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The Evaluation of Hemiplegia' Physical Conditions for Personal Hygiene Assistive Devices

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Abstract. To increase the efficiency of communications between therapists and assistive device designer, a systematic procedure for assistive device designs needs to be established. This study conducts the research by focusing on the case of Hemiplegia. The Analytic Hierarchy Process (AHP) is applied to develop the rank and weights of the evaluation categories in physical examinations to inform assistive device designers. After combining the opinions of 21 physiotherapists, occupational therapists, and physiatrists, the sequence and weights of evaluation categories during design are: mental consciousness (0.19), cognition (0.17), coordination (0.16), motor function (0.14), communication (0.08), joint range of motion (0.08), muscle strength (0.07), muscle tone (0.06), sensory function (sensation) (0.06). Results of this study will provide references for designers in their future assistive device development.

Keywords: Hemiplegia, Physical Conditions, Personal Hygiene Devices, Assistive Devices Design

1. Introduction

Devices that can help the disabled to live their lives with greater convenience, higher independence, and

Better life quality are deemed as "assistive devices" (Chang, 2004). Assistive devices enable autonomy, and correspond with the "people-oriented concept". In Taiwan, 16.81% of people aged above 65 have self-care difficulties. In specific, 74.22% of them have difficulties in going up and down the stairs whereas 53/83% of them have difficulties in taking a bath. These indicated that disabled people need others' help to move and to take care of their personal hygiene most (Minister of Interior, 2009)

However, only a few studies have ever looked into personal hygiene assistive devices. Currently, there are two types of personal hygiene assistive devices. The first type of hygiene assistive devices is operated by care takers as the patients (e.g. systemic paralysis) cannot wash their faces or bodies. This type of products includes bath bed and hair wash station. The other type of hygiene assistive devices is operated by patients without any assistance from others. This type of products includes bath gloves, curved bath brush…etc.

These two types of assistive devices are for patients with systemic paralysis and patients with self-care abilities respectively. In the current market of personal hygiene assistive devices, there are only few types of assistive devices available to the disabled patients with self-care abilities. Thus due to the limitations of current products, users often fail to complete their tasks (e.g. washing faces or bodies) independently. For the disabled, accomplishing a task without any help from others could prove their self-value. Therefore, developing personal hygiene assistive devices for the independent operations by patients with different functional disorders is significant and necessary.

Different users have different levels of capabilities in handling assistive devices. Following the design of assistive devices, therapists still need to tailor the devices according to users' personal measurements andrequirements (Chen, 2010). Although customizing or modifying assistive devices could provide users products which suit their needs better, the manufacturing procedure of assistive devices by medical teams and assistive device designers is inside the black box and deemed as the property of these professionals. A standard design procedure cannot be established.

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This study treats Hemiplegiaas the studied cases and aims to develop personal hygiene assistive devices. Drawing on the opinions of medical teams, this study hopes to establish a systematic communication platform for assistive device design. In the case of Hemiplegia, they have different movement patterns at different recovery stages. Generally, therapists need to conduct physical examinations for each evaluation category and keep the records in order to determine the movement patterns of the studied patients and provide suitable assistive devices based on the examination results. For hemiplegia, there are many categories in the required physical examinations. Of all, which evaluation categories are relevant to the assistive device design and selection? To provide assistive device designers useful information, this paper hopes to convert the "physical examination information" to "assistive device design criteria" with the suggestions from medical teams taken into account. Moreover, this paper also aims to define the relationship between the physical conditions of Hemiplegiaand the design criteria for hygiene assistive devices. Research results are expected to enhance the efficiency of communications between medical teams and assistive device designers.

2. Theoretical Foundation

2.1. Physical Evaluation Categories of Assistive Technology

Purchasing assistive devices for the disabled is process of multiple steps, including "needs assessment", "practical care", "funding", "supply", "training", and "service" (Brown, 1996). In terms of the assistive technology assessment process, many scholars made suggestions about the evaluation categories of the selection of assistive technology equipment. Rothstein (1995) suggested that an evaluation of users' functionality and environment was necessary. Bain (1997) suggested that apart from users' functionality and environment, an evaluation of the interface between users and assistive devices needed to be done. Sprigle4 compared patients' abilities and task requirements before making selecting defining the properties of suitable assistive devices. Cook (2002) mentioned in the study that a standard assistive technology assessment process should start from understanding the patient and evaluating the patient's movements, cognitive functions, sensory functions, and linguistic competence, and then select the appropriate assistive devices and provide trainings.

Accordingly, the primary task of assistive technology is to understand users' conditions. However, Hemiplegiaoften has different levels of brain tissue damages or deaths, which consequently cause different levels of impact on patients' physical functions (Department of Health of Hong Kong Special Administrative Region, 2012). An appropriate selection of brain attack assessment may help understand the degrees of damages in the aspects of patients' disorders, malfunctions or life qualities. For medical intervention, treatment planning, and clinical experiments, this assessment is an important tool (Liang, 2009). As early as 1960, Brunnstrom proposed the physical examination categories for Hemiplegia. These categories are further classified into the following groups: consciousness, cognition, communication, ROM, muscle strength, muscle tone, sensation, motor function, and coordination.

2.2. Analytic Hierarchy Process

The analytic hierarchy process (AHP) is helpful in enhancing the understanding of situations. However, when it comes to "select the proper solution", assessments of alternative solutions have to be conducted based on certain foundations in order to determine the priorities of various alternatives and choose the most suitable solution. Given this theoretical background, AHP was developed and used in the economics, societies, management, governments, business, industries, health care, and education (Wikipedia, 2012). To modify the physical examination categories and make them meet the design criteria for assistive devices better, this paper employs the analytic hierarchy process and establishes the evaluation ranks and weights of 9 physical examination categories (Brunnstrom, 1960) to provide references for designers.

3. Research methods

3.1. Physical Evaluation Categories of Assistive Technology

A rehabilitation team is often involved with professionals of different expertise, including nursing staff, physiotherapists, occupational therapists, physiatrists, linguistic therapists, and physicians with rehabilitation

training (Wikipedia, 2012). As this study focuses on personal hygiene assistive devices, linguistic therapy is not relevant. Thus 7 medical professionals, including physiotherapists, occupational therapists, and physiatrists, are invited to participate this study. They all have at least 4 years of professional experiences.

3.2. Evaluation Categories

Table 1 shows the evaluation categories and content of physical examinations for Hemiplegia (Brunnstorm, 1960). This study particularly has assistive device design criteria tailored for Hemiplegia and hopes to convert the professional opinions into the assistive device design dimensions.

Table 1. Evaluation categories and content of physical examinations for Hemiplegia

	Evaluation category	**Evaluation content**
1	Consciousness	Clear, Drowsy, Coma
		Glasgow coma scale
2	Cognition	Problem solving, Orientation Memory, Abstract thinking Attention, Rancho Los Amigos Level of Cognitive Function
		unilateral neglect, Apraxia, Body scheme disorder, Spatial relation syndrome
3	Communication	Follow 1-step command, Follow 2-step command, Gesture, aphasia, dysarthria trachea operation
4	ROM (range of motion)	Active ROM, Passive ROM
5	Muscle Strength	MMT(manual muscle test)
		major muscle measurements
6	Muscle Tone	hypotone, near normal, hypertone flaccid, spasticity, rigidity
7	Sensation	Light touch, Proprioception Thermal sensation, Position sense, Motion sense Motion sensitivity test Diplopia, homonymous hemianopia, nystagmus
8	Motor Function	rolling over, transferring, dynamic and static sitting balance , dynamic and static standing balance (Romberg test) , one-leg stance , motor function of upper extremity, walking ability (wheel chair, on foot, slopes, stairs, obstacles)
9	Coordination	Resting tremor, Intentional tremor Finger-nose-finger test, Heel on shin test

Table 2. Rank of weights of evaluation categories for designing stroke patients' hygiene assistive devices

Rank	**physiotherapist**		**occupational therapist**		**physiatrist**		**Aggregatedopinion**	
	Evaluation cat.	weight	Evaluation cat.	weight	Evaluation cat.	weight	Evaluation cat.	weight
1	Consciousness	0.30	Cognition	0.19	Coordination	0.22	Consciousness	0.19
2	Cognition	0.17	Consciousness	0.13	Motor Function	0.17	Cognition	0.17
3	Coordination	0.13	Motor Function	0.13	Consciousness	0.16	Coordination	0.16
4	Motor Function	0.10	Coordination	0.12	Cognition	0.13	Motor Function	0.14
5	Communication	0.07	Sensation	0.12	ROM	0.10	Communication	0.08
6	ROM	0.07	Communication	0.10	Communication	0.06	ROM	0.08
7	Muscle strength	0.07	Muscle strength	0.08	Muscle strength	0.06	Muscle strength	0.07
8	Muscle Tone	0.05	ROM	0.07	Muscle Tone	0.05	Muscle Tone	0.06
9	Sensation	0.04	Muscle Tone	0.07	Sensation	0.04	Sensation	0.06

3.3. Analytic Hierarchy Process

Professionals who participated in this study would, based on their professional judgments, compare the required evaluation categories in physical examinations for Hemiplegia' hygiene assistive devices and give feedback.

4. Results

Table 2 shows the rank of weight of each evaluation category for designing stroke patients' hygiene assistive devices. Table 2 summarizes the individual opinions and aggregated opinions of physiotherapists, occupational therapists, and physiatrists.

5. Conclusion and discussion

According to the results, physiotherapists suggest that the development of personal hygiene assistive devices for Hemiplegia needs to first evaluate their consciousness (0.3), cognition (0.17), coordination (0.13) and motor function (0.10) while occupational therapists rank evaluations of consciousness (0.19), consciousness (0.13), coordination (0.12), and sensation (0.12) as priorities. Moreover, physiatrists propose that coordination (0.22), motor function (0.17), consciousness (0.16), consciousness (0.13), and ROM (0.10) as the substantial evaluation categories during the process of assistive device design.

Based on the overall opinions of 21 physiotherapists, occupational therapists, and physiatrists, the rank and weights of evaluation categories during assistive device design are: consciousness (0.19), cognition (0.17), coordination (0.16), motor function (0.14), communication (0.08), ROM (0.08), muscle strength (0.07), muscle tone (0.06), and sensation (0.06). The research results of this study find out that "consciousness" and "cognition" are the most important physical conditions to support patients' independent operation of hygiene assistive devices. In other words, during hygiene assistive design for stroke patients, users have to pass the thresholds of consciousness and cognition criteria to be qualified for independent use of assistive devices. The designers could then design self-care assistive devices for them. Furthermore, "coordination" and "motor function" are important evaluation categories too. During assistive device design, designers need to take "coordination" and "motor function" into account to provide suitable and usable products for stroke patients.

To provide assistive device designers the useful information, this paper employs AHP and converts the physical examinations on Hemiplegia into the design criteria for assistive devices. Besides defining the relationship between the physical conditions of Hemiplegia and the design criteria of hygiene assistive devise, this paper also establishes weights of evaluation categories. As the results of this study are expected to provide references of stroke patients' hygiene assistive device design for designers, findings in this paper will be further extended in the future to investigate the possibilities of the communication efficiency improvements between medical teams and assistive device designers.

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