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Using Music to Reduce Noise Stress for Patients in the Emergency Department: A Pilot Study

Alison E. Short, PhD, MA[1], Nicole Ahern, MPsych[2], Anna Holdgate, MMed[1,2], Jenny Morris, MClinPrac[3], and Balwinder Sidhu, PhD, MSc[4]

Abstract

High noise levels in the emergency department (ED) affect patient care and cause noise annoyance (stress) to patients. This pilot project aimed to reduce noise stress by offering patients in the ED a coping strategy: headphones and music. In this randomized controlled study, 30 patients meeting study criteria were recruited, with half undergoing the music intervention. This involved listening to music via headphones and an MP3 player from preloaded playlists in four relevant genres. All participants completed a pre- and post-self-report stress tool, a self-report noise disturbance scale, and visual analogue scales related to stress and music. Results showed a trend toward decreased negative affect scores in the intervention group. Positive affect scores remained constant or increased. Individual comments suggested participants' enjoyment, distraction, and "escape" from the environment. Results suggested that music may be a beneficial intervention to reduce ED noise stress; however, further exploration is needed.

Keywords

emergency department, noise stress, music, care environment

Background

Hospital environments and their effects on patients have been receiving considerable attention,[1,2] including the problem of auditory noise. Elevated noise levels in hospitals have been reported worldwide, with levels exceeding World Health Organization (WHO) recommendations, from diverse countries such as Brazil, Turkey, India, Greece, Taiwan, and the United Kingdom.[3-8] High noise levels have a substantial impact on patient care and behavior.[9,10] Too much noise may have an impact on sleep, tolerance of pain, and hearing and comprehending speech, and on age-related factors.[3,7,10-13] Additionally, sudden increases in noise can elicit specific physiological responses such as hypertension, tachypnoea, tachycardia, and vasoconstriction.[14]

The Nature of Noise

According to the WHO,[3] noise is defined as "unwanted sound" (p. vii). Beyea[15] also chooses to define noise as "any sound that is undesired or interferes with one's hearing of something" (*Merriam-Webster's Collegiate Dictionary*,[16] p. 840). Noise is physically measured via sound pressure levels using the logarithmic decibel (dB) scale, and the standardized frequency A-weighting curve, dB(A), is used to approximate the subjective human perception of sound.[17] Fluctuating sound levels are averaged via a calculation of the A-weighted "energy equivalent level," or L_{Aeq}.[3] Functionally, an average healthy human ear will notice a change of 1 dB(A) or more; an increase of 3 dB(A) indicates double the sound intensity, and an increase of 10 dB(A) means that the human ear perceives the sound as twice as loud. The WHO[3] has established hospital noise guidelines for patient treatment areas ($L_{Aeq} \leq 35$ dB) and nighttime background noise ($L_{Aeq} \leq 30$ db).

Noise Stress

Noise levels above thresholds of 50 to 55 dB(A) are known to cause noise annoyance and consequent noise stress.[3] With even higher levels, over 80 dB(A), there is a known increase in aggressive behavior.[3] Anxiety has been reported by family members experiencing the strange sounds of monitors and life-support equipment.[18] Topf[19-21] has further investigated noise disturbance in the hospital setting, confirming that hospital sounds are an ambient (environmental) stressor.

[1] University of New South Wales, Sydney, Australia
[2] Liverpool Hospital, Liverpool, Australia
[3] The College of Nursing, Australia
[4] Sydney South West Area Health Service, Liverpool, Australia

Corresponding Author:
Alison E. Short, Centre for Clinical Governance Research in Health, Australian Institute of Health Innovation, University of New South Wales, Sydney, NSW 2052, Australia
Email: a.short@unsw.edu.au

To address noise stress, Topf[19] suggests offering patients choices of sound reduction and coping strategies, including the use of relaxation and music. In fact, music has been used to reduce stress in a wide range of settings.[22-24] As a chosen and controlled sound, music has the capacity to counteract or mask the "unwanted" nature of noise. As Standley[25] states,

> Noise is a periodic vibration that results in irregular frequencies with inconsistencies of tension, stress, and configuration. Thereby, noise produces fatigue and stress in the listener. Ambient noise is the totality of the noises in one's environment that is present but not chosen.... [In contrast,] music is an auditory stimulus with many cognitive elements such as melody, rhythm, harmony, timbre, form, style, and expressive characteristics that are processed simultaneously or in sequence. These cognitive elements are organized according to established rules of music within each culture. Repeated listening processes and identifies the organization and even allows the development of aural expectancies. (p. 108)

Studies using music to reduce stress have focused on its relaxing qualities.[23] The application of relaxing music to the medical situation for purposes such in as the current research project has rarely been addressed in existing music therapy or health care literature. Except in an overtly individualized music therapy context, scant information was found on the use of music for relaxation in a medical setting. Even existing studies such as those related to colonoscopy,[26] preoperative anxiety,[27] and physiological and psychological reactions to pain during cardiac procedures[28] typically give little information about the music used and its application process. However, the need for patients to have control over selecting the music for their relaxation experiences is important.[23] Most effective results in promoting relaxation within the music therapy field arise from studies where the music is both individualized and involves elements of personal choice.[29,30] Few indications exist of how this may be applied in the busy hospital context.

Noise Stress in the Emergency Department

Noise levels in the emergency department (ED) have not been extensively studied. However, in a previous foundational study, we measured noise levels in our ED in Australia. Recording data in decibels in 6 ED patient locations over 24 hours, we found that sound levels varied between 64.0 and 55.8 dB, with some diurnal variation in noise levels, thereby consistently exceeding recommended WHO levels.[31] Our results were similar to reported studies from emergency care or similar hospital areas in Brazil (64.2 dB; Otenio et al[5]), Greece (59 dB; Tsara et al[6]), the United Kingdom (approximately 58 dB; McLaren & Maxwell-Armstrong[4]), and the United States (52.9 dB by Tijunelis et al[32]; 60-65 dB by Orellana et al[33]), and our results were somewhat less than those found in a large Indian hospital (58-71 dB by Vinodhkumaradithyaa et al[8]).

In all cases, the reported noise levels were in the region of noise stress (over 50-55 dB); hence, addressing noise stress in the ED is a very relevant issue in the worldwide health care context. This article outlines a pilot strategy we undertook to help reduce noise stress for patients attending our ED. The aim of the Sound and Silence in the Emergency Department (SSED) pilot project[34] was to investigate whether the stress levels of patients attending the ED could be reduced by offering patients headphones and music.

Method

Patients routinely placed in the most noisy, "acute" areas of the ED (see Short et al[31]) were randomized to receive either music or no music, and all recruits completed study questionnaires. Given a high proportion of culturally and linguistically diverse (CALD) patients attending this ED, recruitment from the four most common language groups (Vietnamese, Arabic, Spanish, and Chinese) was also built into this inclusive health care research protocol. These four most common language groups were determined via routine ED statistics. The study was approved by the regional ethics committee. Written consent was obtained from all participants, with translations and bilingual workers used where necessary.

Participants

All patients who were situated in the acute area of the ED were eligible to participate, providing they met the following study criteria: (a) were older than 18 years of age, (b) had a Glasgow Coma Scale (GCS) of 15,[35] (c) were fluent in English or one of the four most common identified language groups (Vietnamese, Chinese-Cantonese and Mandarin, Spanish, and Arabic), (d) had no psychosis or serious mental illness, (e) had no major hearing deficit, and (f) were identified by clinical staff as likely to remain in the ED for a minimum of 2 hours after initial medical assessment. Patients were recruited following their ED medical consultation.

Materials

Questionnaires. All participants completed questionnaires as part of the study materials. In addition to demographic information, participants were asked to indicate their overall perception of stress on a visual analogue scale (VAS) from 0 (*least stressed*) to 10 (*most stressed I could ever be*) at the beginning and the end of the study. (Reliability of the VAS with repeated measures has been reported[36] to range from .95 to .99).

The participant's perception of stress was measured via a validated assessment tool, the Positive and Negative Affect Schedule (PANAS),[37] since it has been reported that negative affect is related to self-reported stress using the PANAS.[38,39] The PANAS contains a 10-item positive affect subscale and a 10-item negative affect subscale. The PANAS can be used with a number of temporal instructions, and for the purpose of this study participants reflected on how much they were feeling each of the 20 emotions with the present *moment* instruction. Responses were recorded on a 5-point Likert-type scale ranging from 1 (*very slightly*) to 5 (*extremely*). (Reliability of the PANAS using the moment instruction is .89 for the positive subscale and .85 for the negative subscale. Test-retest reliability using the moment instruction for the positive subscale is .54, and the negative subscale has a test-retest reliability of .45.)

To investigate the nature of noise disturbance as experienced by patients, the Disturbance Due to Hospital Noise Scale (DDHNS)[19] was modified from the original 24 items to 10 items. Patients were asked to rate which (named) noises disturbed them during their stay in the ED on a 5-point Likert-type scale from 1 (*very slightly*) to 5 (*extremely*). According to Topf,[19] the DDHNS has internal consistency, with a Cronbach's alpha coefficient reported of .94. In the current study, the Cronbach's alpha coefficient was .89, indicating high reliability for this scale. Exit questions also asked for free-text responses regarding the "best" and "worst" things about being in the ED.

Music and music equipment. Recorded receptive music was delivered individually via an MP3 player with headphones as the treatment intervention, according to the preexisting funded research SSED protocol.[34] Participants assigned to the music intervention selected music from four playlists to use during the 2-hour intervention, with each playlist consisting of at least 30 minutes of music (with capacity for repetition). Musical genre choices were (a) classical, (b) ambient, (c) world, and (d) modern music, resulting from an extensive developmental process (see Short & Ahern[40]). Playlists were uploaded onto an MP3 (J-Player), which participants received together with disposable headphones for use during their stay in the ED. All MP3 players were placed in a clear disposable bag for infection control purposes. Participants were instructed on the use of the MP3 player. At the end of the study period, participants responded to a music equipment review to gauge listening choices, interruptions, and music use, and whether they felt that the music had made a difference to how they felt while in the ED, with a VAS indicating direction (worse or better).

Procedure

Patients were recruited in predetermined time periods during normal weekday work hours. All consecutive patients in the study time period were screened and reviewed for study criteria, with the last patient enrolled 2 hours before the end of each study time period. According to this time-structured recruitment process, all consecutive patients during the study time period were screened and reviewed for study criteria. A total of 30 patients were recruited, comprising 15 control and 15 music intervention. All participants were randomly assigned to control or intervention groups according to the last digit of their medical record numbers (odd numbers for the music condition; even numbers for the control group). The research project was implemented by a research assistant following a research algorithm (see Figure 1), which included scanning, screening, consultation, and the use of bilingual workers where necessary. Questionnaires were administered at the beginning and the end of the 2-hour study period for all participants; the control group received no intervention apart from the questionnaires. Data obtained were collated, entered, and analyzed using tools such as the SPSS statistical computer program.

Results

Demographics

A total of 65 patients in the ED were invited to participate in the pilot study. Of these 65, 19 participants declined to participate, 13 failed to meet study criteria (length of stay in the ED), and an additional 3 participants were lost to follow-up due to discharge. Of the identified CALD patients, 4 needed a bilingual worker (1 Chinese, 2 Vietnamese, and 1 Arabic). However, lack of availability of the relevant bilingual worker at the time of recruitment precluded participation due to consent issues. Only one CALD patient was recruited and completed the study according to the established protocol. Seven additional CALD patients did not meet study criteria due to being outside of the four selected CALD groups. Other screened patients were excluded due to being diagnosed with psychosis or a serious mental illness ($n = 16$). One male patient was excluded due to having a GCS of 13, and 3 screened patients were not eligible to participate because they were younger than 18. The ages of study participants varied between 21 and 91 years ($M = 57.7$). Male patients were the largest group of participants ($n = 26$), and the most common male presentation to the ED was due to heart complications, which included angina, chest pain, and heart attack ($n = 14$). For female patients ($n = 4$), the most common presentations were for abdominal pain and lower limb pain ($n = 2$).

The 30 eligible and recruited patients were evenly divided between the two arms of the study (control and music intervention). For both groups, the most common triage categories[41] were Categories 2 and 3, and both groups were predominantly male (80% or more men). Both groups had a similar age spread (music intervention: 21-91 years; control: 23-90 years); however, the mean age was higher for the control group (62.6 years vs. 52.8 years for the music intervention group). The single patient recruited from a non-English-speaking background (Vietnamese) was randomized to the control group.

Perceived Stress and PANAS

A one-way, between-groups multivariate analysis of variance was performed to investigate if a music intervention reduced the level of perceived stress of patients in the ED. The dependent variables used were perceived stress, positive affect, and negative affect. The independent variable was music treatment. Preliminary assumption testing was conducted, with no serious violations noted. There was no significant difference between the music intervention and the control group on the combined dependent variables: $F(3, 23) = 0.126$, $p = .944$; Wilks's Lambda = .984; effect size = .016.

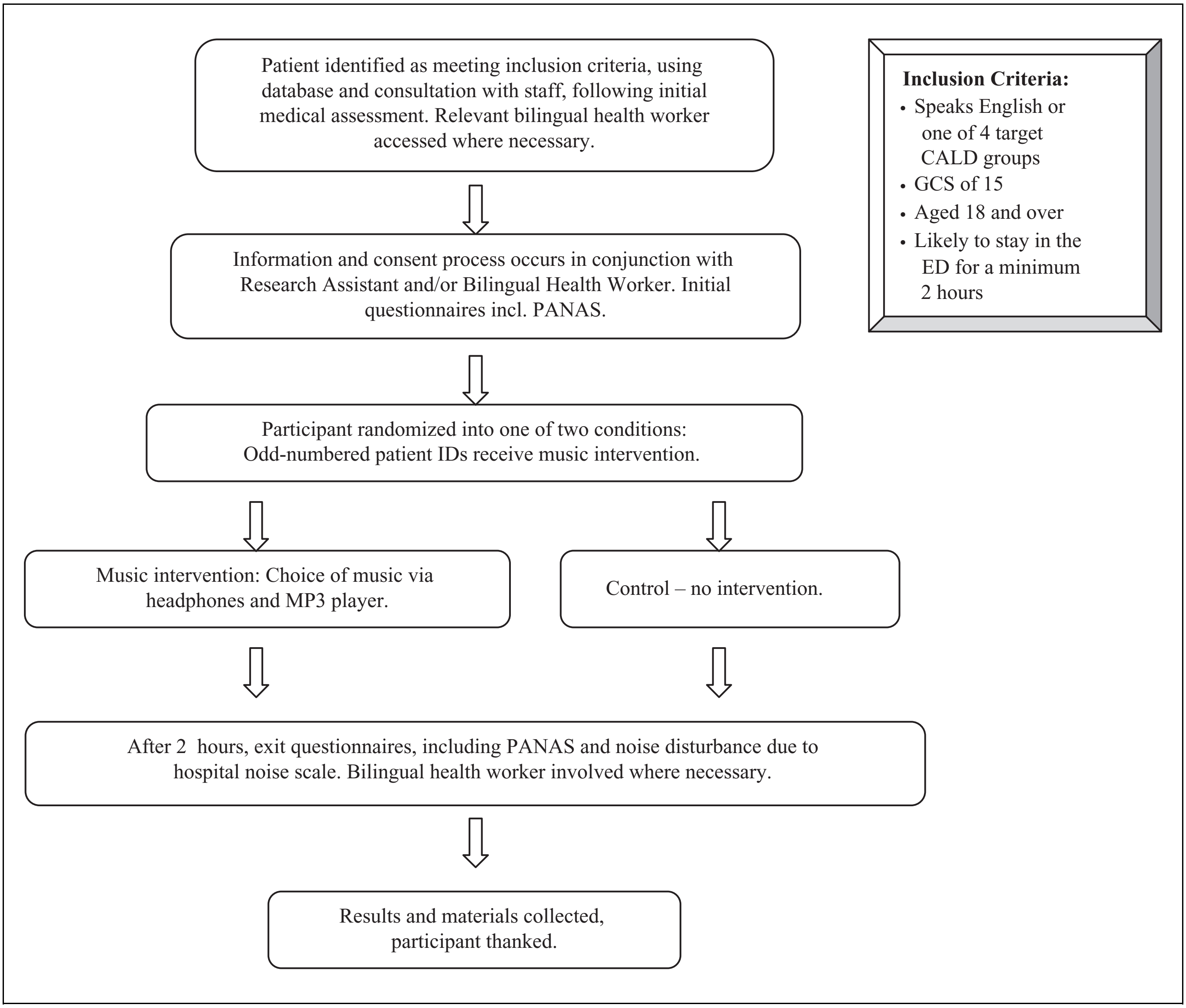

Figure 1. Flow diagram of study design.
CALD = culturally and linguistically diverse patients; GCS = Glasgow Coma Scale; PANAS = Positive and Negative Affect Schedule.

When the results for the dependent variables were considered separately, using a Bonferroni alpha level of .17, there were no significant differences between the music and control groups on perceived stress, $F(1, 25) = 0.248$, $p = .623$, effect size = .010; positive affect, $F(1, 25) = 0.130$, $p = .721$, effect size = .005; or negative affect, $F(1, 25) = 0.364$, $p = 0.552$, effect size = .014.

Patients in the music intervention group tended to commence the study with a higher negative affect score (20) as measured on the PANAS compared to the control group's negative affect score (16). At termination of the study, both the music intervention group and the control group showed a decrease in negative affect. The music intervention group showed a greater decrease in negative affect scores when compared to the control group's negative affect scores (14 and 13, respectively); however, this trend was not significant. No adverse effect on positive affect for either control or intervention groups was reported, indicating that the music did not make participants feel worse.

Noise Disturbance While in the ED

Investigating noise disturbance via the modified DDHNS, there was no statistically significant difference between the music group and the control group. Results of the DDHNS were pooled according to "not disturbing" (score of 1) or "disturbing" (score of 2-5). The four most disturbing categories of sound were reported to be (a) alarms on equipment; (b) the intercom and paging system; (c) visitors; and (d) patient sounds such as coughing, snoring, gagging, and moaning. The percentages of patients reporting disturbance due to specific noises is noted in Table 1

Table 1. Ranked Percentage of Patients Reporting Disturbance by Specific Noises in the Emergency Department

Identified sound	%	*n*
Alarms on equipment	100	22
Intercom and paging system	63	24
Visitors	50	20
Patient sounds such as coughing, snoring, gagging, and moaning	48	27
Doors opening, closing, slamming	43	21
Falling objects such as pans, patient charts	43	21
Socializing at the nurses' station	36	22
Telephones	36	22
Equipment used for patients such as suction/breathing machines	30	23
Conversations between hospital personnel at bedside	30	23

(note that percentages have been adjusted according to how many people answered each question).

Materials Review—Music

In the music intervention, the most frequently listened to style of music was the modern playlist ($n = 6$, 20%), followed by the classical playlist ($n = 4$, 13.3%), ambient music playlist ($n = 3$, 10%), and then world music playlist ($n = 1$, 3.3%). One participant reported that he listened to all four styles evenly. Most music participants, 66.6% ($n = 10$), indicated that they listened to more than one style of music within the 2-hour study time. Interruptions while listening to the music were reported by 60% of participants, and the most common reasons for such interruptions were "family/friends" (44.4%) and "medical staff" (55.5%).

When asked if the music had made a difference to how they felt while in the ED, 14 out of 15 patients responded "yes." When further questioned about the nature of this difference, the average score on the VAS (from 1 = *the music made me feel worse* to 10 = *the music made me feel better*) was 7.4, with a range of scores from 5 to 10 (see Figure 2). No participants reported that the music made them feel worse. Six of the 15 participants offered additional comments about the music. Their statements included, "Thought it was absolutely fabulous, blocked out conversations," "Gives you more time out of here, more peaceful," "Good choice of music," "Quietened me down," "Calmed me right down," "Very good idea for passing the time, relaxes you."

Discussion

This pilot project provided greater understanding of the possibility of using music to address auditory noise in the ED in order to decrease stress levels for patients situated in the most noise-prone areas. It further elicited subjective information about the nature of sounds contributing to noise disturbance and stress in the ED and captured information about the patient's experience of listening to music in this situation.

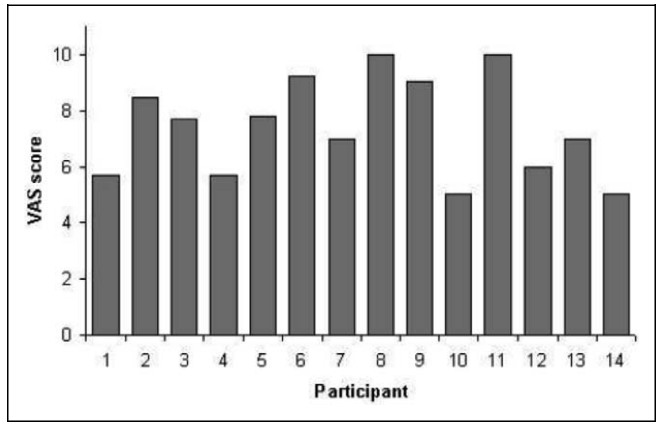

Figure 2. Visual analogue scale (VAS) scores regarding the difference music made.
0 = *made me feel worse*, 10 = made me feel better ($M = 7.4$).

Reduction of Stress Levels

While there were no significant differences between groups, the music group showed a trend toward a greater reduction in PANAS negative affect scores comparatively. This suggested that the music assisted with reducing noise stress caused by being in the ED. It is also important to note that there were no adverse affects, as positive affect scores were constant or increased, suggesting that the intervention was beneficial.

Nature of Noise Disturbance

This study identified four major sources of noise stress: (a) alarms on equipment; (b) the intercom and paging system; (c) visitors; and (d) patient sounds such as coughing, snoring, gagging, and moaning. Anecdotally, participants' comments suggested that they were aware of the noise but accepted it as part of the hospital and the work that needed to be done.

Listening to Music

Participants randomized to the music intervention indicated that it made them feel better, with individual comments suggesting that participants enjoyed listening to the music, that it allowed them to "escape" the environment, and that it served as a distraction.

Stress and Negative Affect

The connection between stress and negative affect has already been outlined.[38,39] While both the music intervention group and control group showed a decrease in negative affect, the music intervention group showed a greater decrease in negative affect scores when compared to the control group's negative affect scores. Importantly, no adverse effect on positive affect for either the control or intervention groups was reported, suggesting that the music did not make participants feel worse. This was given further support by the self-report VAS, where most participants in the music intervention stated that the music made a difference to how they felt while in the ED and that it was for the better. This is even more interesting in light of the fact that patients in the music intervention group tended to commence the study with a higher negative affect score compared to those in the control group.

By further understanding the effects of sound and noise, it may be possible to develop other strategies for minimizing noise and for assisting patients (such as the use of headphones) and potentially screening patients for noise sensitivity, such as those less familiar with the hospital, those prone to confusion and likely to misinterpret sounds, and those most sensitive to sounds as a primary sensory modality.

Limitations

The major limitation with the pilot study was the small sample size, thereby placing constraints on the interpretation of the results. An additional limitation of the current study was that the majority of participants where male, with female patients being underrepresented. This limitation reduces the generalization of the trends found within this study. Demographically, the age of the participants was also not representative of the department as a whole. The inclusion of CALD groups and bilingual workers in this study proved problematic in the implementation phase, with coordination of the workers to be available when required being a major issue linked to the unpredictable nature of ED presentations. The symptomatology of the patients also seemed to limit recruitment. Anecdotally, the research assistant noted that "pain" was often given as the main deterrent for not participating, which may need to be taken into account in further studies. Finally, it was difficult to anticipate which patients would remain in the ED for 2 hours, due to changing circumstances and ED patient flow issues. Further investigation should be undertaken into technical issues such as the effect of the music played through headphones in blocking or muffling the noise. Impetus is also needed to further develop a suitable music tool for this context (see Short & Ahern[40] for more extensive discussion).

Final Recommendations

While not statistically significant, the trend of results from this pilot study suggested that music may reduce noise stress in the ED. The mechanism by which it may achieve this has not been addressed in this study, although related literature suggests a role for music in serving as a distraction (coping) or a way to relax and reduce pain. It is recommended that an additional study incorporate a larger study group, with further investigation of the factors involved. Nevertheless, this pilot intervention has developed and tested a methodology for investigating and addressing noise stress in the ED via a music intervention, with a view to enhancing patient care in the emergency context.

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Bios

Alison E. Short, PhD, MA, BMus, RMT, MT-BC, FAMI, RGIMT, is a research fellow at the Centre for Clinical Governance Research in Health, Australian Institute of Health Innovation, at the University of New South Wales in Sydney, Australia.

Nicole Ahern, Grad. Diploma in Science (Psychology), Masters of Forensic Psychology, was a research assistant in the Emergency Medicine Research Unit at Liverpool Hospital in Liverpool, Australia.

Anna Holdgate, MBBS, FACEM, MMed, is director of the Emergency Medicine Research Unit at Liverpool Hospital in Liverpool, Australia.

Jenny Morris, Certificate of Nursing, Certificate in Acute Care & Masters of Clinical Practice (Emergency Nursing), is post graduate program co-ordinator, The College of Nursing, Australia.

Balwinder Sidhu, PhD, MSc, is the service manager of Multicultural Health Service in the Sydney South West Area Health Service in Liverpool, Australia.