DEVELOPMENT OF A REHABILITATION ROBOTIC DEVICE: NATIONAL DIFFERENCES IN THERAPIST PRACTICE

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Abstract
Rehabilitation robotic devices could aid therapists in providing therapeutic exercises. National differences between clinical practices of therapists may affect the acceptance of such a device. This research seeks to discover the preferences of therapists with respect to features of an upper limb rehabilitation robot, specifically presenting results from the United States, Canada, and Australia.

INTRODUCTION

Stroke is the leading cause of adult disability in the world [1]. Consequently, countless hours are spent in rehabilitating stroke survivors. This rehabilitation is crucial for stroke survivors to regain function and reduce impairment in order to live more independently. As motor impairment affects 80% of stroke survivors, and as the loss of motor function can lead to serious impairment and disability, many therapists work to increase motor function in stroke survivors [2].

Current stroke therapy is therapist intensive, involving one-on-one rehabilitation sessions. In order to alleviate the burden to therapists and increase stroke survivor access to rehabilitation, rehabilitation robots have been developed to support the process. Rehabilitation robotics for the upper limbs, under the guidance of stroke therapists, have been shown to improve stroke survivor outcomes and are comparable to typical therapy delivered by therapists [3]. Although these devices have been around for over a decade, they are not commonly used in clinics and hospitals. This may be due to many factors such as cost, usability, or size of the equipment.

This study is part of a larger project to design an upper limb robotic rehabilitation device. The first part of this research was to conduct an international survey to gain a better understanding of therapists' current practices and requirements for such a tool. It was recognized that differences in clinical practices of stroke therapists may affect the specifications for design, acceptance, and usage of a rehabilitation robotic device. Also, differences between country of practice may influence the types of rehabilitation robotic programs that may need to be developed..

This paper presents a subset of the international survey data, namely the differences in treatment approaches, aims of rehabilitation, and movement facilitation between Canada, the United States (USA), and Australia.

METHODS

Questionnaire

A questionnaire was designed based on a previous survey [4], contextual observation sessions of treatment sessions by stroke therapists, and interviews with stroke therapists. The survey specifically targeted upper limb rehabilitation and was divided into six sections: therapist background and treatment approach, aims of rehabilitation, tone, facilitation of movement, sensory feedback, and potential attributes of a robotic rehabilitation device [5]. In all there were 85 questions on the survey. All materials used in this study were approved by the appropriate institutional research ethics boards.

Survey distribution

Information about the survey was explicitly distributed to Australia, Canada, the UK, and the USA although therapists from any country could have responded as the survey was online and accessible by anyone. Information about the survey was distributed from April 2010 to June 2010 in Canada, the USA, and the UK and from June 2010 to July 2010 in Australia.

Survey analysis

To ensure a reasonable sample, the results were tabulated by percentage for multiple choice questions and medians and combining agreement (strongly agree and somewhat agree) or importance (very important and somewhat important) when Likert scales were used. Neutral responses were excluded as there were not enough to ensure a reasonable sample. Pearson's chi square significance test was used to see if there was any relationship between the therapists' country of practice and responses in other sections [6]. Countries which had less than five responses in 80% of the cells were taken out of the chi square analysis for comparisons between countries. Data with statistically significant differences are reported along with data that showed high statement agreement or high importance amongst therapists surveyed.

RESULTS

A total of 233 surveys were analyzed, giving a confidence level of 95% and a confidence interval of 6.5%. All calculations were based on the actual number of responses for the parameter being analyzed.

Demographics

Most respondents were physiotherapists (72%) or occupational therapists (27%) who held a Bachelor's degree (61%) or higher (33%), or a diploma (6%). 55% of respondents had worked with stroke survivors for more than 10 years, 17% had worked with them for 6-10 years, and 27% had worked with them for 1-5 years. The therapists who responded worked in many different countries: Australia (48%), Canada (28%), the USA (16%), the Republic of Ireland (6%), Sweden (1%), UK (<1%), Switzerland (<1%), Columbia (<1%), and Israel (<1%). Two respondents did not indicate their country of practice.

Comparisons were made using data from Australia, Canada, and USA, as the responses from the other countries were too few to perform the necessary calculations.

Current methods of stroke treatment

As shown in Figure 1, current methods of stroke treatment differed significantly ($p<0.05$) by country in eight out of the twelve categories. Only four categories, 'repetitive task training', 'mental imagery', and 'joint position biofeedback', and 'splinting or orthosis' did not have statistically significant differences in responses.

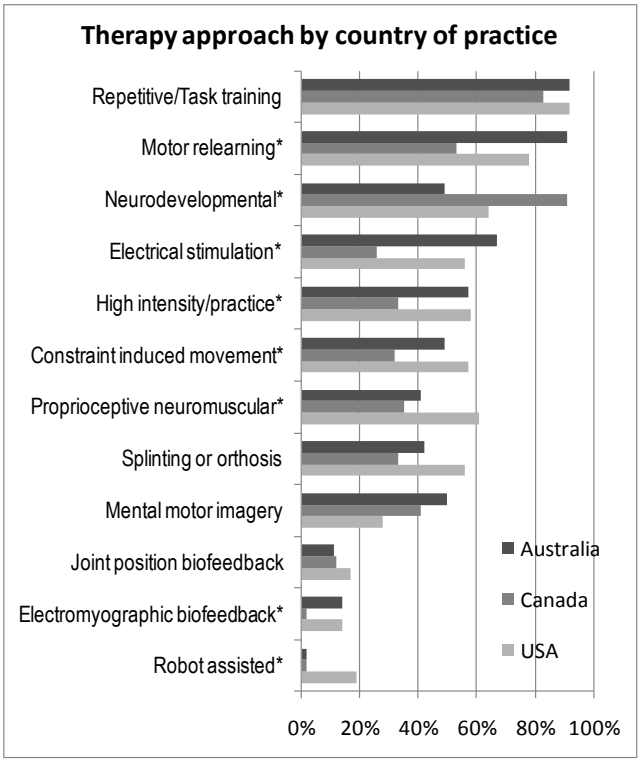

Figure 1. Differences in therapeutic approaches between countries. *Statistically significant differences ($p<0.05$)

Aims of rehabilitation

There was a statistically significant difference ($p<0.05$) for only two categories. For the category 'learn how to isolate muscle activation' therapists from Australia (79%)

found it more important than those in the USA (69%) or Canada (59%). 'Learn compensational strategies' was more in favour in Canada (72%) compared to USA (67%) or Australia (37%). Most therapists from all countries felt that facilitating functional activities (average 95%), preventing further injury or complications (average 93%) and improving co-ordination (average 91%) were important aims of upper limb stroke rehabilitation.

Facilitation of movement

In the section 'facilitation of movement' there were a number of statistically significant differences. Although most therapists would agree that 'strength training is important to incorporate in any stroke rehabilitation program', Australian (95%) and Canadian (83%) therapists were more likely to agree than American therapists (66%). Australian therapists were more likely to agree with 'electrical stimulation is a good way to increase muscle movement' (58%) compared to Americans (58%) or Canadians (41%). Canadian therapists were less likely than the other countries to agree with the 'high intensity of focused therapy will allow the stroke survivor to recover sooner' (Canadian 70%, American 94% and Australian 89%). Fewer therapists agreed with the statement 'passive upper limb movement will naturally lead to active upper limb movement', however American therapists were slightly more likely to agree (14%) compared to Australian (2%) or Canadian (11%). Of special note, therapists from all countries (no statistical significant difference) mostly agreed that 'stroke survivors need task oriented training and practice (average 99%) and that stroke survivors need context-specific cognitive learning, feedback, and practice (average 94%)

Managing muscle tone

There were a couple items that had statistically significant differences when comparing between therapists' country of practice. Respondents working in Canada were more likely to agree (strongly agree or somewhat agree) with 'decreasing tone is important when facilitating movement' (86%) than those from Australia (74%) or the USA (66%). Canadians also agreed with 'movement should be slow for those with high tone' (66%) than those working in the USA (51%) or Australia (41%).

Rehabilitation Robotic Requirements

For the 29 categories in the rehabilitation robotic requirement section, most therapists were in agreement with the majority of the items, except for the requirement of providing arm stability, which found (with statistical significance) that a greater percentage of therapists from the Canada (94%) agreed arm stability was an important requirement than respondents from the USA (78%) or Australia (87%).

DISCUSSION

Findings from this study will be used to guide the design of a robotic rehabilitation device for the upper limb, and also to begin to understand how such a device may be better integrated into clinical practice. Understanding similarities and differences between countries may be important to the development of a rehabilitation robotic device that is acceptable in general clinical practice.

Although robot-assisted rehabilitation is not high in any country, it is used more by American therapists than those in Australia or Canada. This may reflect the health care system of each country, or it may reflect national differences in acceptance of new technology for therapy. As most upper limb rehabilitation robotic devices come from American companies [7], this may also explain the discrepancy in usage.

Some differences between therapists' practice from country to country may be expected as different countries have different guidelines and recommendations for stroke therapy. Therapists' education in different countries may stress one approach over another, which may also lead to differences in stroke therapy approaches.

Where there are similarities in responses between therapists from different countries, these can be used to inform the basic upper

limb robotic rehabilitation unit. Aims such as facilitating functional activities and preventing further injury or complications can be incorporated into the basic unit. Where there are differences, different modules or programs may be developed for a specific country.

Canadian therapists seem to prefer the neurodevelopment therapy approach compared to therapists from the other countries, whereas Australian and American therapists prefer the motor relearning approach. A robotic device developed for a Canadian audience may need to work with the neurdevelopmental approach, which may include joint and muscle biofeedback to ensure proper positioning as well as allowing for muscle tone management. Devices aimed at American and Australian audiences may need to incorporate motor relearning principles, for example having a device that could sense what part of an activity a user is not able to perform and assigning tasks to the user. This may be more readily incorporated into the software development rather than the hardware development.

As robotic rehabilitation devices have the advantage of providing high intensity practice, they may also be more readily accepted in Australia or the USA as these countries currently use more high intensity or practice in their approaches and therapists from these countries tended to agree that high intensity, focused therapy would allow a stroke survivor to recover sooner.

CONCLUSIONS

A stroke rehabilitation robotic device may have different acceptance rates in different countries depending on the view of stroke rehabilitation held by therapists in that country. Developing programs targeted at specific approaches to stroke rehabilitation may aid in the reception of such a device into clinical practice. Future focus groups would need to reflect different approaches in stroke therapy in order to develop acceptable modules.

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