



January 2014

Rehabilitation of the Upper Extremity after Stroke: Current Practice As a Guide for Curriculum

Mylene Schriener

Rockhurst University - USA, mylene.schriener@rockhurst.edu

Janell Thome

Rockhurst University - USA, thomej@hawks.rockhurst.edu

Monica Carrier

Rockhurst University - USA, carrierm@hawks.rockhurst.edu

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Recommended Citation

Schriener, M., Thome, J., & Carrier, M. (2014). Rehabilitation of the Upper Extremity after Stroke: Current Practice As a Guide for Curriculum. *The Open Journal of Occupational Therapy*, 2(1). <https://doi.org/10.15453/2168-6408.1056>

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Rehabilitation of the Upper Extremity after Stroke: Current Practice As a Guide for Curriculum

Abstract

Stroke is the leading cause of disability in the United States and a top diagnosis for occupational therapy (OT) services among neurological conditions. Academic programs teach OT students neurological frames of reference (FORs) to provide a foundation for future practice. To meet accreditation standards, entry-level curricula must reflect current practice and evidence-based interventions. A survey of OT practitioners working in upper extremity stroke rehabilitation was conducted to investigate current clinical practice in a variety of treatment settings. Survey questions probed the use of motor rehabilitation techniques exclusive to one of six neurological FORs: Brunnstrom, Constraint-induced Movement Therapy, Neurodevelopmental Treatment, Proprioceptive Neuromuscular Facilitation, Rood, and Task-Oriented. Responses from 167 OT professionals indicated interventions representing all six FORs are currently being utilized in stroke rehabilitation. Techniques from the Task-Oriented and Neurodevelopmental Treatment approaches were used most frequently; however, the Rood-based techniques were used much less than interventions from the other FORs. No single neurological approach was found to dominate practice regardless of the number of years of experience in stroke rehabilitation or years since graduation from an entry-level program. A majority of participants appear to employ techniques from multiple approaches frequently, suggesting contemporary OT practice in upper extremity stroke rehabilitation is eclectic in nature.

Comments

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Keywords

eclectic, education, motor control theories, neurofacilitation theories, practice

Cover Page Footnote

We thank Sara Savidge, OTR/L, Rachel Sedlacek, OTR/L, and Caylee Strnad, OTR/L for their contributions to the preparation of the study which was completed while they were students in the Rockhurst MOT program; Mary Jane Youngstrom, MS, OTR/L, FAOTA for her review and comments; Michael Clump, PhD and Mohamed Kohia, PT, PhD for their assistance with statistical analysis; Liz Zayat, MS, OTR/L, Catherine Thompson, PT, PhD, and the OTs at KU Medical Center who previewed the survey; and the 2011 Neurological Theories Capstone group who prepared the pilot study.

Credentials Display

Mylene Schriener, PhD, OTR/L; Janell Thome, OTR/L; Monica Carrier, OTR/L

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DOI: 10.15453/2168-6408.1056

The progress of modern science and health care is rapid and multi-directional. It is incumbent upon the occupational therapy (OT) profession to keep its practitioners as up-to-date as possible in order to provide appropriate and effective care for clients of all ages and needs. One challenge brought on by the dynamic nature of health care services is the education of new OT practitioners that is in step with current advancements yet remains true to the core values and methods developed during a century-old history of care. Academic institutions and clinical fieldwork sites must prepare entry-level occupational therapists and occupational therapy assistants to become competent generalists (ACOTE, 2012). OT program accreditation standards include a mandate to teach intervention planning that is “culturally relevant, reflective of current occupational therapy practice, and based on available evidence” and that is “based on appropriate theoretical perspectives, models of practice, and frames of reference” (ACOTE, 2012, p. 23). To ensure relevance with health care trends and current research, OT program faculty must actively evaluate and adjust curriculum to train students appropriately for informed decision making in clinical fieldwork and future employment.

Of all of the subjects covered in an OT program, few could be more significant than the care of persons who have experienced a stroke. According to the American Heart Association, someone in the United States has a stroke approximately every 40 seconds (Roger et al., 2011). It is one of the leading causes of long-term disability in the U.S., affecting more than one

million persons aged 18 years and older (CDC, 2009). It is, therefore, reasonable to conclude that stroke rehabilitation is one of the most common services performed by OT practitioners. In a 2007 survey of registered occupational therapists certified in the profession for three years or fewer, stroke was by far the top diagnosis among neurological conditions for services being provided by respondents, leading the list at 23.5%, followed by dementia at 15.6% (NBCOT, 2008).

Upper extremity (UE) hemiparesis is a common impairment caused by stroke and is of particular concern to occupational therapists due to its debilitating impact on the performance of activities of daily living (ADLs) and full engagement in occupations (Page, Sisto, Levine, & McGrath, 2004). The goal of this study was to investigate the current clinical practice in UE motor rehabilitation following stroke, particularly as it relates to techniques that are based in neurological motor frames of reference (FORs). This knowledge is helpful for planning and guiding the teaching-learning process used in curriculum. It is important for students to know the current state of practice as well as the efficacy of the techniques they will utilize.

Literature Review

Quite appropriately, the treatment of stroke survivors is a major focus of OT educational programs. A 1990 study of academic content reported that 30 of 33 undergraduate and graduate programs dedicated class time to the discussion of stroke, with the mean number of class hours on the subject topping the list of 28 medical conditions (Nelson, Cash, & Bauer, 1990). Lecture and lab

hours devoted to the diagnosis included instruction in specific neurological approaches focused on regaining movement. Such approaches have been developed and subsequently adopted by both the OT and physical therapy (PT) professions as the result of advances in the field of neuroscience. Over time, the Proprioceptive Neuromuscular Facilitation (PNF), Rood, Brunnstrom, Neurodevelopmental Treatment (NDT), and motor control FORs have become a standard part of the OT curriculum (Nelson et al., 1990).

Four neurofacilitation FORs developed in the mid-1900s focused on promoting normal motion in the UE using reflexes and repetitive movement patterns (Cohen & Reed, 1996). PNF proposed that body segments normally move in diagonal patterns through all three cardinal planes (Rust, 2008). Range of motion and isotonic and isometric contractions were combined to develop a normal balance of agonist and antagonist. The Rood approach stressed the importance of early reflexes in the relearning of motor control through the use of techniques for muscle facilitation and inhibition (Rust, 2008). For example, fast brushing and icing facilitated muscle activation while prolonged stretch and neutral warmth encouraged muscle relaxation. The Brunnstrom approach used primitive synergistic patterns in training to improve motor control through central facilitation (Latham, 2008). This frame of reference (FOR) proposed that voluntary movement could be developed from the basic synergies, which were enhanced through the use of tactile stimulation and muscle and tendon tapping. NDT, also referred to as the Bobath

abnormal reflex activity in muscle tone and increase control of normal patterns of movement (Levit, 2008). Inhibition interventions, such as blocking abnormal patterns of movement, addressed problems with tone and incoordination, while facilitation techniques were used to train normal movement patterns by using light contact with key points of control.

More recently, research in motor learning has been combined with the consideration of the person-environment interaction to focus on the practice of functional activities for the remediation of limb impairment (Bass-Haugen, Mathiowetz, & Flinn, 2008). Task-Oriented interventions are a contemporary approach focusing on meaningful tasks and functional goals through the use of real objects and natural environments. Practice and experimentation in different contexts using various strategies are employed to find the optimal solution for a motor problem or skill acquisition. Constraint-induced Movement Therapy (CIMT) involves restraining the less-affected UE 90% of waking hours while encouraging use of the affected UE for 6 hours in order to increase motor function (Taub et al., 1993). Traditional CIMT has been criticized for being difficult to implement in a clinical setting due to the intense amount of time and resources needed for the therapy and restraining periods (Page, Sisto, Johnston, Levine, & Hughes, 2002).

The prevalence of motor neurological technique usage has been acknowledged in existing literature. A study of six rehabilitation hospitals documented OT interventions, which included both neurofacilitation and motor learning techniques for

the treatment of neurological conditions (Latham et al., 2006). OT practitioners in this setting demonstrated “an integration of multiple treatment approaches to facilitate performance of daily activities” (Latham et al., 2006, p. 376). Of the neurofacilitation interventions, NDT was the most frequently reported, being employed in 19.1% of all therapy sessions, followed by PNF in 3.6% of sessions, and Brunnstrom in less than 2% of sessions. Motor learning was utilized in 42.6% of all sessions, but no detail was provided to differentiate the use of the Task-Oriented approach within this category. CIMT was reportedly used in 2.7% of sessions. The authors suggested the findings depicted a trend away from neurofacilitation techniques toward motor control and motor learning approaches in OT treatment protocol. This viewpoint echoed a similar assertion made by Jette et al. (2005) in a study of PT practices in stroke rehabilitation. More recent research has confirmed traditional neurofacilitation approaches continue to be used in practice, despite the lack of scientific evidence to support the effectiveness or superiority of the techniques compared to newer motor learning approaches (Fleming-Castaldy & Gillen, 2013).

Research describing the relationship between what is taught in the classroom and its subsequent usage in practice is limited. A study performed in the Midwest determined which treatment methods occupational therapists and physical therapists employed in stroke rehabilitation (Natarajan et al., 2008). Researchers asked therapists to identify neurological approaches learned in their formal education and those

subsequently utilized in practice. Respondents were offered the opportunity to choose more than one method for each question from a list that included CIMT, Bobath/NDT, Brunnstrom/PNF (combined as one option), and Rood, among others. The results indicated Bobath/NDT and Brunnstrom/PNF were the FORs most frequently learned and practiced. The authors suggested that there is a connection between curriculum content and practice; however, they also found evidence demonstrating that those who graduated before the newer FORs emerged learned the more recent approaches by alternate means and incorporated them into their interventions. The limitations of this study included its small sample size and narrow area of coverage (two Midwestern states). The authors noted that the therapists appeared to combine methods into an “eclectic approach” to therapy and suggested creating a new, ideal approach (Natarajan et al., 2008, p. 846).

Results from studies regarding how practitioners value and apply FORs have been mixed. Law and McColl (1989) and Ikiugu (2012) found the majority of therapists felt FORs are important for guiding practice, while O’Neal, Dickerson, and Holbert (2007) determined only 26% of therapists viewed it as highly important. Ikiugu (2012) postulated that OT practitioners are eclectic by nature. This researcher felt that in order for practitioners to be effective and to address all the occupational needs of a person, occupational therapists must draw from more than one FOR. Indeed, flexibility in the application of a variety of motor rehabilitation approaches has been identified in practice. In a study completed nearly 20 years

ago, 431 members of the Neurodevelopmental Treatment Association completed a questionnaire focused on the then-current practice in NDT (DeGangi & Royeen, 1994). Many of the therapists reported using a combination of NDT and other treatments, such as PNF. It was postulated that an eclectic approach better met the needs of the clients. In contrast, a study regarding perceived adherence to a particular FOR protocol found a mismatch between perception and actual practice (Tyson & Selley, 2007). Many therapists viewed themselves as eclectic when in reality their style was predominantly NDT in nature.

Because existing literature presents incomplete data concerning the use of neurological approaches in stroke rehabilitation, additional research is necessary to gain a clear picture of current usage of motor rehabilitation techniques in OT practice. The purpose of this study was to examine the use of various movement-restoring approaches by looking at the frequency with which specific treatment techniques associated with each approach are used. It is important that curriculum content teach current clinical practice as well as evidenced-based practice to prepare students to make informed decisions once in the clinical setting.

Methods

Research Participants

The researchers performed quantitative descriptive research to gather information about clinical practices in UE stroke rehabilitation. A survey probed the use of intervention techniques which have roots in the six neurological FORs

occupational therapists and occupational therapy assistants who have worked in UE stroke rehabilitation in the past three years. The study excluded those who had not worked with stroke survivors within the stated time period because work performed more than three years ago may not reflect current trends in health care practice. The sample was recruited by invitations to participate, which were disseminated through the American Occupational Therapy Association OT Connections forum, Midwest OT associations, and alumni lists and fieldwork sites associated with entry-level OT programs located in the Midwest.

Six state associations agreed to forward the email invitation to its members, allowed researchers to send the email directly, or posted the message on its website or in its newsletter. Nine entry-level programs agreed to forward the email message to alumni or post it on an alumni Facebook page. Researchers also contacted fieldwork sites associated with their academic program to invite additional survey participants. A total of 174 OT practitioners responded to the survey. The results from seven participants were not included due to incomplete responses, reducing the sample size to 167. Eighty-five percent of the respondents were certified to practice in Illinois, Kansas, and Missouri. The remaining respondents were certified in Alabama, Arkansas, California, Idaho, Iowa, Minnesota, Nebraska, Oklahoma, Oregon, Texas, and Washington.

Materials and Instrumentation

The research instrument was a 29-question electronic survey. Eleven demographic questions captured the characteristics of the sample, which

included education, experience in stroke rehabilitation, and specifics about their clinical practice. Eighteen questions addressed the use of intervention techniques related to specific neurological FORs, with three questions pertaining to each of the six approaches. For instance, a question asking how often a practitioner used high-frequency vibration to stretch and strengthen a contracting muscle represented the Rood approach, while a question asking whether a practitioner encouraged the client to restrain his/her unaffected arm using a sling or mitt for at least six hours throughout the day described a principle of CIMT. Each question was written to describe one technique associated with one specific neurological FOR for purity of statistical analysis. The survey did not disclose the FOR associated with each question. Participants reported how often they used the technique described in the question throughout the entire plan of care for a patient undergoing post-stroke treatment. Responses were recorded on a 4-point Likert scale defined as: Usually (75%-100% of the time), Sometimes (50%-74% of the time), Rarely (25%-49% of the time), and Almost Never (less than 25% of the time).

The draft survey was reviewed by OT and PT faculty members who have taught neurological approaches in their respective programs but were unaffiliated with the study. Their examination and comments were obtained to ensure the questions were exclusive to one FOR. The survey was piloted with several OT practitioners in the field to receive feedback on the clarity of the questions and the length of the survey.

Procedures

After approval of the study by the university's Institutional Review Board, researchers contacted fieldwork sites, academic programs, and state associations to assist in recruiting participants. Researchers obtained consent statements from schools and OT associations which agreed to transmit the invitation on behalf of the researchers. A duplicate survey solicitation was posted on the AOTA OT Connections forum. The message contained an explanation of the purpose of the study, a confidentiality statement, informed consent, and a link to the survey, which was posted on a third-party survey website. By accessing, completing, and submitting the survey, a respondent indicated his/her consent to participate voluntarily in the study. The survey was open to collect responses for eight weeks.

Data Analysis

The on-line website hosting the questionnaire automatically stored data from anonymous responses for research analysis. IBM® SPSS® Statistics version 20.0 was used to perform statistical tests. Information from the demographic questions was analyzed using frequency and descriptive statistics to capture the characteristics of the sample. Data concerning years of experience in stroke rehabilitation, years since graduation, level of education, and practice setting was used to explore potential differences in the practitioners' approaches.

Descriptive statistics were used to determine the general usage of the FORs across the entire pool of participants as well as within each setting. Points were assigned to each level of the Likert scale, from 1 (Almost Never) to 4 (Usually). The points given

to each of the three questions describing a particular FOR were averaged to determine the frequency with which a participant utilized that FOR in his or her practice. Mean scores of the entire sample were determined for the six FORs based on the individual responses analyzed in this manner. The formula $(M-1)/3$ was used to convert the mean score into a descriptive percentage of time a FOR was used over the course of treatment. Mann-Whitney analyses were conducted to determine the statistical differences between the mean frequencies of use. Mean scores were also analyzed within the subset of each practice setting to determine the FOR used most by OT professionals working in that setting.

The Spearman test of correlation was conducted to determine the relationship between the number of years of experience in stroke rehabilitation and the neurologic interventions

utilized in practice. The same test was also performed to investigate potential relationships between the number of years since graduation or the type of entry-level education and the techniques used. Additionally, researchers performed an analysis of the scores respondents gave to the techniques related to each FOR as a possible indicator of whether OT practice in UE stroke rehabilitation is eclectic or strictly follows a specific neurological approach.

Results

The 167 survey respondents represented all levels of entry-level degrees available to OT practitioners. The mean years since graduation from the entry-level program was 15.12 years ($SD = 10.90$), and the mean number of years of experience in stroke rehabilitation was 13.63 years ($SD = 9.78$). Table 1 details the demographics of the sample.

Table 1
Demographic Description of Education and Experience of Respondents

Entry-level degree	<i>n</i>	%		
Associates	16	10		
Bachelors	74	44		
Masters	72	43		
Doctorate	5	3		
	Years since graduation		Years of stroke rehab experience	
Range	<i>n</i>	%	<i>n</i>	%
0 – 5 yrs	44	26	44	26
6 – 10 yrs	17	10	27	16
11 – 15 yrs	37	22	33	20
16 – 20 yrs	21	13	28	17
21 – 25 yrs	13	8	12	7
26 – 30 yrs	12	7	15	9
31+ yrs	23	14	8	5

Figure 1 illustrates the mean Likert scores for the six FORs based on the average scores given to the three techniques representing each approach. The Task-Oriented approach was used most frequently ($M = 3.20$, $SD = 0.690$) followed closely by NDT ($M = 3.19$, $SD = 0.65$); however, the difference between the two approaches was not statistically significant and the effect size was small

($p = .638$, $\omega^2 = .026$). The differences in means of all approaches were statistically significant, with the exception of the difference between Brunnstrom and CIMT ($p = .107$, $\omega^2 = .088$) and Task-Oriented and NDT as reported above. Rood was reportedly used the least ($M = 1.67$, $SD = 0.61$), with an effect size exceeding .6 based upon the Mann-Whitney test of differences performed with all other FORs.

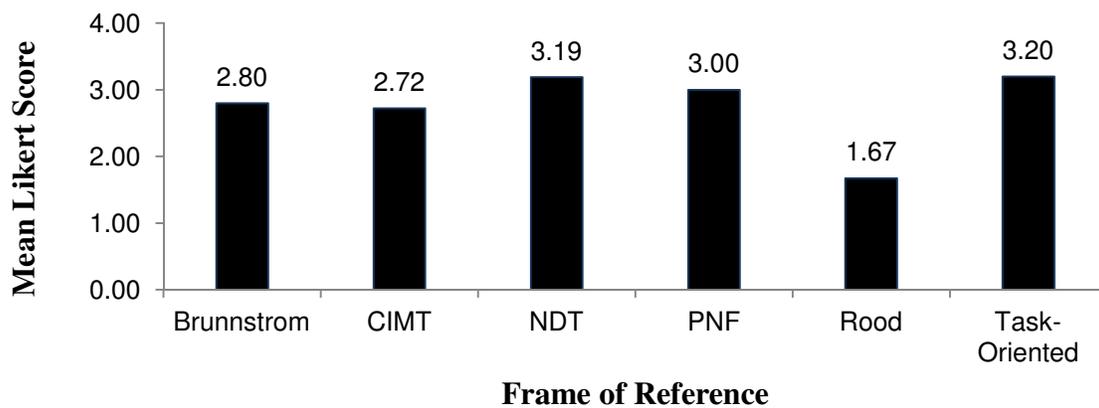


Figure 1. Mean Likert scores. This figure illustrates the usage of the FORs based on the rating each participant assigned to the three techniques representing a specific FOR.

Converting the means to percentages showed the Task-Oriented and NDT techniques were utilized 73% of the time over the course of stroke rehabilitation. Rood techniques, however, were used only 22% of the time. Spearman tests of correlation between the use of specific motor rehabilitation techniques and years since graduation, years of experience in stroke rehabilitation, and entry-level degree yielded results no greater than $r = .13$.

Table 2 lists the results of an examination of the usage of techniques in individual types of practice settings. In all settings, the most used FOR was either Task-Oriented or NDT. The individual therapy techniques described in the 18 FOR-related questions were tested to determine frequency of use. Table 3 lists the four most used and the four least used techniques.

Table 2

The Two Most Used Frames of Reference by Setting Based upon Reported Techniques

Setting	No 1	No 2	N
Acute	NDT	Task-Oriented	92
Community	Task-Oriented	CIMT	7
Home Health	Task-Oriented	NDT	37
Inpatient Rehabilitation	Task-Oriented	NDT	79
Outpatient Rehabilitation	NDT	Task-Oriented	59
Pediatrics	NDT	Task-Oriented	21
Skilled Nursing Facility	Task-Oriented	NDT	79

Table 3

Most Used and Least Used Motor Rehabilitation Techniques

Technique	Rank	M	SD	% Used
Practice donning and doffing a shirt (Task-Oriented)	1	3.74	0.60	91
Training normal movement patterns through proper positioning and slow, controlled movements (NDT)	2	3.54	0.69	85
Intensive practice of purposeful activity using the affected arm (CIMT)	3	3.53	0.69	84
Visually following the hand as it performs patterns of movement (PNF)	4	3.51	0.77	84
Use of high-frequency vibration to stretch and strengthen a contracting muscle (Rood)	15	1.97	0.99	32
Use of fast brushing to stimulate the skin over a muscle (Rood)	16	1.72	0.85	24
Restraint of the unaffected arm using a sling or mitt for at least 6 hours throughout the day (CIMT)	17	1.65	0.82	22
Use of icing to facilitate muscle activation (Rood)	18	1.32	0.61	11

Discussion

All FORs represented by the techniques described in the survey were reportedly used at least 50% of the time during the course of treatment with the exception of Rood, which was used 22% of the time. The results indicate OT practice does not appear to be moving away from the older neurofacilitation techniques as has been suggested by previous research on PT practice (Jette et al.,

2005). NDT continues to be the most used of the neurofacilitation techniques in the treatment of stroke, mirroring the findings of previous surveys of OT and PT professionals (Latham et al., 2006; Natarajan et al., 2008). With respect to Rood, all three techniques described in the survey rank in the bottom four of the 18 techniques listed. However, it is difficult to determine the true clinical use of the Rood techniques since the Likert option Almost

Never did not distinguish between 0% of the time (never used) and 24% of the time, which are widely disparate representations. Nonetheless, its significantly low ranking justifies contemplating the relevance of the Rood approach in contemporary practice. The CIMT technique of restraining the UE for six hours ranked second from the bottom with a mean score indicating it is used 22% of the time in the course of treatment, which is dramatically lower than the reported use of the other two techniques (84% for the practice of purposeful activity and 66% for the forced use of the affected UE in ADL tasks). The results support the findings of Page et al. (2002) that constraining the UE is difficult to implement in clinical settings.

The researchers believe the top FOR ranking of each practice setting is an accurate reflection of the nature of the setting. OT practice in the home health and skilled nursing settings are conducted in the clients' residences where they perform ADLs on a daily basis. Inpatient rehabilitation and community settings are designed to include equipment and room arrangements to simulate a more natural context. Therefore, it is logical that techniques from the FOR most focused on functional activity, the Task-Oriented approach, dominate practice when rehabilitation services are performed in the most natural environments. Acute, outpatient, and pediatric facilities are generally not set up to replicate home-like contexts; therefore, OT practitioners tend to gravitate more toward NDT-related techniques and the retraining of normal movements rather than the practice of daily tasks.

The results of correlation tests indicate there is no single FOR that dominates practice regardless

of the length of time since the practitioner's graduation or his/her years of experience working with stroke survivors. Similarly, the date of graduation or years of experience in stroke rehabilitation does not limit the treatment techniques employed by occupational therapists and occupational therapy assistants. Previous research suggests that OT and PT practitioners who completed school prior to the introduction of formal education in the newer methods have made themselves familiar with these approaches and incorporated them into their protocols (Natarajan et al., 2008).

If no particular FOR dominates OT practice, then it is reasonable to consider that OT practitioners may be eclectic in the treatment of the UE during stroke rehabilitation. To test this proposition, the researchers defined respondents as "eclectic" if the techniques from three or more of the six FORs were reportedly implemented in their practices a majority of the time, represented as receiving a mean Likert score of 3.0 or above. An analysis of the data determined 66% of respondents met that definition. Tyson and Selley (2007) proposed the melding of techniques may be due to there being more similarities than differences between FORs. DeGangi and Royeen (1994) attributed eclecticism to therapists' exposure to multiple FORs. They suggested education in many FORs creates a wide-based perspective from which practitioners can draw for their treatment protocols. Ikiugu (2012) felt adequate therapists must be eclectic in order to address all of the occupational performance needs required for each client to participate in his/her life skills. Other researchers

have considered an eclectic approach may indicate therapists combine techniques from a variety of approaches because there is “a need for an optimal approach to be developed through more research” (Natarajan et al., 2008, p. 846).

By providing a glimpse of current OT practice in the field of UE stroke rehabilitation, the study’s findings have the potential to improve the relevance of curriculum content in OT practice. OT program faculty can compare the results with research on the efficacy of stroke rehabilitation interventions and with current course content to provide justification for maintaining or adjusting program curriculum as it pertains to instruction in neurological FORs. A future systematic review could identify which of the techniques and FORs described in this study have been shown to produce positive outcomes based on current evidence. By uniting data on current practice and evidence-based interventions, such a review may be used to shape curriculum in accordance with the profession’s vision to ground its practice in science and research (Fleming-Castaldy & Gillen, 2013). Additionally, a survey of occupational therapy and occupational therapy assistant faculty could be conducted to examine how neurological interventions are being addressed in entry-level programs. The results of such a study may be beneficial in analyzing differences between what is being taught and the profession’s commitment to evidence-based practice.

While useful to academicians, the results of this study also provide practitioners and researchers with a picture of interventions currently used in

that many core techniques of UE stroke rehabilitation that are common to multiple FORs, i.e., quick stretch and weight bearing, were not included in the survey. Nonetheless, occupational therapists and occupational therapy assistants may compare their practice with the reported trends, and researchers can use the data as a foundation for further study. The survey findings suggest additional research is needed to further explore the eclectic nature of OT in rehabilitation protocols and probe practitioners’ clinical reasoning regarding the choice of FORs and techniques they employ.

There are several limitations associated with the collection of data. Because the recruitment method primarily targeted practitioners connected with Midwest OT associations and academic programs, the responses represented a limited geographic area. Future research on this topic should focus on practitioners working in states outside the Midwest. The design of the survey limited the level of insight into respondents’ practice. Additionally, the survey did not address which motor rehabilitation techniques respondents learned in their entry-level programs; therefore, connections cannot be made between their responses and what they were taught in school. A future study comparing practice to curriculum should investigate not only interventions used but also techniques and FORs learned in OT programs. The 4-point Likert scale was not sensitive enough to capture the significant and fundamental difference between never using a technique and employing it 24% of the time. By allowing only closed responses to FOR-related questions, it did not allow participants to explain their answers.

Conclusion

A survey of occupational therapists and occupational therapy assistants was conducted to collect data on intervention techniques currently being employed in the motor rehabilitation of the UE after stroke. The results demonstrated the neurological techniques featured in the survey are being utilized in clinical practice. However, the techniques of the Rood approach are used significantly less than the other FORs. The results

suggest OT practitioners appear to apply a variety of neurological approaches and do not confine themselves to FORs that were popular at the time of their entry-level education. Curriculum today should incorporate both evidence-based practice and current clinical practice to prepare students to make well-informed decisions in their future fieldwork and professional careers.

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