Multimedia-Based Therapy Model for Non-Pharmacological Stroke with Decrease Impaired Muscle Strength

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Abstract. Stroke patients who experience a decrease in muscle strength need to do exercises so that they can increase their muscle strength. In order to enable the patient does exercise independently the multimedia-based stroke therapy model is needed. These exercises can be done independently, with supervision of the family member at home. So, we develop prototype of the multimedia-based therapy for the family member so that they can assist patients performing exercises without attending therapy session in hospital. This model was built according to the advices from physiotherapist and a medical rehabilitation doctor. This model has been evaluated through focused group discussion by physiotherapists. And they gave positive responses to this proposed model.

1. Introduction
Definition of stroke according to the World Health Organization is prominent clinical signs of focal or global form of brain dysfunction that develops quickly, with symptoms lasting 24 hours or longer and can lead to death, with no apparent cause other than vascular [6]. Characteristics of all types of stroke is a neurological dysfunction with onset relatively sudden, involving one or all of the following signs: weakness, numbness, loss of sight, diplopia, dysarthria, gait abnormalities, aphasia, vertigo, or degrees of impaired consciousness [1]. Post-stroke rehabilitation is an effort to repair limb disability or decreased function. One motivation of this study is to help the families of stroke patients to perform muscle strength therapies independently at home. Post-treatment recovery and prevention of stroke risk factors can reduce mortality and increase post-stroke disabilities [2]. One part of post-stroke rehabilitation is therapy to improve muscle strength. The table 1 shows the muscle strength scale.

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Hemiparetic stroke patients with decreased muscle strength is usually affect half of the body. Some stroke patients experience these because of having a stroke bihemiparetic continued on different sides of a stroke before. Stroke patients, aided by family members, can do therapy to increase muscle strength independently at home. It is necessary to have and an exercises guidelines in hand to do so. Moreover, such multimedia-based guidelines were preferable because it could give more information and interactivity on stroke treatment guidelines for cases of decreased muscle strength.

Muscle strength 0 and 1 are suggested for therapy with a stimulant special tools. This research can illustrate some examples of multimedia visualization in the form of examples of movement therapy with patients with minimal muscle strength 2. If a patient has muscle power 2, it is expected to perform routine exercise therapy can be increased to have the muscle strength of 3 and so on until the maximum results obtained. Before doing movement therapy using this application, one is expected to consult with the patient's medical rehabilitation doctor and physiotherapist.

Multimedia-Based studies related to post-stroke rehabilitation have been studied: The book with the title active again after a stroke is equipped with a CD tutorial book is written by experts in the field of medical rehabilitation aimed to help stroke patients can perform therapeutic exercises independently with the help of a family member to do some post-rehabilitation movements [4]. Some of the videos available on YouTube which are published by hospitals in Singapore [8]. A product with a base pin board, namely designing plaything for post-stroke patients, has been investigated by Rosyada et al [7]. Identification System Based Rehabilitation Needs Affordable Technology For Stroke Patients In Indonesia has been investigated by Hariandja [9]. The interactive tools using smart phones that are connected between the patients with people who care has been investigated by Hariandja and Maitimo Robert [10]. However to our knowledge the study on animation therapy model for stroke patients has never been investigated.

This paper is outlined as follows. In section 2, explained the problem description. In section 3, the proposed method is presented. In section 4, we explained implementation about the software navigation, structured questions, and then therapy solution. In section 5, evaluation from focus group discussion of physiotherapist. Last but not least, in section 6 conclusion to further improvement.

2. Problem Description
How to develop an expert system for the treatment of stroke? How to integrate expert systems on multimedia-based applications? How to build an interface that is user friendly for patients with stroke? The difference with previous studies is that the proposed was built with animations and visualizations focus on therapy to improve muscle strength in stroke patients that experience decreased muscle strength. Multimedia animated visualization is more interactive therefore allow a user to use the navigation buttons on the menu available on the model.

Table 1. Muscle strength scale table*

| Findings                                                                 | Grade |
|--------------------------------------------------------------------------|-------|
| Normal motor power                                                       | 5     |
| Able to overcome gravity and significant resistance but strength not quite normal | 4++   |
| Able to overcome gravity and moderate resistance                         | 4+    |
| Able to overcome gravity and mild resistance                             | 4     |
| Able to overcome gravity but not resistance                              | 3     |
| Unable to overcome the force of gravity but able to move in the plane of the supported extremity | 2     |
| Flicker movements only                                                   | 1     |
| Total paralysis                                                          | 0     |

*a courtesy of Miller DW Hahn
3. Method
This study uses two methods in collecting the data, i.e.: secondary data collection methods (medical records from the hospital) and literature study method. There were 101 medical record data collected to obtain examples of classification decreased muscle strength. A literature mainly focused on multimedia-based application development. Expert systems are included in decision support systems. In general, expert systems is a system that is trying to adopt human knowledge into a computer, so that the computer can resolve the issue as it is commonly done by experts [3]. A general description of expert system on the model of stroke therapy tools are focused on patients with impaired muscle strength decrease. By doing exercises independently with the help of families the stroke patients were expected to improve muscle strength until its maximum muscle strength. In general overview of the system can be seen in figure 1 below:

![Figure 1. System overview.](image)

On Figure 1 above can be defined when a patient experienced a total breakdown of communication or have very weak muscle strength cannot be treated with this tool. Patients who have the muscle strength 2, 3 muscle strength, and muscle strength 4 can be treated with this proposed tool. The design of this application can be described with a Finite State Machine which can be seen in Figure 2 below:
Finite state machine is the overall picture of the application, after caption “A” can see figure 3 on decision tree because this models was built according decision tree.

To diagnose muscle power stroke patients with impaired muscle strength decline in this study using structured questions. After going through the structured questions, the diagnosis of muscle strength of each part of the limb is shown so that it can be used to determine the therapeutic solution. The structured questions can be seen in the decision tree in Figure 3 below:
Figure 3. Diagnosis decision tree to determine muscle strength therapy solutions.

Figure 3 caption:
A Does the patient have communication disorders?
B Does the patient impaired limb?
C1, C2 Does the patient have a total muscle paralysis?
D1, D2 Does the patient can perform the movement without against gravity?
E1, E2 Does the patient able to do movement against gravity?
F1, F2 Does the patient can perform movement against gravity with mild loads.
S1 Cannot be treated with this application due to special handling needs in terms of communication.
N Normal, does not need to do therapy.
S2 Cannot be treated with this application because paralyzed muscle strength (muscle strength 0).
S3 Cannot be treated with this application because muscle strength is flicker movements only (muscle strength 1).
S4 Solution therapy with a sliding movement to the right and to the left (muscle strength 2).
S5 Solution therapy with movement up and down without load (muscle strength 3).
S6 Solution therapy with movement up and down with the load (resistance) (muscle strength 4).

The answer of each limb in question will be used in the decision tree to produce a summary diagnosis. An example of this summary diagnosis is as follows: right hand muscle strength is normal, normal right leg muscle strength, muscle strength 3 left hand, left leg muscle strength 3. This tool would inform user that the patient has decreased muscle strength on both left hand and leg. When user clicking the button labelled "please click menu suggestions therapy", the example of animation of the therapy exercises will be played. There were sentences which describe how many times this movement should be done.

4. Implementation
The screenshot below describes the software implementation of the expert system, see figure 4. In this application, the "home" also serves as the main menu page that is used to select the modules that exist in the application. Graphical User Interface on this application can be seen in Figure 4 below:

![Graphical User Interface](image)

**Figure 4.** Graphical User Interface

The system information menu is a general description of this application. The menu contains information about the scale of muscle strength and muscle strength information. Sample cases and therapy menu are some structured questions that lead to the diagnosis of muscle strength and therapy advice. The menu in this application is also equipped with the "home", "back", and "exit". Home button to return to the main menu, back button to go back into the previous menu, and out button to end the application program. When the example of button was clicked user will need to answer the structured questions on communication ability and muscle strength. Examples of the structured questions on the model this tool can be seen in Figure 5 (question about communication ability) and Figure 6 below (questions referring to the diagnosis of muscle strength). For communication disorders, muscle strength 0 and muscle strength 1, this tool cannot be used and the menu will appear warning that patient cannot be helped with this tool. One example of structured questions will refer to the third muscle strength can be seen in Figure 6 below:

![Structured question example](image)

**Figure 5.** Structured question example about communication ability.

One example of the menu display muscle strength 3 therapy suggestions can be seen in Figure 7 above. Muscle strength 3 exercises for the wrist joints consist of two kinds of movement. If exercise 1: selected hand movement joint parts lifted up his palms do against gravity. If exercise 2: selected hand movement wrist joints prone parts movement against gravity. For exercise 2 visualization can be seen in figure 8 below:

![Animation example](image)

**Figure 6.** Structured question example to the diagnosis of muscle strength.

**Figure 7.** Animation example of exercise 1.
Figure 8. Animation example of exercise 2.

Therapy movement is repeated 8-10 times for each movement and exercise therapy is done 3 times a week, all movements to adjust the patient’s condition. Once the patient can perform the movement with the optimal range of motion, there are advises to see the doctor to assist the muscle strength prior to go the next level therapy.

5. Evaluation

This model was shown to the group of 10 physiotherapist. They been asked about their opinion on some indicator, i.e.: application flexibility, application functionality, productivity applications and then usability according to ISO 9126. These indicators were then divided into 18 sub-indicators, i.e.: for application flexibility consists of 5 sub-indicators such as display, language, creativity, ease of use, and grouping action. For application functionality consists of 4 sub-indicators such as reliability, consistency, modelling material, and quality. For productivity applications consists of 5 sub-indicators such as the material suitability, submission info, level correctness, completeness of information, effectiveness of use. And the last indicator is usability theory according to ISO consists of 4 sub-indicators such as easy to understand, learn ability, operability, and attractiveness.

The FGD had been done by the group of physiotherapists. They evaluated the performance of the proposed model. The data is then tabulated to facilitate the testing process. The result given in this study are "expert system performance can be received by users" with a value of 75% acceptance. The total value of the average user acceptance is greater than the value of the hypothesis, the results obtained count value of 0.803 means that the application made resulting assessment data on the performance of the application being built was acceptable by physiotherapist. Moreover, they rate the application performance was “good enough”. Result from focus group discussion is an average value of acceptance of more than 80%. However, they also pointed areas where the improvement need to be done, i.e. grouping of action, consistency, and operability. These indicators were rated 74%.

The groups also give some suggestions applications should be made more attractive by adding a better design to increase the interest of the user. This tool should be developed using mobile-based applications because mobile-based device is more user friendly. Some movements require a view from above in order to visualize the animation appear more clearly, but in this study only the view from the front and some animations with the view from the side. Model tools need to be developed to a wider scope, for example by adding exercise to the movement of the head. In anticipation of a situation which any family members who do not computers literate, it is necessary to add guidance and training before using this tool. Prior doing this therapy, patients are expected to check and consultate to a doctor because they need to assess their level of muscle rigidity possessed. Improvement to this model can be done by developing 3D animation.
6. Conclusion
Expert system for determining the level of muscle strength in stroke cases has been develop using combines decision tree successfully developed. Results of the evaluation models evaluated by physiotherapists have been considered as good and the application is expected to help the patient’s family to do independent therapy. Further studies are needed to improve and extend coverage to the 3D animation.

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