

Development of a cognitive-based smartphone application for Malaysian Parkinson's disease patients: Exploring the possibility?

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ABSTRACT: The COVID-19 pandemic has accelerated the digital health system. Healthcare organizations want to give medical treatment to individuals who live a great distance away. As a result, they are emphasizing the creation of bespoke telemedicine apps. The number of individuals using telemedicine apps is increasing significantly. Increasing technology gives patients healthcare resources. This has been made feasible via a new telemedicine system and by developing a telemedicine app. Patients can use several technologies to communicate with healthcare professionals. For comfort and privacy, you can employ live visual media. The creation of telemedicine apps is the most attractive and practical investment. With the growing availability and usage of technology in PD, the focus of these technologies is gradually turning toward the disease's vast spectrum of Non-Motor Symptoms (NMS). The nature of NMS makes them difficult to objectively measure, further development and building on experience gained in other conditions may still result in NMS capture that is feasible. Although it is impossible to offer recommendations for the use of digital technology outcomes for NMS in clinical practise based on currently available data, evidence for these devices is evolving, and such guidance may become accessible in the not-too-distant future. To our knowledge, this is the first telemedicine method of its sort to address cognition as one of the NMS in Malay PD patients. The project will be done on two consecutive phases (1 year each); Phase1 aims to develop the Dementia Coach Mobile App, and Phase2 aims to validation of this app by using PD patients sample from SASMEC. Therefore, we hypothesize that developing a friendly mobile app to assess dementia for PD patients is highly beneficial and could be used for diagnosis of NMS in PD patients.

Keywords: telemedicine; non-motor symptoms; PD; dementia; Malay;

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1.0 LITERATURE REVIEW

The number of elderly people worldwide is rising at an alarming rate, with almost 10,000 people turning 65 in the United States every day (Olshansky *et al.*, 2009). This dramatic rise in elderly people is also followed by an ever-increasing need for healthcare in the geriatric community (Olshansky *et al.*, 2009). The life span of the worldwide population had been increasing due to better health care system, diagnosis, and increased awareness. Parkinson's disease (PD) is one of the most common age-related neurodegenerative diseases (Hindle, 2010). Neuronal loss in genetic and sporadic PD is one of the significant causes of PD and other neurodegenerative diseases. The biomarkers for the diagnosis and prognosis of PD are still not well defined; hence the late diagnosis with reversal of the disease is difficult (Miller and Ocallaghan 2015). It is crucial to find novel mechanisms for prognosis and diagnosis, and pathogenesis. The mechanism of neuronal loss is still not precise in PD and needs to be investigated further to find novel targets for therapeutic interventions.

To facilitate the clinical diagnosis of PD, numerous studies have focused on biomarkers based on neuroimaging and molecules in cerebrospinal fluid (CSF) and peripheral blood. For example, neuroimaging abnormalities detection by SPECT, meta-iodobenzyl guanidine I 123, sonography, PET, or MRI, have been tested in patients with moderate or advanced disease. These allow non-invasive tracking of molecular targets of relevance to neurodegeneration, but the cost is too high to use these techniques as screening tools in the general population. Likewise, several blood and cerebrospinal fluid (CSF) biomarkers such as α -synuclein and DJ-1 have been tested to diagnose PD, but the outcomes have been inconsistent, possibly due to the highly heterogeneous study population sample contamination and non-standardized sampling processes. To effectively address the health of the elderly, especially those with PD needs in the years to come, it will be important to establish strategies to track the health status of the elderly and identify the most productive methods for remote surveillance, disease prevention and health care. Recent technological developments, such as television and telemedicine, have been especially useful in various environments (Levine and Gorman, 1999; Rosser *et al.*, 2001; Rajan, 2012; Clifford and Clifton, 2012; Rogante *et al.*, 2010).

The systems allow remote interactions between patients, physicians, and students critical to the next generation of clinical research and therapy (Panayides *et al.*, 2010; Koch, 2006). Smartphones are cell phones specializing in producing a new generation of clinical research with additional computing capabilities/services (Fortney *et al.*, 2011; Boulos *et al.*, 2011).

In addition, the number of mobile and pervasive medical applications on smartphones in the general population is rising and can be increased to include clinical research. Several papers have recently defined potential for mobile apps in circumstances, control of prescription drugs, food intakes, depression, strokes, diabetes, rehabilitation, opioid enforcement and patient care (Doherty and Oh, 2012; Dufau *et al.*, 2011; Gill *et al.*, 2012; Martin *et al.*, 2012; Mellone *et al.*, 2012a, 2012b; Klasnja and Pratt, 2012; Worryingham *et al.*, 2011). Moreover, amid numerous advancements in cell phone science, the utility and value of smartphone apps used for clinical research or care for the elderly remain almost unknown. The latest proposal focuses on creating a mobile app for PD patient memory, mobility and fragility. The purpose of this proposal is to create a new cognitive test (Touch Screen Technology Processing Speed) that is suitable for use in elderly people with remote testing capabilities. The significance of this proposal is the development of smartphone-based evaluation batteries for cognitive and motor function in patients with PD.

Interacting via the Internet has become a common part of our lives, sending emails to others throughout the world, blogging, social networking, attending online CME courses, and so forth. Technology also can foster advances in patient safety and patient care and allow neurologists to reach underserved rural areas to provide care remotely. As the use of Internet technology in medicine rapidly expands, neurologists considered how some of those technologies might be applied to their practices. Telemedicine is the use of technology to facilitate clinical care at a distance. Telemedicine technologies typically include but are not limited to telephone, email, and real-time videoconferencing. Neurology, as a speciality, adopted telemedicine long ago to facilitate stroke treatment. "Telestroke" networks link stroke neurologists with

hospitals underserved by specialists. A stroke neurologist typically "sees" a patient by audio-visual link, receives images and laboratory test results, and consults with emergency department providers to deliver expert stroke care. Telemedicine, if done well, can benefit patients. Thoughtful consideration and planning are required before adopting telemedicine technologies. Telemedicine is used to increase access for rural and underserved areas, allowing for the delivery of longitudinal and acute patient care, patient monitoring, and specialist consultations. Telemedicine is increasingly viewed as a means to improve health care delivery, and the telemedicine industry is projected to be an \$18 billion global market by 2015. One of the key challenges in treating mental health problems is the high degree of variability in therapy response. Because it is difficult to determine which individual will respond to which treatment, clinicians must rely on trial and error to find something that works. This lack of precision means that people remain symptomatic for longer than necessary and suffer physical side effects that can be particularly serious in older adults.

2.0 KNOWLEDGE GAP AND SIGNIFICANCE

Degenerative disorders of the central nervous system (CNS), such as Parkinson's disease (PD), affect the human motor system and present a variety of deficits, such as cognitive impairment and motor dysfunction ([Mack and Marsh, 2017](#)). Examples of such dysfunctions include reduced speech ([Ludlow et al., 1987](#)), higher regular calorie consumption ([Marder et al., 2009](#)), increased rigidity, decreased dexterity, and extreme tremor ([Louis, 2009](#)). Current research focuses on identifying early signs of diseases so that future medical assistance can postpone their growth ([Pereira et al., 2019](#)). The Self-Administered Gerocognitive Test (SAGE) ([Scharre et al., 2010](#)) is a widely used tool for cognitive assessment of MCI and early symptoms of dementia. SAGE is commonly used to classify MCI, AD, and PD ([Athilingam et al., 2015](#)). Recently, a variety of works have focused on providing automated cognitive and motor function self-assessment tests on electronic consumer devices, such as smartphones ([Aghanavesi et al., 2017a](#)), laptops ([Sisti et al., 2017](#)) and dedicated graphics tablets ([Sole-Casals et al., 2019](#)). Commonly conducted studies involve the tasks of Archimedes spiral drawing ([Aghanavesi et al., 2017b](#); [Chen et al., 2018](#); [Lopez-de-Ipina et al., 2018](#)), finger tapping ([Sisti et al., 2017](#)), freehand drawing tasks ([Lin et al., 2018](#)), and tracing tasks ([Chen et al., 2018](#)). Methods used to analyze the collected spatiotemporal finger tapping, finger tapping, or pen route data include statistical analysis ([San Luciano et al., 2016](#)), discrete cosine

transform (DCT) features ([Sole-Casals et al., 2019](#)), entropy, and fractal dimension analysis ([Lopez-de-Ipina et al., 2018](#)).

Non-motor symptoms (NMS), which play a critical role in the natural history of Parkinson's disease and are a significant predictor of patient and caregiver quality of life, have received little attention as a target for objective assessments using digital technologies. Monitoring and measuring NMS in Parkinson's disease is hampered by the physiology of some NMS, which makes objective measurement challenging, not just from a digital health viewpoint. Similarly, dedicated non-motor measures are not always capable of detecting and accurately identifying NMS ([van Wamelen et al., 2020](#)), especially when these scales are used to assess patient or clinician-reported outcomes rather than physiological processes. Currently, the only somewhat well-explored NMS component of PD in which wearable technology has been used is actigraphy for circadian and sleep problems ([Maglione et al., 2013](#)). However, initiatives have been undertaken in recent years to address the objective assessment of some additional NMS in PD. Apart from the twin issue of objectively measuring NMS and then converting them to digital health outcomes, there are no clear standards or criteria for selecting, technological validation, and clinical validation of innovative digital endpoints ([Kruizinga et al., 2020](#)). Beyond research initiatives, the use of technology-based digital devices should seek to augment objective and more widely used subjective measures, including as scales and questionnaires, in identifying the presence and severity of symptoms in the clinical care of PD ([Bhidayasiri et al., 2017](#); [Antonini et al., 2018](#)). Numerous types of digital technology have been created in recent years to assess cognitive performance. While many of these technologies have not been tried in persons with Parkinson's disease, there are several trials in people with Alzheimer's disease. Due to the nature of cognitive assessment, digital health technologies range from wearable sensors to phone apps that cover various aspects of cognitive function, such as the "Remote Assessment of Disease and Relapse – Alzheimer's Disease" (RADAR-AD), which uses remote monitoring to measure cognitive and affective biomarkers actively and passively ([Owens et al., 2020](#)).

3.0 METHODS IN BRIEF

The evaluation software will be designed exclusively for touch-screen smartphones and compatible with all Apple iPhones and Android phones. The software used for development is a Microsoft ASP.Net framework

programmed using C#, jQuery Mobile, and JavaScript. Shortly, the app will be friendly and easy to use with English and Malay language interface. The app includes buttons for tools, Managing symptoms, tracking progress, learning, getting support, and Glossary. The main part of the app will be dementia algorithms or roadmaps, which is a cascade of assessment and examination of cognitive functions like Interactive Zarit Burden Interview and Brief Interview of Mental Status. The app will contain the following icons/Sections: Background, Types of dementia, Dementia Risk factors, clinical assessment, available treatment, nursing guidelines, Health care professional section, Dementia roadmap, Brief Interview of Mental Status (BIMS). Plus icons like: search, about, Disclaimer, Glossary, Interface language. Technology firms such as MongoDB offer the tools to integrate a platform to store all files. We utilize many encryption technologies to guarantee that the app complies with HIPAA and GDPR and safe patient data. In general, the development of Android is needed to run the app on most mobile platforms. We are planning to build an Android version for iOS afterwards.

4.0 HYPOTHESIS

The current protocol focuses on developing a computerized model/smart phone application that assesses the cognitive and motor deficits of PD patients at the early stage, thus helping in early diagnosis and better follow up with more years of healthy life. Dementia Coach App is the proposed name for this new app. Our hypothesis is to develop a mobile app to assess the cognitive functions and dementia of a selected sample of Malay PD patients from SASMEC neurology clinic using the developed mobile dementia app. This app will help in the early diagnosis of NMS of PD patients.

Author Contributions: WM conceived and designed the experiments and the protocol. All authors wrote and critically reviewed the paper.

Conflicts of Interest: The authors declare no conflict of interest.

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