



Published in final edited form as:

Heart Lung. 2015 ; 44(5): 416–425. doi:10.1016/j.hrtlng.2015.06.010.

The influence of music during mechanical ventilation and weaning from mechanical ventilation: A review

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Abstract

Background—Mechanical ventilation (MV) causes many distressing symptoms. Weaning, the gradual decrease in ventilator assistance leading to termination of MV, increases respiratory effort, which may exacerbate symptoms and prolong MV. Music, a non-pharmacological intervention without side effects may benefit patients during weaning from mechanical ventilatory support.

Methods—A narrative review of OVID Medline, PsychINFO, and CINAHL databases was conducted to examine the evidence for the use of music intervention in MV and MV weaning.

Results—Music intervention had a positive impact on ventilated patients; 16 quantitative and 2 qualitative studies were identified. Quantitative studies included randomized clinical trials (10), case controls (3), pilot studies (2) and a feasibility study.

Conclusions—Evidence supports music as an effective intervention that can lesson symptoms related to MV and promote effective weaning. It has potential to reduce costs and increase patient satisfaction. However, more studies are needed to establish its use during MV weaning.

Keywords

Artificial Respiration; Mechanical Ventilator; Weaning; Airway Management; Music; Music Therapy

Introduction

Initiation of mechanical ventilation (MV)^a to treat acute respiratory failure is a lifesaving intervention. Causes of acute respiratory failure include pulmonary disease, neuromuscular disease, shock, and major surgery.¹ Recent estimates have found that over half of all ICU

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^aMV – mechanical ventilation

patients require MV.² An estimated 800,000 patients undergo MV in the U.S. each year with a cost of approximately \$27 billion.¹ On average, patients who receive MV stay 4 days longer in the ICU and an additional 6 days in the hospital compared to ICU patients who do not.³

Generally, as patients recover from acute illness, they can be “weaned” from ventilatory support. Weaning is a gradual decrease in ventilator settings that leads to termination of MV support.⁴ Successful weaning depends on respiratory muscle strength, adequate respiratory drive, acid base balance, neurological status, as well as psychological readiness.⁵⁻⁷ Nationwide, the mean number of ventilator days is 5.6, but 5% to 20% of intubated patients require support for at least 21 days.^{3,8} Delays in extubation can be due to severe respiratory muscle deconditioning, poor nutrition, upper airway edema, and decreased level of consciousness secondary to over-use of sedative medications.⁹ Extubation failure can lead to ventilator-associated pneumonia, airway trauma, increased costs and high mortality rates.¹⁰ Patients who require MV for greater than 3 weeks account for more than 50% of total ICU costs.¹ MV and MV weaning lead to an array of distressing symptoms such as pain, agitation, lack of sleep, and especially anxiety.¹³ Unmanaged anxiety stimulates the sympathetic nervous system, increases work of breathing and fatigue, and severely impedes ventilator weaning;⁴ it can be particularly severe for the ventilated patient, and, if not treated promptly, can increase recovery time and patient mortality.^{11,12}

Current symptom management practice for patients receiving ventilatory support primarily involves the administration of numerous sedative and analgesic medications which can prolong ventilation and increase length of ICU stay.^{11,13} Overuse of these medications can lead to fatigue, delirium, muscle weakness, and post-traumatic stress disorder (PTSD).¹⁴ However, sedative administration is only one symptom management strategy used to help alleviate anxiety. A number of integrative, non-pharmacological interventions have been shown to be beneficial for anxiety symptom management in non-ICU patients such as music, imagery, massage, and animal assisted therapy.¹³

Music intervention is the non-pharmacological, integrative therapy of interest in this review; it has been shown to decrease anxiety during MV.¹⁵ Decreasing anxiety could help promote more efficient ventilator weaning and hasten ICU discharge. This is significant in that “even nominal decreases in length of time spent in the ICU or the duration of mechanical ventilation have the opportunity to significantly reduce hospitalization costs.”^{3(p. 1271)} Incorporating music into the care of the ventilated patient has strong potential to alleviate the symptom burden and the high cost of conventional treatments as well as increase patient satisfaction and promote efficient weaning.^{4,13,16,17}

The purpose of this narrative review was to describe the state of the science on music as an integrative intervention during MV and ventilator weaning, and to identify current gaps in knowledge regarding use of music intervention for symptom management, specifically during weaning. This review provides an evidence-based background for music intervention and supports the need for future studies on music intervention during weaning.

Background

Weaning from Mechanical Ventilation

The weaning process involves a gradual decrease in ventilator settings as a patient's respiratory status improves, leading to termination of MV support.⁴ As the acute cause of respiratory failure resolves and the patient can tolerate independent respirations, the artificial airway is removed.^{9,10,18} For some, weaning can be a lengthy process. Recent estimates state that more than 40% of the total duration of MV is spent enduring the weaning process.⁶ While advancements in ventilator management protocols have been made, a universal protocol to determine readiness to wean based on strict physiological measures has not been established.¹⁰ It has been predicted that patients' subjective perceptions of weaning may strongly influence weaning outcomes, but the extent of their role in successful outcomes remains unclear.¹⁹ Most weaning guidelines require a formal assessment of readiness to wean before beginning weaning trials. Weaning trials generally require a patient to tolerate spontaneous respirations for at least 30 minutes. A patient is usually ready for extubation after two or more successful weaning trials. If a patient fails a weaning trial, extubation is not safe and weaning is continued. Up to 20% of ventilated patients experience extreme weaning difficulty and cannot be extubated.^{6,8,10}

Extubation failure is the inability to sustain spontaneous breathing after removal of the artificial airway with the need for reintubation within 24–72 hours.⁹ Extubation failure can lead to airway trauma, ventilator-associated pneumonia, gastrointestinal bleeding, and blood clots. It can increase costs, result in longer ICU stays, and increase morbidity and mortality.^{6,9,10} It has been estimated that extubation failure occurs at least once in up to 47% of mechanically ventilated patients.⁹ Timely, effective weaning is critical to decreasing the personal and economic cost of MV and extubation failure.¹⁹

Anxiety during Mechanical Ventilation and Ventilator Weaning

Anxiety, a state marked by dread, fear, apprehension, increased motor tension and autonomic arousal, is a major psychological stressor with harmful physical manifestations that are often experienced during MV and ventilator weaning.^{17,20} High stress and anxiety levels in mechanically ventilated patients have been associated with increased patient morbidity and mortality.^{15,21} Up to 85% of ventilated patients experienced anxiety,¹² and 60% of those patients reported feeling scared most of the time.²² Sustained high levels of anxiety activate the sympathetic nervous system, which causes an increase in heart rate, blood pressure, and respiratory rate, and initiates an unfavorable neurohormonal response.^{23–25} Arousal of the sympathetic nervous system can cause serious complications including arterial and venous constriction, myocardial stimulation, and bronchoconstriction.²³ Arterial and venous constriction in the lungs severely impedes the ability to oxygenate tissues effectively,²⁶ which increases the work of breathing, induces fatigue, and can extend the need for MV.⁷

Weaning requires increased respiratory effort and can further exacerbate anxiety and its manifestations. If patients are not properly educated and encouraged during weaning, they may feel increasingly anxious, which can lead to increased dyspnea, panic, and a fear of

abandonment as ventilator support is decreased.^{7,19} It has been shown that patients who did not wean successfully reported more fatigue, dyspnea, and less weaning self-efficacy.¹⁹

Symptom Management with Sedative Medications

Nurses are responsible for ICU patient symptom management. Current practice to alleviate distressing symptoms involves the administration of sedative and analgesic medications which can lead to prolonged ventilation and increased lengths of ICU stays.^{11,13,17} At times, medication is necessary to facilitate patient comfort, safety, and promote recovery.²⁷ However, these highly potent medications can contribute to a multitude of complications such as fatigue, weakness, delayed weaning, and PTSD.¹⁴ Indeed, many side effects have been associated with sedative agents such as hypotension, increased risk for ventilator-associated pneumonia, and delayed ventilator weaning.^{28,29–33} Overall, deep pharmacological sedation during MV increases patient morbidity. A strong correlation exists between continuous sedation and prolonged ICU stays, increased rates of organ failure and reintubation.^{28,34} Over-sedation with continuous infusions can greatly alter routine neurologic assessments which may lead to the ordering of unnecessary costly diagnostic exams (i.e., CT scans, MRIs).³⁴ Sedative agents can cause severe short-term and long-term issues with memory and cognition.

There is growing evidence supporting the notion that mechanically ventilated patients can benefit from an increased awareness of their surroundings.³⁴ Recent studies indicate that patients who were most awake and aware of their surroundings during MV had the lowest PTSD-like symptoms after hospital discharge.³⁴ Continuous high doses of sedative medications can cause severe long-term psychological damage such as continued anxiety post-ICU discharge, depression, and paranoid delusions.²⁸ Neurological impairment from sedatives can necessitate reintubation and negatively impact the weaning process.⁹ Continuous sedation is a major risk factor for extubation failure.⁹ Integrative therapies such as music, in addition to sedative and analgesic medications, can synergistically enhance comfort and relaxation during MV.¹³

Symptom Management with Music Intervention

Music is a non-pharmacological intervention that integrates physiological and psychological components to reduce stress and anxiety and promotes overall well-being.^{23,24} Music intervention can abate the stress response, decrease anxiety during MV, and induce an overall relaxation response by reducing stimuli that cause stress, synchronizing body rhythms such as breathing and heart rate, and by positively influencing emotional feelings of the listener.³⁵ This relaxation response can lower cardiac workload and oxygen consumption, which promotes more effective ventilation and accelerates ventilator weaning.^{23,36} Music that contains simple repetitive rhythms, low pitch, slow tempos, harmony and lack percussive instruments and vocals have been shown to reduce anxiety.^{25,28}

Although it is noted in the literature that music is commonly used in nursing care, there are currently no standard protocols or guidelines to direct ICU staff on the most appropriate and useful methods to incorporate music into daily care of the ventilated patient. Music is

inexpensive when compared to sedative and analgesic medications,^{17,23} and has been shown to reduce anxiety and sedative exposure, which decreases the time the nurse must spend providing calming techniques and other pharmacological intervention to ventilated patients.^{5,17,23–25} The success of weaning could be significantly impacted by music intervention, but this assertion requires further examination of existing evidence to determine the influence of music on the weaning process in patients receiving MV. The following research methods were employed to identify the most relevant literature regarding music intervention and MV.

Methods

A narrative review was guided by the flowchart described by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement.³⁷ A comprehensive computerized search of the literature on music intervention during MV was conducted using the OVID Medline, PsychINFO, and CINAHL databases with the guidance of an expert professional biomedical librarian. Subject headings used in the searches included “respiration, artificial”, “ventilators, mechanical”, “ventilator patients”, “airway management”, “music”, and “music therapy”. The subject headings were exploded to yield adequate resources for review. Cross-referencing was used to identify additional relevant articles for review. Title and abstract review was used to identify primary research studies. The review was not limited by study design or date published. Quantitative and qualitative studies that examined the use of music intervention during MV and ventilator weaning to reduce physical and psychological symptoms, as well as studies that evaluated the patient experience of music intervention during MV were examined. Studies that assessed the infant and pediatric populations and studies not published in English or translated into English were excluded from the review. Duplicate studies were also excluded.

The initial review yielded 156 potentially relevant articles. After duplicates were removed, 86 abstracts were reviewed; 27 potentially relevant articles were reviewed in full-text. Those not meeting inclusion criteria were excluded (not published in English [n=3], involved infants or pediatrics [n=2]). Four unpublished manuscripts were identified by title. Additional attempts were made to obtain the unpublished manuscripts but were unsuccessful. In total, 18 studies were eligible for review (See Figure 1 for the PRISMA Flowchart used to document the progression of this review). Using the Matrix Method,³⁸ a standardized data display was used to chronologically evaluate and extract information from each study such as author, journal, and year, study purpose, setting, number of subjects, methodical design, sampling design, variable measurement, subject characteristics, findings and limitations, and information related to weaning.

Results

Most studies investigated music intervention during MV; only one study explored music intervention during ventilator weaning (see Table 1). One qualitative study that explored patients’ experiences with music while ventilated was reviewed. One study used both quantitative and qualitative methods. The remaining 16 studies used quantitative methods to evaluate physiological signs of anxiety as well as a variety of anxiety, agitation, and

sedation scales to measure the effectiveness of music intervention. The quantitative studies included randomized clinical trials (n= 10), case controls (n=3), pilot studies (n=2), and a feasibility study (n=1). A variety of control conditions were used such as headphones to promote a relaxing environment, ICU usual care, and historical controls. The results of the review are presented using the following eight subject headings. The first two subheadings relate to methodological aspects of studies: 1) Duration, Frequency and Timing of Music Intervention, 2) Patient Wakefulness, Music Styles, and Music Selection. The remaining six subheadings refer to outcomes and interventions of studies: 3) Influence of Music on Sedation and Agitation, 4) Influence of Music on Physiological Arousal, 5) Influence of Music on Biomarkers of the Stress Response, 6) Influence of Music on Anxiety, 7) Patients' Self Report of Experiences with Music, and 8) Nurses' Evaluation of Music Intervention.

Duration, Frequency and Timing of Music Intervention

The duration, frequency, and timing of music intervention varied greatly across studies. All studies implemented music for a minimum of 30 minutes once per day, but some music listening sessions lasted up to 90 minutes and intervention frequency ranged from one to three times per day. The duration of study protocols ranged from one day to up to 30 days. Four studies implemented music intervention during the late afternoon or early evening.^{35,39–41} Others implemented the intervention during the morning and then again in the evening^{21,34} or randomly throughout the day depending on unit and nurse schedules.^{23,24} One study implemented music listening during nighttime sleep⁴² and another allowed patients to listen to music continuously during the post-operative period.⁴³ In a study that evaluated music during weaning, the timing of the music intervention depended on where the patient was in the weaning process (early versus more progressed).⁴ Chlan et al. used a unique approach that allowed patients to self-direct the frequency, length, and timing of the music intervention.^{17,44} Ultimately, consensus regarding the most effective and appropriate duration, frequency and timing of music intervention could not be determined from the literature.

Patient Wakefulness, Music Styles, and Music Selection

Investigators required varying levels of patient wakefulness for study inclusion. Most investigators required patients to be alert and mentally competent in order to participate in study consent.^{4,17,23,35,39,40,43–45} Many studies mentioned conditions such as “alert and oriented”, “following commands”, “not confused”, and “able to effectively communicate” as inclusion criteria but few required official screens for delirium as part of the pre-enrollment process. It is not known to what extent wakefulness impacts the physiologic results of music intervention during MV and ventilator weaning.

All studies in this review implemented styles of music that were considered “relaxing” including nature based sounds, classical, and easy listening. Previous research has demonstrated music most effective at reducing anxiety is familiar to the patient, contains 60–80 beats per minute with simple arrangements and lacks words.¹³ However, whenever possible, patients should be solicited personally for their specific musical preferences because certain styles of music can trigger music memories that evoke profound emotional responses.¹³ Chlan et al. and Hunter et al. encouraged patients to self-select their preferred

music styles.^{4,17} Some investigators allowed patients and families to choose from a predetermined list of music selections.^{23,25,35,36,40,41,45,46} One study had patients select their music choice prior to undergoing cardiac surgery. Upon awakening, patients were allowed to change their music choice if desired.⁴³ Hunter and colleagues utilized live music at the bedside.⁴ Many investigators used the expertise of a music therapist to help design the music portfolio or help implement intervention and evaluate patient preferences.^{4,17,44,47} It was common for investigators to enhance the environment of both control and experimental groups to promote relaxation by dimming lights, closing curtains/doors, and placing signs outside to alert staff and visitors to the intervention.^{23,25,35,40–42} Some also provided patients with verbal instructions to think of pleasant thoughts during the intervention.^{35,40} In summary, inconsistencies exist concerning ideal patient wakefulness for study inclusion. However, increased patient wakefulness affords greater patient control and independence in regards to music choice.

Influence of Music on Sedation and Agitation

Several studies have evaluated and confirmed the hypothesis that music intervention can decrease the need for sedatives during MV. In a study designed to test whether listening to self-initiated, patient-directed music (PDM) reduced sedative exposure during MV, investigators used a sedative drug intensity score which revealed sedative exposure was significantly reduced in the PDM group.¹⁷ In a study by Conrad et al., a continuous infusion of propofol was suspended prior to the intervention for both the experimental and control groups and was reinitiated after the intervention.⁴⁸ Patients in the experimental group did not require additional doses of propofol during the intervention, whereas patients in the control group occasionally needed extra doses of propofol to maintain ventilator compliance.⁴⁸ In a study by Saadatmand et al., the Richmond Agitation Sedation Scale (RASS), a 10-point scale with four levels of agitation ranging from combative, to calm and alert, to unarousable, was used as a measurement of sedation effectiveness.³⁹ Results demonstrated the odds of having higher agitation in the control group was approximately 11.24 times that of the intervention group, suggesting that the music intervention, which consisted of nature-based sounds, could decrease agitation levels in sedated, mechanically ventilated patients.³⁹

Influence of Music on Physiological Arousal

Evidence reveals music can reduce the physiological signs of anxiety such as respiratory rate, heart rate, and blood pressure among patients who are mechanically ventilated. In several studies, music intervention groups experienced a significant decrease in respiratory rate.^{23–25,35,40,41} The significant reduction was seen over time, suggesting a cumulative dose effect.^{24,35} A number of studies found that music intervention significantly reduced heart rate.^{24,25,35,40,41,48} The literature also reveals a trend of decreasing heart rates both during and after music intervention. The reductions were also seen over time suggesting a cumulative dose effect.^{24,35,40} Music intervention was effective at decreasing blood pressure.^{24,25,35,39,42,48} Conrad et al. found that not only did arterial blood pressure decrease significantly in the music group, it also increased significantly in the control.⁴⁸ Similarly, Almerud et al. noted a significant decrease in blood pressure during music intervention as well as a corresponding rise after cessation of treatment.⁴²

Influence of Music on Biomarkers of the Stress Response

Several studies explored the influence of music on biomarkers of the stress response by testing blood and urine samples in patients undergoing MV.^{45,47-49} These biomarkers included blood levels of corticotrophin, cortisol, epinephrine, norepinephrine, dehydroepiandrosterone (DHEA), growth hormone, adrenocorticotropin hormone (ACTH), interleukin-6 (IL-6), prolactin and prolactin monomer, leptin, MET-enkephalin, and C-reactive protein.^{45,47,48} Chlan et al. evaluated urinary free cortisol (UFC).⁴⁹ While not significantly different among groups, less profound spikes in urinary free cortisol (UFC) levels were observed. Beaulieu-Boire et al.⁴⁷ found that blood cortisol and prolactin decreased after music listening. In another study by Conrad et al., decreases were seen in plasma concentrations of IL-6, DHEA, and epinephrine.⁴⁸ Chlan et al. did not find any statically significant decreases in serum biomarkers, but attributed the results to a wide variability in mean levels of biomarkers and small sample size.⁴⁵ The connection between biomarkers and clinical observations of anxiety such as increased heart rate and respiratory rate remains unclear. Some hypothesized explanations for inconsistent results provided by investigators were drug administration, number of ventilator days, and large variability in baseline biomarker levels and variability among critically ill patients.

Influence of Music on Self-Reported Anxiety

Over half of the articles reviewed included a self-reported assessment of anxiety. The reliability of these self-reported measures is difficult to assess because most subjects receive sedative medications during MV. A number of instruments were used to measure anxiety across studies with varying results. These included: Visual Analogue Scale for Anxiety (VAS-A), Anxiety Faces Scale (FAS), The Spielberger State-Trait Anxiety Scale (STAI) [20 items and 6 items]. Music was found to be an effective intervention to reduce anxiety in the mechanically ventilated patient.^{35,40,43} In one study, both the music condition and the rest condition experienced reduced state anxiety scores, but the music intervention was more effective than a rest period in reducing anxiety.²³ Another study found that at any point, the music group had a VAS-A score that was significantly lower than the usual care control group. One study detected a significant difference between anxiety scores using the FAS.³⁹ The odds of having a high anxiety score in the control group was 4.5 times the same odds of having higher anxiety scores in the music group.³⁹

Patients' Self Report of Experiences with Music

Two studies primarily aimed to investigate patients' experiences of music intervention by interviewing patients after extubation.^{42,46} Both interviewed patients while they were still in the hospital, shortly after being extubated. When interviewed, no patients were immediately able to recall that they had listened to music.^{42,46} In one study, the music played during MV was also played during the interview to jog patients' memory, which was a successful tactic.⁴⁶ It is unknown whether the timing of the interviews affected patients' ability to recall information accurately due to the administration of sedative medications in the days before the interviews.

Patients who underwent music intervention during MV were able to recall memories of pain, anxiety and discomfort, as well dreams and delusions. For many, music was a happy

memory among traumatic memories while undergoing MV.⁴⁶ Lee et al. conducted a post intervention satisfaction survey, and 88% of subjects expressed satisfaction with music.²⁵ Another study reported that 95% of the time, participants felt that music was helpful, and 100% of study subjects would participate in a music intervention again.⁴ In addition, 98% of music sessions that were surveyed, the participant felt less anxious, and after 80% of the music sessions surveyed, the participant reported less stress than expected.⁴

Nurses' Evaluation of Music Intervention

Several investigators solicited nurses for their subjective evaluation of patients' response to music intervention. Nurses expressed positive feelings towards music intervention. Stubbs reported that none of the nurses' interviewed felt there were any disadvantages to music.⁴⁶ Chlan et al. did not receive any comments from nurses that would suggest the music protocol was burdensome to their patient care practices.¹⁷ Lee et al., created a resting behavior observation list which was a checklist for research staff to identify four types of behavior: restlessness, facial distortion, restfulness, and sleep.²⁵ A greater increase in the proportion of "comfortable behaviors" were observed in the music group compared to the control group.²⁵

Hunter and colleagues⁴ administered Likert-type scale surveys [1 = strongly disagree, 5=strongly agree] to bedside nurses to investigate their observations and satisfaction with the protocol. Nurses ranked the statements "patient appeared less anxious" and "there was less need for medical intervention" with a mean score of at least 4.2 or greater. In addition, nurses felt that music reduced their personal stress, was incorporated unobtrusively, and was useful for their patient. Chlan et al. found that nurses were willing to use the music intervention and had a positive view of the intervention.⁴⁴ This is important, since nurses are primarily the ones who are responsible for promoting and implementing music intervention at the bedside.

Discussion

This narrative literature review supports the use of music intervention in patients undergoing MV. While the aim was to focus on music to reduce psychophysiological symptoms, especially anxiety, during weaning trials, there is a striking lack of studies testing music listening during weaning. Of the three studies that examined music during ventilator weaning, only one was in English⁴ and it was a feasibility study. While a majority of the evidence centers on symptom management with music during MV, important aspects are gained from the review.

Hunter et al.⁴ specifically evaluated music during ventilator weaning. This study demonstrated that music is an effective complement in difficult to wean patients by decreasing the physical signs of anxiety.⁴ Music was well received by both patients and staff, which adds to its feasibility in practice.⁴ Failure to wean from the ventilator is a complex physical and psychological setback that frequently impacts ventilated patients. Little is understood regarding the influence of psychophysiological symptoms on weaning trials and ways in which music can lessen these symptoms during weaning trials to promote

efficient ventilator termination. There is a critical need for more studies that investigate music to reduce distressing symptoms during ventilator weaning.

Incorporating music during weaning trials is an innovative intervention that warrants more thorough investigation for the following reasons: (1) Close to 1 million individuals endure MV each year in the United States.¹ (2) Weaning is a necessary process for MV to be terminated and spontaneous independent breathing achieved. (3) More than 40% of the total duration of MV is spent enduring the weaning process.⁶ (4) Music is a feasible non-pharmacological intervention to help alleviate anxiety and other distressing symptoms in order to promote successful weaning.⁴

Limitations to this Review

There are several limitations to this review. A single author evaluated the studies and only studies published in English were included. Three original non-English studies were identified in the search of the literature but were not used in this review. In addition, only published literature was included. Unpublished literature such as abstracts and unpublished dissertations and theses were not included in this review. Only adults over 18 were included in the studies reviewed. Music has a strong influence on the psychological wellbeing of adolescents, and it is not known how music intervention can impact adolescent ventilated patients. Many studies had small sample sizes. There is a need for randomized clinical trials that are adequately powered to answer questions asked, and a need for consistent measures and protocols so that findings can be compared across studies. The majority of studies focused on music to manage symptoms of anxiety; examination of additional symptoms of MV weaning such as agitation, lack of sleep, and pain is warranted.

Conclusion

Collectively, the studies included in this review indicate that music can decrease psychophysiological symptoms for patients undergoing MV, which may lead to improved patient satisfaction and promote overall recovery from conditions requiring MV.⁴³ A decrease in distressing symptoms could encourage a beneficial relaxation response. Achieving a more relaxed state can help reduce the necessity for sedative medications and may eventually decrease the overall length of time ventilatory support is needed.²⁴ While ICU staff can easily implement music as a non-pharmacological intervention,⁴² patient initiated music listening is a plausible and effective intervention strategy.¹⁷ The evidence from the studies evaluated for this review suggests that music can decrease the physiological and psychological symptoms as well as reduce sedative exposure in the ventilated patient. However, this review reveals the noticeable absence of research that examines the influence of music intervention during weaning from mechanical ventilation. Further research in this area is warranted in order to determine if music intervention can reduce distressing symptoms and favorably impact important clinical factors such as time to weaning trials, length of weaning trials, successful weaning readiness, and ultimately, total ventilator days and ICU length of stay.

Acknowledgements

Research reported in this publication was supported by National Institute of Nursing Research of the National Institutes of Health under award number [FNR014591A].

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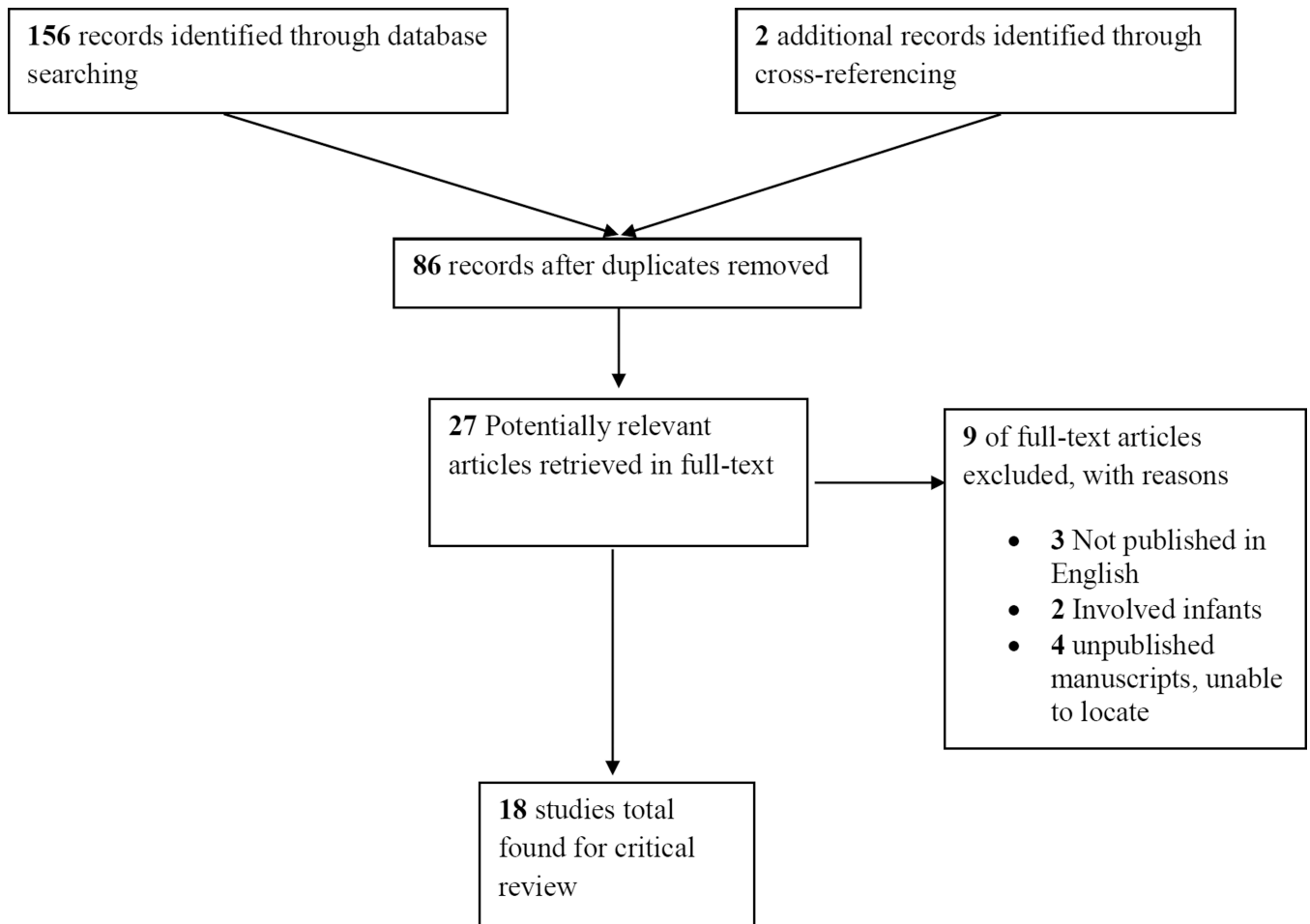


Figure 1.
Audit trail of literature search using PRISMA Flowchart

Table 1

Summary of reviewed studies.

Author/Year	Design	Purpose	Setting/Subjects	Variables Measured	Findings
Almenud&Peters son, (2003) ³⁵	Mixed Methods <ul style="list-style-type: none"> Intervention: Classical music for 30 minutes in conjunction with night sleep Control: Rest under similar circumstances as the intervention group 	Purpose: to discover whether music therapy had a measurable relaxing effect on patients who were temporarily on a respirator in an ICU and after completion of respirator treatment investigate those patients' experiences of music therapy	16 bed ICU in Sweden <ul style="list-style-type: none"> 20 subjects for quantitative data 6 subjects for qualitative interviews 	1 Quantitative: Vital signs every 5 minutes during intervention 2 Qualitative: Interview questions about memories of MV after ventilation terminated	- Statistically significant drop in BP ⁶ during intervention - Non-statistically significant drop in HR during intervention - Subjects had poor memory of time on the ventilator. No subjects recalled listening to music while ventilated - Three themes identified: 1) Anxiety and discomfort, 2) Illusory Feelings, 3) Close Relationship
Beaulieu-Boire, et al. (2013) ³⁴	Randomized Crossover (3 days with a washout on day 2) <ul style="list-style-type: none"> Intervention: Slow tempo music for 1 hour, 2 times per day Control: Rest with headphones with no music 	Purpose: to evaluate the impact of slow tempo music listening periods in mechanically ventilated intensive care unit patients	16 bed ICU in a tertiary hospital in Canada <ul style="list-style-type: none"> 49 subjects 	1 Vital signs before and after intervention 2 Sedative drug consumption 3 Blood tests for biomarkers before and after intervention	- No significant change in vital signs observed - Trend towards decrease in Fentanyl in intervention group - Blood cortisol and prolactin decreased after intervention
Chlan (1995) ³³	Two group experimental design <ul style="list-style-type: none"> Intervention: Classical music listening for 30 minutes during late afternoon/evening Control: Rest with headphones with no music 	Purpose: to examine selected psychophysiological responses of mechanically ventilated patients to music	Single ICU at a tertiary care center in the US <ul style="list-style-type: none"> Intervention group: 11 subjects Control group: 9 subjects 	1 Vital signs before, at 5 minute intervals during intervention, and 5 minutes after intervention 2 Anxiety measured using Profile of Mood States (POMS) 30 item short form	- Statistically significant decreases in HR, BP, and RR observed in the intervention group - Statistically significant difference found in POMS scores between groups
Chlan (1998) ³²	Two group experimental design	Purpose: to test the effects of music therapy	4 urban ICUs in the US	1 Vital signs at baseline, every 5	- Statistically significant difference

Author/Year	Design	Purpose	Setting/Subjects	Variables Measured	Findings
Chlan et al. (2013) ¹⁷	Three group randomized clinical trial <ul style="list-style-type: none"> • Patient Directed Music (PDM): self-initiated, PDM with preferred selection tailored by a music therapist • Headphones (HP): self-initiated application of noise canceling headphones • Control: Usual Care (UC) 	Purpose: to test whether listening to self-initiated PDM can reduce anxiety and sedative exposure during ventilator support in critically ill patients	12 ICUS at 5 urban hospitals in the US <ul style="list-style-type: none"> • PDM group: 126 subjects • HP group: 122 subjects • UC group: 125 subjects 	<ol style="list-style-type: none"> 1 Daily anxiety measured by visual analogue scale 2 Sedative exposure measured by sedative drug intensity score 	<p>Subjects were able to independently request music</p> <p>Nurses were cooperative in offering the intervention</p> <p>PDM subjects had significantly lower anxiety scores than subjects in the UC group</p> <p>By the 5th study day, anxiety was reduced by 36.5% in PDM patients</p> <p>PDM significantly reduced measures of sedative exposure</p> <p>By the 5th study day, PDM subjects received 2 fewer sedative doses than subjects in the UC group</p>
Conrad et al. (2007) ⁴⁰	Two group randomized clinical trial <ul style="list-style-type: none"> • Intervention: slow movements of Mozart's piano sonatas for 1 hour • Control: Rest for 1 hour with headphones with no music 	Purpose: to identify mechanisms of music-induced relaxation using a special selection of slow movements of Mozart's piano sonatas	1 ICU <ul style="list-style-type: none"> • 10 subjects 	<ol style="list-style-type: none"> 1 Vital signs, continuously during intervention 2 Brain electrical activity, continuously during intervention 3 Serum levels of stress hormones and cytokines before and after intervention 4 Requirements for sedative drugs 5 Level of sedation before and after music intervention 	<p>The intervention significantly reduce the amount of sedative drugs needed to achieve a comparable degree of sedation</p> <p>Subjects that received music had increased levels of growth hormone and decreased levels of interleukin-6 and epinephrine</p> <p>The reduction in stress hormones in the subjects that received music was associated with a significantly lower blood pressure and heart rate</p>

Author/Year	Design	Purpose	Setting/Subjects	Variables Measured	Findings
Dijkstra, et al. (2010) ²¹	Two group randomized clinical trial <ul style="list-style-type: none"> Intervention: Listened to music 3 times for 30 minutes over 2 days Control: had 3 rest periods for 30 minutes of 2 days 	Purpose: to determine the effects of music on physiological responses and sedation scores in sedated, mechanically ventilated patients	3 ICUs in a university hospital in the Netherlands <ul style="list-style-type: none"> Intervention group: 10 subjects Control group: 10 subjects 	<ol style="list-style-type: none"> Vitals signs at baseline, after 5, 10, 20, 30, 60 minutes Sedation scores measured by the Ramsay Sedation Scale measured at baseline and after music or rest 	<ul style="list-style-type: none"> Subjects in the intervention group had higher sedation scores, indicating music leads to a deeper level of sedation No significant decreases in physiological parameters were observed
Han et al. (2010) ²⁸	Three group randomized clinical trial <ul style="list-style-type: none"> Listening to relaxing music for a single 30 minute session Headphones with no music for a single 30 minute session Control with quiet rest for a single 30 minute session 	Purpose: to examine the effects of music intervention on the physiological stress response and the anxiety level among mechanically ventilated patients in the intensive care unit	A single ICU at a large teaching hospital in China <ul style="list-style-type: none"> Music listening group: 44 subjects Headphones group: 44 subjects Control group: 49 subjects 	<ol style="list-style-type: none"> Vital signs, baseline, during intervention and at 5 minutes after intervention Anxiety measured by the Spielberger State-Trait Anxiety Scale, measured before and after 30 minute session or all groups 	<ul style="list-style-type: none"> Significant differences among groups for HR, BP, RR, and anxiety Significant reduction in physiological stress response over time in music listening group Significant increase in physiological stress response over time in control group Significant reduction in anxiety score for the music group and headphone group
Hunter et al. (2010) ⁴	Feasibility study with historical controls <ul style="list-style-type: none"> Intervention: 45–60 minute MT sessions offered 3 times/week during weaning trials; time of session determined by where patient was in weaning process 	Purpose: to determine the feasibility of incorporating music therapy in to the weaning process and to evaluate the efficacy of the intervention based on levels of anxiety, days to wean and patient/nurse satisfaction	A single pulmonary step down unit of a large tertiary teaching hospital in the US <ul style="list-style-type: none"> 61 subjects 	<ol style="list-style-type: none"> Anxiety measured by a patient survey and a staff survey Vital signs before and after each music therapy session Days to Wean (DTW) Satisfaction measured by a patient survey and a staff survey 	<ul style="list-style-type: none"> Patient and nurse satisfaction with the intervention were both high Significant difference in HR and RR found from beginning to the end of the music therapy session suggesting a more relaxed state had been achieved Staff assessment of anxiety demonstrated patient appeared to be less anxious after intervention

Author/Year	Design	Purpose	Setting/Subjects	Variables Measured	Findings
Korhan et al. (2011) ²³	Case control experimental study <ul style="list-style-type: none"> Intervention: Classical music listening for 60 minutes Control: Usual ICU care 	Purpose: to investigate if relaxing music is an effective method of reducing the physiological signs of anxiety in patients receiving mechanical ventilator support	A single ICU in a teaching hospital in Turkey <ul style="list-style-type: none"> 30 subjects for the intervention 30 subjects for the control 	Vital Signs measured immediately before the intervention, at the 30 th , 60 th , and 90 th minutes of the intervention, and 30 minutes after the intervention	<ul style="list-style-type: none"> Subjects in the music group had significant lower mean RR and BP than the control group The decrease in RR and BP improved progressively in the 30th, 60th, and 90th minutes of the intervention suggesting a cumulative dose effect
Lee et al. (2005) ²⁴	Two group randomized clinical trial <ul style="list-style-type: none"> Intervention: 30 minute relaxing music listening Control: 30 rest period with headphones with no music 	Purpose: to investigate effects of music on the anxiety of patients on mechanical ventilators as assessed by objective parameters and a subjective validated anxiety scale	A single ICU in Hong Kong <ul style="list-style-type: none"> Intervention group: 32 subjects Control group: 32 subjects 	<ol style="list-style-type: none"> Vital signs measured before and after the intervention Anxiety measured by the Chinese version of the Spielberger State Trait Anxiety Inventory Scale measured before and after the intervention Resting Behavior Observation checklist 	<ul style="list-style-type: none"> Significant decreases in HR, RR, systolic BP and diastolic BP were noted after the music intervention in the music group An increased in observed resting behaviors was observed in the intervention group
Saadatmand et al. (2013) ³¹	Two group randomized clinical trial <ul style="list-style-type: none"> Intervention: 30–90 minutes of listening to nature based sounds Control: 30 minute rest period with headphones with no music 	Purpose: to identify the effect of the nature-based sounds ³ intervention on agitation, anxiety level, and physiological stress responses in patients under mechanical ventilation support	A single ICU in a teaching hospital in Iran <ul style="list-style-type: none"> Intervention group: 30 subjects Control group: 30 subjects 	<ol style="list-style-type: none"> Vital signs measured before the procedure, at the 30th, 60th, and 90th minutes of the procedure and 30 minutes after procedure Anxiety measured by the FACES anxiety scale 30 minutes after the intervention Agitation measured by the Richmond Agitation Scale during the intervention 	<ul style="list-style-type: none"> The intervention group had significantly lower systolic BP, diastolic BP, anxiety and agitation levels than the control group The reductions observed were progressive over time, indicating a cumulative dose effect

Author/Year	Design	Purpose	Setting/Subjects	Variables Measured	Findings
Stubbs (2005) ³⁹	Qualitative Study <ul style="list-style-type: none"> Intervention: 30 minutes of relaxing music listening on 2 prescribed occasions 	Purpose: to gain insight into patients' and nurses' perception of the benefit of music therapy during critical illness and to add to the body of knowledge in nursing around the use of therapies complementary to medicine	A single ICU in a community hospital in the US <ul style="list-style-type: none"> 5 patients 4 nurses 	<ol style="list-style-type: none"> Unstructured interviews after ICU discharge but before leaving the hospital. Results were analyzed according to Burnard's framework 	<ul style="list-style-type: none"> When interviewed, no patients remembered listening to music. Nursing staff made time tables of music interventions which was successful in jogging patients' memories Patients' notable comments concerned 1) imagery, 2) being somewhere else, 3) pain perception altered by music, 4) sleep relaxation, 5) music dreams None of the nurses interviewed felt there were any disadvantages and found the results to be positive
Twiss et al. (2006) ³⁶	Two group randomized clinical trial <ul style="list-style-type: none"> Intervention: listened to music continuously throughout surgery and while in ICU Control: received usual postoperative care 	Purpose: to determine the effect of music listening on postoperative anxiety and intubation time in patients undergoing cardiovascular surgery	A single ICU in the US <ul style="list-style-type: none"> Intervention group: 28 subjects Control Group: 32 subjects 	<ol style="list-style-type: none"> Anxiety measured by the Spielberger State Trait Anxiety inventory administered the night before surgery and the 3rd postoperative day Intubation time – measured by the time patient left the OR until they were extubated 	<ul style="list-style-type: none"> Subjects in the music group had significantly lower anxiety scores Subjects in the music group had fewer minutes of postoperative intubation after cardiovascular surgery
Wong et al. (2001) ²²	Crossover design with random assignment <ul style="list-style-type: none"> Randomized to get 30 minutes of music therapy then 30 minutes of uninterrupted rest or vice versa Music: relaxing music via headphones 	Purpose: to assess the effectiveness of music therapy in decreasing anxiety in ventilator dependent patients	A single ICU in Hong Kong <ul style="list-style-type: none"> 20 subjects 	<ol style="list-style-type: none"> Vital signs measured before intervention and at 5 minute intervals throughout intervention Anxiety measured by the Chinese version of the Spielberger State Trait Anxiety Inventory measured before intervention 	<ul style="list-style-type: none"> Music listening was more effective in decreasing state anxiety than uninterrupted rest period Significant difference of BP and RR were observed at the end of the intervention between the two conditions, with

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Author/Year	Design	Purpose	Setting/Subjects	Variables Measured	Findings
^b	<ul style="list-style-type: none"> Control: uninterrupted rest 			and immediately after intervention	music being superior to the rest period

^b HR-heart rate, BP – blood pressure, RR – respiratory rate