



Utilizing Healthcare Analytics for Early Detection and Management of Alzheimer's Disease

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1. Project Overview

Alzheimer's disease, also known as AD, is a complicated neurodegenerative form of dementia that displays symptoms concerning cognitive deterioration in many patients worldwide. Since it's the type of dementia that affects a majority of the patients, it is a disorder that poses a major concern not only to the patients but also to carers and health systems globally (Dubois B, et al., 2016) Alzheimer's can be identified in its early stages and hence, if diagnosed and treated early, patient health can be significantly positively impacted, and its progression slowed. (Prince M)

The present project outlines an effective approach to visualize a Healthcare analytics system at Med-IT which will employ EHR and clinical data, as well as apply analytical techniques to detect high-risk individuals, track their conditions and find the best treatment options. In this case, we envision using data to support timely interventions, individually tailored patient care plans, and choice-making by clinicians.

There have been growing changes in the assessing of AD from a categorical approach (presence or absence) to a spectrum approach in the more recent past. This continuum comprises preclinical, prodromal and dementia stages, which identify the progressive characteristic of the illness. Consequently, efforts for the early detection of AD, especially during the prodromal or pre-dementia phases are now emphasised. (Wimo A, et al, 2018)

Early detection seems to mean identifying AD before people present with symptoms that make them worry or seeking help, perhaps even before dementia develops. This approach is different from the early diagnosis approach, which would need population or targeted screening to first enroll participants in the preclinical phase of AD.

This paper proposes to comprehensively review the scientific literature with the specific focus on what is known about the advantages and/or disadvantages of an early diagnosis of AD. Therefore its importance in defining the meaning of timely diagnosis for patients, caregivers, healthcare providers and the healthcare system within the current literature forms the basis of this study. This review will provide valuable insights into the opportunities and barriers associated with timely AD diagnosis, informing future research and clinical practice in this critical area of dementia care.

2. Background of the Study

Alzheimer's disease (AD) is a type of dementia that causes a gradual, progressive loss of cognitive function in millions of people around the globe. This is a progressive diseased state with the failure of memory and thus the ability to solve problems and think. Being the first and the most prevalent type of dementia, AD brings numerous problems for patients, carers, and health care facilities.

Project Proposal

AD has shifted from an on-off conceptions to disease continuum conceptions. This continuum includes:

- Preclinical AD: The preclinical stage characteristic by neuropathological adverse changes even though cognitive capabilities remain to be intact (Wimo A, et al, 2018) (Prince M)
- Prodromal AD (also called Mild Cognitive Impairment due to AD): A symptomatic pre-AD phase with progressive cognitive decline in the absence of significant disability.
- AD Dementia: The stage in which cognitive impairment interferes with activities of daily living (Dubois B, et al., 2016)

3. Objectives

The primary objectives of this project are:

- Early Detection: Create and use machine learning models and dashboards to screen potential patients with Alzheimer's Disease based on demographic data, disease history, and lifestyle.
- Personalized Treatment Plans: Develop treatment plans that are based on patient's personal information and would be applicable on timely basis to patient needs.
- Monitor Disease Progression: Introduce permanent systems of assessment of cognitive functioning and functional status, which would allow the cliques to change the treatment strategy in time.
- Healthcare Provider Support: Give effective dashboards and reporting solutions that will help healthcare professions to visualize, analyse and decide in real-time.

4. Project Scope

The scope of this project encompasses the following key components:

- Data Collection and Integration: Retrieve patient's EHR data which include demographic characteristics, the patient's medical history, cognitive status (MMSE), lifestyle indicators which include BMI, smoking and exercise regimes among others. These will be integrated into a hub clinical data warehouse in order to process them into meaningful data.
- Predictive Model Development: Use machine learning algorithms and statistical methods to develop risk estimate models to determine physical probability for the development of Alzheimer's Disease. These models will then undergo back testing with real past data to arrive at accurate models.
- Dashboard Development: Develop and realise effective and engaging interfaces, which serve as risk evaluation, patient outcomes, and treatment effectiveness graphs. These dashboards will be specifically designed for clinical, caregiver and administrative end user audiences.

Project Proposal

- **Training and Implementation:** Design an educational campaign that will allow introducing the analytics to the healthcare professionals and teach how to work with them and read results. This training will also comprise of practical practice sessions and will have follow-up services.

5. Key Deliverables

The key deliverables for this project include:

- **Integrated Clinical Data Warehouse:** A live implementation of the unified EHR & clinical data warehouse comprising only the data about the patients with Alzheimer's disease, both accurate and accessible.
- **Predictive Analytics Models:** Sound models that enable the conditional assessment of patients predisposed to Alzheimer's in relation to issues affecting progression as well as timely treatment.
- **Custom Interactive Dashboards:** Graphical interfaces providing instant presentative data that enables clinicians to prompt decisions for patient care.
- **Comprehensive Training Materials:** Pamphlets, videos, and practical sessions for a targeted development of skills needed to operate the new analytics system by the health care providers.

6. Success Criteria

The success of this project will be measured by:

- **Predictive Model Accuracy:** The ultimate aim of attaining over 80% accuracy for risk-predicting at-risk patients through models' validation against archival data.
- **Dashboard Usability:** Some of the evidence includes the overall impression of the dashboards by healthcare providers in terms of how easy they are to use and whether they provided helpful information for coming to clinical decisions.
- **Early Detection Rates:** The progress in early discovery and diagnosis of Alzheimer Disease which will be determined through a timeline of diagnosis before and after the program's enactment.
- **Patient Outcomes:** Better efficacy in terms of rate of reported cognitive impairment and other symptoms in patients after follow-up and according to questionnaires received from the patients.

7. Operational Definitions:

1. **Alzheimer's Disease (AD):** Chronic brain disease that advances over time and produces dementia.

2. Timely Diagnosis: Evaluation conducted when people come to medical help because of noticed changes in their thinking abilities, behaviour, or functioning; may precede dementia.
3. Early Diagnosis: Screening for asymptomatic phase to diagnosis AD.
4. Prodromal AD: Mild cognitive impairment occurring in the pre-dementia stage, along with maintenance of independence.
5. Mild Cognitive Impairment (MCI) due to AD: NIA-AA term for symptomatic pre-dementia Alzheimer's Disease phase.
6. Preclinical AD: The latent or prodromal phase of the disease when pathological changes affect the nerve tissue while cognitive functions remain intact.
7. AD Dementia: The final stage of the disease where the cerebral changes can considerably limit the functioning of a person.
8. Biomarkers: Previous studies employed biological markers capable of identifying AD pathology non-invasively, i.e. in vivo.
9. Clinical Dementia Rating (CDR): Scale assessing dementia severity based on the severity staircase ranging from 0 (The patient has no dementia) to 3 (The patient has severe dementia).

8. Dataset Overview

The project will employ a data set containing 2149 of patients include full health records regarding to Alzheimer's Disease. This dataset includes:

1. Demographic Details: In comparing patient risk profiles, the following demographic variables have been adopted; Patient ID number, age, gender, ethnicity and education level.
2. Lifestyle Factors: These include obesity measured by body mass index, smoking status, alcohol consumption, physical activity, diet and sleep quality to pinpoint modifiable risk.
3. Medical History: Alzheimer's disease, cardiovascular disease, diabetes, depression, head injury, and hypertension in the family, crucial for constructing predictive models.
4. Clinical Measurements: Cardiovascular health biomarkers such as blood pressure levels or cholesterol levels to check on one's general health.
5. Cognitive and Functional Assessments: The outcomes in MMSE scores and functional assessment to quantify the patients' cognitive deterioration.
6. Symptoms: Various insights regarding typical signs of Alzheimer's – useful to assess the disease consequences.
7. Target Variable: A binary variable, Diagnosis status for Alzheimer's Disease where 0=no and 1=yes; this variable has been chosen as the main outcome for the predictive analysis type.

This abundance of data will help analyse the risk indicators and Kao graph of Alzheimer's to produce efficient prognosis indicators and tailored treatments.

9. Conclusion

The use of a healthcare analytics solution that targets on diagnosis and treatment of Alzheimer's Disease can positively change the patient status. Through using EHR data as well as applying predictive analytics as well as intuitive dashboards, it becomes feasible to contact proper interventions as well as proper decisions on the part of the healthcare providers. This activity in the healthcare sector not only targets improving the quality of results received by patients but also tries to build up healthcare efficiency and increase the effectiveness of the service.

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