

Designing and Producing a Telerehabilitation Mobile Application and a Web-Based Smart Dashboard for Online Monitoring of Patients at Risk of Stroke During COVID-19 Pandemic and Post-Pandemic Era

Mohammad Rezapour^{1,2*}, Nouredin Nakhostin Ansari^{2,3}

¹Faculty Member of the Iranian Ministry of Science, Research and Technology, Tehran, Iran

²Department of Physiotherapy, School of Rehabilitation, Tehran University of Medical Sciences, Tehran, Iran

³Research Center for War-affected People, Tehran University of Medical Sciences, Tehran, Iran

*Correspondence to

Post-Doctoral IT Fellow, Tehran University of Medical Sciences. Assistant Professor; Faculty member of the Iranian Ministry of Science, Research and Technology, Iran. Tel (Office): +98 21 77533939. Fax: +98 21 77727009, Zip: 11489. E-mail: m.rezapour@modares.ac.ir

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Abstract

Introduction: Millions of patients suffer from stroke every year, and it is very important for physiotherapists to keep in touch with patients through models that provide physiotherapy over a distance, especially at the time of the COVID-19 pandemic. One key topic within the realm of provision of distance physiotherapy services is “TeleRehab” technology, short form for telerehabilitation. Moreover, the analysis of the gathered stroke data needs business intelligence (BI) technologies, which can help to gain insights into risk factors and improve medical decision-making.

Methods: This research consists two sections: (a) an online web-based intelligence dashboard was implemented, which provides analyzing the clinical data of 1219 patients and investigating risk the factors of ischemic versus hemorrhagic stroke; and (b) designing a mobile application that can be run on both Android and iOS operating systems, which was successfully tested, as an TeleRehab solution.

Results: The designed intelligence dashboard was equipped with a geographical information system (GIS) system that provided the possibility for the analysis of stroke status in any geographical location and discovering the relationships between patient-related contributors in each type of stroke.

Conclusions: Both of these products can help patients undergoing medical rehabilitation, especially during COVID-19 conditions. The TeleRehab program is considered as a facilitator, especially at this time when keeping a social distance is necessary, to prevent exacerbation of patients’ complications and reduce the work burden on health personnel. The intelligence dashboard also provided a user-friendly tool for the analysis and running of queries about stroke for decision-making.

Keywords: Telerehabilitation, COVID-19, Mobile application, Stroke, Smart dashboard

Introduction

Stroke is a leading cause of morbidity and mortality worldwide,¹ and the latest studies have declared that there are 80.1 million individuals suffering from stroke, with stroke causing 6.2 million deaths every year worldwide.²⁻⁴ A recent study in Iran demonstrated that there was a meaningful reduction in stroke admissions during the COVID-19 pandemic, up to 40%.⁵ Therefore, it is necessary to use communication tools to reduce patients’ complications.

But, one of the main aims of medical rehabilitation is to improve the quality of life of stroke patients, and physiotherapy (PT) is a common treatment for patients with pain or muscle spasticity caused by the upper motor neuron syndrome (e.g., stroke, multiple sclerosis) and uses various movement therapy techniques to fulfil this purpose.⁶

In today’s world, it is important to consider achievements in digital-physical therapeutic practices and telehealth.⁷ An obvious advantage of telehealth is the

ability to offer professional exercises to the patient (or his/her family) at home, reducing the requirement and costs for travelling to PT offices. Moreover, incorporating telehealth in home-based interventions is one potential way to increase the level of interventional support.⁸ This can involve a variety of methods and tools such as phone devices, web-based platforms,⁹ and videoconferencing. However, the quality and effectiveness of these interventions are still unclear in the exercise and oncology settings.^{8,10-12} More precisely, anyone could not claim that telehealth is an effective alternative to face-to-face rehabilitation exercise.⁸

Especially, beyond the COVID-19 pandemic, telehealth can reach those living in the regions where exercise oncology resources may be limited.¹³ In fact, it also can play an important role in healthcare management during COVID-19.¹⁴ One key topic within the realm of the provision of distance physiotherapy services is the “TeleRehab” technology, shortform for Tele-Rehabilitation. Yet, these technologies have not been expanded plausibly, and there is limited understanding of how they contribute to clinician-patient telecommunications.¹⁵

So, in this study, we applied a rehabilitation mobile technology, namely TeleRehab. TeleRehab is a format of telehealth accessible to anyone who has only a mobile phone and provides continuing physiotherapy services, reducing disease burden on the healthcare system. Using a mobile application would facilitate communication between the physiotherapist and the patient and cuts expenses to the lowest level. In addition, an online dashboard was designed by the corresponding author, with the ability to analyze the data of patients with stroke.

Materials and Methods

An intelligent analytical tool is needed to analyze the factors that lead to different types of strokes. In order to reduce the rate of referrals to rehabilitation centers during the COVID-19 outbreak, communicating with patients and being informed of their condition is important for the physician to provide timely orders to reduce their complications. Therefore, we here aimed to design a mobile application to offer these services.

Stroke Risk Factor Analysis

First, to analyze the risk factors leading to stroke, we designed an intelligence dashboard based on Microsoft Power-BI and launched it on the web. This dashboard can be accessed via the Internet from any point of the world and is based on the data of 1219 stroke patients.

A Step Towards Post-Stroke Risk Management

Then we designed a TeleRehab mobile application, executable on Android and iOS, for providing physiotherapy services safely and effectively during the severe acute respiratory syndrome Coronavirus 2 (SARS-

CoV-2) pandemic. We used the “lab study” methodology to test if patients can actually use the product as a TeleRehab solution.

Results

Intelligence Dashboard: Monitoring Stroke Risk Factors

The designed dashboard is available both through the address: <https://app.powerbi.com> or by taking a mobile camera on a QR code (Figure 1).

A view of the dashboard home screen has been shown in Figure 2. As it has been illustrated in the southwest corner of the Figure 2, the dashboard was equipped with a geographical information system (GIS) that provided intelligence analysis of stroke status anywhere by discovering the relationships between variables, showing to the analyst in an overview what risk factors have arisen in each type of ischemic or hemorrhagic stroke. Chart located in the northeast corner of the Figure 2 shows the main types of strokes, which would change based on the selected region in GIS or other indicators.

TeleRehab: An Approach to Reduce Unnecessary Referrals and Increase Social Distance

The current version of our TeleRehab program was designed for physiotherapy offices in Iran and for Persians (Figure 3) and was successfully implemented without the need for supplementary or special software installation. This can be effectively extended to other requested languages, especially at this time when social distance is necessary to prevent exacerbation of patients' complications and reduce the burden of the COVID-19 pandemic on health personnel.

An overview of the ability to provide application menus for non-Persian language readers is provided in Figure 4.

Discussion

During the COVID-19 pandemic, the TeleRehab designed here can facilitate physiotherapy procedures. Furthermore, the patients' data obtained by this technology can be used in complementary analytical tasks (such as data mining) and for identifying health patterns for making better health decisions.¹⁶⁻¹⁹ The TeleRehab application can be a useful model for delivering health services amid the COVID-19 pandemic. Physiotherapists can provide their patients with necessary consultations about preventive measures against the coronavirus infection; patients can receive their therapeutic exercise programs, and finally,



Figure 1. QR Code for Running Designed Stroke Analytic Dashboard.

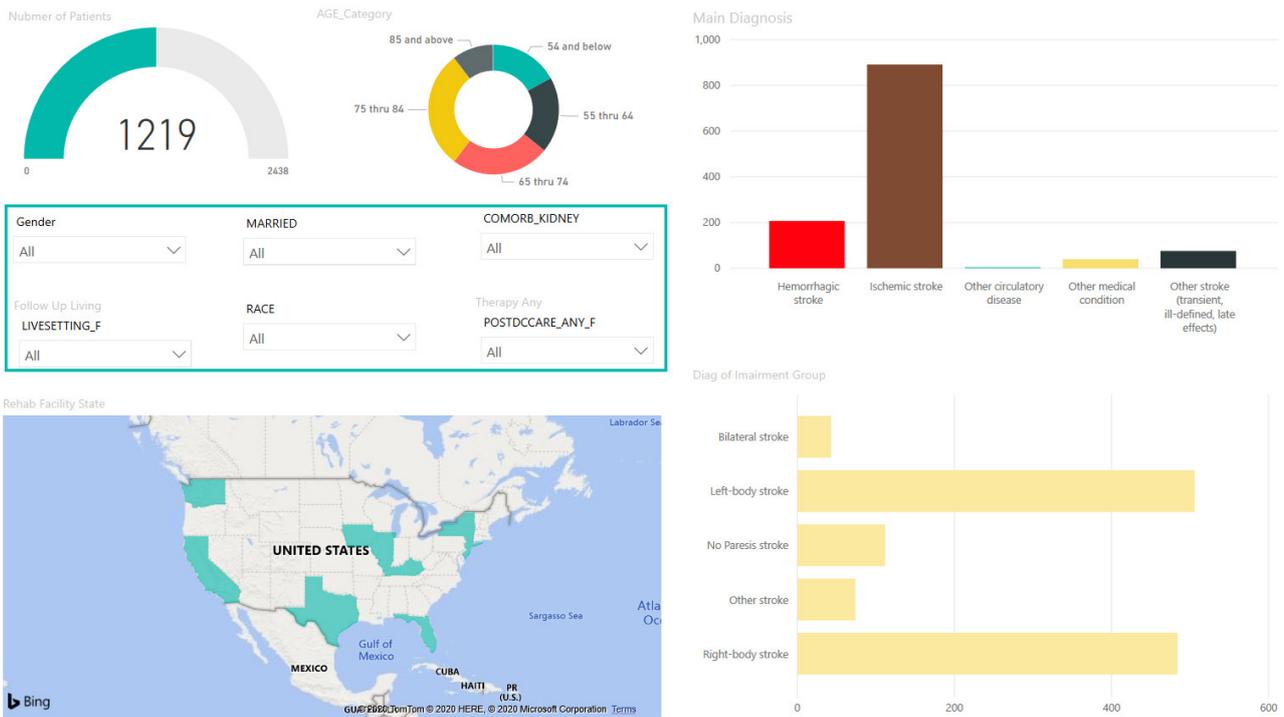


Figure 2. A View of the Stroke Analytic Dashboard Home Screen.



Figure 3. The Main Menu of the Designed TeleRehab Application in Persian.

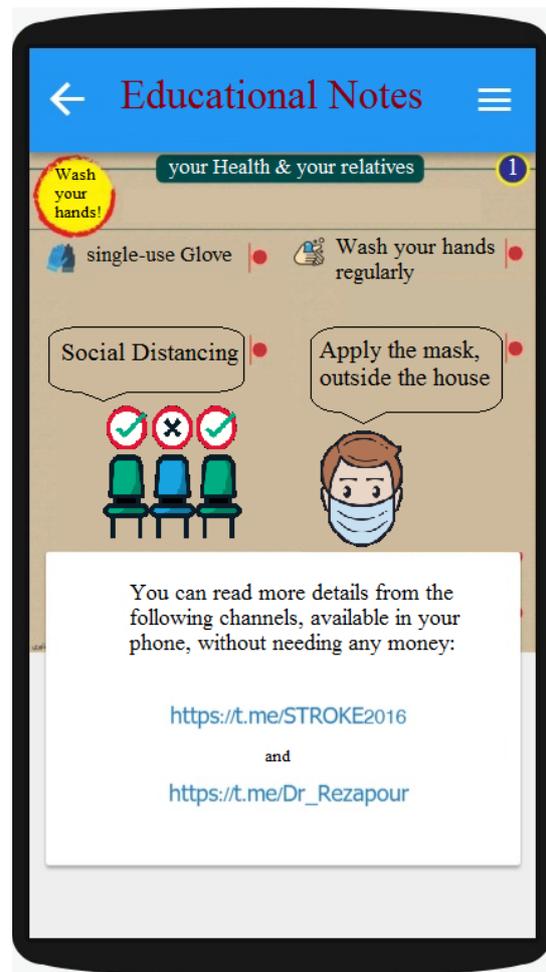


Figure 4. The Main Menu for International Readers.

physiotherapists can monitor their patients' health status and refer them to other healthcare professionals in the case of a health emergency.

Similarly, telemedicine has been implemented using a non-mydratic camera for better screening of patients.²⁰ The same technology has also been useful for detecting diabetic retinopathy.²¹ Another study developed a TeleRehab system based on virtual reality technology that requires having a computer at home.²² Our new application; however, does not require a computer for installation and is available for mobile phones commonly used by people (i.e., 120% of the population by August, 2019).²³ The logical possibility that more than 100% of people use mobile phones is that some people have more than one mobile phone. Nowadays, the term "u-Health" has been suggested to designate telemedicine, in which "u" stands for the ubiquitous technology, connecting health providers and patients in ubiquity.²⁴

Conclusion

Both of the products designed in this research can help improve the quality of life of the patients requiring medical rehabilitation services, especially during the COVID-19 outbreak, partly by reducing the need for their travelling to physiotherapy centers. The mobile application is also beneficial for physical therapy practitioners. In fact, digital physical therapies and Tele-health, as safe communication and effective digital practices, are accessible and easy-to-use for physiotherapists. Also, the intelligence dashboard designed offered a user-friendly tool for the analysis and run queries against stroke data and created a visualized data platform in any geographical location, and finally could improve health decision-making and strategic planning.

In the current situation, regarding the coronavirus pandemic and double entanglements for families with stroke patients, extending the utilization of both the software designed in the present study is strongly recommended. Further studies can be done according to the outputs of the designed dashboard, and for this, it is recommended to pay attention to recent researches that have revealed the risk factors for stroke.²⁵⁻³⁰ There are also many other models which use much simpler methods like signal analysis, which is very popular in medicine.³¹⁻³⁸ Although the current version of the designed TeleRehab application is based on the Persian language, it is extendable to other languages as well. Also, authors welcome stroke data from other countries to enrich the smart dashboard, providing the possibility of simultaneously comparing stroke risk factors in different regions.

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Authors' Contribution

MR and NNA were involved in planning the work and designed the project. MR performed the experiments and developed the smart dashboard. MR wrote the article. All authors provided critical feedback and helped shape the research, analyze data, and prepare the manuscript.

Competing Interests

There is no conflict of interest. None of the authors have any financial relation with the commercial tools, such as Power BI, Android or IOS operating systems, mentioned in this article.

Ethical Approval

This study was approved by the Ethics Committee of the Iran National Science Foundation (INSF). The project was supported by INSF under the reference number 97006815 on 2019-Sep-18. The paper was a part of postdoctoral research fellow by Dr. Mohammad Rezapour with the guidance of the supervisor professor Dr. Nouredin Nakhostin Ansari, that was financially supported by the Iran National Science Foundation (INSF) (Grant No. 97006815).

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