The Rebellion of Music in Medicine: Using Music Therapy to replace Opioids.

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"Tradition becomes our security, and when the mind is secure it is in decay."

- ***Jiddu Krishnamurti***

A violinist stands backstage at the Royal Albert Hall in London, England. He applied the delicate rosin to his bow as five-thousand two hundred and seventy two people await the soloist with their intent stares. A surgeon washes his hands, scrubbing underneath each fingernail, in between each groove and fold of skin. He steps into the surgical theatre under the gaze of five surgical staff and 5 students eager to learn. The violinist raises his instrument, sets his fingers, raises his bow with a flacid yet powerful wrist, exhales and produces melodious notes. The surgeon grabs firmly the ten-blade, presses delicately yet fiercely down on the patient's skin bringing out the first drops of blood. A musician is responsible for the entertainment of their audience for two hours while a surgeon is responsible for the life of their patient for days. How could one compare a musician with a surgeon without blatant disregard for the difference of their careers? Music has long been dismissed from the medical community because of physicians – who have attended school for over two decades – refusing to accept that something as abstract as musicianship is able to treat disease in a non-molecular level. One of the most prominently prescribed drug are opioids. Their efficiency with suppressing pain has made them the staple medication for pain management. The powerful nature of opioids is mute when their addictive nature is considered.

In 2012 there were enough opioid prescriptions in the United States for every man, woman, and child to have their own. This was the peak of the opioid crisis in the United States. In 2001 The Joint Commission, a not-for-profit company whose mission it is to constantly improve health care for the public, released their "Pain Management Standards". These guidelines promoted the idea of pain as the "5th vital sign" and required for physicians to treat pain to a zero level. Concurrently at the turn of the millenia, opioids were first proposed as the new medication of choice to treat pain because of their power and effectiveness. With the threat of being fined for poor service, doctors began to over

prescribe opioids for even the most minor pains. With that has also come a dramatic spike in drug-related overdoses.

There has been a gradual move to reduce the prescription and access to opioids since 2012. The initial rise in opioid prescriptions has been accredited to the lack of pilot studies done on the addictive nature of narcotic painkillers. A recent study at the University of Michigan reported that patients only consume 27% of the opioids prescribed to them (Howard, R., Fry, B., Gunaseelan, V., 2018). The rest are disposed of improperly or sold in Narcotic Mills – places you simply pay for pills. Medical institutions have proposed many alternatives to the prescription of narcotics in order to restrict access for patients. One alternative is cognitive behavioural therapy (CBT); this aims to restructure the way one thinks to promote positivity. A subset of CBT is music therapy (MT). Everyone uses this principle at some point in their lives whether it is the soothing music we hear in a therapist's office or the jubilant melodies from a violinist on stage. Prior to the shooting of Congresswoman Gabby Giffords in 2011 there was little research done on music therapy; it was simply proposed as an addition to traditional techniques for its observed calming effects. Music therapy has struggled to be established as a mainstream form of treatment as it changes the way we view medicine. Traditionally, patients are cured on a chemical level with a pill. Music therapy, however, targets the patient in a holistic manner where it treats the external and internal environment (Mukherjee, S., 2015). This form of treatment has potential to reduce our reliance on pills such as opioids to treat pain in surgical patients.

This paper will analyse the current literature surrounding the use of music therapy to aid patients before, during, and after surgical operations. I will first look at the first pieces of literature surrounding music therapy, and then present evidence for the power of music therapy's use in surgery. Before I present any literature I will explain a few methods which researchers used to gather data in their experiments. The first is the use of The State-Trait Anxiety Inventory (STAI) to quantity the anxiety being perceived by patients. This measure is used in clinical settings to diagnose anxiety and differentiate it from characteristic

depression. The form consists of questions which ask the patient to rate a specific feeling or emotion on a four-point scale. The reliability of the STAI has been reviewed thoroughly and consistency coefficients for the scale have ranged from .86 to .95 (Spielberger et al., 1983). Patient perceived pain was measured in a similar fashion where researches asked patients to rate their pain levels before (as a baseline) and after the surgery. A common type of study cited in this paper is a meta-analysis or systematic review. These are situations where in a scholarly article the authors "aim to give a conceptual presentation of the effect that music has on the pre- and postoperative course of surgical patients" (Moris, D., Linos, D., 2013, pg. 719). Data is used from past experiments performed by other researchers at other institutions looking at data of similar interest. Using the data published in the studies I will present in this paper, I will argue for the use of music therapy as an alternative method to treating anxiety and pain for surgical patients.

I. Music Therapy in Context: a form of Cognitive Behavioural Therapy

Fundamentally, music therapy is a form of cognitive behavioural therapy (CBT). CBT is used to reshape how one thinks into a more positive manner. Essentially, CBT and music therapy are methods of controlling the mind and the body. CBT is becoming increasingly used to manage pain in the place of opioids for chronic pain. It has been shown that opioids aren't effective for long-term pain as they simply mask deeper psychological torment. Using the principles of CBT music therapy could be used in place of drugs by forcing the brain to think positively. Music therapy was defined in a popular *CNN* article as "the use of music to achieve non-musical goals" (Storrs, 2017, np). I will discuss the neurological mechanisms behind music therapy later in the paper but for now it is important to understand the initial hypothesis behind music therapy.

Music therapy shows the ability to reduce anxiety and pain in surgical patients by placing the brain in a positive environment. Siddhartha Mukherjee, MD and cancer researcher, postulated that the future of medicine is the manipulation of cell environments to prevent disease. In a

Ted Talk he gave, Mukherjee compared his theory to that of a person with depression. Currently we treat such a disease with a cocktail of antidepressants which don't cure the issue, they simply numb it. A futuristic – and hopefully more effective – treatment for depression could be changing one's entire physical environment, targeting and changing cues in one's life which are the source of the illness. Music therapy works upon this principle, reducing pain and anxiety in a patient by putting the body in a positive and tranquil state (Mukherjee, S., 2015). Treating the environment of a patient to enforce positivity is not the status quo in any surgical department, but it shows the potential to be safer, cheaper, and more effective than narcotics.

II. Literature Review

The use of music therapy to aid in healing for patients after surgery was first brought under the public's eye when Congresswoman Gabby Giffords was shot in the head. Concurrent with speech, movement, and electrical therapy, Giffords was assigned music therapy by her doctor in order to target rehabilitation of holistic brain processing. Giffords later stated that the music therapy she was subjected to helped "[work] on developing [her] attention, memory and overall executive function," (Sanjay, G., 2011, np). Four years later a state-of-the-art study published in *The Lancet*, a prestigious peer-reviewed general medical journal, proposed music therapy as an option for patients as a cheaper and safer alternative to many drugs (Hole, J., et al. 2015). Another major meta-analysis on data where surgical patients were presented with

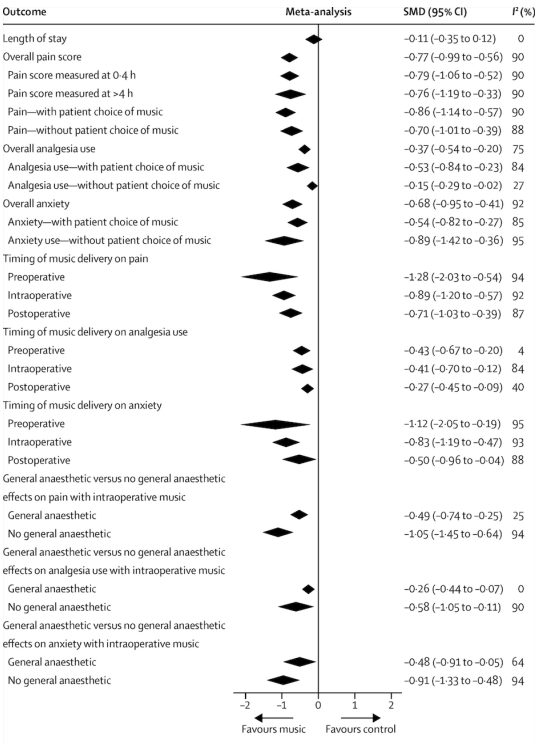

Figure 1: Means of variables analyzed in Hole et al. (2015)

music therapy was published in the *Journal*

of Surgical Endoscopy by Demetrios Moris and Dimitrios Linos (2013). This study found similar results to Hole et al. in *The Lancet*. Music therapy was shown to be effective at lowering anxiety before and during surgery and reducing pain in surgical patients post-op. A CNN article written in 2017 titled "*Surgery patients hear benefits of music therapy loud and clear"* made these results popular to the general public where it gained momentum to fund more research. Music therapy was praised as a cheap and safe alternative to drug remedies for medical issues such as pain, anxiety, and ADHD (Storrs, 2017).

III. Pilot Studies

The first significant study published on the use of music therapy in 2003 showed that music could reduce anxiety in patients undergoing minor surgery with local anesthesia. Two clinical nurse researchers studied the effect of music therapy on patients undergoing surgery with local anesthesia. They reported with statistical significance that patients who listened to their choice of music during surgery experienced significantly lower anxiety levels, heart rates, and blood pressure compared to a control group (Mok, E., et al., 2003). Initial reports found that music therapy primarily reduced patient anxiety before and during surgery. A later study in 2006 found similar results but was conducted on patients under general anesthesia (Sendelbach, S.E. et al., 2003). With supporting results these two studies showed that whether or not the patient was under general or local anesthesia, music therapy is beneficial. Claims about music therapy having the potential to treat patient symptoms such as pain and anxiety were overshadowed by the gowing reliance on opioids and other drugs to treat the same symptoms. Lack of conclusive, peer-reviewed research and arrogance in the scientific community kept music out of the confines of medicine.

IV. Music therapy and Anxiety

The most conclusive effect of music therapy on surgical patients is a reduction in anxiety (measured using the STAI). Besides pain, anxiety is the most prevalent symptom that patients experience before, during, and after surgery. High anxiety levels lead to

elevated heart rates, higher blood pressures, and an increase in anesthesia needed. All these factors create a more stressful environment for the surgeon to operate in, increasing the probability of complications. Anxiety after a surgery is also very common and hinders healing and rehabilitation while magnifying pain. The first findings of music therapy's influence on patient anxiety was reported by a team of clinical researchers in *The Journal of Cardiovascular Nursing*. A significant reduction in anxiety ($P \leq .001$) was reported for patients who received 20 minutes of musical intervention twice a day the three days after cardiac surgery compared to a control group (Sendelbach, S. E., et al., 2003). While opioids became the staple drug to remedy pain, the trend of overprescription transcended symptoms and medications such as *Xanax* became a popular choice to treat anxiety. One can argue that music therapy won't make an operation smoother or improve one's chances of making a full recovery, but no one can deny that music therapy can reduce anxiety in surgical patients. This is especially crucial before a surgery where patients are forbidden from consuming any food or liquid for six hours, pills included. The current "state-of-the-art" for treating patient anxiety before a surgery relies on drawing hope and will from loved ones for support. Music therapy has the ability to eliminate that anxiety in a cheap, safe, and effective manner which could possibly limit complications before and after an operation.

Another systematic review of the effect of music intervention on surgical patients who received music therapy before and/or during surgery found an 8.6% reduction in patient anxiety ($P = .004$) compared to a control group – calculated using STAI scores (Rudin, D. et al., 2007). A study which looked at the use of music therapy during surgery instead of before or after an operation found a significant reduction in state anxiety for burn-care patients receiving a change in dressing (Rohilla, L. et al., 2018). Music therapy is a powerful tool to which can effectively be applied to surgical patients because it is so versatile. MT can be used before, during, or after an operation. The intervention of music with surgical patients is important to promote a healthy and safe environment during the operation and a state of healing after surgery.

V. Music therapy and Pain

Music therapy shows potential to also reduce pain for patients. A significant cause of the rise of the opioid epidemic in the United States was the overprescription of narcotic pain medication. Thus, the results of MT on mitigating pain have potential for reducing the amount of opioid pills needed to be prescribed, reducing the potential abuse of leftover narcotics. Pain is also a source of anxiety for patients before a surgery as they worry about the pain they will experience after the operation. Sendelbach et al. (2003) shows statistically significant decreases in pain ($P = .009$) with patients who received MT for 20 minutes twice a day for three days after the operation. This has since been researched more thoroughly and in a systematic review Kühlmann, AYR., et al. (2018) found a 10% decrease in pain for patients provided with music therapy compared to a control. The experiment done by Rohilla et al. (2018) on burn victims showed that on a scale of 0 (signifying no pain) to 10 (extreme pain), patients who received MT experienced pain at 3 rather than the control, 4.5 (Rohilla L., et al., 2018). Kühlmann, AYR., et al (2018) stated that patients who received MT intervention experienced a 10% in reported pain after a significant surgical operation, but failed to provide a timing in which MT appeared to be most effective. The report also stated that unlike the use of the STAI to measure anxiety – a form which has been peer-reviewed thoroughly and shows a strong ability to diagnose state versus trait anxiety – there is no arbitrary to rate pain. Thus, the risk of bias in the studies is moderate to high. The earlier study done by Sendelbach et al. (2003) did, however, propose a time frame of 20 minutes twice a day for three days after the operation. Days 1 and 2 were shown to have the most drastic effect on pain (Sendelbach, S.E., et al., 2003). Furthermore, Rohilla et al. (2018) displayed the ability of MT to decrease perceived pain in patients undergoing a minor operation when the music was presented before and after the operation. Subjects underwent 30 minutes of music therapy before and after the dressing change and their pain levels were measured before, during, and after the operation. All data points displayed a decrease in pain as time

increased, suggesting that music therapy is also useful for preventing possible pain.

While laboratories and research institutions from around the world are looking to develop the next painkiller we are overlooking an effective resource we have access to right now. It takes about thirty minutes after ingesting an opioid for the pain-relieving effects to take over. In that same time, music therapy can be used strategically as it was in Sendelbach et al. (2003) and Rohilla et al. (2018) to find the same pain-alleviating effects. Music therapy isn't something that can only be found within the ink of a physician's signature on a prescription pad, it is a resource which can reduce surgical patient anxiety, pain, and most importantly, drug reliance.

VI. Music therapy and Opioid Consumption

Music therapy has a very practical use for reducing the prescription of opioids. It is possible that patients could use music therapy to magnify the effects of opioids. A group of researchers in Michigan performed a post-operative study which looked at the consumption of opioids versus the amount of pills prescribed. They published that patients only reported using 30% of the total amount of pills prescribed by their surgeon. On average, patients reported consuming 9 pills out of the total 30 prescribed. The researchers also noted that patients used .53 more pills for every additional pill prescribed (Howard, R., et al., 2018). One cause for the rise of the opioid epidemic in the US was prescribing more pills than a patient needed which lead to either an opioid dependency, or the resale of the pills on the black market. Rohilla et al. (2018) showed that patients who were presented with 30 minutes of music therapy before and after a minor operation to change a burn dressing only used opioids to manage pain at a frequency of 9.6% whereas the control was 34.6% ($P = .002$). Music therapy showed the ability to reduce the intake of opioids for patients by 72.2% (Rohilla, L., et al., 2018). Music therapy is able to treat pain and anxiety in a way opioids and benzodiazepines can, respectively, because of the neurological processes behind music therapy.

VII. The Neurological Mechanisms behind Music Therapy

Music therapy is effective at treating pain and anxiety in surgical patients because of the "feel-good" chemicals released in response. Research collected by Aniruddh Patel, Ph.D., a professor at Harvard University, shows that when the music is presented to a subject, there is activity in the nucleus accumbens. This is a reward center in the brain which uses the neurotransmitter dopamine, a chemical which is responsible for the feeling of happiness. This is the same neurotransmitter which is released when we are kissed, when we play sport, and when we process opioids. This would support the studies done in *The Lancet*, the *British Journal of Medicine*, and the *Journal of Surgical Endoscopy* which correlate music with pain-relieving effects. Music therapy releases dopamine just as painkillers such as Morphine do, helping ease the recovery and anxiety in patients brought on by surgery (Great Courses, 2015).

Music therapy has also been shown to affect neurological development. A team of researchers at the University of Vermont found a strong positive correlation between people (aged 6-18 years) who played music regularly and cortical thinning. Musicians were found to show a faster rate of brain maturation than non musicians (Hudziak, J. et al., 2014). The areas in the frontal cortex which code for inhibition control and emotion developed faster in musicians between the ages of 6 and 18, perhaps enhancing flexible cognitive function, decision making, and fine motor skills. This is an example of the long-term effects than enhancing one's environment with music can have.

VIII. Anecdotal Evidence for Music Therapy

The Joint Commision released their "Pain Management Standards" in 2001 to improve patient satisfaction. What they didn't anticipate was that those same patients would over indulge in the drugs which numbed their pain, bringing on one final symptom: death. Hole et al. (2015) found that patients prefered music therapy to the alternate control. Figure 2, below, displays the reported patient satisfaction when provided music therapy compared to a control shows a strong positive SMD

(standardized mean difference), implicating that patients were very in favor of MT. If statistical evidence for music therapy and its physiological effects aren't conclusive enough to support the adoption of a new model of patient care, thenb the medical community should heed the word of the patient: music therapy is beneficial to all parties.

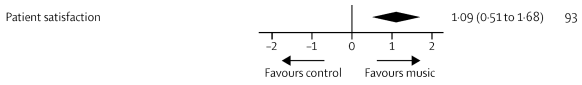

Figure 2: SMD of patient satisfaction reported in Hole et al. (2015)

IX. Discussion and Conclusion

When I was going up I was an avid student, devouring any neuroscience journal I could get my hands on. At the same time I was a musician, a violinist. I was raised in the confines of tradition. If one wanted to be a musician then they must take a conservatory track, hopefully securing an orchestral seat after graduation. If one wanted to be a doctor then they would take a university pre-med track going onto medical school and eventually, residency. Social biases towards the separation of music and science carry on to a professional environment as well. Physicians are too quick to reach for their prescription pad and write of another ambiguous medication for a problem which doesn't warrant it. Why wouldn't they? If a patient complains about a pain then why wouldn't the responsible doctor aid them with a drug which numbs that pain? It is only a logical practice of medicine. Pills and drugs treat symptoms at a micro level. They focus on molecular manipulation, and sometimes drugs only numb a larger issue. The future of medical care should consider treating one's environment instead. The resistance to adopt such a system stems from the refusal of science to adopt a delicate form of art such as music. I am here to argue for the rebellion of music in science.

Long stood are the traditions between music and science. Undoubtedly, this separation between art and science has led to exponential growth in both fields. In an era where borders are becoming evermore fluid it is time to redefine the place of music in medicine. Furthermore, opioids terrorizing their way through our nation call for alternatives in pain management. Since the turn of the

millennium opioids have claimed 165,000 lives. The use of music therapy has shown extensive benefits to reducing anxiety, pain, and patient experience in surgical operations. It is time we use music therapy to revolutionize the patient experience. Music is not exclusive for conservatory musicians and medicine isn't an exclusive space for surgeons and staff

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