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A New Model of Patient Monitoring System for Lymphatic Treatment of Leg Pain based on Double-Loop Feedback Theory

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Abstract— **Leg pain occurs in many people nowadays due to today's lifestyle. This leads to the development of various treatments for leg pain. However, there are some issues regarding the existing leg pain treatments. The first issue is the treatment method where most treatments for leg pain use compression but they are costly, time-consuming and cumbersome, which require patients to visit hospitals regularly that affect patient's compliance to continue with treatments. The second issue is the treatment time frame for leg pain is within a short time frame, whereby it is difficult to see the major effect of a certain treatment. The third issue is the lack of a system to monitor the patient's rehabilitation progress to increase patients' confidence to continue treatment consistently to cure their leg pain. Therefore, this research is conducted to cover all issues of existing research under the main area of health informatics. This research will be conducted in Nilai, Negeri Sembilan where 30 respondents with leg pain problems will be chosen as samples of this research and treatment will be conducted for 6 months. The treatment method is by using fingertips massage with oral and topical medication, where oral medication is disregard herb-based pills and topical medication is cinnamon cream. This system is needed to help patients to resolve their leg pain through the lymphatic treatment model. This lymphatic treatment model for leg pain resolution will be a useful guide for all patients with leg pain and also the caretaker of that patient. It requires a low cost and especially beneficial to lower to the middle-class community. This research is significant for the national agenda as it falls under the national research priority area of Health and Medicine. The expected outcome of this research is a new concept of the systematic patient monitoring system for lymphatic treatment of leg pain based on double-loop feedback theory.**

Keywords— **Patient monitoring system, Lymphatic treatment, Leg pain, Double-loop feedback, information system**

I. INTRODUCTION

The lymphatic system consists of a network of lymph vessels and organs and specialized cells throughout the body. It is an essential part of the body's defense against invading micro-organisms. The lymphatic system is the lesser-known part of the circulatory system, working together with the cardiovascular system to transport a fluid called lymph around the body. The lymphatic system plays a vital role in the defense of the body against disease [1].

There are many causes for leg pain but the main focus is related to lymphatic system treatment. There are various research studies on the treatment of leg pain involving the lymphatic system. However, all these treatments involve cost and the need to go to the clinic or hospital to be treated. Not all people have the opportunity and capital to go to the clinic or hospital to get treatment. Usually, the cost for the treatment of leg pain is quite high in the clinic and hospital. However, the result of hospital treatment varies according to the individual. Some individuals cure treatment for a long period, some individuals only cure for a short period, and others do not cure at all from the treatment.

Among popular methods for leg, pain treatment is compression. [4] proposed velcro adjustable compression wraps (ACW) and inelastic multicomponent compression (ICM) bandages in the initial treatment of leg lymphedema. This study is randomized but conducted in a controlled trial. In patients with moderate to severe lymphedema of the legs, ACW achieved a significantly more pronounced reduction in volume after 24 hours than IMC bandages [6] examined the effectiveness of an advanced pneumatic compression device (APCD) in reducing limb volume (LV), and to evaluate clinician and patient-reported outcomes. Patient-reported outcomes showed a significant increase in the ability to control lymphedema through APCD treatment, with an increase in function and a reduction in the interference of pain. Results demonstrate that reduction in LV and pain, combined with the functional improvement and patient satisfaction can be achieved, providing a tangible benefit for lower extremity patients. [11] proposed near-infrared fluorescence lymphatic imaging (NIRFLI) for non-invasive, real-time assessment of lymphatic contribution in the etiology and treatment of leg ulcers and to access the Lymphatic impact of a single session of sequential pneumatic compression (SPC). Results from this research confirmed that lymphatic dysfunction at an early stage in the etiology of venous ulcer formation and demonstrate the potential therapeutic mechanism of SPC therapy in removing access fluid.

Numerous and varied health information web sites have been developed and are now operating. [5] developed a telerehabilitation self-management program for persons with chronic lower limb swelling and mobility limitations. The evidence-based educational materials developed as part of the self-management program for lower limb chronic swelling/lymphedema in persons with limited mobility were found to be valid, accurate, and complete with high ratings of clarity. The readability and suitability ratings indicated that the materials are appropriate for various levels of health literacy in the study population. It can be assumed that TR is a viable method of providing a home-based self-management program on lower limb chronic swelling/lymphedema in people with mobility limitations and can decrease the burden associated with lifelong management of this debilitating condition.

[12] mentioned that people today have become more interested in disease prevention and health promotion, rather than disease treatment, and have shown a tendency to get various types of information from diverse media and try to apply it to themselves. In the current ubiquitous environment, health information support services have generally been developed in a format of inputting bio-information into a computer for network-based transmission. Even though there are a large number of health information websites exist today, they do not seem to be effective for users' healthcare needs and health promotion, not only because of the limitations of web-based information but also due to a lack of customized healthcare services.

II. PROPOSED FRAMEWORK

The methodology can be divided into 2 parts. Firstly, is to develop a lymphatic treatment model for leg pain resolution. This research will be conducted in Nilai, Negeri Sembilan will be the population for this research. 30 human subjects with leg pain problems will be chosen as samples of this research and treatment will be conducted for 6 months. The treatment method is by using fingertips massage with oral and topical medication, where oral medication is diabegard herb-based pills and topical medication is cinnamon cream.

Secondly, is to develop a patient monitoring system that is intelligent. The development of intelligent systems specifically knowledge-based systems requires the development of a knowledge-based that has to include general and specific knowledge to solve problems in a well-defined domain of expertise. The process of knowledge-based construction is identified as knowledge engineering and generally follows a specific methodology. One of the first steps of this process is ontology development. Ontologies are a central building block of the Semantic Web [7]. It describes the domain concepts and the relationships between them and therefore presents a meaningful domain language to humans and machines. Thus, ontology becomes the knowledge-based of the intelligent system.

Information Management Modeling using Prolog

The proposed Information Management Ontology is first modeled using Prolog. Later, the finalized ontology will be constructed using OWL syntax in the Protégé-OWL tool. Prolog stands for PROgramming in LOGic and it was developed from a foundation of logical theorem proving and essentially used for research in natural language processing [2]. Prolog allows for rapid prototyping of specifications, proofs, and tests. As such, Prolog is chosen to demonstrate the proposed logical specification of the ideal executable lymphatic treatment of leg pain resolution.

Basic Information Management Modeling using Protégé OWL

Protege-OWL provides great facilities to define and describe concepts with a richer set of operators such as and, or, union, negation, etc. Complex concepts can, therefore, be built up in definitions out of simpler concepts. Moreover, the reasoner can check whether or not all of the statements and definitions in the logical model are consistent and can also identify which concepts fit under which definitions [8]. Hence, the reasoner can ensure the correct hierarchy. This is particularly useful when dealing with cases where classes can have more than one parent. These criteria are rational as to why Protégé OWL is chosen to be embarked on this research.

Basic Information Management Modeling using SWRL

Semantic Web Rule Language or SWRL is a proposal for a Semantic Web rules-language combining sublanguages of the OWL Web Ontology Language (OWL DL and Lite) with those of the Rule Markup Language [13]. Compared with Description Logic Programs, another rule language in the Semantic Web for combining rules and OWL, SWRL takes a completely different integration approach. While Description Logic Programs is the intersection of Horn logic and OWL, SWRL on the other side is the union of them. In Description Logic Programs, the resultant language is relatively inexpressive language overall as it is difficult to see the restrictions are either natural or satisfying. Contrariwise, SWRL maintains the full power of OWL DL in its practical implementations. SWRL, therefore, is an excellent semantic web rule language to add more expressivity to the OWL ontological model in this research work.

Architecture

This research proposes to use Semantic Web techniques such as OWL to encode system metadata. The open-source reasoner Pellet to provide standard reasoning services for OWL ontologies involved; the Semantic Web Rule Language (SWRL) to infer knowledge by assessing the information on lymphatic treatment on leg pain resolution; Jena an OWL API to manipulate OWL data models and to perform reasoning based on Description Logic engines and using Tomcat as the deployment server.

The ontology will be constructed using OWL syntax in the Protégé-OWL tool and combined by sets of rules represented in SWRL, the Semantic Web Rule Language. For this research, OWL is used for expressing the ontology and is combined with Semantic Web Rule Language (SWRL) to add more expressivity to OWL. Semantic web ontology language OWL has recently emerged as the de-facto standard for intelligent applications that utilize the ontologies as a knowledge formalization tool. OWL, in combination with the SWRL rule language and with domain-independent reasoners, provides a generally recognized expert system development framework. Concerning the structured lymphatic treatment of leg pain resolution, OWL provides essential infrastructure concurrent with these special needs.

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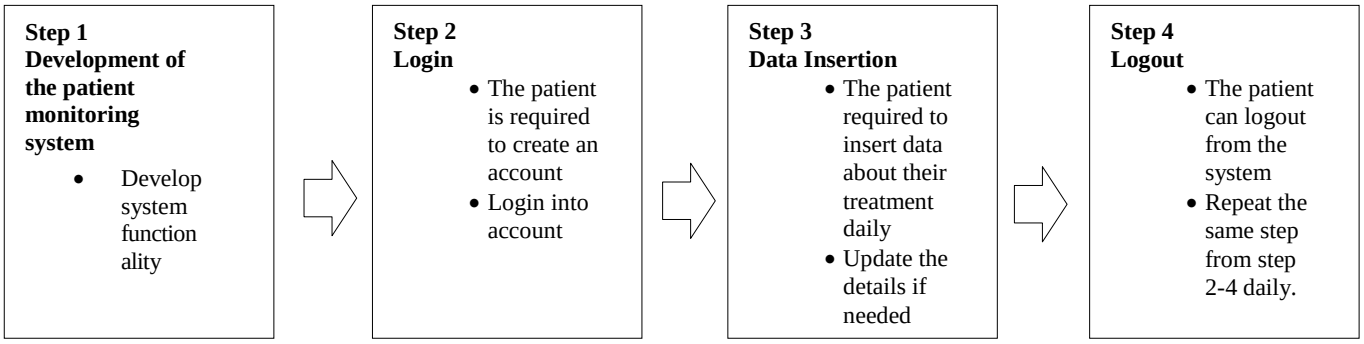

Fig. 1 Proposed framework for patient monitoring system

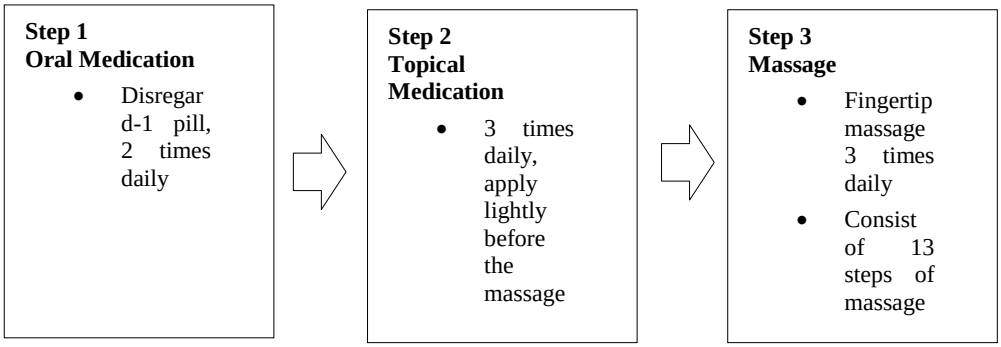

Fig. 2 Proposed framework for lymphatic treatment model for leg pain resolution

Based on Figure 1, there are 4 steps of conducting a proposed framework for the patient monitoring system. The system consists of the user and administration panel page. However, the procedure focus on the user site as it will be the platform for data collection. Users are required to make daily insertion data regarding massage and how many pills they are consumed throughout the whole day.

The first step begins with the development of the patient monitoring system. The system consists of a few functions, which are inserted delete, and viewing. Other than that, there is a video insert into the system as a guide for the patient on how the massage is supposed to be conducted. All 13 steps are displayed and demonstrated to provide an understanding of patient

As for the second step, patients are prerequisite to log in and create an account for themselves. It will ensure for them to track their daily massage and pills intake routine. Apart from that, a login account can help to differentiate which patient with the correct password and username thus preventing data misconfiguration.

The third step includes the patient inserting data on medical intake and massage daily. The patient can also update which are insert and delete any data if it is false and imprecise. The insertion of data can be displayed on the same page where the patient add their details. The data display also implicates patients' determination to join and make changes in their life.

Finally, the last step indicates the patient to log out of the system. The logout session can help them from unauthorized users to access the system without patient consent. Others, it can prevent any data manipulation which can be missing or disclose to the public.

Based on Figure 2, the second framework is the lymphatic treatment model for leg pain resolution. Step 1 begins with oral medication. This step is crucial where the patient is needed to consume 1 disregard pill, 2 times per day without fail. The pills help the treatment to function well to reduce leg pain.

Moving to step 2, a topical medication. The medication requires to be applied by the patient 3 times daily and ensure to apply lightly before the massage while the last step which is step 3 is a massage. The patient can apply a fingertip massage 3 times daily and follow the massage instruction from the video which has already been displayed in the system. The massage consists of a 13 step treatment which implies the pressure massage across 13 lymphatic points on the human body.

III. CONCLUSIONS

This paper has proposed the 2 different framework which is a patient monitoring system and lymphatic treatment model for leg pain resolution. It also includes the implementation of ontology development to describe in detail the relationship between domain concepts and present a powerful domain language for both machines and humans.

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REFERENCES

[1] Abrahams, Peter, ed. (2008). How the body works: A comprehensive illustrated encyclopedia of anatomy. London: Amber Books Ltd.
[2] Bratko, I. (2001) Programming in Prolog for Artificial Intelligence, 3rd edition, London: Addison-Wesley.
[3] Carless, David (2019). Feedback loops and the longer-term: towards feedback spirals, Assessment & Evaluation in Higher Education, 44 (5), 705- 714.
[4] Damstra, R. J. & Partsch, H. (January 2013). Prospective, randomized, controlled trial comparing the effectiveness of adjustable compression Velcro wraps versus inelastic multicomponent compression bandages in the initial treatment of leg lymphedema. Journal of Vascular Surgery: Venous and Lymphatic Disorders, 1 (1), 13-19.
[5] Faett, B. L., Geyer, M. J, Hoffman, L. A., & Brienza, D. M. Design and development of a telerehabilitation self-management program for persons with chronic lower limb swelling and mobility limitations: Preliminary
evidence. Nursing Research and Practice, 2012, 1-10.
[6] Muluk, S. C., Hirsch, A. T. & Taffe, E. C. (October 2013). Pneumatic compression device treatment of lower extremity lymphedema elicits improved limb volume and patient-reported outcomes. European Journal of Vascular and Endovascular Surgery, 46 (4), 480-487.
[7] Herman, I. (2007), "What is the Semantic Web?", http://www.w3.org/RDF/FAQ [accessed 18 February 2016]
[8] Horridge, M., Knoblauch, H., Rector, A., Stevens, R., and Wroe, C. (2004) A practical guide to building OWL ontologies using the Protege-OWL plugin and CO-ODE tools, 1st edition, University of Manchester, CO-ODE project.
[9] Malasinghe, Ramzan and Dahal (2019). Remote patient monitoring: a comprehensive study, Ambient Intell Human-Computer, 10, 57–76.
[10] Mohammed Talal, A. A. Zaidan, Bilal Bahaa and A.s. Albahri (March 2019). Smart Home-based IoT for Real-time and Secure Remote Health Monitoring of Triage and Priority System using Body Sensors: Multi-driven Systematic Review, Journal of Medical Systems, 43 (3), 1-34.
[11] Rasmussen, J. C., Aldrich, M. B., I-Chih, T., Darne, C., Banghe, Z., O'Donnell T. F. Jr., Fife, C. E., Sevick-Muraca, E. M. (January 2016). Lymphatic transport in patients with chronic venous insufficiency and venous leg ulcers following sequential pneumatic compression. Journal of Vascular Surgery: Venous And Lymphatic Disorders, 4 (1), 9-17.
[12] Sang-Yeob, O., Supratip, G., Kyungyong, C., Joong-Kyung, R. and Jung-Soo, H. (2014). Recent trends in convergence-based smart healthcare service, Technology and Health Care, 22, 303–307.
[13] W3C (2004) "SWRL: A Semantic Web Rule Language Combining OWL and RuleML", http://www.w3.org/Submission/SWRL/ [accessed 18 February 2016].