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THE EFFECTS OF ARTIFICIAL INTELLIGENCE ON NEURODEGENERATIVE DISORDERS

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Neurodegenerative disorders are characterized by the progressive damage of the nervous system that encompasses the brain, nerves, and spinal cord. The most common neurodegenerative disorders include Alzheimer's disease and Huntington's disease. They affect a person's ability to carry out daily activities. As neurons overseeing the transmission of electrical signals become dysfunctional, different parts of the body struggle to communicate with each other. With a network failure, people lose the functions of their brain, experiencing memory loss, unclear speech, motor loss, impaired vision, anxiety, and other symptoms of cognitive decline.

Finding a cure for neurodegenerative disorders has been challenging because of the limited diagnosis and the experimentation of potential drugs. Diagnosing a patient with neurodegenerative disorders requires extensive symptom observation and a family history survey. Additionally, there is not a lot of information available about neurodegenerative disorders. However, artificial intelligence (AI) has rapidly developed and is beginning to tackle

these issues. As a result, AI has become a turning point in the production, research, and assessment of neurodegenerative disorders outside of the capability of traditional medicine.

Artificial Intelligence Discovering Cures to Neurodegenerative Disorders

The Correlation Between Misfolded Proteins and Neurodegenerative Disorders

The accumulation of misfolded proteins can result in neurodegenerative disorders (Reynaud, 2010). Proteins are organic macromolecules responsible for nearly all functions in the human body, including metabolic reactions, facilitating the immune system, and providing structural support. A protein's structure; has four levels: primary, secondary, tertiary, and quaternary. On the primary level, proteins comprise a basic amino acid chain s linked with a covalent peptide bond. On the secondary level, the amino acid chain is locally folded into alpha helixes and beta sheets due to the hydrogen bond between the atoms of the polypeptide backbone. The tertiary structure is where the polypeptide chain folds into a three-dimensional structure depending on the amino acids' polarity. The nonpolar side chains will cluster within the molecule's interior to enable contact with the aqueous environment. Contrarily, the hydrophilic polar side chain will arrange outside the molecule to form hydrogen bonds with water. Quaternary structures are an association between two or more polypeptide chains, but it does not apply to all proteins. Each protein has its respective shape based on its amino acid sequence. Under mutations or cellular aging that can deteriorate and change the sequence, proteins can misfold and lose their native structure. Without proper structure, proteins fail to achieve their original function. For example, in neurodegenerative disorders, the accumulation of misfolded proteins stresses cellular responses to protect the cell from the toxic build-up. However, prolonged stress on the proteasomal machinery responsible for the degradation of misfolded

proteins can result in the induction of specific death pathways that can damage neuron pathways and lead to neurodegenerative disorders (Rao & Bredesen, 2004).

AI Predictions of Neurodegenerative Disorders' Protein Structures

Deepmind, an artificial intelligence company, created AlphaFold, an AI program that generated a method to accurately predict the 3D structures of more than 200 million proteins used in the human body (Sparkes, 2022). The unprecedented speed and accuracy of AlphaFold enable researchers to collect structural models on any protein sequence and study its pathological mechanisms. AlphaFold collaborated with the European Molecular Biology Laboratory's European Bioinformatics Institute (EMBL-EBI) to launch the AlphaFold Protein Structure Database in 2021. The massive database allows the three-dimensional protein structures predicted by AlphaFold to be searchable to anyone worldwide.

With neurodegenerative disorders rooted in misfolding proteins, AlphaFold's prediction of protein structure is a significant step toward developing new treatments. For example, Alzheimer's disease, the most common type of dementia, affects over 50 million people with memory loss and thinking skills to the point that they cannot execute daily tasks. Researchers have hypothesized that neurodegeneration is caused by the accumulation and aggregation of misfolded proteins known as amyloid beta peptides that form intracellular neurofibrillary tangles (NFTs) and activate a cascade pathway. The cascade pathway, also known as a signaling pathway, activated by misfolded amyloid peptides, results in inflammatory response and oxidative stress, resulting in progressive neuron damage. Additionally, NFTs are accumulations of abnormal filaments of hyperphosphorylated tau protein that disintegrate microtubes that provide a structural backbone for axons and dendrites that carry electrical impulses around the body in means of communication (Chuguransky, 2021). A damaged nervous system with the loss

of axons and dendrites causes the brain to fail to control thought, memory, motor skills, and other processes that cognitive health regulates in the human body.

AlphaFold's ability to predict the structure of proteins are vital tools in researching neurodegenerative disorders. By developing an accurate model of the proteins presented in patients with neurodegenerative disorders, researchers can learn about the mechanisms of the proteins that develop these conditions to help create a cure in the coming future.

AI Predictions on the Effects of Drugs on Neurodegenerative Disorders

To explore the effectiveness of potential treatment at low cost and resources, Harvard-affiliated Massachusetts General Hospital and Harvard Medical School developed an artificial intelligence capable of predicting the effects of different drugs on the nervous system (Hampton, 2021). Traditional clinical trials require several months to two years to pass the first phase, where they examine the safety and dosage of the drugs on lab animals. It takes substantial time and resources to distribute, regulate, and wait for responses accordingly. Therefore, DRIAD (Drug Repurposing in Alzheimer's Disease) was created. It utilizes machine learning, a subset of artificial intelligence, that holds vast data and analyzes patterns to measure what happens to neurodegenerative disorders when specific drugs are applied. This approach is a turning point in finding cures. Researchers can acquire drugs' negative and positive effects quicker than traditional clinical trials. DRIAD allows researchers to tackle which proteins are targeted by the drugs, playing a significant role in developing treatments as neurodegenerative disorders are rooted in protein misfolding. With data being collected faster, the cure for neurodegenerative disorders is closer.

Artificial Intelligences Diagnosis of Neurodegenerative Disorders

Identification of Symptoms Through AI

AI is revolutionizing healthcare, which increases the accessibility and convenience of diagnosing conditions. For example, in 2016, Viewmind, a digital health company, developed an AI-powered technology to provide a precise diagnosis of a person's neurocognitive health. It administers a 15-minute Virtual Reality (VR) exam that collects about 100,000 data points from the patient's eye movements. They correlate the person's data to a database on various neurodegenerative disorders. With a 97% accuracy rate, Viewmind allowed patients to acquire a diagnosis before obvious symptoms surface (Edwards, 2022). Also, Viewmind is far more accessible, considering the exam's short time.

Additionally, a study team at the University of Florida utilized an AI that has an algorithm to predict the chances of a patient developing neurodegenerative disorders. One Florida+ Data Trust, a centralized research patient data containing health records for millions of people in Florida, was used to identify which patients will likely develop Alzheimer's. The prediction model with more flexibility by calculating information such as lifestyle habits, behaviors, healthcare records, and medications showed higher accuracy levels, indicating that neurodegenerative disorders have roots in genetic and environmental factors. With a high accuracy rate of 90% a year before diagnosis, AI has the potential to recognize symptoms far quicker than health professionals can recognize (UF Health, 2023).

Disadvantages of Traditional Examination

Artificial intelligence examinations to identify neurodegenerative disorders cost less than traditional examinations. Traditional examinations include extracting cerebrospinal fluid, a liquid flowing in and around the brain and spinal cord, and a PET scan to detect amyloid beta deposits

and tau protein, hallmarks of neurodegenerative disorders. While these examinations also have health risks due to radiation, they are extremely pricey, with a PET scan costing up to $6,000 per scan (Diffen, n.d.). In addition, a significant consequence of traditional examination is that patients typically do not visit the hospital for a diagnosis unless an obvious symptom appears. However, when they face motor and memory loss symptoms, their neurons have already progressively been damaged. However, AI can recognize subtle information, as seen in Viewmind, where VR can accurately identify cognitive disorders using only eye movements a year before diagnosis. Then, they can correlate it to neurodegenerative disorders using a massive database to inform the patient and their physician.

Conclusion

Neurodegenerative disorders refer to a range of medical conditions characterized by damage to the nervous system. The brain eventually fails to properly perform basic tasks, such as remembering, walking, or thinking. While the condition surfaced centuries ago, science has yet to find a cure because of the lack of information and the difficulty of diagnosing. It requires extensive observation, exceeding basic yearly physical examination. However, in the past decade, AI has revolutionized the world of healthcare, including becoming a turning point in diagnosing neurodegenerative disorders. Researchers can try out potential cures without spending the time and resources holding traditional clinical trials on animals and humans. In addition, doctors are recognizing symptoms earlier on and making examinations more accessible in terms of price using artificial intelligence.

References

Alberts B, Johnson A, Lewis J, et al. Molecular Biology of the Cell. 4th edition. New York: Garland Science; 2002. The Shape and Structure of Proteins. Available from: https://www.ncbi.nlm.nih.gov/books/NBK26830/

Chuguransky, S. (2021, September 1). *Alphafold, a novel tool shedding light on Alzheimer's disease proteins*. Alphafold, A Novel Tool Shedding Light on Alzheimer's Disease Proteins – InterPro – Articles. Retrieved April 29, 2023, from https://proteinswebteam.github.io/interpro-blog/2021/09/01/AlphaFold,-a-novel-tool-shedding-light-on-Alzheimer-s-disease-proteins/

CT Scan vs pet scan. Diffen. (n.d.). Retrieved April 29, 2023, from https://www.diffen.com/difference/CT_Scan_vs_PET_Scan

Edwards, M. (2022, March 24). *How AI can revolutionize the diagnosis of Neurodegenerative Disorders*. Med-Tech. Retrieved April 29, 2023, from https://www.med-technews.com/medtech-insights/ai-in-healthcare-insights/how-ai-can revolutionise-the-diagnosis-of-neurodegenerative-/

Folger A, Wang Y. The Cytotoxicity and Clearance of Mutant Huntingtin and Other Misfolded Proteins. Cells. 2021 Oct 21;10(11):2835. doi: 10.3390/cells10112835. PMID: 34831058; PMCID: PMC8616338.

Hampton, T. (2021, March 4). *Ai reveals current drugs that may help combat Alzheimer's* Harvard Gazette. Retrieved April 29, 2023, from https://news.harvard.edu/gazette/story/2021/03/ai-reveals-current-drugs-that-may-help-combat-alzheimers/

Nucleic Acids Research, Volume 50, Issue D1, 7 January 2022, Pages D439 D444, https://doi.org/10.1093/nar/gkab1061

Sparkes, M. (2022, August 4). DeepMind's protein-folding AI cracks biology's biggest problem. New Scientist. Retrieved April 29, 2023, from https://www.newscientist.com/article/2330866-deepminds-protein-folding-ai-cracks-biologys-biggest-problem/

UF Health. (2023, February 27.) *Using artificial intelligence and patient medical records to predict Alzheimer's disease.* University of Florida News. Retrieved April 29, 2023, from https://news.ufl.edu/2023/02/ai-to-predict-alz/