Hydrotherapy: Application of an Aquatic Functional Assessment Scale (AFAS) in Aquatic Motor Skills Learning

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Abstract

Objective: *To describe the application of an aquatic functional assessment scale in aquatic functional motor skills learning, through hydrotherapy in a heated pool, to classify adaptation and independence of the participants in the water.*

Methods: *Application of a hydrotherapy program to assess behavioral objectives, evaluation criteria which were defined as learning levels, ranked from 1 (0%) to 5 (100%) with Aquatic Functional Assessment Scale (AFAS) predicting, since no execution of motor skills, full or partial support or help to execution of motor behavior aquatic independence. The practice was conducted in a heated pool (33 to 34 ºC) in Brazil, with six participants with spinal cord injuries (three paraplegics and three tetraplegics). The program in hydrotherapy occurred in 15 intervention sessions, 30 minutes each, four times a week.*

Results: *Participants had average level of learning above 80.0% (level 4) in 20 of the 26 motor behaviors assessed aquatic. The paraplegic group's results were 80.0% during phases "adaptation(A)", "mastering of the liquid medium (D)" and "global fitness (Cd)". The tetraplegic group's results were above 90.0% during "D" and "Cd".*

Conclusion: *The planning of new strategies in the hydrotherapy in a heated pool using an aquatic functional assessment scale contributed to the development of aquatic motor behaviors.*

Keywords: Hydrotherapy, SCI, aquatic assessment, aquatic functional physical therapy, water environment.

Introduction

In the area of health and rehabilitation, the professional practice based on evidences and the search for better interventions have shown that measuring the functional results in all health environments is truly needed (1). Assessment in physical therapy is an essential instrument to predict kinetic-functional intervention, either as health promotion or therapy. Advances based on scientific evidences have allowed the physiotherapy process to be precise and the intervention program in physical therapy to have more effective and efficient results. It is necessary to develop studies to analyze and create new assessment systems, so that the intervention based on the experience of professional practice can be confirmed by scientific data (2). This also happens with hydrotherapy, broader word that indicates the work with aquatic therapies, known nowadays as aquatic physical therapy (3), area that has been developing and obtaining functional results with patients based on the professional experience, but needs to improve its scientific foundations.

The objective of this paper is to describe the application of an aquatic functional assessment scale, conducted in a heated pool, which allows us to classify adaptation and independence when patients perform motor behaviors. This scale was initially presented by Israel (4) in his doctorate thesis, to evaluate people with spinal cord injuries.

Since then it has been used in intervention programs for people with neurological and musculoskeletal sequelae (5).

The hydrotherapy program in which the scale was used involved intervention planning and aquatic evaluation. In the physical therapy assessment in hydrotherapy, Israel (4) initially proposes categorizing patients with: identification, anamnesis, physical exam, as well as specific and complementary tests. For the intervention, specific objectives are defined, and after that, it is time to choose contents and water activities, as well as define criteria to evaluate acquisition of expected behaviors in the objectives. Thus, the functional assessment scale to be presented here intends to analyze aquatic motor abilities learning, meeting a need in the hydrotherapy in heated pools. This has contributed to monitor the progress of each patient and to assess efficiency of interventions in aquatic physical therapy.

In an aquatic physical therapist's routine, assessing patients both on ground and water is a demand. Literature has shown that in ground assessment there have been many instruments developed; however, despite some attempts, there are gaps concerning validation of techniques and aquatic evaluation equipment. Another aspect to be considered in a professional routine is the cost of some equipment that has been used for research, but is not viable for daily practice. Therefore, it is essential to have new assessment techniques which can be reliable and more accessible to physical therapists.

In studies about aquatic field, what can be found are methodologies involving assessment out of water with scales or instruments already validated scientifically. For example: Teixeira-Arroyo and Oliveira (6), who used psychomotor evaluation form adapted to analyze behaviors of children with cerebral palsy in the water; Murcia and Pérez (7), who applied to children a questionnaire of aquatic perception; Santana, Almeida and Brandão (8), with specific instruments such as the use of a fibromyalgia impact questionnaire and index scale sensitivities after using the water method Ai Chi; Kesitas et al. (9), using both the Ashworth and the functional measurement scale on individuals with spinal cord injuries and spasticity; a study to investigate flexibility and muscular strength (10); Keller et al. (11) analyzed the physiological aspects of blood pressure and heart rate at rest and during walking immersion; and Fibra et al. (12) assessed quality of life after hydrotherapy.

Besides these studies, biomechanical measures have been investigated in pools, such as in Barela, Stolf and Duarte (13), with kinematic analysis, force reaction and electromyography in gait of adults; Barela and Duarte (14), checking elderly gait parameters in and out of the water at various levels of immersion. There are also Cuesta-Vargas et al. (15), who analyzed the neuromuscular electromyographic activity in up and walk in the water, and Haupenthal et al. (16), who investigated the vertical and anteroposterior components of ground reaction force in the race and at two levels of immersion in water.

In the qualitative analysis in the pool, there is a movement assessment by observing these movements from definitions of motor skills previously categorized, such as the study of Israel and Pardo (17), who described aquatic motor behaviors to subjects with spinal cord injuries. More recently, Candeloro and Caromano (18) analyzed predefined aquatic motor activities, and grades from 1 to 3 were given to each of them; they also controlled blood pressure and heart rate as stress indicators due to water activity. Therefore, it is necessary to develop tests for aquatic assessment.

Israel (19) and Israel and Pardo (20) have recommended the intervention methodology with differences in complexity and progression of aquatic activities from simple immersion to complete body control, and the aquatic exercises were divided in the following phases: ambiance (A), liquid environment domain (D), relaxation (R), specialized therapeutic exercise (E) and global organic conditioning (Cd). It is essential to revisit some concepts in order to understand observational practices performed by the physical therapist that works with aquatic resources in pools. The first concerns the area of motor behavior which includes motor learning, control and development. Motor learning involves comprehension of processes and their mechanisms underlying the acquisition of motor skills (4). Different approaches attempt to explain how human motion learning is. One involves the mechanisms of perception and selective attention, retention, motor skill execution, as well as the motivational aspect during this process (21). In the pool, with gravity in parts immersed, due to Archimedes's principle, there are different settings in sensorimotor perceptions for the body to adapt and be able to run the motor gestures.

Throughout life, human beings acquire sensorimotor control of their movements. For the quality and coordination of these movements to occur, proprioceptive adjustment is necessary for the person to experience functional experiments; this qualitative aspect is called motor skill.

The person faces restrictions in three different aspects involving: the individual (organism) with his/her biological, physical, cognitive and affective characteristics; his/her environments (social and professional); and his/her tasks (daily activities). According to this systemic approach, during life the organism grows and develops different dimensions, including the sensorimotor (22, 23, 24). The process of developing strategies for functional movements (22) in the terrestrial environment and the aquatic environment still needs to be clarified.

The hydrotherapy in heated pools is known as a set of therapeutic and/or preventive techniques and methods aiming at the welfare of the person with or without neurological injuries, or even with other types of physical, musculoskeletal, cardiorespiratory or functional alterations.

In addition to the various neural perceptions and therapeutic goals, heated pools, with their specific physical characteristics (principles of Archimedes, Pascal, Reynolds, among others) and thermal characteristics (25), require special strategies to evaluate the results obtained with the aquatic practice, such as measuring the quality of movements, pain reduction, and increased muscle strength.

Therefore, it is demonstrated the relevance of developing and using assessment instruments of aquatic physical therapy evaluation that allow us to investigate patients' progress. In this study, we report the application of the criteria adopted in Aquatic Functional Assessment Scale (AFAS) for motor skills learning in a heated pool and its use for evaluating results of a hydrotherapy program.

Methods

For this study we created an aquatic functional scale (AFAS) with criteria for observation of aquatic motor skills in a heated pool. To test this assessment tool, six spinal cord injured male patients (without contraindications to the practice of hydrotherapy) were invited: three paraplegics and three quadriplegics, and all signed an informed consent form. The research followed the ethical standards for human research.

The method used was the application of a hydrotherapy program to develop aquatic motor skills, whose evaluation criteria were defined as learning levels of the acquired skills, ranging from 1 (0%) 5 (100%). In Figure 1, there are criteria that comprise the Aquatic Functional Assessment Scale (AFAS).

5 : learning **TOTALLY ACHIEVED**; patient can perform the behavior, showing complete motor domain;
4 : behavior performed **WITHOUT SUPPORT**, but with partial domain and coordination during the movement;
3 : behavior performed **WITH PARTIAL SUPPORT**; patient performs the motor behavior with difficulty, requiring support in 1 or 2 parts of the body (for example: on the head and on the torso, or on both feet);
2: behavior performed **WITH TOTAL SUPPORT**; patient needs support on the body in more than 2 parts;
1: CANNOT perform the behavior.

Figure 01: AFAS Criteria for Classification of Levels of Aquatic Motor Behavior Learning in Intervention Sessions (4, p. 76).

Evaluation criteria are provided for the motor learning in different situations: no skill execution; total help or support; partial help or support; execution with partial or complete motor control indicating the quality of the gesture execution or independent aquatic motor behavior. The program was implemented in a heated pool (33-34 ºC), in Curitiba (Parana, Brazil).

The implementation of the hydrotherapy program occurred in 15 intervention sessions, 30 minutes each, four times a week. Initial and final evaluations were conducted in the water, and participants acted as their own control (26). The program trained 26 aquatic motor behaviors within five hydro-therapeutic treatment phases (19): "ambiance" - aquatic motor behaviors A1 to A8; "liquid environment domain" - behaviors D1 to D8; "specialized therapeutic exercises" - behaviors E1 E4; "global organic conditioning" - behaviors Cd1 the CD6. The relaxation phase (R) was only used to reduce spasticity occasionally during water intervention; no specific motor behavior was characterized during this phase (Fig. 2).

Hydrotherapy Phases in Swimming Pool- Motor Behaviors Observed

***ADAPTATION (A)**

A1= enters the pool
A2= puts the face in the water
A3= puts the face in the water and breathes
A4= dips the whole body into the water
A5= slides immerse in water
A6= floats supine position
A7= floats in prone position
A8= on the plateau, passes from prone to sitting position

*** MASTERING OF THE LIQUID MEDIUM (D)**

D1= floats upright in water with the aid of upper limbs ("kneeling position")
D2= keeps the balance sitting on the water
D3= changes from supine to prone position (vertical rotation, now called transverse)
D4= changes from prone to supine position (vertical rotation, now called transverse)
D5= changes from supine to prone position (horizontal rotation, now called longitudinal)
D6= changes from prone to supine position (horizontal rotation, now called longitudinal)
D7= performs mixed rotation (vertical and horizontal rotation, now called transversal longitudinal)
D8= rolls freely in the water

***ESPECIALIZED THERAPEUTIC EXERCISES (E)**

E1= on the plateau, while sitting, goes from sitting to standing
E2= on the bar, goes to standing
E3= stands (with or without splint in lower limbs)
E4= walks (with or without splint in lower limbs)

***GLOBAL FITNESS (Cd)**

Cd1= swims utility backstroke
Cd2= swims adapted backstroke (with bilateral strokes)
Cd3= swims adapted backstroke (with alternate strokes)
Cd4= swims adapted crawl
Cd5= swims adapted breaststroke
Cd6= swims adapted butterfly stroke

Observation: if it is necessary, when spasticity influences patient's motor performance, include the Relaxation phase (R)*

Figure 2: Phases of Hydrotherapeutic Treatment and Aquatic Motor Behaviors Observed (4).

The results were statistically analyzed descriptively, adopting the parameters shown in Fig 3.

Level 5 - 100% of behavior achieved;
Level 4 - 75% of behavior achieved;
Level 3 - 50% of behavior achieved;
Level 2 - 25% of behavior achieved; and
Level 1 - 0% of motor behavior.

Figure 3: Percentages Parameters and Their Respective Levels of Aquatic Motor Behavior Learning (Adapted from Israel , 4).

Considering the scores (5, 4, 3, 2, 1) defined in this scale (Fig. 3), one can interpret it as *the percentage of learned behavior* in relation to the maximum score (score 5) and construct a variable to assess behavioral change (4), that is, the learning level achieved at the end of interventional aquatic program. This learning level had the following qualitative and quantitative interpretation (4):

- 1,0 a 1,9 = does not perform
- 2,0 a 2,9 = needs lots of physical support
- 3,0 a 3,9 = needs a little physical support
- 4,0 a 4,9 = performs independently, with partial motor control
- 5,0 = performs independently, with total motor control

The aquatic functional assessment scale (AFAS) was applied during observation of the execution of motor skill that was being evaluated in the first execution of the movement (motor behavior) in initial aquatic assessment before the intervention, and after the final application of hydrotherapy program in six participants with spinal cord injuries. The characterization of the subjects was built using interviews (Fig. 4).

Participants/ Characteristics	P1	P2	P3	T1	T2	T3
Age (years)	49	29	28	28	31	24
Marital status	Married	Single	Married	Married	Married	Single
Initial level of neurological spinal cord injury	T11-T12	L1	T7-T8	C5-C6	C6-C7	C5-C6
Current occupation	Craftsman	Advertiser	Shopkeeper	System analist	Shopkeeper	System analist
Previous experience with water	No	Yes	Yes	Yes	Yes	Yes

Figure 4: Characteristics of Study Participants

The results showed that all participants achieved independence in the aquatic environment (Fig. 5, Fig 6). Figure 5 presents the results of initial evaluations and final stages of treatment of the paraplegic group, showing progress in learning of motor behavior of the three subjects in each of the phases.

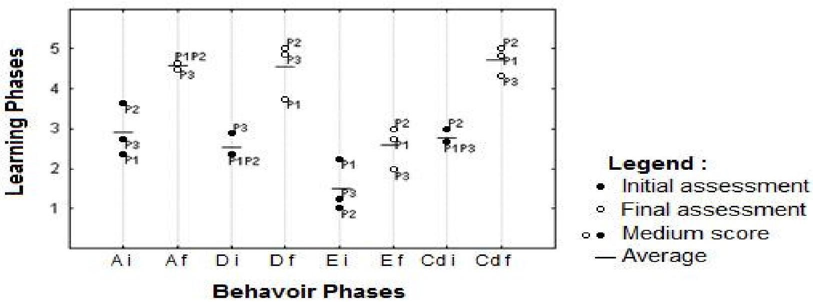

Figure 5: Paraplegic Group Average Initial and Final Assessment.

In Figure 6 we present the results of the average ratings of the initial and final phases of treatment of the quadriplegic group. Progress has occurred at all stages for the three participants.

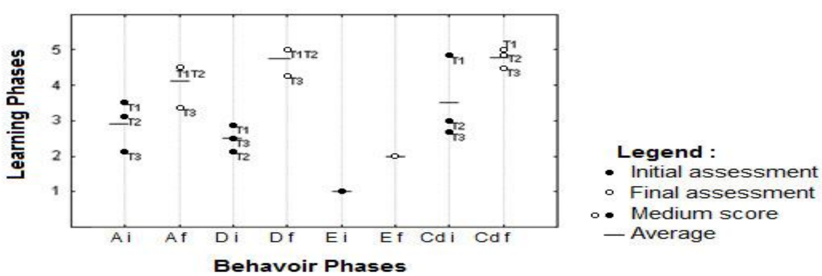

Figure 6: Tetraplegic Group Average Initial and Final Assessment.

Participants had an average level of learning above 80% (level 4) in 20 of 26 water motor behaviors assessed. In Figure 7, the average aquatic motor learning of both groups is presented.

Phases/Average learning level*	Paraplegics (3)*		Tetraplegics (3)*	
Adaptation	2.8 (40.0%)	4.6 (87.6%)	2.0 (26%)	3.8 (72.6%)
Mastering Of The Liquid Medium	2.6 (37.6%)	4.6 (87.6%)	2.8 (32.6%)	4.8 (86.0%)
Specialized Therapeutic Exercises	1.6 (12.6%)	2.8 (40.0%)	1.0 (0%)	2.0 (26.0%)
Global Fitness	2.8 (46.0%)	4.7 (82.6%)	3.2 (66.0%)	4.8 (86.0%)

Figure 7: Average Learning Level of Aquatic Motor Skills by Paraplegic and Tetraplegic Participants in Application of Aquatic Functional Assessment Scale (AFAS).

Note: *Significant averages in nonparametric Wilcoxon tests.

The paraplegic group evolved up 80% in the following phases: adaptation, mastering of the liquid medium and global fitness (Fig. 8).

PARAPLEGIC GROUP	Average Learning Level		Comparison between moments*	
	INITIAL	FINAL		
Number of patients ***	**3**	**3**	**p - value**	**Conclusion ****
Adaptation	**2.6 (40.0%)**	**4.5 (87.5%)**	0.055	SIG.
A1	2.0 (25.0%)	4.3 (82.5%)	0.051	SIG.
A2	4.0 (75.0%)	5.0 (100%)	****	
A3	2.5 (37.5%)	5.0 (100%)	0.09	SIG.
A4	3.0 (50.0%)	4.3 (82.5%)	0.051	SIG.
A5	2.7 (42.5%)	4.0 (75.0%)	0.051	SIG.
A6	3.3 (57.5%)	5.0 (100%)	0.051	SIG.
A7	3.3 (57.5%)	4.7 (92.5%)	0.079	SIG.
A8	1.0 (0.0%)	4.3 (82.5%)	0.051	SIG.
Mastering Of The Liquid Medium	**2.5 (37.5%)**	**4.5 (87.5%)**	0.055	SIG.
D1	2.7 (42.5%)	4.7 (92.5%)	0.055	SIG.
D2	3.7 (67.5%)	4.7 (92.5%)	0.042	SIG.
D3	2.0 (25.0%)	4.7 (92.5%)	0.051	SIG.
D4	2.7 (42.5%)	3.7 (67.5%)	0.09	SIG.
D5	2.3 (32.5%)	5.0 (100%)	0.051	SIG.
D6	2.3 (32.5%)	4.7 (92.5%)	0.055	SIG.
D7	2.3 (32.5%)	4.7 (92.5%)	0.055	SIG.
D8	2.3 (32.5%)	4.3 (82.5%)	0.051	SIG.
Specialized therapeutic exercises	**1.5 (12.5%)**	**2.6 (40.0%)**	0.09	SIG.
E1	1.7 (17.5%)	2.3 (32.5%)	0.159	**NS**
E2	1.3 (7.5%)	2.7 (42.5%)	0.051	SIG.
E3	1.3 (7.5%)	2.7 (42.5%)	0.051	SIG.
E4	1.7 (17.5%)	2.7 (42.5%)	0.09	SIG.
Global Fitness	**2.8 (45.0%)**	**4.7 (92.5%)**	0.055	SIG.
Cd1	2.3 (32.5%)	5.0 (100%)	0.051	SIG.
Cd2	1.3 (7.5%)	5.0 (100%)	0.051	SIG.
Cd3	2.7 (42.5%)	4.7 (92.5%)	0.055	SIG.
Cd4	4.0 (75.0%)	4.7 (92.5%)	0.079	SIG.
Cd5	3.7 (67.5%)	4.7 (92.5%)	0.09	SIG.
Cd6	2.7 (42.5%)	4.3 (82.5%)	0.051	SIG.

*** Wilcoxon Test**	
Test hypothesis	H o : there is no difference in behavior at both moments H ^ : final behavior is higher than initial one
Test statistics	Z O BS > Z CRÍTICO (or equivalent if p- value is less than 0.100) rejects hypothesis H 0, that is, final behavior is statistically higher than initial one. Therefore, there is an increase in learning level at final moment.
** conclusion at a significance level of 10% - one-sided test.	
*** because some patients presented behavior totally achieved (score 5) in the beginning of the program, they were not considered for the alteration assessment. Therefore, number of patients varies according to the different comparisons.	
**** number of patients smaller than two.	

Figure 8: Nonparametric Wilcoxon Test for Paraplegic Group.

The quadriplegic group evolved up 90% at stages mastering of the liquid medium and global fitness, indicating that participants with more severe motor sequelae also obtained independence in the pool (Fig. 9).

TETRAPLEGIC GROUP	**Average Learning Level**		**Comparison between moments***	
	INITIAL	**FINAL**		
Number of patients ***	**3**	**3**	**p - value**	**Conclusion ****
Adaptation	**2.0 (25.0%)**	**3.9 (72.5%)**	0.055	SIG.
A1	2.0 (25.0%)	4.0 (75.0%)	0.079	SIG.
A2	3.0 (50.0%)	5.0 (100%)	****	
A3	3.0 (50.0%)	5.0 (100%)	****	
A4	1.0 (0.0%)	3.3 (57.5%)	0.09	SIG.
A5	1.0 (0.0%)	2.0 (25.0%)	0.159	**NS**
A6	3.0 (50.0%)	5.0 (100.0%)	****	
A7	3.0 (50.0%)	5.0 (100.0%)	0.079	SIG.
A8	2.7 (42.5%)	3.7 (67.5%)	0.138	**NS**
Mastering of the Liquid Medium	**2.3 (32.5%)**	**4.8 (95.0%)**	0.055	SIG.
D1	3.0 (50.0%)	4.7 (92.5%)	0.051	SIG.
D2	3.5 (62.5%)	4.5 (87.5%)	0.079	SIG.
D3	3.3 (57.5%)	4.7 (92.5%)	0.051	SIG.
D4	3.0 (50.0%)	5.0 (100.0%)	0.042	SIG.
D5	2.0 (25.0%)	5.0 (100.0%)	0.09	SIG.
D6	1.7 (17.5%)	5.0 (100.0%)	0.051	SIG.
D7	1.0 (0.0%)	4.3 (82.5%)	0.051	SIG.
D8	1.0 (0.0%)	4.7 (92.5%)	0.051	SIG.
Specialized Therapeutic Exercises	**1.0 (0.0%)**	**2.0 (25.0%)**	0.042	SIG.
E1	1.0 (0.0%)	2.0 (25.0%)	0.042	SIG.
E2	1.0 (0.0%)	2.0 (25.0%)	0.042	SIG.
E3	1.0 (0.0%)	2.0 (25.0%)	0.042	SIG.
E4	1.0 (0.0%)	2.0 (25.0%)	0.042	SIG.
Global Fitness	**3.2 (55.0%)**	**4.8 (95.0%)**	0.051	SIG.
Cd1	2.0 (25.0%)	5.0 (100%)	0.09	SIG.
Cd2	1.0 (0.0%)	5.0 (100%)	0.079	SIG.
Cd3	2.5 (37.5%)	4.5 (87.5%)	0.09	SIG.
Cd4	4.0 (75.0%)	4.7 (92.5%)	0.079	SIG.
Cd5	3.5 (62.5%)	5.0 (100%)	0.09	SIG.
Cd6	4.0 (75.0%)	4.0 (75.0%)	0.5	**NS**

*** Wilcoxon Test**	
Test hypothesis	H o : there is no difference in behavior in both moments H ^ : final behavior is higher than initial one
Test statistics	Z O BS > Z CRÍTICO (or equivalent if p- value is lower than 0.100) rejects hypothesis H 0, that is, final behavior is statistically higher than initial one. Therefore, there is an increase in learning level in final moment.
** conclusion at a significance level of 10% - one-sided test.	
*** because some patients presented behavior totally achieved (score 5) in the beginning of the program, they were not considered for the alteration assessment. Therefore, number of patients varies according to the different comparisons.	
**** number of patients smaller than two.	

Figure 9: Nonparametric Wilcoxon Test for Tetraplegic Group.

Discussion

The process of aquatic planning and assessment should consist of tests and/or examinations on the ground, according to traditional physical therapy, and also tests or observations in the aquatic environment, both at the beginning and at the end of the hydrotherapy program in a heated pool. This is because the evidence based on practice of physical therapists needs records and control of water activities proposed and their results, both qualitative or quantitative. Furthermore, it is necessary to improve the strategies of physical therapists in stimulating learning motor skills in the water to benefit people that use these services (7, 27, 28, 29, 30, 31, 32).

In this process of organizing water activities, it is essential to have available the results of functional assessments to meet therapeutic goals established, increase sequence and complexity of exercises and determine evaluation criteria, i.e., monitor the participants and their functional outcome.

As there are only a few aquatic assessment tools and they still need improvement in practice based on evidences, the results obtained with those participants with spinal cord injuries indicate that the measures used were reliable, valid and sensitive, corroborating the study conducted by Gantschnig, Page and Fisher (33), about validating an instrument to assess motor skills.

In the analysis of the systemic model considering the area of motor behavior there is interference among the different dynamics of the nervous system of people in the development process, including those involving interactions and meanings of human movement during human motor learning (21, 34). The internal change in the motor domain of the individual, due to learning, may indicate a relatively permanent breakthrough in performance as a result of the practice of motor skills (35). This whole process is controlled and depends on neural plasticity that is stimulated by tasks and environments and has feedforward mechanisms (response with anticipation of motor actions) and feedback (feedback system), allowing the completion of the movement or gesture with quality, that is, with motor skills (36).

The motor gestures and other concepts in the area of motor behavior, when are discussed in the practice of hydrotherapy in heated pools, suffer influences of the aquatic environment and allow body perceptions in different aquatic exercises and stimulation (29, 37). The quality of gesture or motor behavior is called aquatic motor skill. When this action or motor task is performed in the pool, it requires functional movements that take advantage of the physical and thermal properties of water for the benefit of the person. Motor skills must be learned to run functionally with domain of movement within the pool. In this study, we adopt the definition of motor behavior as a gesture of movement observed. For example, a person can walk in the pool with or without skills, that is, with or without quality when performing body movement in the water.

In this study there was significant learning in aquatic behaviors observed, and this was verified in studies conducted by Kesiktas et al. (9) with SCI, in which there was reduced spasticity, favoring functional movements. Masumoto and Mercer (38) analyzed locomotion in the water with electromyography and indicate that there is a differential response of the nervous and musculoskeletal systems regarding direction and speed of water movement. The probable factors that influence these responses are the reduction of weight bearing in the water by the principle of buoyancy, stability by hydrostatic pressure and water whirling (39), reduced proprioception and alteration of vestibular function (38).

In the case of participants with spinal cord injury it is vital to consider that the residual motor repertoire of each participant interfered directly in their learning, since each subject was compared to himself. But anyway, for most behaviors, considering the percentage of learning, there was a significant difference between the assessment before and after the hydrotherapy program, which reinforces the relevance of the results obtained in the tests. It is important to emphasize that all participants underwent the same aquatic program, which was the independent variable, and everyone learned. Although all of them have learned, this happened at different levels. This can probably be explained by factors such as the motor experiences of each participant (22, 31, 35), their previous experience with water immersion (25), with the type and extent of spinal cord injury, among others. Israel and Pardo (20) have already pointed out that in neurological patients it is necessary the tonic control to promote functionality and aquatic motor skills. Becker (29), Stevens and Morgan (31) and Chiumento et al. (40) also show physiological effects and physical properties as benefits and facilitation of functional movements in the water.

The learning of aquatic motor skills may be influenced by floating and hydrostatic forces, besides the association of thermal effects of immersion in warm water (3,16). Rebutini et al. (25) also indicate the hydrodynamic drag as one of the factors of resistance to displacement of the body immersed in water.

Still considering the learning process inside the pool, quality of the gesture can be assisted by the stabilization provided by the hydrostatic pressure; there is also the possibility of influence of the aquatic resistors, such as surface tension, viscosity and turbulence (25, 29). The aquatic motor behavior of submerged parts of human body is also influenced by Archimedes's principle using the action of buoyancy as a facilitator, support or resistance to movement, depending on type, direction and speed of movement performed, causing flotation or not of the body part involved in the gesture.

Within the systematic model of motor learning one must consider that the environmental factor is decisive − in this case, the heated pool − as well as other aspects, such as the proposed task with systematic and controlled aquatic activity with specific exercises of functionality (23) and aquatic resistance training (25). And finally, the person (patient) submitted to immersion may or may not present injuries or change of form, structure, function and body density, as in this case, participants with spinal cord injury and its motor sequelae and sensory changes.

Other studies show benefits of the aquatic practice for motor behaviors acquisition as well as for physical and physiological aspects. Brandalize et al. (21) state that people with chronic exposure to sensory conflicts develop mechanisms for postural adjustments. Xavier Filho and Manoel (34) reviewed studies on aquatic motor behavior indicating that aquatic activity is challenging, since it requires pedagogical planning and suffers environmental constraints due to the properties of water, motion exercises proposed and the boundary of a pool, so as to achieve the development of aquatic skills. Chiumento et al. (40) consider physiological and thermo regulation aspects that benefit the person with spinal cord injury when he/she receives intervention in a heated pool.

Concerning aquatic assessment, a multidimensional evaluation is a possibility, and Candeloro and Caromano (18) indicate a specific assessment for adaptation to the water. Found additional benefits in the practice of aquatic exercise, despite the limitations of research evidence in aquatic therapy, as indicates that in adults with neurological issues aquatic exercises have improved range of motion, control of ataxia, balance, gait, flexibility, strength, body composition, muscular endurance, as well as affection and self-esteem, and mood and health-promoting behaviors (8,9,10,12). Candeloro and Caromano (10), Keller et al. (11) and Fibra et al. (12) show benefits regarding functionality and quality of life through programs of aquatic exercise.

Another approach that helps to explain the aquatic learning of motor skills is planning the work of physical therapists, as occurred in this hydrotherapy program (20), and a systematic evaluation of results by means of appropriate instruments such as the AFAS.

In aquatic physical therapy, the aquatic planning, considering different complexities − in this case, the individual characteristics of each injured participant −, attempts to systematize the evaluation procedures, outline the objectives, select activities and define phases and aquatic exercises for the intervention in pools (4). A new program for aquatic intervention in neurological patients is presented (17,19,31). The aquatic intervention in rehabilitation must be multimodal and interdisciplinary and studies indicate early onset of hydrotherapy in a heated pool to prevent injuries and also postoperatively (37, 40).

There are many factors that can interfere with motor learning in the pool, thus we still need a larger number of studies for proper knowledge of facilitations and difficulties during the training of aquatic motor skills, as well as the development of other instruments for data collection within the aquatic environment, and other hydrotherapy techniques (13, 15, 34).

In conclusion, this study demonstrated that aquatic functional assessment scale (AFAS) was sensitive to evaluate motor skills learning with hydrotherapy program proposed to patients with neurological sequelae. The scale proved to be a useful tool for the systematic evaluation of motor skills in the aquatic environment.

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