Canary in an operating room: integrated operating room music

Alistair MacDonald[1] & Joseph Schlesinger[2]
[1]Saint Patrick Hospital, [2]Vanderbilt University Medical Centre
USA

Abstract

Loud music in the operating room may lead to missed alarms and deleterious patient outcomes. A music volume controller that integrates operating room music with vital sign data from the anaesthesia monitor was tested in a clinical environment with twenty-one anaesthesiologists and nine operating room personnel. Background music volumes were reduced or silenced based on flexible algorithms for heart rate, oxygen saturation or blood pressure. After implementation, study participants completed a survey to assess the performance and usefulness of the device. The results indicated the music volume controller was functional and clinically useful and may promote patient safety.

Introduction

Music is an integral part of surgery today. While studies have demonstrated that music reduces surgeon stress and improves the speed and quality of surgical closures, there is evidence that music poses a distraction hazard and contributes to intraoperative noise pollution which may mask an impending emergency (Lies & Zhang, 2015). The American College of Surgeons (ACS), the American Society of Anaesthesiologists (ASA) and the Association of periOperative Registered Nurses (AORN) and The Joint Commission (TJC) have issued independent statements regarding distraction and noise in the operating room (ACS, Statement on Distractions in the Operating Room, 2016, AORN, Position on Managing Distractions and Noise, 2015, ASA, Statement on Distractions, 2015, TJC, Minimizing Noise and Distractions in the OR and Procedural Units, 2017).

The acoustics in the operating room are generally poor and noise levels frequently exceed Occupational Safety and Health Administration (OSHA) safe exposure standards. Powered orthopaedic saws and drills, forced air warmers, fluid collection suction systems, clanging metal instruments, conversation, electronic equipment and music all contribute to high levels of noise pollution. In one study, the noise in the operating room measured over 100dB for 40% of the time during orthopaedic and neurosurgery procedures, levels comparable to those of a busy freeway (Katz, 2014). The signal-to-noise ratio required for speech discrimination in the operating room is greater both because hard flat walls cause sound reverberation and surgical masks preclude lip reading. As a result, communication is challenging and conversations

In D. de Waard, F. Di Nocera, D. Coelho, J. Edworthy, K. Brookhuis, F. Ferlazzo, T. Franke, and A. Toffetti (Eds.) (2018). Proceedings of the Human Factors and Ergonomics Society Europe Chapter 2017 Annual Conference. ISSN 2333-4959 (online). Available from http://hfes-europe.org

routinely exceed ambient noise levels. The addition of music helps surgeons ignore distracting sounds, but raises the overall level of ambient noise in the room and further impairs communication, alarm detection, and cognitive processing (Stevenson, 2013). As operating rooms have evolved from cassette players at the head of the bed to central streaming music systems, anaesthesiologists have a lesser degree of control of the acoustic environment in the operating room (Schlesinger, 2015). The current state of practice entails the anaesthesiologist perceiving the pitches and tones of the anaesthesia monitor (e.g. pulse oximetry) over the noise in the room, recognizing there is a problem, and requesting the circulating nurse to interrupt his or her duties to turn the music down or off. In an emergency that requires clear communication, delays in minimizing noise can be critical (Weldon, 2015).

We hypothesized that building intelligence into the operating room music system was feasible and would be useful to the anaesthesiologist and operating room personnel. As an example of an intelligent audio system, modern car stereos now restrict the volume of music until seatbelts are fastened. The precondition of an acceptable pulse oximetry measurement for operating room music could be compared to that of the fastened seatbelt for a car. Similarly, a car's radar, lasers, and cameras can detect an impending collision and integrate with the vehicle's braking, steering and audio systems as a mitigating 'pre-crash system'. A slowing heart rate, diminishing blood pressure, or declining oxygen saturation could be deemed an 'impending collision' that requires a quieter environment for the surgical team to communicate and concentrate on the patient. Our objective was to test a system with both preconditions and automatic music volume reductions based on user-controlled thresholds for heart rate, systolic blood pressure, and oxygen saturation in a clinical environment.

Methods

The study was approved by the Providence Saint Patrick Hospital Joint Investigational Review Board and written informed consent was obtained from patients. The study involved the use of one music volume controller in one operating room at Saint Patrick Hospital. The music controller (CanaryBox™, Canary Sound Design LLC, USA) was interfaced with a Philips Intellivue™ monitor using the RS232 data port and connected to a music source and the operating room audio system (Figure 1).

The study was designed to assess the preferences and experiences of the anaesthesiologist and operating room staff after using the music controller for one day. As usual, music selection and listening volumes were at the discretion of the surgeon and operating room staff. The target sample size was 30 users for a minimum of one day. All patient and cases were eligible for inclusion.

Table 1. The vital sign ranges for music volume adjustments and "time-in-zone" delays to prevent nuisance triggers

	Full volume	*Half volume*	*Music off*
Oxygen saturation (SpO_2) %	$90 \leq SpO_2$	$85 \leq SpO_2 < 90$	$SpO_2 < 85$
SpO_2 delay		20 seconds	10 seconds
Heart Rate (HR) bpm	50 ≤ HR ≤130	40 ≤ HR <50, or 130 < HR ≤150	HR < 40, or HR > 150
HR delay		20 seconds	10 seconds
Systolic Blood Pressure (SBP) mm Hg	80 ≤ SBP ≤ 170	70 ≤ SBP <80, or 170 < SBP ≤ 190	SPB < 70, or SPB > 190
SBP delay		60 seconds	30 seconds

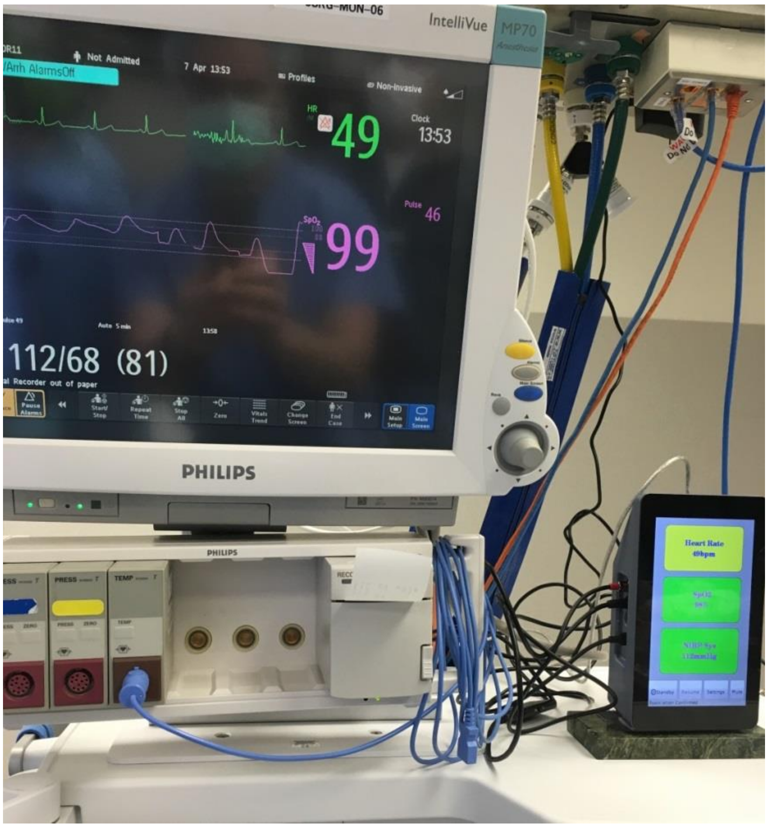

Figure 1. Music Volume Controller Interfaced with Anaesthesia Monitor. The photo shows the position of the music volume controller next to the anaesthesia monitor. The heart rate of 49 beats-per-minute triggers a music volume reduction and this is indicated by a colour change on the controller screen from green to yellow.

The device parameters were adjustable so they could be customized to the patient and the procedure. Default settings of the device for adult patients were as follows:

1) music at full volume if oxygen saturation (SpO_2) >90% and heart rate (HR) between 50 and 130 beats per minute and systolic blood pressure (SBP) between 80mm Hg and 170mm Hg; 2) music at half volume if SpO_2 between 85 and 90%, or HR between 40 and 50bpm or 130 and 150bpm, or SBP between 70 and 80mmHg or 170 and 190mm Hg; and 3) music off if SpO_2 85%, or HR <40 or >150bpm, or SBP <70 or >190mm Hg. To minimize nuisance triggers delay periods ('time in zone') were set for SpO_2 and HR at 10 seconds for full mute events and 20 seconds for half volume events. For SBP, delay periods were set at 30 seconds for full mute events and 60 seconds for half volume events. All volume changes were gradual (fade-in/fade-out) to not startle the surgeon (Strickland, 2015).

Following clinical use, anaesthesiologists and staff were asked to complete a survey assessing performance and usefulness of the music controller.

Results

The target sample size of 30 users was reached and included 21 anaesthesiologists and 9 operating room personnel. *Table 1* - shows the results of the survey including a condensed selection of written responses to open ended questions. Twenty-nine participants responded that they would use the controller again.

Table 1. Survey Data: Responses from 21 anaesthesiologists, 6 nurses, 1 surgeon, 1 surgical technician, and 1 physician assistant.

How much did your room use the music volume controller?

Number of hours	**Number of responses**
>4	23
2-4	6
<1	

How did the volume controller function?

Rating	**Number of responses**
well	27
okay	3
poorly	0

Sample of written responses

What worked well?	**What did not work well?**
Music stopped when O_2 sat went to 80%	
Liked the ability to mute and suspend	Hard to hear a 50% reduction in music
Silenced music when SpO_2 was disconnected	Would like default profiles - adult, paediatric
Responded appropriately to bradycardia	Needs better fixed presets
Intuitive, easy to use	Pandora™ 'timed out' - thought it was controller
Turned off music during hypotension	

Discussion

A majority of anaesthesiologists feel music is a distraction if a patient is having anaesthetic-related problems, so it is important for the anaesthesiologist to have the ability to quickly and easily minimize this source of intraoperative noise (Strickland, 2015). This study tested the feasibility of implementing a volume controller that reduces or silences music automatically based on adjustable vital sign algorithms. Based on experiences of thirty users, the system was found to be functional and clinically useful. Limitations of the study include majority of anaesthesia over surgical clinician response and involvement of only one hospital. Future research on integrated operating room music in a multicentre trial may be useful to assess the effects of automated noise reduction on clinical performance and patient safety.

Disclosure footnote

Dr. MacDonald is the developer of CanaryBox™ and co-founder of Canary Sound Design, LLC.

References

American College of Surgeons. Statement on Distractions in the Operating Room. ACS website. www.facs.org/about~acs/statements/89-distractions. Accessed October 1, 2016.

American Society of Anesthesiologists Committee on Quality Management and Departmental Administration (QMDA). Statement on distractions. ASA website: www.asahq.org/~/media/Sites/ASAHQ/Files/Public/Resources/standards-guidelines/statement-on-distractions.pdf. Accessed January 27, 2016.

AORN Position Statement on Managing Distractions and Noise During Perioperative Patient Care (2015). *Association of Perioperative Registered Nurses Journal*, 99, 22-26.

Katz, J. (2014). Noise in the Operating Room. *Anesthesiology*, 121, 894-898.

Lies, S.R., & Zhang, A.Y (2015). Prospective randomized study of the effect of music on the efficiency of surgical closures. *Aesthetic Surgery Journal*, *35*, 858-863.

Schlesinger J (2015). In response: smart operating room music. *Anesthesia & Analgesia*, *121*, 836.

Stevenson, R.A., Schlesinger, J.J., & Wallace, M.T (2013). Effects of divided attention and operating room noise on perception of pulse oximeter pitch changes: a laboratory study. *Anesthesiology*, *118*, 376-381.

The Joint Commission. Minimizing Noise and Distractions in the OR and Procedural Units. The Joint Commission website. https://www.jointcommission.org/assets/1/23/Quick_Safety_Issue_35_2017_Noise_in_OR_FINAL.pdf. Accessed November 1, 2017.