

## **Thesis Project Portfolio**

### **The Use of Acoustic Stimulation to Increase Slow-wave Activity in Alzheimer's Disease Patients**

(Technical Report)

### **Should Chemotherapy Continue to be Used as Treatment for Cancer?**

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science  
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In Fulfillment of the Requirements for the Degree  
Bachelor of Science, School of Engineering

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## **Executive Summary**

### *Technical Project*

Alzheimer's disease (AD) progressively affects patients' memory, thinking, and behavior, and is a degenerative brain disease that affects 6.7 million (10.7%, or 1 in 9) Americans over the age of 65, with this percentage increasing with age (Alzheimer's Association, 2023). This debilitating disease kills more people than breast and prostate cancer combined, with the number of deaths doubled between 2000 and 2019. Although the pharmaceutical industry offers available treatments, they only minimize the symptoms as the disease progresses and do not provide a cure (NIH National Institute of Aging (NIA), 2023). Literature indicates that decreased cerebrospinal fluid (CSF) activity in the brain due to disrupted sleep cycles with age is a contributing factor to Alzheimer's disease. CSF, correlated with deep sleep, removes waste in the form of amyloid-beta plaques and tau tangles. Plaques can build up within the brain, leading to slower connections and a loss of brain function (Han et al., 2021). The first stage is mild cognitive impairment (MCI) due to Alzheimer's disease, where patients experience very mild symptoms that generally don't interfere with everyday activities. To tackle this issue, auditory stimulation during sleep is a promising therapy, as it increases slow wave activity (SWA) in older adults with MCI (Papalambros, 2019). SWA, which occurs during nREM sleep, is also associated with memory consolidation (Born, 2010). For our technical project, we aimed to increase CSF activity by delivering auditory stimulation to the brain during sleep to amplify slow waves, which would clear the plaques that contribute to Alzheimer's disease.

### *STS Research Paper*

In the US, cancer ranks as the second leading cause of death after heart disease. For 2023, it is estimated that over 1.9 million new cases of cancer will be diagnosed, with an expected

609,820 deaths, or approximately 1,670 deaths per day (American Cancer Society, 2009). Cancer is a group of diseases characterized by the uncontrolled growth and spread of abnormal cells that can result in death if left untreated. One of the most common treatments for cancer is chemotherapy, which destroys fast-growing cells in the body. However, since it is not specific to its targets, it can cause damage to healthy, fast-growing cells as well, resulting in adverse reactions or side effects (Johns Hopkins Medicine, 2023). Due to the varying response of each person's body to treatment, it is also challenging for doctors to predict how the body will react. My STS research paper aims to examine the history of chemotherapy and explore alternative cancer treatments that could potentially reduce the physical, mental, and emotional toll on cancer patients and their caretakers. The analysis will include case studies and personal anecdotes, as well as statistics and historical data to provide a comprehensive view of the issue.

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