ROLE OF THE COGNITIVE SCREENING TOOL IN EARLY DEMENTIA DIAGNOSIS

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Abstract: Dementia diagnosis is a very complex task at its early stages because its various subtypes have the same symptomatology. Moreover, it becomes difficult to detect mild cognitive impairment with age because with aging, there is an increased prevalence of both health illness and sensory deficit. Therefore, a short screening tool is required to define a clear boundary between symptoms of normal aging and mild cognitive impairment as well as between different subtypes of dementia before proper diagnosis. Screening of dementia in developing countries is a challenging task due to educational and cultural versatility and only one cognitive test is not enough to screen out demented subjects in mass population. The aim of this paper is to analyze need, benefits and difficulties during the selection of cognitive test for a cognitive screening instrument to facilitate interdisciplinary approaches of early dementia diagnosis with least assistance of clinical person for the increasing population of a developing country.

Keywords: Dementia, Mild Cognitive Impairment, Cognitive Test

I. INTRODUCTION

Dementia is a disorder which leads to impaired cognitive capability and memory loss (Scott and Barrett, 2007). Dementia is defined as group of symptoms due to incidence of any neurological illness, brain injury and other medical condition. According to DSM-5, Dementia is also defined as major neurocognitive disorder and significant cognitive impairment is characteristic of dementia. It is also referred as an age related disorder. Cognition basically involves complex attention, executive function, learning, memory, perceptual- motor, language and social cognition. There are more than 12 etiological subtype mentioned in DSM-5. AD is the most common type of dementia faced by the aged individuals. (Scott and Barrett, 2007; Herbert et al, 2003). Recent studies found that the most abundant (50-75%) subtype is due to Alzheimer's disease (AD) followed by vascular disease (VaD): 20-30% and Frontotemporal lobar degeneration (FTLD):5-10% in developed countries (world Alzheimer Report 2009).The result of certain researches have given us four subtypes of dementia. These four subtypes of dementia are as follows (Grand, Caspar and MacDonald, 2011),

i. Alzheimer's Disease
ii. Frontotemporal Dementias
iii. Vascular Dementias
iv. Dementia with Lewy bodies/Parkinson's Disease dementia.

II. CHALLENGES IN DIAGNOSIS OF DEMENTIA

The accuracy in the diagnosis of precise subtype of dementia is very important to identify the cause, as well as allow designing long term planning for treatment (Sandson and Price, 1996). There are certain challenges that clinicians face while diagnosing dementia. The major ones include,

There are same symptoms for different kinds of dementia and thus are difficult to differentiate from each other i.e. dementia associated with cerebrovascular diseases, depression, Parkinson's disease, Lewy body dementia, nutritional deficiencies, and depression and drug reactions. All of these dementias are difficult to diagnose precisely from one another.

- Certain dementias have more than one cause and thus are termed as complex dementias or mixed dementias.
- There is a lack of clearly defined boundaries between symptoms of normal aging, onset of Alzheimer's disease (AD) and mild cognitive impairment (MCI).

Referring to the previous point, there is no single test present that can be implied to diagnose dementia due to AD even at its progressive stages.

III. INTERDISCIPLINARY APPROACHES TO PREDICATION ON EARLY STAGE DIAGNOSIS OF DEMENTIA

Various interdisciplinary approaches have been designed for the early stage diagnosis of dementia, but these demand greater time and money Neurological changes which are determined by the use of diagnostic markers. Neurological changes induce physical changes in the brain anatomy, and these changes are detected by EEG or other brain imaging techniques. Their classification gives us neural model, which is an alternative method for understanding and explaining these physical changes.



Fig.1. EEG based approach

Neurological models approach includes both neurochemical and neurobiological markers (e.g. neurofibrillary tangles or senile plaque) which are very difficult to detect at early stage of dementia and different analytical methods for imaging brain's anatomy and functionality (e.g. CT-scan or MRI) are effective at later stages of diseases. Other hand, electroencephalography (EEG) based approach is used to detect neurodegenerative disease at early stage as shown in Figure 1. Preprocessing is performed on raw EEG signal remove unwanted noise and artifacts. Features such as power, entropy, mutual information, correlation and fractal dimension (Kolekar et al. 2000) from EEG signal are extracted. Classification techniques such as artificial neural network (Buscema et al. 2010), Hidden Markov Model (Kolekar and Sengupta 2004), Bayesian classifier (Kolekar 2011; Kolekar and Sengupta 2015) are used for diagnosis of early dementia. Recently EEG based approaches for early disease detection and prediction is widely used due to high temporal resolution, economical and portable reasons (Kumar and Kolekar 2014).

IV. BENEFITS OF COGNITIVE SCREENING TOOL

Mild cognitive impairment MCI can be an early sign of different neurological conditions that finally leads to memory deficit or dementia. The cognition plays a critical role in many neurodegenerative diseases. The screening tests can help clinicians and physicians to detect undiagnosed dementia (Boustani et al, 2003). The cognitive screening tools will also help us discover new therapeutic interventions that can delay disease progression from different neurodegenerative disorders to dementia. These tools will differentiate between demented and non-demented patients and will also help us to determine the pharmacological and non-pharmacological interventions in a patients centered decision making process. They will assist to select proper treatment for AD dementia and its other types.

It has been observed that many patients suffering from dementia are not properly and formally diagnosed (Bradford et al. 2009). Screening is necessary to increase case/subject identification. It also give a feedback for patient care that follow diagnosis relative to the costs of failing diagnosis and costs of the screening and diagnostic process. It subject to nonclinical influence and systematic case finding at the population level will give a platform to develop guidelines for establishing standard value of early case finding to patients and families as well as to health system and society.

These tools will allow the confirmation of dementia diagnosis. Furthermore, confirmation permits initiation of planning, organization ongoing care, and taking suitable step towards long range planning for financial and social wellbeing for both patient and family care partners. Early detection facilitated by screening may allow proactive comprehensive management of the patient with dementia to begin at milder level of impairment before a crisis disrupts the patient's life and requires urgent intervention.

V. REVIEW OF COGNITIVE TEST FOR DEMENTIA SCREENING

Dementia is an acquired syndrome that presents in the form of loss in memory and cognitive impairment. It is caused by many diseases; most common of these diseases are the Alzheimer's disease and cerebrovascular ischemia (Boustani et al, 2003). Every subtype shows different early symptoms for example, memory impairment is first stage of Alzheimer's disease in elders, while vascular demented patient shows executive function impairment and cognitive slowing. Similarly in fronto temporal lobar degeneration the early symptom is behavioral variant, semantic dementia and progressive non-fluent aphasia. For the Screening tools of dementia to work efficiently, they must have the following characteristics,

- Screening test takes time $\leq$ 10 min.
- It must be accurate and valid.
- It should have the ability to clearly define dementia, cognitive impairment or other neurodegenerative disorder.
- Screening can be done easily at primary care settings by non-clinical staff.
- Any patient should undergo the screening test without any sort of educational, language and cultural barriers.
- Can be used by clinicians or primary care person without payment of copyright and copyrights should not be an issue.

Here we will discuss certain tests that can be used by clinicians and non-clinician in both primary care and specialist settings, for the screening of dementia as well as its various subtypes.

a. Cognitive Tests for both Primary Care Services and Specialist Services

Addenbrooke's Cognitive Examination (ACE): It is a brief test. The main problem with this test is the time taken for the administration. This test takes 16-20 minutes to be administered, however the positive feature is that it is sensitive to the early dementia and allow clinicians to differentiate between different subtypes i.e. AD, PDD, PSP and FTD (Reyes et al,

2009). The other form of this test is (ACE-R) which is **Addenbrooke's Cognitive Examination-Revised**. The ACE is less accurate than ACE-R but it is recommended for both primary care and general hospital settings. And both tests cannot differentiate vascular dementia and lewy body dementia.

Clock Drawing Test (CDT): Clock drawing test is very easily administered, non-threatening and free of language and education barrier. Moreover the administration time is also very less and thus can be utilized in a busy practice i.e. hospital settings. It is also less offensive (Peter and Pinto, 2009). The CDT allows the patient to draw a clock on the piece of paper and then points are given out of 6 depending upon the drawing. The administration time is also less i.e. few minutes. However the short comes of this test is that it does not differentiate between DLB, AD and PD (Cahn-Weiner et al, 2003). But it is the best test for assessing executive function and visuospatial decline at early stage (Shulman, 1993).

Mini Mental State Examination: The mini mental state examination has high test, retest reliability and consistency. This test takes less than 10-15 minutes by a trained person. This test has a total of 11 questions or items and total points are 30. The cut-off score or in other words the score for dementia negative patients is 24. However it also lacks sensitivity in cases of early dementia and cannot assess executive abilities and visuospatial skills.

Free and Cued Selective Reminding Test (FCSRT): This test checks cognition by identification of different pictures (i.e. banana, cup) in response to category cues (fruits and crockery). The patients are asked to recall them freely. This test also takes approximately 10-15 minutes to be administered. So far we have discussed both tests which can be implied in primary care as well as specialist settings. Now we will discuss the tests that are validated for primary care.

b. Cognitive Tests for Primary Care

Mini Cog: It is actually a combination of three item word memory and the clock drawing test. It takes a total of approximately three minutes to administer. This test is a better alternative for less educated people as well as non-English speakers (Borson et al, 2000). Although it takes less time but it is less sensitive and therefore has less advantage.

Memory Impairment Screen (MIS): The administration time of this test is 4 minutes. This test is performed by asking the subject to read the four targets (that are to be remembered) aloud from the printed paper. After that category cues are presented to the subject and are asked to identify the target word that matched the category. This test has low sensitivity but greater specificity.

General practitioner assessment of cognition (GPCOG): The GPCOG has nine questions which includes time orientation, a recent event recall, and few words recall test such as name and address of a person. It also have an informant questionnaire which can be used together to increase sensitivity of whole test (Brodaty et al., 2002). It takes approximately four minute for each patient assessment and less than two minutes for informant screening. Some sample studies shows specificity and sensitivity of GPCOG comparable with MMSE. The advantage of GPCOG is less administration time, less educational bias and involvement of informant or family person. It is a comparatively new instrument then MMSE, therefore requires more validation in various educational and cultural background

VI. DISCUSSION

Dementia is a clinical syndrome with deterioration of normal cognitive abilities and daily functioning (Grand, Caspar and MacDonald, 2011). So far we have discussed different tests for the screening of dementia at early stages. Each test has its own pros and cons. At primary care settings, the better option is the ACE-R but it takes much more time and should only be used in doubtful cases (Velayudhan et al, 2014). Similarly in primary care settings, MIS is a better alternative to mini cog as it is superior in both sensitivity and specificity. (Kuslansky et al, 2002), but it does not assess executive function. Therefore GPCOG is better suited in primary care settings as it takes less time and includes memory as well as executive skill assessment. Moreover, it is easy to administer for non-clinician. But it has low specificity without informant questionnaire. In cases of developing countries one cognitive test is not enough to screen out demented subjects on mass population because of educational and cultural versatility and most of the elderly are still uneducated in middle and low income countries. There is requirement of multiple language accessibility which is available with GPCOG online assessment and with Mini-cog. Therefore, a combination of two or more cognitive test would be considered as better screening tool for early dementia. And more combination of cognitive test studies with their validation is required. Similarly Cordell et al. 2013 reviewed many cognitive tests and recommended a combination of five cognitive patient and informant assessment which require further validation. This combination again would have time limitation and less specificity in absence of informant.

CONCLUSIONS

In this paper, we have discussed certain screening tools and tests that are used to detect dementia at earlier stages and its various subtypes. Our paper suggests that in both primary care and specialist settings ACE-R is a better test while in only Primary care settings there is a need of test that should be

done at lesser time and that test is MIS. MIS is better option than mini cog. Thus, sensitivity and specificity of two combinations, GPCOG with MIS and MIS with mini-cog can be used as a screening tool, but further validation of these combinations will be required. In the near future administer time can be further reduced by using emerging technology (e.g. mobile apps, or online assessment). However, these kind of cognitive screening tool can used as good ascent to increase accuracy of various machine learning approaches in future.

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