

Chapter 6

E-Health Decision Support Systems for the Diagnosis of Dementia Diseases

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ABSTRACT

The increase of incidence and prevalence of dementia diseases makes urgent the clinical community to be supported in the difficult diagnostic process of dementia patients. E-health decision support systems, based on innovative algorithms able to extract information from in vivo neuroimaging studies, can make a quite different way to perform neurological diagnosis and enlarge domains and actors involved in the diagnostic process. A number of image-processing methods that extract potential biomarkers from the in vivo neuroimaging studies have been proposed (e.g. volume segmentation, voxel-based statistical mapping). A number of new shape descriptors have also been developed (e.g. texture-based). Other approaches (e.g. machine learning, pattern recognition) have been proven effective, for both structural and functional data, in making automatic diagnoses. The integration of these sophisticated diagnostic tools into secure, efficient, and wide e-infrastructures is the prerequisite for the real implementation of e-health support services to the clinical and industrial communities managing dementia patients.

INTRODUCTION

Dementia, one of the most severe and frequent neurodegenerative disorders in the elderly population, has important and dramatic health as well as socio-economic implications. Furthermore, the

incidence and prevalence of these diseases is increasing, due to the aging population, particularly in the United States, Europe, and Japan.

Several pathologic mechanisms can cause cognitive impairment, so the primary objective of clinicians is to identify possible underlying disorders in order to better define prognosis, treatment and patient management.

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Thanks to the great advancement in the knowledge of pathophysiological mechanisms involved in dementia diseases and to the recent availability of methods and algorithms from the neuroinformatics domain able to extract new knowledge from biomedical images, *in vivo* neuroimaging studies have increased their role in the process of making a diagnosis in dementia. At present, highly prevalent and burdensome chronic conditions such as some neurodegenerative and neurodevelopment disorders can be diagnosed early with image-based markers of structural and functional brain changes: neuroimaging techniques, such as Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET), allow at present a non invasive extraction of information from medical images invisible to the naked eye, enabling to perform early pharmacological or rehabilitative interventions.

This chapter aims to give an overview of the most innovative and promising methods to support medical decision in the diagnosis of dementia. Different approaches have been investigated, including validated applications (e.g. statistical parametric mapping for differential diagnosis), currently in use in the medical environment, and more advanced systems (e.g. pattern recognition for classification of diagnosis), in a earlier life cycle time.

Particular emphasis has been devoted to the importance of transferring these applications into secure and efficient e-infrastructures (e.g. Grid infrastructures) and of creating wide networks among clinical and research centres, healthcare institutions and medical industries regarding dementia diseases, in order to share the proposed methodologies, optimizing the organizational processes of managing dementia patients, and accelerating the large beneficial impact on practice for all stakeholders.

BACKGROUND

The first clinical criteria for the Alzheimer disease (AD) (1984) defined it as having a single stage, with diagnosis based on clinical symptoms. According to these criteria, disease-free subjects were considered dementia-free subjects and the only proof of AD was represented by autopsy, through the presence of deposited amyloid plaques and τ protein tangles.

Scientific evidences coming from *in vivo* neuroimaging studies of patients with suspected dementia diseases showed the potential of *in vivo* non invasive imaging technologies to support medical decisions in the diagnosis of dementia diseases.

In 1994, The Quality Standards Subcommittee of the American Academy of Neurology published “practice parameters” for the diagnostic evaluation of persons suspected of having dementia. These guidelines established neurologic examination as the standard, and certain laboratory tests as essential components of the diagnostic procedure. However, neuroimaging studies were suggested only as “options,” i.e. “management strategies for which there is unclear clinical certainty.”

A few years later, in 1997, the usefulness of these practice parameters for the assessment of dementia was examined by reviewing a large number of consecutive cases. The main finding of these evaluations was that diagnostic accuracy was improved by neuroimaging studies, although with a predictable increase in costs. Findings proved that neuroimaging studies frequently changed clinical diagnosis (19%-28%) and patient management (15%).

Structural neuroimaging techniques, such as Computerized Tomography (CT) and Magnetic Resonance Imaging (MRI), provided useful information in the diagnosis of AD and in predicting the development of dementia, e.g. by measurements of hippocampus atrophy, where the most prominent structural damage occurs at a macroscopic level.

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