

The Cause Analysis and Treatment of Alzheimer Disease

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Abstract. Alzheimer's Disease (AD) is a common neurodegenerative disease that mainly affects the elderly. The onset of this disease is insidious, and the course of the disease is characterized by chronic progressive development, mainly manifested as symptoms such as memory loss, language ability decline, spatial cognitive impairment, emotional and behavioral abnormalities, etc. As the condition worsens, the patient gradually loses their ability to live, ultimately leading to severe dementia. Recent studies have found that the age of onset of the disease is gradually shifting to younger. Once the onset of AD can not be reversed, care and treatment are very difficult, bring a heavy burden to the patient's family and society, scientific prevention can effectively delay or reduce the incidence. This article explores the etiology of AD, including genetics, lifestyle and environmental factors, biochemical mechanisms, and outlines current treatment methods, cutting-edge research progress and future trends, providing readers with a comprehensive understanding. Studies have shown that maintaining a clean environment, a balanced diet, moderate exercise and developing good social habits and positive emotional attitudes can help prevent the AD.

Keywords: Alzheimer Disease, etiology, treatment modalities, epidemiological trends.

1. Introduction

Alzheimer's Disease (AD) stands as one of the common neurodegenerative disorders among the global elderly population. Characterized by a gradual decline in cognitive functions, particularly memory, language abilities, and daily living skills, AD significantly impacts individuals [1]. According to the World Health Organization (WHO), approximately 50 million people worldwide suffer from dementia, with 60-70% of these cases attributed to AD. As the global population aging intensifies, the incidence rate of Alzheimer's disease is expected to continue to rise. It is expected that by 2050, the number of AD patients worldwide will reach 153 million. Alzheimer's disease has become the fifth leading cause of death worldwide [2]. Although the exact pathogenesis of AD has not been fully elucidated, research evidence suggests that the occurrence of this disease is the result of multiple factors working together, involving multiple levels such as genetics, environment, and lifestyle.

2. The Causes of Alzheimer Disease

Two types of abnormal protein (β -Amyloid Protein ($A\beta$) and Tau Protein) aggregations are commonly observed in the brains of AD patients: $A\beta$ forms amyloid plaques in the brain, regarded as a key pathological hallmark of AD. The accumulation of $A\beta$ protein is thought to trigger an inflammatory response that leads to nerve cell damage. Abnormal phosphorylation of tau protein leads to the formation of paired helical filaments (PHF) and neurofibrillary tangles (NFT), causing intracellular obstruction, cell destruction, and neuronal dysfunction, ultimately leading to cognitive decline [3,4].

So far, the pathogenic mechanism of AD is still not completely clear. This article will focus on various related factors, pathogenic hypotheses and the latest research results.

2.1. Genetic Factors

Genetics plays a pivotal role in the pathogenesis of AD, especially in early-onset AD (typically occurring before the age of 65). The following genes were found to be strongly associated with Alzheimer's disease:

The APOE-ε4 allele is considered a major risk factor for Sporadic Alzheimer's Disease (SAD). APOE gene involvement in lipid metabolism may impact the clearance of β-amyloid protein in the brain, thereby elevating the risk of the disease. Studies have found that familial Alzheimer's Disease (FAD) is usually associated with mutations in the APP, PSEN1 and PSEN2 genes. Mutations in these genes usually result in an abnormal accumulation of β-amyloid, forming amyloid plaques that damage brain cells. According to the study, less than 1 percent of the world's people carry "deterministic genes," or Alzheimer's disease, just a matter of time.

2.2. Neuroinflammation

In recent years, increasing evidence has shown that neuroinflammation plays a pivotal role in the progression of Alzheimer's disease. As a major participant in the inflammatory immune process, the levels of inflammatory factors and neuropeptides are significantly correlated with the cognitive function of AD patients. Although some AD patients have Aβ deposition, they have no obvious dementia symptoms, which may be related to inflammation suppression in the neuroimmune process [5]. Elevated plasma levels of inflammatory cytokines, particularly IL-1β, IL-6, and TNF-α, are associated with more severe cognitive decline in AD patients. The current explanation for this is that astrocytes convert killer microglia into microglia focused on destroying Aβ and NFTs by releasing IL-3, so lower IL-3 levels are associated with worse cognitive function [6].

2.3. Cardiovascular Disease

Cardiovascular diseases (such as hypertension, diabetes, and high cholesterol) have been significantly associated with the development of Alzheimer's disease. The health status of the cardiovascular system affects blood and oxygen supply to the brain, thereby influencing the function and survival of neural cells [7].

2.4. Environmental Factors

Environmental factors play an important role in Alzheimer's disease. Studies have shown that chronic exposure to high concentrations of air pollutants, such as particulate matter and nitrogen dioxide, can increase the risk of Alzheimer's disease. These air pollutants can be inhaled into the human body, thus affecting the normal function of the brain. Heavy metals, pesticide residues and other pollutants in the daily diet are also associated with the occurrence of AD.

In addition, people who work under high pressure for a long time often face overuse of their brain power, which poses a greater burden on the brain. Over the long term, the brain's cognitive ability will gradually decline.

Social environmental factors such as low education level are also important risk factors for AD, that is, cognitive stimulation activities such as high education level, the nature of mental work and long-term positive and extensive social relationships can improve the brain's "cognitive reserve", so that individuals can better perceive and cope with various cognitive-related tasks under the condition of the same number of neurons. Having a higher "tolerance" to brain aging, correspondingly, old age shows a stronger interest in the surrounding things, a higher degree of perception and mental activity, and thus delays brain aging [8].

2.5. Lifestyle Factors

Lifestyle also has a significant impact on the development of AD. Long term smoking and drinking habits can damage the ability of blood supply to the brain, leading to the death of brain cells and a decline in memory. For example, nicotine can seriously damage the cell structure of the inner wall of blood vessels, so that blood vessels contract, so that tissues and organs are ischemic. Smokers have an increased risk of cerebrovascular disease and a higher risk of dementia. In addition, long-term lack of exercise and physical activity can also increase the risk of illness. The relationship between dietary habits and AD is closely related. Research shows that high cholesterol, high fat and high sugar diet habits easily lead to atherosclerosis, affect the blood supply of the brain, and then damage nerve cells.

3. Prevention and Treatment Status

3.1. Early Diagnosis

Recent advances in medical technology have made early diagnosis of Alzheimer's disease increasingly feasible. Brain imaging techniques (e.g. PET scans and MRI), cerebrospinal fluid tests, and the discovery of new biomarkers enable the detection of early signs of the disease before symptoms emerge. However, these diagnostic methods are still hindered by high costs and limited application scopes [2].

3.2. Pharmacological Treatment

Current pharmacological treatments for AD primarily focus on symptom alleviation. Common drugs include:

Acetylcholinesterase Inhibitors: Such as Donepezil, Galantamine, and Rivastigmine, which improve cognitive symptoms by increasing acetylcholine levels in the brain. Donepezil, for example, is used to treat mild and severe dementia symptoms of AD. It mainly improves clinical symptoms and signs of patients by reversibly inhibiting acetylcholinesterase in the brain, improves the level of acetylcholine in the brain tissue of patients, restores cholinergic nerve conduction, and improves the memory, cognitive ability and nerve ability of patients

NMDA Receptor Antagonists: Like Memantine, which modulates the role of glutamate (a neurotransmitter) in the brain to slow the symptoms of moderate to severe Alzheimer's disease.

While these drugs can slow down cognitive decline to some extent, they cannot halt or reverse the disease process. In recent years, targeted therapies focusing on β -amyloid and Tau proteins have become research hotspots, with some monoclonal antibody drugs approved for clinical use, but their efficacy and side effects are still under further investigation.

3.3. Targeted Therapies

Recent research has emphasized targeted therapies aimed at the pathological mechanisms of Alzheimer's disease, particularly drugs targeting β -amyloid and Tau proteins.

Anti- β -Amyloid Monoclonal Antibodies: Such as Aducanumab and Lecanemab, which aim to slow disease progression by clearing β -amyloid from the brain. While these drugs have shown potential efficacy in some clinical trials, they are also associated with significant side effects requiring further research and clinical validation.

Tau Protein-Targeting Drugs: Drugs targeting Tau proteins are still in development and testing, aiming to prevent or reverse abnormal phosphorylation and tangle formation.

3.4. Non-Pharmacological Interventions

Non-pharmacological interventions also play a crucial role in the prevention and treatment of Alzheimer's disease. Cognitive training, physical exercise, social interaction, and dietary modifications (e.g. the Mediterranean diet) have all been found to positively delay cognitive decline. Additionally, Follow the advice of your doctor for your health management, controlling cardiovascular risk factors (e.g. hypertension, diabetes, high cholesterol) has been proven to reduce the risk of developing Alzheimer's disease.

Cognitive Behavioral Therapy: Including cognitive training and memory reinforcement training, these intervention measures can stimulate the cognitive function of the brain, effectively delay the degradation of cognitive function, and improve the quality of life of patients.

Physical Exercise: Regular aerobic exercise can improve blood circulation in the brain, promote neuronal growth and connectivity, and delay disease progression. In addition, strength training also helps maintain muscle mass and metabolic levels, further promoting brain health. Research has shown that moderate to high-intensity exercise, prolonged sitting for less than 4 hours, and 7 hours of sleep can reduce the risk of Alzheimer's disease by 41%.

Psychological and social support: Providing family education and psychotherapy can help alleviate stress for patients and their caregivers, enhancing patients' overall quality of life.

Social interaction: Actively participating in social activities can stimulate the emotional and cognitive regions of the brain, reduce feelings of loneliness and depression, and thus improve cognitive abilities.

Dietary regulation“A diet rich in healthy fats, whole grains, fish, lean protein, nuts, fruits and vegetables has been proven to fight obesity, diabetes and improve cognitive function. Try to avoid eating foods high in sugar, salt and fat, maintain a balanced diet, and properly supplement Omega-3 fatty acids, vitamin B12 and other nutrients can help protect brain health. In addition, studies have shown that regularly drinking green tea can improve memory and attention, and delay brain aging [9].

Research has found that between 47% and 72.6% of AD prevalence could be prevented with active intervention.

3.5. Future Directions of Treatment

Immunotherapy and gene therapy targeting A β and Tau proteins have emerged as research hotspots in recent years.

Gene Therapy: gene editing technologies (e.g., CRISPR-Cas9) have shown potential in the treatment of neurodegenerative diseases, potentially preventing or treating Alzheimer's disease by correcting relevant gene mutations in the future.

Stem Cell Therapy: offers hope for repairing damaged neurons or replacing dead neurons, although this technology is still in the research phase.

4. Future Trends

4.1. Increasing Incidence

As the global population ages, the incidence of AD is projected to rise significantly over the coming decades. According to forecasts by the World Health Organization, by 2050, the number of individuals worldwide living with AD could reach 153 million. This trend will impose immense pressure on healthcare systems and place heightened demands on families and caregiving resources.

4.2. The Significance of Early Intervention

In the future, with the deepening of research into the early pathological mechanisms of AD, early intervention is poised to become crucial in preventing and delaying disease progression. This encompasses the widespread adoption of early diagnostic tools, the development of preventive medications, and broader health education initiatives aimed at enhancing public awareness of AD [2].

4.3. The Evolution of Personalized Medicine

As precision medicine advances, personalized treatments tailored to individual genetic, environmental, and lifestyle factors are emerging as a pivotal direction for the prevention and management of AD. By understanding the specific risk factors of each patient, tailored interventions hold the potential to exert a more substantial impact in both prevention and treatment.

4.4. Societal and Economic Impacts

The prevalence of AD not only affects the medical field but also exerts profound influences on society and the economy. Increased family caregiving burdens, shifts in the labor market, and the growing elderly population all pose new challenges to the allocation of societal resources. Consequently, governments and society must devise long-term strategies to address this impending public health challenge.

5. Conclusion

Despite the numerous challenges currently faced in combating Alzheimer's disease, advancements in technology and research hold promise for mitigating the spread and impact of this disease through early diagnosis, personalized medicine, and comprehensive societal interventions. Effective prevention is an important task to cope with the current challenge of AD. The protective effect of multi-factor combined intervention of controllable factors such as diet and lifestyle on Alzheimer's disease has been recognized by certain clinical trials, and these intervention methods are easy to accept. However, optimizing prevention decisions and effective drug research and development require a comprehensive and clear understanding of the interaction between risk factors, the mechanism and degree of action, and early screening methods, as well as continuous exploration of new risk factors, which are the directions of research efforts. At the same time, the boundaries of science need to continue to extend to provide more ideas and ways for human to explore the pathogenesis of AD. It is believed that with the continuous innovation and application of modern medicine and bioengineering technology, medical workers will be able to better treat AD in the future

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