

Advances in medications and treatments for reducing memory loss in Alzheimer's disease

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Abstract. Alzheimer's disease (ad) is a disease in which brain cells deteriorate, leading to dementia and cognitive decline. It is mainly caused by cholinergic functional problems and the accumulation of amyloid plaques in the brain. Age, genetics, head damage, vascular disease, infection and environmental factors can also cause the disease. Currently, only two drugs have been approved for the treatment of Alzheimer's disease, but they only target symptoms and cannot cure or prevent the disease. Ongoing research aims to better understand Alzheimer's disease and develop treatments that can slow or change its progress in response to mechanisms such as beta-amyloid plaques, inflammation and cholinergic dysfunction with abnormal tau metabolism. The focus of this review is on current drug therapy and the causes of Alzheimer's disease, including those that change the disease, as a partner, or use natural compounds.

Keywords: Alzheimer's disease(ad), Beta-amyloid plaques, Inflammation, Cholinergic dysfunction.

1. Introduction

Alzheimer's disease is a progressive degenerative brain disorder that primarily affects memory, thinking, and behavior. It is one of the leading causes of dementia and affects millions of individuals worldwide. Over the years, significant advancements have been made in understanding the disease and developing drugs and treatments to reduce memory loss in Alzheimer's. Slowing memory decline is important because it can positively impact an individual's quality of life, functional abilities, mental well-being, relationships and social engagement, rehabilitation and recovery, healthcare costs, and research advancements. It helps individuals maintain cognitive abilities, independence, and overall well-being. Studying methods to slow memory decline is crucial in addressing the challenges associated with cognitive impairment [1-4].

2. Alzheimer's Disease and Memory Loss

Alzheimer's disease (AD) is a neurodegenerative disease characterized by progressive memory loss and cognitive decline. This is the most common form of dementia. Alzheimer's disease is characterized by

the formation of plaques and tangles in the brain. Plaques are clumps of an abnormal protein called beta-amyloid that pile up between nerve cells, while tangles are twisted fibers of another protein called tau that pile up inside cells. These plaques and tangles disrupt communication between neurons, resulting in the loss of brain cells and impaired function of various brain regions. The progression of Alzheimer's disease is divided into mild cognitive impairment (MCI), mild AD, moderate AD, and severe AD. In the early stages, individuals may experience memory loss, and as the condition progresses, the memory impairment becomes more severe, affecting the ability to recall recent events, recognize familiar faces or objects, and engage in conversation.

The progressive nature of memory loss in AD has significant implications for daily living. In the early stages, individuals may require reminders for appointments or assistance with organizing daily tasks. As memory decline worsens, more support is needed to ensure medication adherence, personal hygiene, and maintaining a safe living environment. Ultimately, patients may struggle to recognize their loved ones, remember their own identity, and perform basic self-care activities. The impact extends beyond memory loss, affecting other cognitive functions such as language, problem-solving, and judgment. Individuals may become disoriented, have difficulty following directions, and experience personality and behavioral changes. AD can also lead to challenges in social interactions and withdrawal from previously enjoyed activities.

The causes and mechanisms of memory decline in Alzheimer's disease are unknown, but various factors are thought to contribute to its development. Genetic factors play a role, with certain mutations in genes such as APP, PSEN1 and PSEN2 increasing the risk of developing AD. However, most cases are sporadic and may involve a combination of genetic, environmental and lifestyle factors. In Alzheimer's disease, the accumulation of beta-amyloid plaques and tangles of tau protein disrupts the normal function of neurons. Beta-amyloid is thought to disrupt synaptic communication between neurons, leading to memory and cognitive impairments. Tau tangles, on the other hand, contribute to the destruction of microtubules, which are basic structures for cell transport and support. In addition, neuroinflammation, oxidative stress, and dysfunction of neurotransmitters such as acetylcholine are thought to play a role in memory decline in Alzheimer's disease. These mechanisms lead to progressive degeneration of brain cells and an overall decline in memory function in AD patients [5-6] (Figure 1).

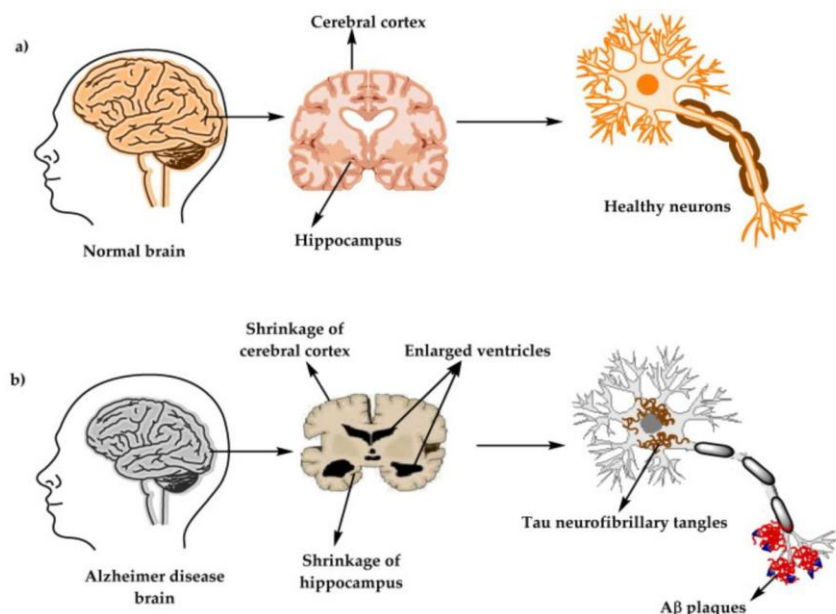


Figure 1. Differences between normal brain and Alzheimer disease brain

3. Current Approaches to Memory Loss Management

Current approaches to memory loss management include cholinesterase inhibitors and NMDA receptor antagonists

3.1. Cholinesterase Inhibitors

Cholinesterase inhibitors are a class of drugs that block the activity of acetylcholinesterase. This enzyme is responsible for breaking down the neurotransmitter acetylcholine in the nervous system. By inhibiting this enzyme, cholinesterase inhibitors increase the level of acetylcholine in the brain, which improves cognitive function, memory, and overall brain activity. These drugs are often used to treat Alzheimer's disease because the disease is characterized by a deficiency of acetylcholine in the brain.

3.2. NMDA Receptor Antagonists

NMDA receptor antagonists are a class of drugs that block the activity of N-methyl-D-aspartate (NMDA) receptors. The NMDA receptor is a glutamate receptor involved in synaptic plasticity, learning and memory formation. By blocking NMDA receptors, these antagonists regulate levels of glutamate, an excitatory neurotransmitter, in the brain. NMDA receptor antagonists have been studied for potential therapeutic use in a variety of diseases, including Alzheimer's disease, depression, and neuropathic pain [7-8] (Figure 2).

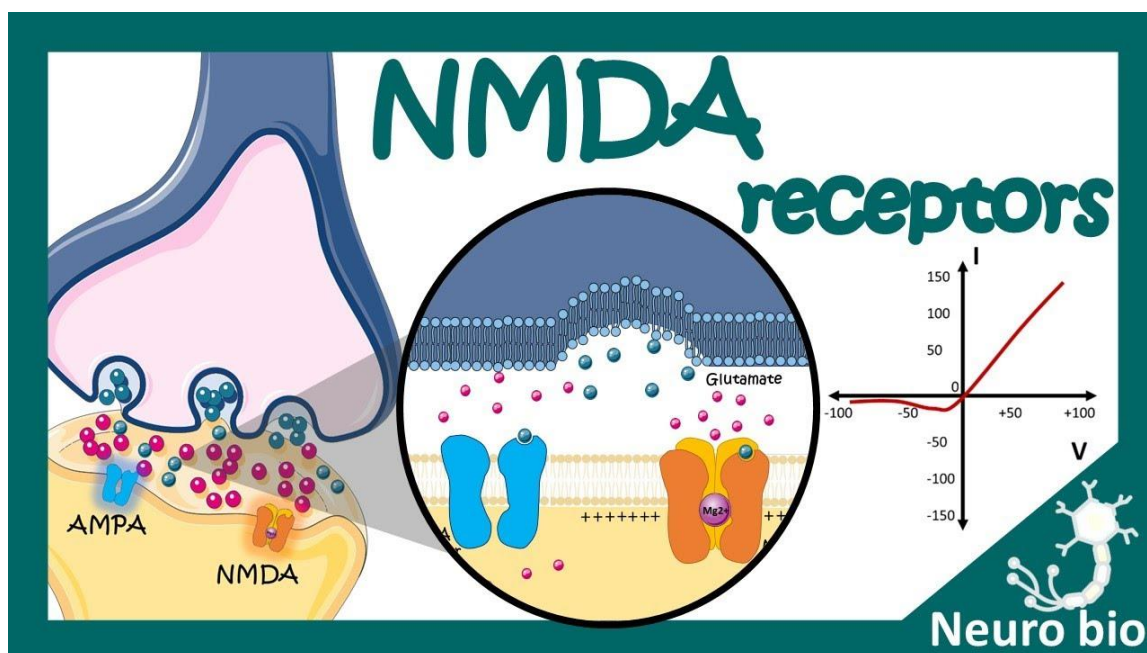


Figure 2. NMDA receptors

4. Emerging Therapies and Experimental Treatments

There are several emerging and experimental treatments for Alzheimer's disease that are being explored.

1. Immunotherapy: This approach involves developing drugs that target and remove abnormal proteins, such as beta-amyloid, that build up in the brains of people with Alzheimer's disease. These drugs help stimulate the body's immune system to clear these proteins from the brain.

2. Gene therapy: Scientists are exploring the use of gene therapy to potentially modify or replace defective genes linked to Alzheimer's disease. This approach aims to restore the normal function of the affected genes and slow or stop the progression of the disease.

3. Stem cell therapy: Stem cells have the potential to develop into different cell types, and scientists are investigating using them to replace damaged brain cells in Alzheimer's patients. Stem cell therapy may help restore cognitive function and slow the progression of the disease.

4. **Tau targeted therapy:** Tau is another protein that accumulates in the brains of Alzheimer's patients. Researchers are developing drugs that target tau tangles to prevent their accumulation and subsequent damage to brain cells.

5. **Reduce inflammation:** Chronic inflammation in the brain has been linked to the development of Alzheimer's disease. Researchers are studying drugs and interventions that can reduce inflammation to potentially slow the disease.

6. **Cognitive training:** Cognitive training programs involve engaging individuals in mental exercises and activities to improve cognitive abilities. Research suggests that these interventions may help slow the cognitive decline associated with Alzheimer's disease.

7. **Lifestyle changes:** Certain lifestyle changes, such as regular physical exercise and maintaining a healthy diet. These have been linked to a reduced risk of Alzheimer's disease. These approaches are being further explored for their potential therapeutic benefits. ll experimental and require further research and testing to determine their safety and effectiveness [9].

5. Multimodal Approaches and Personalized Medicine

Multimodal interventions in memory loss management involve combining pharmacological (medication-based) and non-pharmacological strategies to address cognitive deficits comprehensively. For Alzheimer's disease, pharmacological approaches include cholinesterase inhibitors that raise acetylcholine levels, and NMDA receptor antagonists like memantine regulating glutamate. Non-pharmacological strategies encompass cognitive stimulation, physical exercise, nutritious diets, social engagement, sleep optimization, stress management, cognitive rehabilitation, and environmental modifications. These approaches counteract the multifaceted causes of memory loss.

The synergy between pharmacological and non-pharmacological methods enhances outcomes. Medications provide a cognitive base, while lifestyle changes bolster brain health. This blend minimizes medication side effects and improves the overall quality of life. However, intervention efficacy varies based on individual health and causative factors. Consulting healthcare professionals is vital for personalized, evidence-based plans. Overall, these combined strategies offer a holistic approach to memory loss management, addressing its multifaceted nature and yielding potential benefits for cognitive function and well-being.

Personalized medicine, or precision medicine, tailors medical care to an individual's genetic makeup, environment, and lifestyle for effective treatments. It's especially relevant in genetics, oncology, and neurology, where individual variations impact disease susceptibility, progression, and treatment response. In memory loss and cognitive impairment contexts:

1. **Genetic Profiling:** Genetic testing identifies gene variants linked to memory disorders, aiding early detection and personalized prevention strategies.

2. **Biomarker Assessment:** Biomarkers like amyloid and tau levels gauge disease progression, shaping personalized treatment plans.

3. **Pharmacogenomics:** Genetic analysis predicts drug responses, reducing adverse reactions and guiding medication choices.

4. **Cognitive Profiling:** Identifying cognitive strengths and weaknesses customizes rehabilitation programs.

5. **Lifestyle Factors:** Tailoring interventions to a person's lifestyle, environment, and preferences maximizes efficacy.

6. **Data Integration:** AI and data analysis combine genetic, medical, and lifestyle data to offer personalized treatment recommendations.

7. **Longitudinal Monitoring:** Ongoing assessment adjusts treatments based on individual responses.

8. **Ethical Considerations:** Protecting sensitive data and ensuring informed consent are paramount.

Despite its potential, challenges include standardization, regulations, evidence for efficacy, and accessibility to advanced diagnostics. As these obstacles are addressed, personalized medicine promises targeted and effective interventions for memory loss and cognitive decline.

Numerous studies have explored synergistic effects from combining treatments to enhance outcomes, including memory loss and cognitive impairment. Some notable studies are:

1. FINGER Study: This study, published in *Alzheimer's & Dementia* (2015), investigated a multimodal intervention for cognitive decline risk. Combining dietary guidance, exercise, cognitive training, and risk management, it positively impacted cognitive performance in older adults.

2. MAPT Study: Published in the *Journal of Alzheimer's Disease* (2018), this trial examined antioxidant supplementation, exercise, and cognitive training in mild cognitive impairment. Results indicated that combined interventions improved cognitive outcomes.

3. SNIFF Study: The *Alzheimer's & Dementia*-published SNIFF study (2011) explored intranasal insulin with cognitive training for mild cognitive impairment. Findings revealed improved memory and cognition with the combination.

4. MIND Diet and Physical Activity Study: This *Diabetologia*-published study (2016) focused on type 2 diabetes patients, combining the MIND diet and supervised exercise. Positive cognitive effects were observed, indicating a synergistic diet-exercise impact.

5. MAP Study: Published in *JAMA* (2015), this study evaluated omega-3 fatty acids and lutein/zeaxanthin supplementation in older adults with mild cognitive impairment. The combined supplementation correlated with improved cognitive performance.

These studies showcase the potential benefits of combining interventions like dietary changes, cognitive training, exercise, and supplementation to enhance cognitive outcomes. However, individual responses vary, necessitating further research to validate these approaches. Consulting healthcare professionals before implementing interventions is essential for safety and tailored strategies [10-11].

6. Future Directions and Implications

Reducing memory loss in Alzheimer's disease offers far-reaching benefits. Enhanced well-being, prolonged independence, and improved quality of life result from preserved memory function. Addressing memory deficits fosters functional autonomy, alleviates caregiver burden, and fosters meaningful communication. Mood, social engagement, and overall health benefit, impacting individuals and caregivers positively. Contributions to research and clinical trials arise from improved cognitive abilities, fostering treatment development. Societally, lowered healthcare costs and enhanced productivity stem from reduced cognitive decline. By combining pharmacological, cognitive, lifestyle, and caregiver approaches, memory loss reduction not only benefits individuals but also shapes disease progression and societal outcomes.

Continued research and collaboration are vital in addressing memory loss and cognitive impairment. Research deepens our understanding of the causes and mechanisms of neurodegenerative conditions, guiding interventions. Collaborative efforts facilitate innovative approaches and novel therapies. Optimizing treatments, especially personalized ones, is achieved by collecting diverse patient data. Rigorous research ensures safe and effective interventions. Timing and complexity are addressed through interdisciplinary collaboration, accelerating progress and encouraging innovation. This global impact fosters solutions benefiting diverse populations. Moreover, research educates professionals, caregivers, and the public, reducing stigma and promoting early diagnosis. Ultimately, ongoing research and collaboration drive the development of interventions that enhance the lives of those affected by memory loss and cognitive impairment, offering hope for the future [12-15].

7. Conclusion

Alzheimer's disease (AD) is a worldwide health concern that has led to the revision of diagnostic criteria. The current focus of AD treatment is mainly on managing symptoms rather than altering the disease's progression. Medications such as cholinesterase inhibitors and memantine can improve memory and alertness but do not stop the disease from advancing. Lifestyle changes, including diet and exercise, have shown potential in improving brain health and reducing the risk of AD. However, many drugs being tested in clinical trials targeting the pathological features of AD have not been successful. Researchers are also exploring other potential therapies, such as chaperones and natural extracts from

Chinese medicine. Early initiation of treatment and the use of biomarkers to monitor disease progression are vital for effectively managing AD. The diagnostic process has expanded to include the early stages of the disease and mild cognitive impairment, with additional diagnostic tests available. Nevertheless, current treatment options for AD focus on providing support and alleviating symptoms. Lifestyle modifications are recommended as the initial intervention for all patients. More research and the development of effective strategies for early detection and treatment of AD are urgently needed.

In conclusion, it is crucial to continue advancing our understanding of memory loss mechanisms and treatment strategies. Memory loss significantly impacts individuals and their loved ones, and its prevalence is increasing as our population ages. By expanding our knowledge, we can develop better treatments and interventions. Currently, options for memory loss management are limited, particularly in severe cases like Alzheimer's disease. Early detection and intervention are important, but without a better understanding, it is challenging to develop targeted therapies. Memory loss is complex, and unraveling its intricacies may help identify new targets for treatment. This knowledge can also aid in developing preventive strategies and have broader implications for other neurological conditions. By dedicating resources to this field, we can improve diagnosis, treatment, and prevention of memory loss disorders.

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