during and after surgery when operating with SOTOS. Especially the primary surgeons, assisting surgeons and circulating nurses profited from SOTOS. SOTOS did not reveal a significant impact on the OR-staff's concentration in this study.

Conclusion For urological surgeries using the da Vinci system SOTOS constitutes a technical resource which significantly reduces perceived

noise stress and exhaustion and improves the activity of primary surgeons, assisting surgeons and circulating nurses. These efficiencies likely lead to positive changes in their health and job satisfaction and are hence beneficial to the patient safety and hospital resources.

INTRODUCTION

Every day, surgical teams work in operating rooms (OR) with a noise level similar to a transport highway.¹ Depending on the type of surgery, the average noise level ranges between 51 dB(A)² and 81 dB(A)³ with peaks exceeding 120 dB.⁴ The main reasons for these high noise levels in the OR are staff communication, medical technical devices, dropping metal tools, slamming doors, suction system(s), alarms, the surgical saw, opening of sterile instrument packages and the air circulatory and cooling system.^{2,3,6} Studies have shown that the OR-staff perceives these high noise levels as distracting, stressing and reducing their efficiency.^{5,9} The OR-noise impairs the OR-staff's concentration^{10,11} which has cognitive consequences such as reduced mental efficacy, attention, short-term memory, long-term memory and working memory performance¹² and motor skill consequences such as compromised coordination, dexterity, increased complications and a higher error rate in surgery.^{10,12-15} In addition, noise hinders the communication in the

Meyer-Lamp I, et al. *BMJ Innov* 2020;0:1–10. doi:10.1136/bmjinnov-2019-000413

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Studiengang: BEng Medizingenieurwesen
Modul: Ba4-13 Interprofessional Collaboration

Schriftliche Studien- / Prüfungsleistung
Interprofessionelle Kommunikation und Zusammenarbeit bei
einer Herzoperation

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Fachsemester: 4.
Abgabedatum: 31.07.2020



To cite: Friedrich MG,
Boos M, Pagel M, et al.
BMJ Innov Published Online
First: please include Day
Month Year; doi:10.1136/
bmjinnov-2016-000188

remaining background noise
music, which is queued by
the microphone (ducking). It
programmed on a digital wo-
each team member a selectio-
signals from the OR on their b-
headset. A complex matrix of o-
in this audio technology allows
communication structure. These
were assembled in the Silent Oper-
Optimisation System (SOTOS). The
specifications and user interface are
A pilot study in 2015 using the SOTOS
surgery showed very positive feedback
participating operating team member.
studies focusing on communicational p-

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Der Einfluss des Musik-
Arbeitsleistung von Chi-
Chirurgen

Bachelorarbeit
Prüfungsort:
Universität Göttingen
Oktober 2016

Angefertigt unter den Bedingungen der Prüfungs-
Studiengang Psychologie an der Georg-August-
und Psychologische Fakultät

Vorgelegt am: 14. September 2015
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0 August 2020



GEORG-AUGUST-UNIVERSITÄT
GÖTTINGEN

Der Einfluss von Musik auf das subjektive
Mitgliedern eines OP-Teams

Angefertigt unter den Bedingungen der Prüfungs-
Studiengang Psychologie an der Georg-August-
und Psychologische Fakultät

Vorgelegt am:
Von:

Aus der Klinik für Thorax-, Herz- und Gefäßchirurgie
(Prof. Dr. med. Ingo Kutschka)
der Medizinischen Fakultät der Universität Göttingen



Acceptance of Technological Innovations
Studied by the Example of SOTOS

Akzeptanz von technologischen Innovationen
am Beispiel von SOTOS

Evaluation einer lärmreduzierenden Maßnahme durch das Silent Operating Theatre
Optimization System© bei Herz-Bypass und Herzklappen-Operationen im Hinblick auf das
Stresserleben und die Erschöpfung des Operationsteams

Masterarbeit von
Ulrich G. P. Gräbener

Prüfungsordnung für den Master-Studiengang
Georg-August-Universität Göttingen, Biologische Fakultät, vom
24.03.2016

Stress-Management
durch den Einsatz eines lärmmindernden
Informations-Management-System
bei Herzchirurgischen Eingriffen

Margarete Boos
Imke Penke
Manuela Pagel

INAUGURAL-DISSERTATION

zur Erlangung des Doktorgrades
der Medizinischen Fakultät der
Georg-August-Universität zu Göttingen

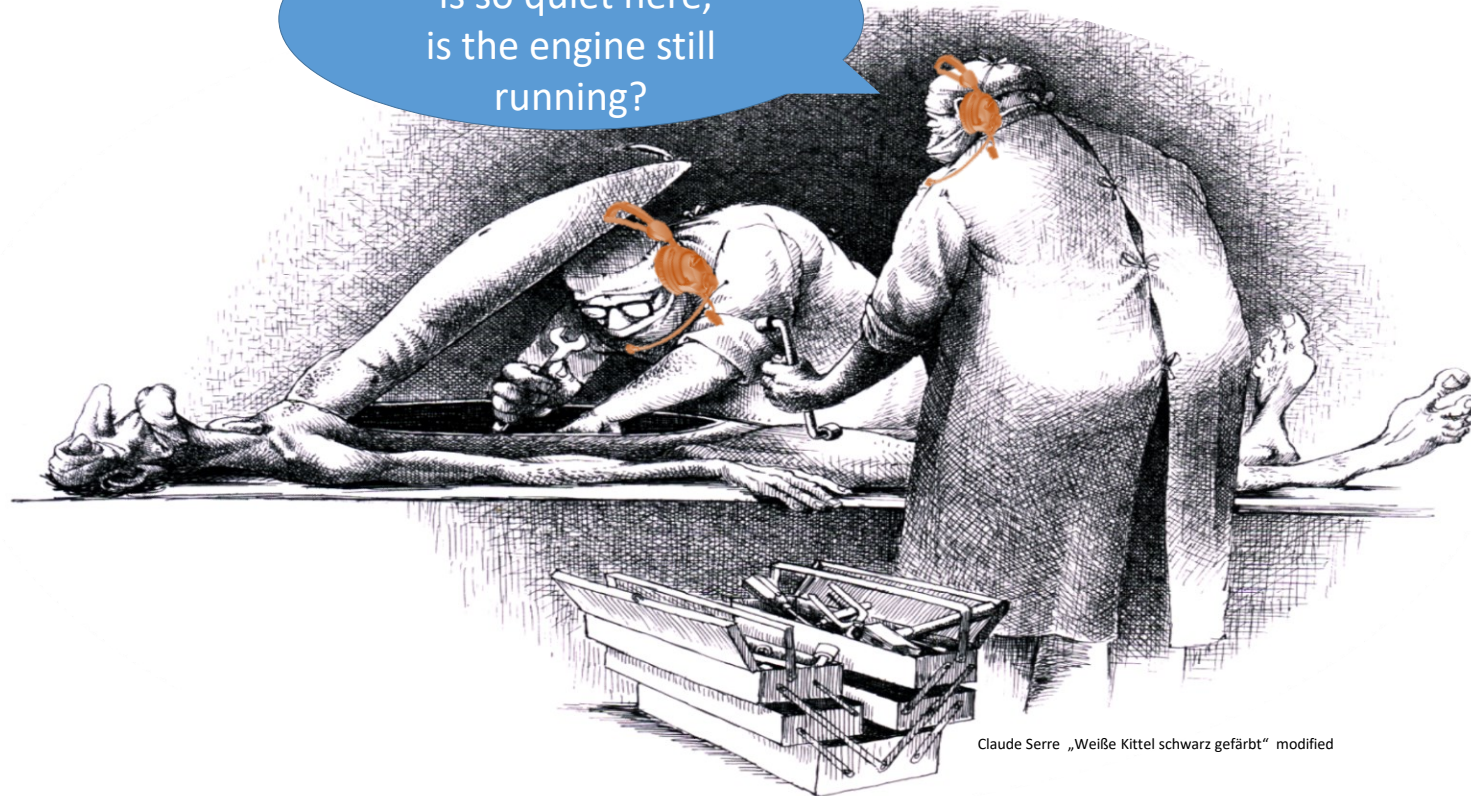
vorgelegt von

Summary



It speaks everything observed so far,
that this polipragmatic approach
has a high impact in this hightech environment
and improves the surgical performance.

Martin –
is so quiet here,
is the engine still
running?



Thank You for your attention!

for scientific background informations
please visit: www.silent-ht-solutions.com

