Team Remember Me

Evangelia Tripolitis
Oluwaferanmi Adeyemo
Grant Ashby
Jeffrey Coy
Klest Sula
Jake Burgholzer

Alzheimer's Disease is growing like no other disease of our time. The disease is already a top priority for our nation and the number of Americans affected by it is only increasing. This number is expected to quadruple to over 13 million by the year 2050, which will make it an unavoidable issue for our nation. And as a group, that is an issue we want to address. We want to focus on a small sector of the disease in an effort to make a difference for patients by making their disease more manageable. All of the most promising current solutions to this problem are based around the concept of music therapy which has been supported by countless scientific articles and shows an incredible amount of potential in terms of reversing or slowing the decline of patients. Due to these findings, our group would like to propose a product that uses the concepts of music therapy in a new and innovative way in an attempt to boost its effectiveness. Our product would take the form of a wristband with biofeedback sensors that detects the heartbeat of the wearer. Previous research has shown a strong correlation between a sharply increased heart rate and agitation among all ages. In order to help calm the patient down, our product would begin playing music for the patient as soon as it detected such an increase. This would ideally divert the patient's attention and thus calm them down and reduce their stress levels. Our group would like to start small-scale by focusing on Alzheimer's patients in Atlanta as this would allow for easy implementation and monitoring of our product. We are also working to keep the cost of this product as low as possible.

Furthermore, dementia diagnosis is on the rise all over the world. It is expected that one third of the people born in Britain in 2015 will be diagnosed with some form of dementia, Alzheimer's being the most common. This is especially concerning because Alzheimer's is currently the only top 10 cause of death in America that can not be cured or even slowed, taking millions of lives and causing grief amongst millions of families. There are 5.2 million people suffering from the disease now, and this is expected to increase by 40% within the next 9 years. Alzheimer's is already so prevalent that it is rare to meet someone who has not been affected by the disease in some way. While the disease has the most obvious and devastating impact on the patient themselves it also causes a lot of stress for friends and family who can do nothing but sit by and watch as their loved one deteriorates into a shadow of their former self.

The stigma surrounding Alzheimer's makes the disease even more difficult to deal with. Patients are often treated as though they lack basic skills and cannot do or understand anything on their own. They are almost expected to have breakdowns at any point and this causes people to alter their behavior around them in a way that infantilizes and almost dehumanizes the patients, causing them to feel like a nuisance. Children who watch their elders treated in such a manner begin to lose respect for the elderly, causing them to lose their status as beacons of wisdom and instead be viewed as unintelligent and senile. However, despite the memory loss associated with the disease, the patients are still aware that they are adults and it is frustrating for them when they are not treated correctly. The pain caused by this treatment often drives patients to depression and adds additional difficulties to the existing symptoms they are already struggling with. However, this also leads to a reluctance to ask for help when they truly need it because the patients do not want to perpetuate the notion that they are unable to do things on their own anymore.

Since Alzheimer's is such a large national problem there is understandably a substantial amount of money allocated towards solving it. The US government sets aside over $100 billion annually for Alzheimer's treatment and research, $226 billion including other forms of dementias. This number is expected to rise to $1.1 trillion by 2050. However the national government is not the only one that is affected financially by Alzheimer's. It costs businesses almost $60 billion annually due to loss of productivity and lack of attendance from primary caregivers in addition to insurance costs. An estimated 17.9 billion unpaid hours are spent caring for Alzheimer's patients. 41% of these caregivers have an income under $50,000 a year. Their contributions to patients have an estimated value of $217.7 billion. Caring for these patients takes a large toll on the families and caregivers as well with 40% suffering from depression and paying an additional $9.7 billion in additional healthcare for themselves.

Despite the vast amount of money spent on Alzheimer's, not too much is known about what causes the disease and how we can prevent it. What we do know is that it is caused by the death of cells in the brain, and is a neurodegenerative disease. The characteristic unavoidable warning signs of the disease that have been observed include age, family history, and the presence of the APOE gene. Other potential factors that increase the risk of getting the disease include diabetes, high cholesterol, high blood pressure (all increase vascular risk), prior head injury, sleep disorders, environment and obesity. There is a large amount of research that suggests these all contribute to Alzheimer's however the only definitive cause that has been identified is simple genetics especially in early onset Alzheimer's (earlier than 65).

How little we have actually been able to discover about the workings of Alzheimer's clearly shows that this is a problem that needs to be addressed much more seriously and urgently than it is being currently. The standard approaches for ensuring the comfort of the patients and

families are rather lackluster and simply focus on trying to control the patient with no real hope for a reversal of any of the effects of the disease. If a method to do exactly this or even simply a way to prevent or drastically slow further decline were discovered, our society as a whole would be much better off. The money the country spends on treatment and that businesses lose because of Alzheimer's could be put towards other pressing issues and the quality of life for millions of people and their families would dramatically improve.

While this would have a very broad effect on all of society our problem space is quite important to people who may be suffering from the effects of Alzheimer's disease. As a group, they would be the ones most directly affected by any developments made on any form of solution to the problem we have chosen to focus on including our own proposal. We believe that they would be very receptive and enthusiastic about our product seeing as its intended purpose is to help them live more enjoyable lives day to day and slow and ideally prevent any further mental decline in patients which lines up with their hopes fairly well. It is hard to imagine anyone suffering from Alzheimer's disease that would not be excited about any chance at improving their condition considering how completely it can ruin their lives. They would also likely want a solution that is fairly low cost seeing as if it was not the vast majority would not be able to afford it and it would do nothing to change their lives in any way since they would have no way of accessing it. However our solution is also designed to be very low cost and affordable for exactly this reason. We do not want something trivial like money stand in the way of a potential improvement to their health that could dramatically improve their quality of life. Another concern of the patients would most likely be how user friendly the device is seeing as it would be very difficult for them to operate and use anything that is high tech due to the difficulties associated with any memory loss disease like Alzheimer's. We have also taken this into account by making a device with a very minimalist design that has as few buttons as possible, no screen, and practically operates on its own without any need for input from the user aside from automatically tracked heart rate.

The families of the patients of Alzheimer's disease would be the next most directly affected by our proposed solution. They have to deal with the "loss" of a loved one as they watch them slowly fade into a shell of their former self and forget who they even are. This is a very difficult thing to deal with and we are sure that the families of anyone afflicted with this terrible disease would be very open and welcoming to any potential solution that could alleviate some of the suffering of their loved one as well as slow their decline so they could be mentally present for a longer time. Similarly to the actual patients the families would also want the solution to be low cost since they would most likely be the ones buying the device for their family member and might not be able to spare a large sum of money for a potential solution when they have bills to pay and mouths to feed. Simply keeping the affected patients in homes or treatment facilities can often be very expensive so any additional costs on top of these for extra treatment devices would

have to be very minor in order to be effective on a large scale. Families often give in to desperation when dealing with these kinds of situations so on the whole they would be very excited to give any new potential solution a try in the hopes of finding something that can help bring back or save a person they love.

Another very important stakeholder that is interested in developments in our solution space are the organizations and communities that house patients with Alzheimer's disease. Their purpose is to keep the patients as healthy as they can for as long as the can which means that they would be very open to any innovations in therapy or treatment as long as they are cheap and effective. Centers that we visited and talked to such as The Fountainview Center already use many forms of alternative treatment including music therapy and would be open to advances in this and other areas of treatment. The top priority for these homes and facilities is to ensure the health and happiness of their patients, so anything that could help with that is naturally a desired development for them. Naturally there will be skepticism but the majority of people working in the field of Alzheimer's would love nothing more than to see a smile on their patients' face and as a result would be willing to give any promising new developments a shot. One more broad but no less important stakeholder is the American Alzheimer's Association. The association's main mission is to further research to end Alzheimer's disease while simultaneously trying to improve the quality of care provided to patients until a cure is found. From this alone it is fairly evident that they would advocate any treatment or therapy that has the potential to improve the quality of life for patients. Remember Me is just a stepping stone towards the ultimate goal of removing the problem of Alzheimer's from this world.

Alzheimer's disease has plagued millions of individuals from the age of thirty onwards and over four million Americans are currently suffering from it. Alzheimer's has devastating effects on the quality of life of patients and the current standard of care is not enough to even come close to alleviating all the stress that patients are put through. However, the effects of the disease are not limited to the individual who has it but are also felt by their families and caregivers. They must also deal with the burdens and stress that come with this disease. Thus, as a team, our goal is to improve the quality of life for Alzheimer's patients in stages 3 and 4 through low tech, easy-to-use, and affordable means in the Atlanta area. The Alzheimer's Foundation of America is dedicated to a similar cause and their mission is to provide optimal services to all individuals confronting dementia and to their families and caregivers and minimize the impact that the disease has on the bonds between families. They are looking into using music therapy in order to achieve these goals. The Alzheimer's Foundation introduced this concept in 2005 and have conducted numerous studies and extensive research for over a decade since with promising results.

Music affects people's moods in an extraordinary way by inducing distinct emotions and potentially bringing back old memories. It can spark compelling outcomes even in patients who are in the later stages of the disease. If music which has been personalized to the unique experiences of each individual is played it has the ability to relieve stress-induced agitation and even ease cognitive function. This happens because "rhythmic and other well- rehearsed responses require little to no cognitive or mental processing" allowing the motor center of the brain that responds to the auditory rhythmic cues takes over. This means that all individuals, regardless of what stage of the disease they are in, have the capacity to engage their minds through simply listening to music. People have a tendency to associate music with both events in their life and a variety of emotions which is why hearing a tune long after a specific event or occurrence often evokes that memory of it. This is the simplified concept behind music therapy.

Another promising solution is the Simple Music Player for Dementia. This is a music player that was designed to be as easy as possible to operate since people with Alzheimer's and other forms of dementia often have difficulty operating modern equipment. "Extensive trials have verified that the operation is highly intuitive and does not require any prior knowledge or memory to start and stop the player." This device is an attempt to better integrate music therapy into the day to day lives of patients in a way that does not feel like they are having to undergo therapy at all. It allows them to treat themselves to some extent.

Even though these solutions are incredible, they each have their own flaws that have prevented them from truly making an impact. Even though music therapy is being implemented and shows a lot of promise, there is no device on the market that is a viable option to treat a large number of patients in this way. The major drawback to the Simple Music Player that has prevented it from becoming a staple for Alzheimer's patients is its price. At $179 for a device that just plays music it is a very tough sell to skeptical consumers.

However, our team has developed a novel way to implement the technique of music therapy through an affordable device that ideally will not cost over forty dollars. We plan making a wearable device that is capable of playing a personalized selection of music for each patient. We also plan on implementing biosensors as well as a way to store data from these biosensors so it can be used in further research.

We hope that our solution can have a significant impact on the treatment of the disease since it is still such a large problem. There are currently, 5.3 million people diagnosed with Alzheimer's in the United States alone. This number is expected to rise to over 9 million by 2030 and over 16 million by 2050. This rate shows no signs of slowing down and is in fact increasing as advancements in other areas of healthcare cause the older population to increase. In addition, only about 45% of cases are diagnosed, so these numbers are actually significantly higher than

they are shown to be. The cost of Alzheimer's is following a similar upward trend. In 2015, the cost of care was 226 billion dollars and this number is expected to rise over 1.1 trillion by 2050. Most everyone currently working on Alzheimer's is dedicated to find a medicinal cure since this is the easiest to get funding for as it produces tangible results in the form of a drug that either does or does not work. Additionally Medicare does not cover anything that is not medicinal. The lack of funding for alternative care options is a large obstacle for anyone hoping to treat the disease in less conventional yet still perfectly valid ways. This is an obstacle that we ourselves must overcome if we hope to be successful which is why we have dedicated ourselves to making sure our solution is as low cost as possible.

One of, if not the single largest, objective our group hopes to accomplish is to produce a viable physical product. This product does not need to be any more than a simple prototype that will aid in indicating that our group has a feasible solution for this grand challenge. This prototype only needs to have the base functionality that we have defined for our solution. This means that it must be capable of analyzing a person's bodily conditions and start playing music when it detects that they are agitated. The simplicity of the product is key in relation to not agitating the patients.

There are many different facets to accomplishing this task. The most difficult part to complete is writing the code for a band that would constantly monitor a patient's condition and activate on its own when a certain combination of signals are received. The initial step towards accomplishing this will be acquiring a biofeedback wristband that can potentially run its own diagnostics on a patient. There are a wide variety of devices on the market today that are capable of doing this however the devices themselves do nothing to analyze all the data they collect. After being gathered it is either stored and uploaded to a computer to be analyzed or synced with an application on a smartphone via Bluetooth that can similarly analyze the data. There are, however, patents for products that contain biofeedback processors within watches or bracelets. By taking one of these devices and altering the coding slightly, our group can potentially find biomarkers that would trigger an action. In our case the playing of the patient's preferred music would be this action. In addition to this, we will integrate an mp3 music player into our device that will be able to store music and play songs that have been previously selected by the patient and/or their family.

In order to help ourselves accomplish this task we have decided to break it down into smaller subunits. The first of which would be obtaining a biosensing wristband that we could break down into its components. We could either code it ourselves and produce a final prototype at a very low cost or we can request funding from grand challenges to purchase an existing band and work on altering its basic functionality and code so that it does what we want it to. The next step should be quite a bit easier; we will have to establish a program that can store songs on the

device and upon being activated can play these songs on shuffle and then shut off once the patient's physical indicators return back to their normal states. One of the issues we expect to face with regard to the actual coding of the band is that our group only has one computer science major and the language required for creating the interface between the biosensors and the reading is likely to be a language that he has no experience with. Due to this, he will have to learn an entirely new coding language and hope there is a quick learning curve in order to produce any sort of product in the time frame we desire. This combined with the fact that our project is very coding oriented has led our group to believe that we may have to gain a group member who has some computer science or coding experience to work with Klest, our Computer Science major.

Another goal is to come up with a design for the physical appearance of the device. What will make this difficult is that we have to make sure that the device has at least an extra 2 gigabytes of storage space so it can download a well sized library of music. We must also decide how we want to power the device. One option is to simply purchase one of the preexisting devices that use modern watch batteries to power the device. However we will most likely use some type of battery that will require charging every few days at least. This means that it will need to have an input for a charging port so the nurses or patients themselves can plug it in at night so it can recharge.

Another potentially difficult component we want to add is a headphone jack. This way patients would be able to listen to their own music without disturbing others around them. We will also add a simple play/pause button on top of the device so patients have the option to listen to music on their own even when they are not feeling stressed. We believe that in addition to making the wristband more desireable, this feature will help prevent the patients from associating the music that plays with stressful emotions since it will always start playing when they are stressed. The last feature we want to add is a simple volume change button on the side. One of the big goals our team has is to keep this product as low-tech and easy-to-use as possible in order to allow patients in a variety of stages of Alzheimer's to use it rather than just targeting one of the seven stages.

Another problem that our group anticipates is keeping the total cost of our prototype as low as possible. Given the current price tags on biofeedback bracelets/watches this could prove to be a defining part of our final device. One option our team has to lower that cost is to pair with a company who currently produces these wristbands, but finding a company who would like to work with us and donate materials will be a challenge of its own. The next problem our group is facing is the feasibility of using a Bluetooth connection to headphones instead of a headphone jack to play the music. One massive potential benefit of using Bluetooth is that the band would be able to link with hearing aids that many patients are already wearing and play music through them which would make it much more comfortable and practical. However if we decide to

implement this it will make it even harder than it already is to keep the cost down. If we succeed in completing this objective we will have correct working code as well as a physical device that functions as intended with the code provided. Failure would be either an inability to produce the physical product, difficulty with our code, or some combination of the two.

As a team, we will utilize the specialized skillsets each one of us has related to our majors to incorporate knowledge on how to make the best bracelet possible. We have a wide range of majors that include chemical engineering, computer science, aerospace engineering, civil engineering, and also biomedical engineering. With our abilities, we will help and collaborate with each other in order to create the end product. Since Klest is our computer scientist, he will be able to help figure out what necessary coding may be needed in order to see this device come to life. During the entire semester, we each had distinct roles as well. In the beginning, Grant proposed the idea of investigating Alzheimer's and its effects on families. Klest and Jeff focused on gathering some ideas of places that we could possibly visit. Evie and Jake researched did plenty of research on what aspect of the problem we could possibly focus on and have a major impact in. Feranmi was our main source of communication. She sent emails to anyone we needed to get into contact with. In addition, as a team we have decided to bring in an electrical engineering student who can help us figure out the most efficient materials we need for this product. Also, his or her knowledge will guide us towards the right structure to accomplish what we are envisioning. Thankfully, every single member will be continuing Grand Challenges this upcoming school year. Having a diverse set of majors in our team will provide room for creativity and allow us to supplement each other's knowledge gaps with the necessary information that not everyone has. We are incredibly excited to see where this project will go and are a dedicated team that is willing to collaborate and make sacrifices in order to see this dream come to life.

Budget

<u>Material and Supplies</u>
3 Watch bands - $60
    For prototype
Screws - $50
    For prototype
Circuit Boards- $100

3 Ipod Shuffles - $120
Bluetooth Headphones - $50

Equipment

Screwdriver Set - $20

For deconstructing Ipod Shuffles and for prototype assembly

Services

20 (per trial) Human Trial Participants - $1000 (per trial)

Total of 3 trials

Travel

No travel Needed

All in all, our expected outcome is to improve the lives of Alzheimer patients through the use of our bracelet. We want to improve the quality of life for stages 3 to 4 of Alzheimer's patients through low tech, easy-to-use, and affordable means in the Atlanta area. We are confident in our abilities and know that this will be accomplished with hard work and dedication.

The majority of products made for Alzheimer's patients are based on the concept of simplicity. Producers want to do everything they can to bring comfort to and satisfy the needs of the patients without causing them any further agitation. Existing products range from soft, touch activated massage pillows to radios that play upon being lifted. Producers try to reduce the amounts of functions and buttons controlled by the patient, thereby reducing the amount of effort they need to put in to get results.

Our method hopes to combine these two goals in making a music therapy device that plays to comfort the patient based off of a biosensor and also has a play button so music can be listened to for leisure or if the need is felt by the patient and not by the sensor. We also plan to work with the option of audible music, since often agitated patients are separated from the population, and work with linking hearing aids, since majority of Alzheimer's patients are over 65 and hearing loss is very common with aging.

While there are a lot of options as far as the form of our device we opted for a wristband style for many reasons. The first and foremost of which is that a device worn around the wrist would be able to monitor a variety of biosignals much more easily than a necklace, ear piece, or any other piece of equipment. Secondly we believe that a wristband is one of the least intrusive accessories for elderly people since a majority of them have watches or have worn watches at some point. This is important because we need to make sure they are as comfortable as possible and our product does not cause them to feel agitated in any way since that is exactly the opposite of what it is supposed to do. Additionally having the device on their wrist allows for easy access so they can start and stop the music or adjust the volume whenever they want. Despite all these

reasons we would still like to do tests on patients to ensure that they would not be bothered by having to wear a wristband all day as their comfort is essential to the success of our project.

We hope that the outcome of our product will be a simple way to use music therapy regularly for help in memory retention and agitation reduction. The music played relaxes the patients in addition to reminding them of their youth. It is often found that Alzheimer's patients remember their youth and only forget their more recent memories which is why music therapy focuses on playing music from the patient's youth. Commonly when they refer to going home, they are referring to their childhood home. The music from this time helps spark these youthful memories and keep them fresh in the patient's mind.

Anticipated problems include the use of technology being too agitating, even if it is a very simple device. Another anticipated problem with our product is the tradeoff between having a fully automated product, eliminating the need for buttons and any action aside from wearing it, and having control in the form of a simple play button which would allow the patients to be able to play the music whenever they wanted. However this could cause problems with patients accidentally playing music.

Despite these minor problems related to our proposed solution, the main goal is to make our product low cost. Through extensive research and watching the documentary, Alive Inside, we came to the conclusion that the ideal price for the product is under forty dollars. In the documentary, the main issue was that it required a forty dollar donation per product which seemed to turn off a lot of future donors to the cause. Because of this our main goal for our project as Remember Me is to create a low cost, highly efficient product to help alleviate stress. Currently, this is being done by simplifying the technology used in the product as well as trying to get the government to cover part of the costs through Medicare.

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