Review Article

Music Therapy: Loud Noise or Soothing Notes?

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Abstract

It is well known that listening to music makes a person feel good and it is also believed that it expedites the body's healing processes so that the person may return to a normal state. This project was undertaken to review the relevant literature to find out why and how this occurs. The first portion of this paper discusses the proposed physiologic mechanisms through which music is thought to affect the body, while the second portion of this paper examines two types of case studies – those in which physiological indices such as heart rate and blood pressure were analyzed, and those in which hormones, chemical, and cytokine levels were analyzed. *Int Pediatr. 2003;18(4):204-208.*

Key words: music therapy, relaxation, alternative medicine, stress

After silence, that which comes nearest to expressing the inexpressible is music.
– Aldous Huxley

The ultimate language of music is related to a world of beauty and harmony, of structure and order of which our patients are deprived because of their illness. Music expresses man's deepest emotions. It can serve him in health and illness, in happiness and in sorrow. Music therapy is one of the most noble functions of music."
– Alvin, *Principles of Music Therapy,*
Quoted in Rebecca J. O'Sullivan, *A musical road to recovery: music in intensive care*

Introduction

Recently, within the past two decades, there has been an increasing interest in studying the relationship between music and its ability to improve the body's healing capacities. This review was conducted with the purposes of: (1) examining the physiological basis behind music therapy, and (2) examining case studies utilizing music therapy in which (a) physiological indices such as heart rate and blood pressure were analyzed, and (b) in which hormones, chemical, and cytokine levels were analyzed.

This review will first discuss the historical aspect of music as a healing tool. Next, the individual components of music and their affects upon the body will be discussed. Following, the proposed physiological basis behind music therapy will be examined. And finally, case studies utilizing music therapy will be discussed.

Historical Aspect of Music as a Healing Tool

For centuries, music and medicine have been linked together.[1-4] The Greeks believed that music had the power to heal the body and the soul, as reflected in their mythology, with Apollo - the god of music, giving rise to his son Aesculapius - the god of healing and medicine.[2] Zenocrates, Sarpenter, and Arion were the first Greeks to use music for the purposes of calming the mentally ill.[3] The playwright Homer believed that music could be used to avoid negative feelings, and philosophers such as Confucius, Plato, and Pythagoras believed that daily exposure to music would enhance one's health.[1,5] Aristotle went so far as to practice psychocatharsis, a belief that those who suffered from uncontrollable emotions would relapse to their normal condition after having listened to music, which raised their souls to ecstasy.[1,4] And in the Bible, the shepherd David is described as calming King Saul's mind with the music of the harp.[3,5]

Following the invention of the phonograph in the late 1800s, hospitals began using music to aide patients in falling asleep, in relieving anxieties before surgery, and in assisting with the administration of local anesthesia.[1,4] Music's acceptance as an effective form of therapy in the medical setting occurred following World War II, when it was used to aide in the recovery

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of soldiers that were wounded, disabled, or shell-shocked.[1-4]

Music therapy deals with the "controlled use of music and its influence on the human being in physiologic, psychological, and emotional integration of the individual during treatment of an illness or disability".[2,5] It has also been defined as the "behavioral science that is concerned with the use of specific kinds of music and its ability to produce changes in behavior, emotions, and physiology".[2,5]

Music has long been recognized as a universal language - capable of breaking down cultural, educational, linguistic, mental, and emotional barriers.[2] It can open lines of communication by eliciting feelings, thoughts and memories, thereby creating a familiar environment reminiscent of the family, homeland, and the past.[2] Its noninvasive nature allows it to be used in a variety of clinical settings, ranging from surgery to postoperative care to neonatal care to intensive care.[2]

Music has been shown to be extremely effective in reducing psychophysiologic stress, pain, and anxiety.[2] By allowing the patient to refocus upon something more pleasant, the isolation and monotony of hospitalization are diverted from his or her attention.[2] Further, by reducing self-preoccupation and by filtering out unpleasant and unfamiliar sounds associated with hospitalization, the needs for excessive medication are reduced, the side effects of the medication are minimized, and a shorter recovery is facilitated.[2] In essence, music produces a counter to the stress response, in that relaxation is promoted, and the body is returned to a healthier balance.[2]

Individual Components of Music and its Affects on the Body

Let us now review the individual components of music - tempo, pitch, volume, and rhythm - and how each affects our body.

Tempo is defined as the pace of the music. Tempos in the range of 60 - 70 beats per minute have been found to be most soothing, because they reflect the similar tempo of the heart. A pace faster than that causes tension, while a pace slower than that creates the feeling of suspense.[3-6]

The pitch or highness or lowness of a sound is determined by the frequency of sound waves and it acts on the autonomic nervous system. A high pitch causes tension, while a low pitch promotes relaxation.[3-6]

The volume, or intensity/loudness of the music, can cause pain if very high, yet can be soothing and relaxing if low.[3-6]

Rhythm helps the body to regain the order that it had previous to the stress caused by the medical illness or condition. Specifically, music assists in restoring the circadian rhythms of temperature and sleep, the ultradian rhythms of autonomic system regulation, metabolic processes, and cerebral dominance, and the rhythms of respiration, peristalsis, and heart rate.[7] In addition, for infants born premature or ill, music helps to recreate the order of the fetal environment experienced *in utero*, and promotes a low arousal state, such that calories are conserved for growth and healing.[3,8,9]

Physiological Basis of Music Therapy

Mechanism through which music is processed, the reticular activating system (RAS), consists of cell groupings located within the brainstem that allow incoming sensory information to be filtered resulting in efficient thought and action. When music is played, stimuli are sent from the axons of the ascending sensory fibers to the neurons of the RAS. The stimuli are then transmitted, by way of the nonspecific nuclei of the thalamus, upwards towards the regions of the cerebral cortex, the limbic system, and the corpus callosum, and downwards towards the regions of the autonomic nervous system and neuroendocrine system.[1,4-6,10-12]

The cerebral cortex is the control center for the sensory, motor, and intellectual regions. Specifically, music is processed in the temporal lobe, which then sends the signals of information to another subdivision of the cerebral cortex, the association cortex. The association cortex is where the highest levels of thinking are performed, including activities such as the development and acquisition of long-term memory, language and speech, musical and mathematical ability, complex motor skills, and abstract and symbolic thought.[11]

The limbic system is responsible for controlling emotions, and also has a role in learning and memory. Located at the border between the cerebral cortex and the brainstem, the limbic system is composed of a ring of connected structures, including the cingulate gyrus, hippocampus, fornix, mammillary bodies, hypothalamus, mammillothalamic tract, anterior

thalamus, and the olfactory bulbs.[11] When music is played, all regions that are networked by the limbic system are stimulated, resulting in feeling and expression.[1,4,9] Music has also been shown to induce phenylethylamine secretion from the limbic system, a neuroamine that is responsible for the feeling of 'love', and which is a compound that is naturally found in chocolate.[9]

The corpus callosum, which is one of the largest commissures, consists of tough fibrous tracts that contain axonal fibers that interconnect the left and right hemispheres of the brain.[11] Music is thought to activate biochemical and electrical memory material across the corpus callosum, thus enhancing the ability of the two hemispheres to work in unity, rather than in opposition.[12]

The autonomic nervous system consists of the parasympathetic and sympathetic systems.[11] Music allows the parasympathetic system to over-ride the sympathetic system, resulting in a relaxed response state.[1,4-6,9,10] Characteristics of the relaxed response include a lowered heart rate, regular deep breathing, muscular relaxation, sleep,[12] and the inducement of an alpha brain-wave frequency, which is produced in conscious states of relaxed wakefulness.[9]

The neuroendocrine system is responsible for the maintenance of the body through the proper secretion of hormones and chemicals into the bloodstream and is affected by music in three principal ways.

First, endorphins - the body's natural opiates, are released from the pituitary gland - thereby relieving pain and influencing mood state and memory.[1,4,6,9,10,12]

Second, there is a decrease in the secretion of catecholamines, such as epinephrine and norepinephrine, from the adrenal medulla.[1,4,6,9,10,12] Associated with a reduction in catecholamine levels are reductions in heart rate, metabolic rate, blood pressure, free fatty acids, and oxygen consumption.[4] In addition, the chances of having a migraine, experiencing coronary heart disease, gastrointestinal ulcers, and cerebral vascular accident decreases.[1,6,10]

Third, there is a decrease in levels of adrenal corticosteroids as well as corticotrophin-releasing hormone (CRH) and adrenocorticotrophic hormone (ACTH), which are secreted during stress.[9]

Music Therapy: Studies of Physiological Indices

Guzetta et al studied the effects of both relaxation and music listening upon patients who had presumptive acute myocardial infarctions. Eighty patients were randomly assigned to either relaxation, to music listening, or to the control group where they were just allowed to rest. The relaxation exercises and music listening were each administered for twenty minutes, three times a day, over the course of a two-day period. Comparison of the patients who had undergone relaxation exercises or music listening to those who had just rested showed that the experimental groups had lower heart rates, higher peripheral temperatures, and decreased incidence for cardiac complications. No comparison was made between the relaxation exercise group and the music listening group.[13]

Steelman et al examined the effects of music listening upon patients who underwent surgery on the hand or wrist, with the use of local or regional anesthesia. Forty-three patients were randomly assigned to either listening to music throughout the surgery or to not listening to music at all. Comparison of the experimental group to the control group indicated that music listening had a significant effect in reducing systolic and diastolic blood pressures.[14]

Updike et al demonstrated the physiological responses of twenty patients in the coronary and surgical intensive care units to taped music programs. Upon comparison of pre and post-test results, a reduction in systolic and diastolic blood pressures, heart rate, mean arterial pressure, and double product index (product of heart rate and systolic blood pressure divided by 100) was observed.[12]

White examined the heart rate and respiratory rate of 40 patients with myocardial infarction, 20 of which listened to relaxation music and 20 of which were assigned to rest as a control group. Upon comparison of the patients who had listened to music to those who had been assigned to rest, White observed that patients who had listened to music had a greater reduction in heart rate and respiratory rate.[4,15]

Barnason et al examined the effects of music listening and music-video therapy on patients two or three days following heart bypass surgery. Ninety-six patients were randomly assigned to music listening, music-video therapy, or rest. The systolic and diastolic blood pressures, and heart rates of the experimental

groups decreased, but was considered statistically insignificant when compared to the decrease observed for the control group.[16]

Elliott et al studied the effects of music listening and muscle relaxation upon patients who had been admitted to the coronary care unit with unstable angina pectoris or acute myocardial infarction. Fifty-six patients were randomly assigned to music listening, muscle relaxation, or rest. The music listening and muscle relaxation exercises were each conducted for half-an-hour, two to three times a day, for two days. Comparison of the experimental to the control group indicated that music listening and muscle relaxation had no significant effects in reducing heart rate or blood pressure.[17]

Thus, while earlier studies by Guzetta, Steelman, Updike, and White supported the beneficial effects of music listening on reducing indices such as heart rate and blood pressure,[4,12-15] more recent studies reported by Barnason and Elliott, in contrast, found the effects of music listening to be insignificant when compared to the control group.[16,17]

Music Therapy: Studies of Hormone, Chemical, and Cytokine Assays

Oyama et al examined the effects of music on the levels of adrenocorticotrophic hormone (ACTH) in fifty dental patients. Comparison of the experimental to the control group revealed significant decreases in ACTH for patients who had listened to music. Additionally, measurements of heart rate and mean arterial blood pressure in patients who had listened to music were reduced.[18]

Tanioka et al studied the effects of music on the levels of noradrenaline and cortisol in surgical patients with epidural anesthesia. Fifteen patients were placed in each group. Comparison of the experimental to the control group revealed a significant reduction in the level of cortisol, and a significant reduction in the increasing level of noradrenaline when measured one hour after surgery and in the post-operative recovery period for music listening patients.[18]

Halpaap et al examined the effects of music on the levels of ACTH and β-endorphin in women in labor. One-hundred patients were placed in both the control and music listening groups. Comparison of the experimental group to the control group revealed that the levels of both ACTH and β-endorphin were significantly reduced in women that had listened to music.[18]

Rider et al studied the effects of music listening with suggestive imagery upon the mean adrenal corticosteroid levels of night shift nurses. Over the course of a month, nurses were instructed to listen to the music once a day for four to five days out of the week. While adrenal corticosteroid levels of the experimental group were lower, the difference was not statistically significant when compared to the control group.[19]

Bartlett et al examined the effects of music listening upon levels of cortisol in healthy patients. Thirty-six volunteers were divided into four groups, two experimental and two control. Members in the first experimental group had their blood taken before and immediately after listening to 15 minutes of music, while members in the second experimental group had their blood taken 24 hours after listening to the music. The control groups had their blood taken in similar fashions, but without the music. Comparison of the experimental to the control group found a significant decrease in cortisol for both the first and second experimental groups.[20]

McKinney et al studied the effects of music imaging, silent imaging, and music listening upon the plasma β-endorphin levels of individuals. Seventy-eight undergraduate students were assigned to any of the three experimental groups, or to a control group of rest. Blood was taken before and after the 2-hour intervention period. Comparison of the experimental to the control group indicated that music imaging alone produced a significant decrease in plasma β-endorphin levels, while silent imaging and music listening showed no significant changes in plasma β-endorphin levels.[21]

McKinney et al also examined the effects of guided imagery and music therapy (GIM) upon the levels of cortisol in healthy adults. Twenty-eight adults underwent six GIM sessions, once every two weeks, with each session lasting approximately 1.5 to 2 hours. Blood samples were taken both before and after the 12-week duration, and also 6 weeks following the conclusion of the GIM sessions. Comparison of the experimental groups to the control groups indicated a significant decrease in levels of cortisol, specifically in the 6-week follow up.[22]

Thus, while studies examining the effects of music on serum levels of ACTH, noradrenaline, and cortisol showed the expected reductions in music-listening

patients, studies examining adrenal corticosteroid and β-endorphin levels in music-listening patients did not show the expected changes. Specifically, Rider's study found the expected decrease in adrenal corticosteroid levels to be statistically non-significant when compared to the control,[19] and studies by Halpaap and McKinney showed decreases, instead of the expected increases, in β-endorphin levels.[18,21]

Conclusion

While music therapy is gaining greater acceptance in the medical community as an effective accompaniment in the healing process, skepticism still remains.

In the published reports reviewed here, there has been no definitive evidence either in support of or in claims against the beneficial aspects of music therapy. Some of the studies supported the expected claims, while other studies found non-significant effects, or in the case of β-endorphins, effects which contradicted what theoretically was expected to occur.

What should be pointed out, however, is that in all of the studies, music listening was found to be at worst non-harmful and at best helpful. As such, even though further studies and research needs to be conducted in this field, the ability of music to perhaps expedite a patient's recovery, even if not in all patients, should merit a continuance of current music therapy programs. However, for facilities in which funding is unavailable, establishment of music therapy programs should be postponed until studies consistently support the beneficial aspects of music therapy programs.

References

1. Cook, J. Music as an intervention in the oncology setting. *Cancer Nursing*. 1986;9:23-28.
2. Johnston, K & Rohaly-Davis, J. An introduction to music therapy: Helping the oncology patient in the ICU. *Critical Care Nurse Quarterly*. 1996;18:54-60.
3. Klein, S. & Winkelstein, M. Enhancing Pediatric Health Care with Music. *Journal of Pediatric Health Care*. 1996;10:74-81.
4. White, J & Shaw, C. Music therapy: a means of reducing anxiety in the myocardial infarction patient. *Wisconsin Medical Journal*. 1991;90:434 - 37.
5. Watkins, G. Music Therapy: Proposed Physiological Mechanisms and Clinical Implications. *Clinical Nurse Specialist*. 1997;11:43-50.
6. O'Sullivan, R. A musical road to recovery: music in intensive care. *Intensive Care Nursing*. 1991;7:160-63.
7. Aldridge, D. Music, communication and medicine: discussion paper. *Journal of the Royal Society of Medicine*. 1989;82:743-46.
8. Burke, M., Walsh, J., Oehler, J., & Gingras, J. Music Therapy Following Suctioning: Four Case Studies. *Neonatal Network*. 1995;14:41-49.
9. Kaminski, J. & Hall, W. The Effect of Soothing Music on Neonatal Behavioral States in the Hospital Newborn Nursery. *Neonatal Network*. 1996;15:45-54.
10. Coughlan, A. Music therapy in ICU. *Nursing Times*. 1994;90:35.
11. Rhoades, R. & Tanner, G. *Medical Physiology*. Boston, Little, Brown and Company, 1995.
12. Updike, P. Music Therapy Results for ICU Patients. *Dimensions of Critical Care Nursing*. 1990;9:39-45.
13. Guzetta, C. Effects of relaxation and music therapy on patients in a coronary care unit with presumptive acute myocardial infarction. *Heart & Lung*. 1989;18:609-16.
14. Steelman, V. Intraoperative Music Therapy: Effects on Anxiety, Blood Pressure. *AORN Journal*. 1990;52:1026-1034.
15. White, J. Music Therapy: An Intervention to Reduce Anxiety in the Myocardial Infarction Patient. *Clinical Nurse Specialist*. 1992;6:58-63.
16. Barnason, S., Zimmerman, L., & Nieveen, J. The effects of music interventions on anxiety in the patient after coronary artery bypass grafting. *Heart & Lung*. 1995;24:124-132.
17. Elliott, D. The effects of music and muscle relaxation on patient anxiety in a coronary care unit. *Heart & Lung*. 1994;23:27-35.
18. Pratt, R. R. (ed.), *The Fourth International Symposium on Music: Rehabilitation and Human Well-Being*, University Press of America, Lanham, MD, New York City, N Y, 1987:88-101.
19. Rider, M., Floyd, J., Kirkpatrick, J. The Effect of Music, Imagery, and Relaxation on Adrenal Corticosteroids and the Re-entrainment of Circadian Rhythms. *Journal of Music Therapy*. 1985;22:46-58.
20. Bartlettt, D., Kaufman, D., Smeltekop, R. The Effects of Music Listening and Perceived Sensory Experiences on the Immune System as Measured by Interleukin-1 and Cortisol. *Journal of Music Therapy*. 1993;30:194 - 209.
21. McKinney, C., Tims, F., Kumar, A., & Kumar, M. The Effect of Selected Classical Music and Spontaneous Imagery on Plasma β-Endorphin. *Journal of Behavioral Medicine*. 1997;20:85-99.
22. McKinney, C., Antoni, M., Tims, F., & McCabe, P. Effects of Guided Imagery and Music (GIM) Therapy on Mood and Cortisol in Healthy Adults. *Health Psychology*. 1997;16:390-400.