



## Designing a 10-in-1 Physiotherapy Wheelchair

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### Abstract

Abstract Stroke Symptoms usually occur due to excessive blood pressure in the body's system. The next problem that occurs to stroke patients is the constraint to move and the difficulty to go to the rehabilitation clinic for follow-up exercises. This study is based on discussions with rehab patients, patient assistants, nurses and therapist. The aim of the study is to design a product which enable the stroke patients to perform minimal rehabilitation exercises without time constraints and having problems to move to the treatment centre. The product is a simple and practical product which combine several of its functionality and easy to operate at home. The study is also conducted to improve and enhance the therapeutic function of existing product such as seat frame, dumbbell weighting equipment for leg muscle training, pedal cycling exercise, hand palm grip sets, finger reflexology therapy sets, set of exercises for wrists, spine training, wheelchair cushions and headboard and area for storage. With this product, the patient does not have to worry about the movement to go to the treatment centre for follow-up exercises. Patients can use this product with only one assistant from a family member and the assistant can monitor and assist from the start.

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*Key-word:* - keyword Stroke, physiotherapy chair, rehabilitation rehabilitation, treatment center

### 1. Introduction

Stroke or stroke disease is considered to be the leading cause of death and also the loss of one's ability. (WHO, 2003) Information from the National Stroke Association of Malaysia (NASAM) shows that approximately 40,000 Malaysians suffer from stroke. (NASAM, 2011). There are also six new stroke cases per hour in Malaysia. (The Star, 2007) Stroke disease is a brain damage and occurs when oxygen in the blood supply to the brain breaks or clogs. Brain damage will affect the main senses, speech and language and understanding. (Julien, 2001)

One of the stages of treatment for severe stroke is that patients need to take medication and must rehabilitate by giving treatment to them. This is to strengthen the weak body condition in movement. In the rehabilitation treatment of the stroke patient, one of the treatment elements is physiotherapy. Physiotherapy is the care or rehabilitation of the functioning of the body movements. (Michael, 2005). Various equipment are provided at the treatment centre for the recovery of the patient. The various types of equipment for therapies are to help patients to learn and retrain ways to balance themselves and also to move about. Nowadays most therapeutic equipment are laid separately for each therapeutic treatment. This will make it difficult for patients to move from one therapeutic device to another and require maximum supervision especially if the therapy is performed at home. It requires the patient to go to the care centre at a specific time with over a relatively long period of time.

The study aims to enable stroke patients to perform a minimum rehabilitation training program without any time constraints and problems to move to the treatment centre. It is easier and practical in a simple product that has been combined with its functionality and is easy to operate at home. Also to improve and enhance research therapy functions to existing products. Product analysis (Table 1) below has been made to obtain the product information on the availability in the market. Four products were analysed and found that only three of them are less than 3 types of therapeutic functions to the wheelchairs. Only one wheelchair has six different types of therapy. Therefore, the new product proposal is to add another 4 types of therapeutic equipment and the result is 10 equipment combine together for therapy training for patients.

**Table 1:** Analysis of product

No	Equipment	Price (RM)	Function	Ref.
1	Wheelchairs that have DOS computer systems, ultrasonic sensors and use motor power	3	DOS computer system, ultrasonic sensor and use motor power	Hélène(2012)
2	Wheelchair uses powered motor	1	Moving using powered motor	D Ding(2005)
3	Manual wheelchair to play badminton and other games	1	Normal wheelchair	C. Hawkins(2013)
4	Physiotherapy wheelchair	6	Normal wheelchair, shoulder therapy training set, hand strength exercise, bicycle exercise, quadriceps exercise and finger ladder reflexology	Rosmawati(2015)
	<b>10 IN 1 PHYSIOTHERAPY WHEELCHAIR</b>	<b>10</b>	Normal wheelchair, shoulder therapy training set, hand strength exercise, bicycle exercise, quadriceps exercise , finger ladder reflexology, spine exercise, wrist exercise, hand grip exercise and storage	

## 2. Methodology

Ideas generated through methodology are in the form of solutions and need to be combined to produce a conceptual design. A concept design is produced by combining sub-ideas with existing equipment. The design concept is based on the combination of a wheelchair and the physiotherapy equipment for stroke patients that are used in the therapy centre. The design concepts are as follows:

Concept 1 - Wheelchair design.

Wheelchair is a key tool used to facilitate movement from one place to another for a permanent or temporary disabled persons to walk or to move.

Concept 2 - Design of shoulder training set. (Shoulder Exercise Pulley Set).

This shoulder training set is used to move the shoulders by pulling the straps connected to the pulley to move the hands and shoulders.

Concept 3 – Set of Hand strength training

This set of strength training exercises is used for strength training of hands and arms.

Concept 4 – Bicycle training (Ride exercise)

This set of exercises is used for the exercise of leg and thigh strength as well as knees

Concept 5 - Set of finger and hand exercises (Finger Ladder Reflexology)

This set of exercises is used for finger and hand exercises

Concept 6- Set of leg exercise (quadriceps exercise)

This set of exercises is used for exercises of leg, thighs, knees and hips

Concept 7- Set of wrist exercises

This set of exercises is used for wrist exercises.

Concept 8- Set of hand grip exercises

This set of exercises is used for exercises for muscles in hand grip

Concept 9-Storage for palm exercises

Design a place to put the storage box for palm exercise materials.

Concept 10 - Set of spine exercises

The seat is design for the body spine exercise

## 2.1 Product Design

Designing, sketching and technical drawings by using AutoCAD software for the product design. It is to get an initial overview of the components that will be used. The sketches of each component parts of the product are designed. After that the technical drawings in detail are made along with the dimensions. Selection of an appropriate design is made and as shown in Figure 1 to ensure and to provide materials according to component design. The selection of materials should be made in accordance with the design in taking account of each component as well as the corresponding costs to be balanced and reasonable. Then the next process is the selection of appropriate materials and which are lighter, cheaper and have the characteristics of durability. The material of plastic and iron are components of the materials used in the product. The final product is shown in Figure 2.



**Figure 1:** Auto CAD Drawing of 10 in 1 Physiotherapy Wheelchair



**Figure 2:** 10 in 1 Physiotherapy Wheelchair

### 3. Product Discussion

#### (a) Chair Frame

The 10 in 1 physiotherapy wheelchair in diagram 1 is drawn in AUTOCAD Autodesk software. In order to create a strong and durable product. Arc welding techniques are used to weld all parts of the body frame using mild steel as its raw material. The arc welding technique is used as it can be done on a large surface. Once the seat parts are connected, the product is painted with black colour.

#### (b) Spring equipment

Spring equipment is installed in two places. The first spring equipment is installed on the frame for the set of therapy exercises for the arm muscles horizontally. The second spring gear is mounted between the seat and the frame of the back seat. This is for a set of exercises for the spine. A key lock is placed there so that the back of the seat can not move backwards and becomes a regular chair. Both springs are made of stainless steel.

#### (c) Dumbbell weight for the leg exercises (quadriceps exercise)

Dumbbell weight is used for the exercise for the legs muscle system. It is installed on both front of the wheelchair along with cushion. From discussion with the therapist it is found that the maximum weight of 1 kg was only used for stroke patients. A set of keys will be placed on both weights to prevent from accident. Then the wheelchair will be fitted with a soft and quality cushions on the iron frame where the patient's foot is used to lift the ballast. This is for patient comfort and prevent the patient's foot from getting injured.

#### (d) Bicycle pedals

Bicycle pedals have the same function as ballast. However, compared to the ballast, pedals cycling uses less force than weighting. Bicycle pedals is installed under the wheelchair and between both seat cushion and ballast. The pedal holder is welded to a fixed position. It will be fitted with a 'lock' key using the bolt and nut. However, this bicycle pedal can be removed for maintenance.

#### (e) Set of hand grip exercises

2 sets of hand grip exercises installed on both sides of the armrest chair. Hand grip devices are for training to open and close the fingers to the palm of the hand. Mini springs are placed on the equipment.

#### (f) Set of finger and hand exercises (Finger Ladder Reflexology)

This therapy is performed to strengthen the muscles and bones in the hands. This exercise is to strengthen the muscles to hold and to stretch to get an object. The therapeutic way is to raise and lower your finger on the equipment which is provided. This set will be made of mild steel and painted for durability.

#### (g) Set of wrist exercises

2 sets of wrist exercises are installed on both sides of the armrest. Wrist set is for training the wrists.

(h) Cushion on the seat and headrest.

Wheelchair seat sold in the store is made of PVC. Therefore for a more comfortable and cool condition a quality cushions are placed on a wheelchair seat and the headrest.

#### 4. Conclusion

10-in-1 physiotherapy wheelchair is designed to enable a stroke patient to perform scheduled rehabilitation exercises with minimal supervision without time constraints and having problems to get to the treatment centre. It is easier and practical in a simple product that has been combined with its therapeutic functionality and is easy to operate at home. The product is using only mechanical concepts and is capable of providing convenience to stroke patients. It can be placed at home, treatment centres and can be moved because of the wheels. It is also designed specifically for patients based on average body size and physical height. The concept of the product is dual function and easy to control. Limitation of the study is restricted to only stroke patients. In-depth research needs to be made so that this product can be used for wider uses such as for anyone to increased stamina and also physical training of athletes.

#### References

- WHO. THE world Health Report 2003: 2003  
Nasam. Know Your Stroke Facts. 2011  
Krishnamoorthy M. Killer Stroke: Six Malaysian hits every hour. The Star. 2007  
Julien Bogousslavsky, Louis R. Caplan, "Stroke syndromes", Cambridge University Press, 2001  
Michael P. Barnes, Bruce H. Dobkin, Julien Bogousslavsky, "Recovery after stroke", Cambridge University Press, 2005  
Hélène M. Larin, Carole W. Dennis, Sharon Stansfield "Development of robotic mobility for infants: rationale and outcomes"  
DOI: <http://dx.doi.org/10.1016/j.physio.2012.06.005> Physiotherapy, Vol. 98, Issue 3, p230–237  
D Ding, R Cooper, (2005) "Electric power wheelchairs : Control System" IEEE, Vol 25 Issue:2, p22-34  
C. Hawkins, P. Coffee, A. Soundye, "Considering how athletic identity assists adjustment to spinal cord injury: a qualitative study" Cited in Scopus: DOI: <http://dx.doi.org/10.1016/j.physio.2013.09.006>  
Physiotherapy, Vol. 100, Issue 3, p268–274  
Rosmawati Ismail, Kamal haron, Sharifah Noor Binti Deraman (2014) "Rekabentuk Merekabentuk Kerusi Roda Fisioterapi Berbagai Fungsi Rawatan Pemulihan", 2014 2nd Innovation and Commercialization of Medical Electronic Technology , p35-40