BALNEO RESEARCH Balneo and PRM Research Journal English Edition
e ISSN 2734 - 8458 p ISSN 2734 - 844X ROMANIAN ASSOCIATION OF BALNEOLOGY

Case study

Aquatic therapy in neuromotor recovery - case study

Elena Vizitiu[1,*], Mihai Constantinescu[1], Corina Poraicu[2]

[1] University "Stefan cel Mare" of Suceava, Suceava, Romania mihai.constantinescu@usm.ro (M.C.)
[2] Centrul Medical Coramed; motoveletcorina@gmail.com (C.P.)

* Correspondence: elenav@usm.ro (E.V.)

Abstract: Worldwide neurological disorders that particularly affect the central nervous system are a major health challenge, leading to deficits accompanied by neuromorphic sequelae with implications for the functional state of the body. Background: Current studies show that hemorrhagic stroke occurs mainly at a young age, often fatal as opposed to ischemic stroke that characterizes old age or an alert lifestyle, both types of strokes can result in motor sequelae and functional (mild, moderate or severe hemiparesis or haemiplegia). The peculiarity of the studied case is the coexistence of multiple comorbidities which require an interdisciplinary team to solve (neurologist, cardiologist, endocrinologist, physiotherapist, psychotherapist, aquatic therapy instructor). The aim of our paper is to demonstrate the efficiency of exercise in the aquatic environment, facilitating the recovery of the functions of the neuro-myo-arthro-kinetic apparatus as well as the cardiovascular and metabolic functions. Results: The main objective is general and muscular relaxation, re-education of external and proprioceptive sensitivity, orthostatic posture and gait reeducation, in conditions of stability and balance. Conclusions: Through the means of aquatic therapy, an attempt is made to obtain the independence of self-care in order to interrelate with the environment, to regain the ADLs, , the family and socio-professional reintegration of the patient.

Keywords: study; stroke; recovery; aquatic therapy; patient

Citation: Vizitiu E., Constantinescu M. and Poraicu C. - Aquatic therapy in neuromotor recovery - case study
Balneo and PRM Research Journal **2022**, *13(3): 516*

Academic Editor(s):
Constantin Munteanu

Received: 01.07.2022
Accepted: 20.08.2022
Published: 01.09.2022

Reviewers:
Doinița Oprea
Sînziana Călina Silișteanu

Publisher's Note: Balneo and PRM Research Journal stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

1. Introduction

Stroke is a neurological disorder, is the second leading cause of death worldwide, with a major contribution to disability, may cause other types of neurological disorders, including Alzheimer's disease, depression [1,2], but also dementia [3]. There are studies that show a possible link between inflammation and ischemic stroke, as in the case of stroke [4]. Even if old age, obesity, menopause, inadequate protein intake or impaired protein synthesis are undoubted factors that cause structural and functional degradation of myoarthrokinetics, they can be antagonized, the situation can become reversible by consuming 0.8 grams of protein / kgcorp / day, by using muscle anabolic hormones, sex steroids, growth hormone or by treating pathological conditions (hypertension, diabetes, HLP) [5]. In terms of aquatic therapy as a therapeutic agent, water is used in recovery centers by physiotherapists, with the aim of *rehabilitating, maintaining or increasing psychomotor functional qualities* in people with varying degrees of disability, transient or chronic [6]. Variants of physical activity in water (Aqua gym and Aqua Jogging) have beneficial effects on multiple levels (stimulation of blood circulation, thermoregulation, improving balance and coordination, rehabilitation of structures affected by injuries, etc.) according to [7].

Recent studies, however, indicate a low involvement of young people in physical activity in water, even if these favorable effects are known [8]

From a pathophysiological point of view, the stroke can be of 2 types: ischemic by *occlusion-clogging* of one or more cerebral vessels with *thrombosis or embolism,* so that the cerebral territory of nervous tissue is no longer nourished, and hemorragic stroke occurs by the *rupture of one or more blood vessels;* so the territory is practically *flooded* , and venous thrombosis occurs when three decisive factors meet *: injury, stasis and hypercoagulability* , the triad known as Wirchow. The causes are frequently disturbed vascular permeability, possibly increased blood viscosity with disturbance of the balance between procoagulants, in favor of occlusion [9,10]

Current studies show that hemorrhagic stroke occurs mainly at a young age, often fatal as opposed to ischemic stroke that characterizes old age or an alert lifestyle, therefore demanding consumptive; both types of stroke can result in motor and functional sequelae (mild, moderate, or severe hemiparesis, or hemiplegia, respectively) [11]. Stroke causes a significant motor deficit, sensory deficit, postural control and language deficit [12].

The consequences of vascular inflammation can result in several types of paralysis: hemiplegia which means the loss of voluntary mobility for half of the body, caused by central lesions of the pyramidal bundle. The causes are known in order of frequency: vascular, tumor, encephalitic or traumatic. The clinical signs are related to the level of the lesion [9], hemiparesis which is a milder form, with reduced mobility, tone and decreased sensitivity to the innervated territory; diabetes mellitus which is a disorder of carbohydrate metabolism caused by an insulin deficiency have an insulin resistance which leads to an accumulation of glucose in the tissues but also in the blood; is associated with disruption of protein and / or lipid metabolism [9].

Sarcopenia (Gr: *sarx* -meat; *penia -loss*) presents a concept from the '90s that consists of a functional decline based on multifactorial causes such as: chronic inflammatory status, inadequate dietary intake, hormonal disorders, age. it is characterized by the progressive loss of muscle mass and strength with the risk of physical disabilities, the consequent decrease in quality of life even until death. After 25 years there is a physiological regression of muscle mass, with the loss of ~ 0.5-1% / year, until the age of III (75 years) when they lose between 30-50%, along with nerve bundles that serve the limbs; thus, the gait, the balance, the abilities, as well as the fineness in the execution of the movements are affected. Decrease in muscle mass and implicitly muscle tone, cause fragility with reduced physiological performance. Muscular atrophy causes metaplasia and degeneration of myocytes in adipocytes and in fibrosis areas, so that lack of exercise leads to decreased muscle tone, strength and mass, thus accentuating sarcopenia ("DON'T *USE, YOU LOSE")* [9].

The diagnosis of sarcopenic damage is made by measuring the parameters by MRI / CT / DXA / BMD, with the determination of muscle, bone and fat mass. For a clinician, as well as for a physiotherapist, simple maneuvers such as: repeated standings up, from sitting on a chair, for 10 seconds, without using the arms as support; stands without support, 10 seconds, with the heel in front of the toe of the contralateral foot, on a line; climbing stairs without losing balance and without support.

According to the latest statistics provided by the World Stroke Organization, in 2016 there were 5.5-5.9 million strokes globally, of which 2.7 million were ischemic, representing 87% of all stroke cases [13]. The incidence of stroke increases with age, doubling after 55 years. However, for people aged 20-54, years the number of cases increased from 12.9% to 18.6% between 1990-2016 [14]. Depending on the sex, it is found that at younger ages, the incidence is higher in women with a higher mortality rate of 5.67% [1].

Case studies on comorbidity factors have been performed and it has been found that metabolic diseases such as Metabolic *Syndrome X, Diabetes, Obesity,*

Dyslipidemia increase the risk of stroke by about 72% [5]. Hypertension, the only aggravating factor, increases the risk of ischemic / hemorrhagic events by 57%. Smoking, excessive alcohol consumption, myocardial infarction, atrial fibrillation, sedentary lifestyle and an inadequate diet increase the risk of stroke by 67%. Environmental factors increase the risk by 28% [3,15].

And the combination of all the listed factors leads to a 90% risk for stroke, regardless of gender or age.

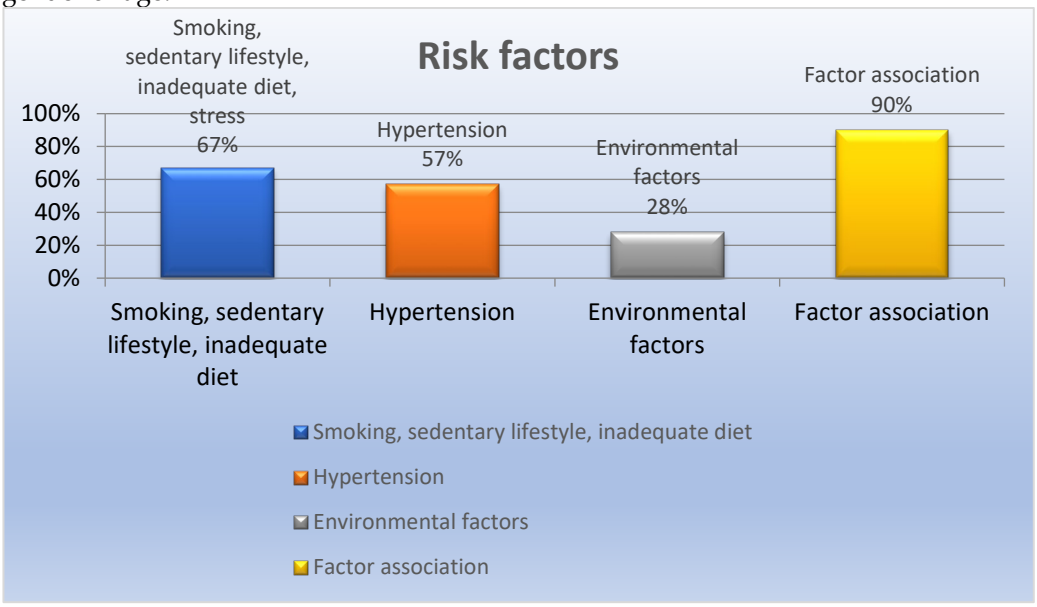

Figure 1. Risk factors in the occurrence of stroke

Genetic risk must also be highlighted in the production of stroke, which is proportional to sex, age and race [3], but also with the heredo-collateral, family antecedents. There are studies that show the association of stroke with increased heredity for diseases of large blood vessels (40%) compared to disorders of small blood vessels (16.7%) [12,14] as well as in patients with genetic mutations and atrial fibrillation, of which stroke may begin before atrial fibrillation is triggered [17,18]. There are studies [19] associating single-nucleotide multiple polymorphisms (SNPs) with high risk or ischemic stroke severity [1]. Thus, polymorphism of brain-derived neurotrophic factor (BDNF), apolipoprotein E (Apo-E), neurotrophic tyrosine kinase receptor, but also mitochondrial AND gene variation, may affect the recovery of people with a stroke [1]. BDNF is known to be involved in synaptic plasticity, learning and memory [1].

Apolipoprotein E (Apo-E) influences post-stroke motor recovery [1] with a role in the growth and regeneration of the CNS tissue, as well as in modulating neural repair, remodeling and protection. After a complex evaluation a neuromotor recovery program, can be quantified to address the members of the affected hemi-body [20].

2.Material and method

Clinical picture: symptoms, signs. The PC patient presents to the physiotherapist with a sequela of ischemic stroke but also with multiple comorbidities present that have aggravated the prognosis of the disease. She has type II diabetes treated with oral antidiabetics (Siofor 1000 mg) and sensory-motor polyneuropathy, grade I / II obesity, complicated mixed dyslipidemia with high-risk stage III hypertension, and cerebral haemodynamic disorders. The patient is being treated with Clopidogrel 75 mg due to a history of deep vein thrombophlebitis, carotid artery stenosis and thrombophilia. In 2012 he presented with Ebstein Barr viral encephalomyelitis with medullary section at T7 level and paraparesis. He also had syringomyelia lesions on his back and lower back.

The PC patient presents with pain in the lower lumbar spine with intermittent and bilateral sciatic irradiation, accentuated by intense or prolonged physical exertion, changes in position or exposure to cold. All against the background of sequelae hemiparesis and more recent paraparesis. Unsystematized fronto-occipital vascular headache with vertigo and secondary dyspeptic syndrome. Polyaltralgia at the level of the large joints with morning stifness and functional impotence, transient with attenuation during the day. Joint pain can be in the context of tendonitis, synovitis and migratory epicondylitis, which occur in the context of functional overload of the plegic limbs.

Right plantar tendinitis, synovitis of the left knee joint and medial epicondylitis of the left elbow were solved by injectable anti-inflammatory treatment, then after the acute remission of acute pain began long-term oral administration, alternating classes of drugs in parallel with local topical synthetic ointments, semisynthesis or natural, complementary to the relief of pain symptoms. Meanwhile, the patient developed post-drug secondary hepatic steatosis and frequent bouts of gastroduodenitis with a risk of HDS (upper gastrointestinal bleeding) which logically led to the establishment of a highly restricted diet. Obesity gynoid status has led to aggravation of incipient gonarthrosis and coxarthrosis pain which in turn has created gait disorders with loss of balance, shocks and frequent falls that have left morphological-anatomical consequences; to remind the fracture without displacement of MTS II (right side metatarsal).

Axial spondylodiscarthrosis together with the C4-5, C5-6 and T4-5 thoracic and L2-3,4-5 lumbar disc herniations, respectively, were treated conservatively, because the unanimous opinion of the neurosurgeons and neurologists was the one of conservative treatment and not a radical cure. Ligament instability in the joints of the bilateral ankle has made possible numerous sprains resulting in ligament tears, chronic edema and joint pain, even if the patient had been advised to wear flexible orthoses. The case being a woman in the second half of her life, she also faced the vegetative manifestations of a physiological menopause on the background of a fibromatous uterus and by the presence of functional gonadal cysts. Characteristic of this pre- and post-menopausal period would be the depressive anxiety syndrome with emotional instability and hormonal somatic transformations, which makes it more difficult to work, respectively the coordination of the rehabilitation program applied by instructors.

Paraclinical investigations - Laboratory examination: Echocardiography performed in 2019: VS = 46 mm, AS = 37 mm, Ao = 20 mm, RV = 27 mm, SIV = 12 mm, PPVS = 12 mm, FE> 50%, pericardium without fluid , free cavities. Standard radiographs: axial face and profile, pelvic for the coxo-femoral joints or for the sacroiliac joints. Regarding the craniocerebral MRI, it concludes with several micronodular lesions of *demyelinating character*, subcortical, frontal and temporal, of vascular nature.

EMG allows to highlight a small amount of voluntary muscle activity. Venous and carotid Doppler that found a 55% stenosis on the right carotid artery and the presence of a thrombus on the large saphenous vein in the right lower limb.

ABI (ankle-brachial index) which normally has values above 1 mmHg. In the PC patient on the right side it has a value of 0.9 mmHg and on the left side it has a value of 0.7 mmHg.

Currently, the patient has a quasi-abnormal electrocardiogram with the presence of a *minor branch block* (BRD), diagnosed in September 2019, but without pathological relevance.

Positive diagnosis: Usually, stroke can be diagnosed clinically, especially in a person over the age of 50 with hypertension, diabetes, or signs of atherosclerosis using well-known neurological maneuvers in the medical world. In the PC patient, the presence of thrombophilia accentuated the positive diagnosis.

The patient presents with a spastic hemiparesis, paraparesis, paresthesias and lower limb pain, cervical-dorso-lumbar discopathy with pluriradicular syndrome, distal sensory-motor polyneuropathy, headache, vertigo, balance disorders, emotional

lability, impaired memory and memory impairment. , pain and paresthesias of the bilateral sciatic type and hypoaesthesia with symmetrically bilateral distal dissections in the lower limbs.

Neurological examination reveals a difference in the sensitivity of one hemibody to the other. Locally it shows unsafe gait, ROT diminished at all levels, Romgerg test with unsystematized oscillations. Transient diplopia with change / narrowing of the visual field.

The differential diagnosis is made with many pathologies such as: expansive intracranial processes, intracranial hypertension, intracerebral hemorrhage, hematoma or tumor, ruptured aneurysm, circulatory vertebro-basilar insufficiency (CVBI); We use computer tomography (CT) or magnetic resonance imaging (MRI) [21].

The patient's evolution went in a positive direction towards improvement; it is further recovered following the complex treatment indicated, both by physiotherapy and by hydrotherapy applied at least 2x / year, in resorts, such as TECHIRGHIOL, as well as SOVATA. The mild climate and environment of these resorts are conducive to slow but lasting recovery [20]. The prognosis is good, of course only if the patient will continue the complex treatment. Complications without treatment consist mainly *of repeated ischemic stroke* or hemorrhagic transformation of the ischemic one.

Quite often, *epistaxis is also seen* as a transient manifestation ORL, of a hypertensive outbreak, which should not be overlooked, being a sign of medium severity that should be solved as soon as possible, and thus prevent a sudden bleeding with an unwanted end. Other complications due to procoagulant status are : deep vein thrombosis, heart attack, pulmonary embolism. Heart rhythm disorders, by affecting the activity of the heart, require adjustment with anti-arrhythmic drugs. Otherwise, heart rhythm disturbances due to pre-existing dyslipidemia and thrombophilia would lead to an unwanted end [22].

3.The hypothesis of the paper

We will assume the improvement of balance and gait after the stroke which is of prime importance and increase the quality of life, so that the use of aquatic therapy has gained more attention in its rehabilitation and we will try to demonstrate the importance of this therapy, early recovery from post-stroke motor impairments.

4. Aim and objectives

The aim of the paper is to demonstrate the theory issued above, namely that exercise in the aquatic environment facilitates the mobility of joint movements with their improvement and recovery of motor skills by optimizing fitness and body shaping.

The applied aquatic procedures will have systemic consequences on the myoarthrokinetic apparatus with the improvement of the ventilatory functions, but also of the cardiovascular, metabolic and neurological ones. Aquatic therapy will be not only curative but also preventive, improving neuropsychomotor health.

Also the goal is to practice movements using the fingers, such as grip, strength and muscle tone in the execution of fine movements in everyday life (tying laces, dressing and undressing with the closure of buttons, eating with gestures of pronation and supination, personal care with the use of toilet, changing position by laterality movements, transfers from supine position to orthostatism, use of stairs, prevention of spasticity) quantified by specific scales.

The method consists in using an alternate daily schedule for 3 months with a one-month break and resumption. Gymnastics will start with stretching exercises at the edge of the pool, and then continue in the water, initially at shallower depths and progressively at greater depths of the pool.

The program should be carried out under the close supervision and guidance of the physiotherapist, and the procedures will be done on a simple, then complex principle, as we increase the intensity of the exercises and their frequency. Since the recovery is long-lasting, programs will include hydro and physical therapy

methods, alternatively, as well as other complementary techniques. We will also use the advice of a nutritionist, in order to compose a diet consisting of good calories (Carbohydrates 50%, Lipids 30%, Proteins 20%).

5. Presentation of the case

The patient is a 55-year-old woman from an urban area, with an obese constitution (grade I). Living and working conditions she is currently retired due to illness, the last job being demanding in extended shifts and standing.

Personal and pathological history :

- 2005 -2006 - Ichemic stroke with right hemiparesis whip sequelae, Sensory-motor polyneuropathy, Type II diabetes mellitus, Dyslipidemia;
- 2007 Aortic and mitral regurgitation, Moderate tricuspid regurgitation, Chronic venous insufficiency CEAP 3:
- 2010 - Stage III hypertension high risk under specific chronic treatment, Deep sequelae venous thrombophlebitis Painful chronic hypertensive heart disease;
- 2011 - Viral encephalomyelitis with medullary section at thoracic level T7, Diaphragm paresis with moderate restrictive respiratory failure on the background of an evolutionary dorsal syringomyelia Depressive syndrome, Burn Out Syndrome vasospastic rhinitis;
- 2013-2014 - Sarcopenia with acetylcholine anti-receptor antibodies <0.2 nmol / L Incipient hip osteoarthritis and bilateral gonarthrosis;
- 2017 - Right carotid artery stenosis Thrombophilia Bilateral sequelae plantar fasciitis Uterine fibromatosis, Axial spondylarthrosis with straightness of the spine;
- 2019 - Right epicondylitis, Cerebral lacunarism, Massive bilateral epistaxis on a hypertensive background, Hepatic steatosis, Chronic drug gastropathy.

Location and basic material conditions

The swimming pool will be used, within the swimming and leisure base of the "Ștefan cel mare" University of Suceava, as well as the recovery facilities within the Corpore Sano resort complex (Techirghiol) beneficial for the patient, as follows: sauna, showers, jacuzzi, Kneipp therapy, salt baths possibly wraps, herbal medicine baths, steam baths, Scottish shower, compressions, frictions, resort therapy and cryotherapy. Materials: cane, balls of various sizes (small, medium, large, smooth or aciform), water dumbbells (0.5 kg), floating devices, etc.

Duration and stages of work

The aquatic therapy program started as a therapeutic method, and will be continued for prophylactic purposes in order to prevent the appearance of contractures and spasticity, but also to improve the quality of life.

So the weekly program includes 3 days a week, Monday, Wednesday and Friday, one hour at pool, this being preceded by the warming up on land, using stretching techniques minimum 10 min. On Tuesday and Thursday there will be fitness exercises at the gym or outdoors, under the "mirror" of the guide. The weekend that is spent at home, will be based on isotonic exercises, combined with light running outdoors; running will be carried out on a suitable ground and with special footwear (10-30 min), or rapid walking, using for support, ski poles or walking poles. It will be considered to change the lifestyle of a sedentary lifestyle as well as a low-calorie diet or a diet consisting of good calorie foods (50% Carbohydrates, 30% Lipids, 20% Proteins). The water regime will be calculated according to the body weight (Water volume ~ Weight in kg x3). General massage will also be used, alternating the therapeutic style, heating, relaxation or specific segments. Massage sessions can last between 30-60 minutes, using revulsive oily substances, alternating with specific anti-cellulite oils. The procedures will be repeated initially daily and then every 2-3 days. Fitness days can be preceded by segmental electrostimulation sessions, followed by wraps and 30-45 minutes in the

thermal bath and of course lymphatic drainage using special "pants" (20-30 min) with varying intensities, depending on the degree of tolerance.

Complex recovery: consists in the application of physical-mechanical, electrical methods, with a certain duration and alternatively. Electro-physiotherapy techniques as well as physiotherapy / aquatic therapy will be used.

It can start with lifestyle changes, quitting smoking, drinking alcohol, returning to a normal nictemeral rhythm with night rest and day time activities, with an age-appropriate diet and carefully calculated calories, so as to avoid false calories, with a water diet corresponding to the body weight, and to achieve weight loss. We have created an alternative program to avoid monotony and to stimulate the proprioceptors through the inhibitory pause.

Aquatic therapy: Water will be used at a temperature of between 32^0 -35^0 so as not to change the body's thermal balance. After the pre-warm-up that takes place at the edge of the pool through isometric exercises / stretching, we will continue with exercises in shallow water. In the first week, the exercises will take place face to face with the specialist guide and depending on the patient's tolerance, following the same principle of gradual increase of physical effort based on the escalation of the complexity of aquatic activity. Once the improvement of the motor function is obtained, medical devices from the endowment of the swimming pool can be added one by one. Taking into account the particularities of the case, we will list some exercises carried out in the pool:

- walking on the bottom of the pool, supportting the hands on the side bar, then warming up, walking through the pool with the swinging moves of the upper limbs;
- flexions: plantar flexion, knee flexion, and hip flexion towards the abdomen with 10 repetitions with each limb, alternatively;
- rotating the ankles inwards and outwards circles, in series of 10 movements each foot, alternatively;
- adduction and abduction of the legs with the knee extended in the 3 axes alternately (front, side and back);
- jumping like a ball but in the water, with both knees flected to the chest and returning with "treading the water" (eye-foot coordination);
- with support to the bar and facing the wall of the pool will walk with small steps on the tops, bringing the foot in front of each other from bottom to top and vice versa about 10 steps repeated 5 times (eye-foot coordination);
- with the lower limbs outstretched, from the position perpendicular to the pelvic wall, with the hand on the bar, performs small and then large circles by rotating the hip, 10 movements in each direction inwards and outwards;
- from the float -position, perpendicular to the pelvic wall, using the flexion of the toes on the bar as support, there will be flexions of the knees and abdominal muscles contractions, successive with a number of 8-10 movements with increasing frequency;
- lunge movements in water, with the support of the feet on the bottom / wall of the pool, using the hands as support, 8-10 times repetitions.
- running on the spot, without support at an increasing speed; exercises for recovery, breathing exercises, relaxing moves (at the end).

Example of using the foam stick, in the water- of 1.5 m depth, with the stick caught with the hands behind the back, performs lifting and descending movements from the dorsal area to the buttocks region parallel to the body;

- with the stick, held to the chest on both ends, lateral movements are made alternately left and right under water, in series of 8;
- holding the stick, with both hands at the ends, at shoulder level, rise above the head, then return to the original position and push forward parallel to the water,

return and then push under the water surface (at 45 degrees), return to the initial position and then lower the cane under water, parallel to the body;
- with the stick gripped with both hands at the extremities, rotations are performed in the left and right alternate torso.

Exercises using balls of different sizes: palm-sized hedgehog- ball, will be passed from one hand to the other, through the water, first in front of the body, then behind the body, in series of 8-10, with the same type of ball can be performed transfers from one palm to another performed with the lower limb in triple flexion, underwater, with the ball raised above the head and transfer to the contralateral limb. A complex movement is obtained in which the joints of the shoulder, hip, knee, ankle are engaged; as well as the small return break but also a slight warm-up, pool rounds are made using a floating device or 1-2 foam sticks.

Exercises using water weights / dumbbells. After attaching the weights / to the wrist, perform several types of similar exercises from the gym.

Weights can be attached for better stability to the ankle, also with the execution of the similar exercises performed in the gym, also may be performed in the aquatic environment: lateral and downward movements to the water surface or during the exercise the clapping of the palms above the head; with the hands raised sideways to the surface of the water, rotations of the fist joint in one direction and in the other direction, in series of 5-8 movements, then large rotations of the shoulder joint will be performed; with the hands facing the surface of the water, swing back and forth movements will be performed next to the body and through the water; with the hands in front it will perform water shears moves from the knee to the surface of the water and vice versa in series of 5, followed by a break.

With support to the bar at the edge of the pool, for the safety of the execution, a series of movements will be made as follows: slight rotations of the ankle inward and outward for warming up; alternate ups and downs of each lower limb in 5-8 sets, also with the leg outstretched, back movements will be performed from the coxo-femoral joint; subsequently the outstretched leg will make lateral movements alternately with the lower limb controlled; it is possible to perform the triple flexion with the knees up to the chest and also with support at the edge of the pool; with the knee extended, make small circles with the sole parallel to the bottom of the pool, then the diameter of the circles will increase; the movements will be performed both clockwise and counter clockwise directions, with one leg and the other.

In the all aquatic exercises, it is important to keep the abdominal wall muscles in tension throughout the exercises as we will work unconsciously on the diaphragm as well [23-28].

6. Results and discussion

Socio-professional and family reintegration took place gradually, especially as the integration process overcame the challenge itself, so that the efforts were channeled towards the use of personal skills, the patient being approached as a combination of new skills and was driven by personal integration motivation. Depending on the degree of recovery of both mental and motor functions, it began with occupational therapies at home, then in the extended family, later in society. Requests gradually increased working hours according to individual tolerance. Thus, depending on the professional aspirations and the degree of professional training, the personal skills were channeled towards a new beginning. The marginalization of the case was thus avoided because the person wanted to return to society even under different conditions than the initial ones. The group therapy and the support of the psychologist and the multidisciplinary team, made her to leave the risk group with great vulnerability, as she proved that she has the strength to start over [29].

Final evaluation of the patient:

Ambulance Functional Categories Scale which concludes a score of *4 out of 5*, independent on flat ground (patient can walk independently on flat ground, but needs help on stairs, slopes or uneven surfaces)

Scale Medical Research Council (MRC) recommended for the evaluation of muscle strength, the gradation of paresis from 0 to 5, the last corresponding to normality and 0 to plegia. The patient has a score of *4 with mild paresis* (movement against resistance, but weaker than on the contralateral side).

Modified Ashworth Scale (MAS) graded from 0 to 5, it assesses the patient's spasticity. PC has a score of 1 with a slight increase in muscle tone, manifested by a hanging and release or minimal resistance at the end of the mobility sector when flexing or extending the affected segment.

The 10 meter distance assessment test is performed at a speed that the patient considers comfortable and can use any support he needs, the movement is done in one direction without turning. The test result showed that the patient has no limitations on daily activities.

- Decreased sarcopenic index ;
- Considerable improvement of the *Barthel index from 30 to 90* out of a maximum of 100 points;
- Slight improvement of *the Berg scale* to assess the balance from 8 to 9 out of a maximum of 14 points, a better score cannot be obtained due to the presence of sarcopenia;
- The sarcopenic index decreased with an improvement in dynapenia;
- The modified Ashworth scale (MAS) for the assessment of spasticity had grade results 4 in 2012 compared to grade 0 in 2020;
- ADL scale (of daily activities) compared to **7** points in 2012 in the initial period reached a score of 38/40 points;
- Improving the *gait test* with comfortable speed and support at least 10 meters without turning for a time of 20 seconds;
- *Quality of Life* rating scale has improved substantially from 33 to 87 out of a maximum of 112;
- Based on the stroke rating scale of the National Institute of Health, the score is between 10 and 20 points with a favorable prognosis in those with ichtus ischemic;

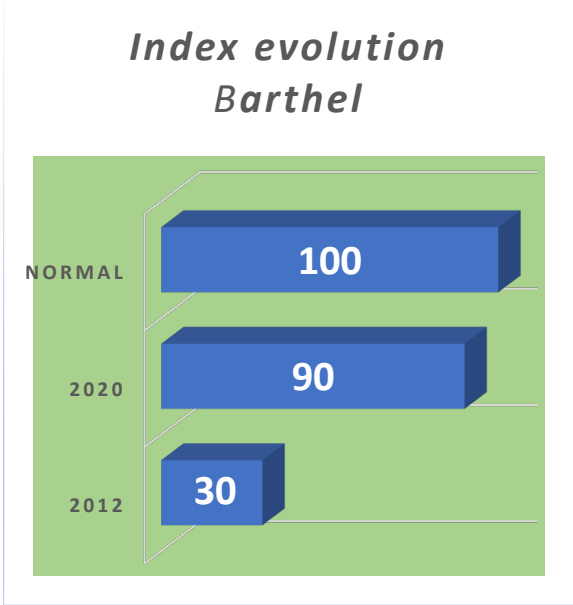

Figure 2. The evolution of the Barthel index

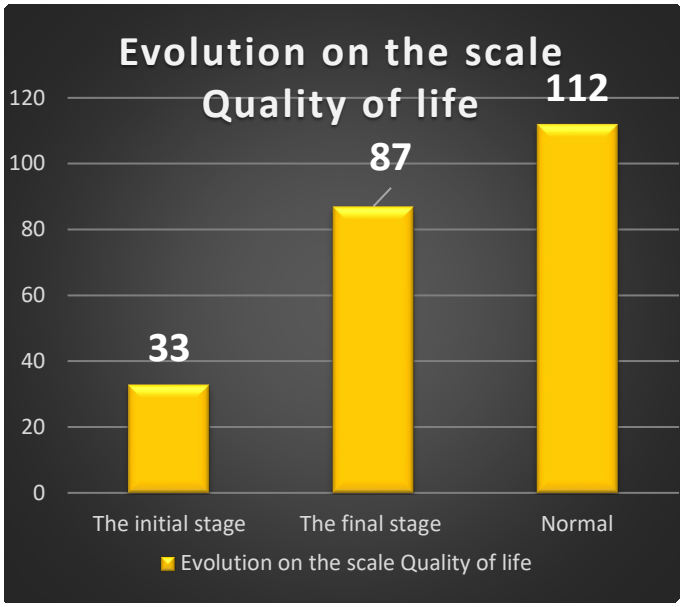

Figure 3. Evolution of the Quality of life scale

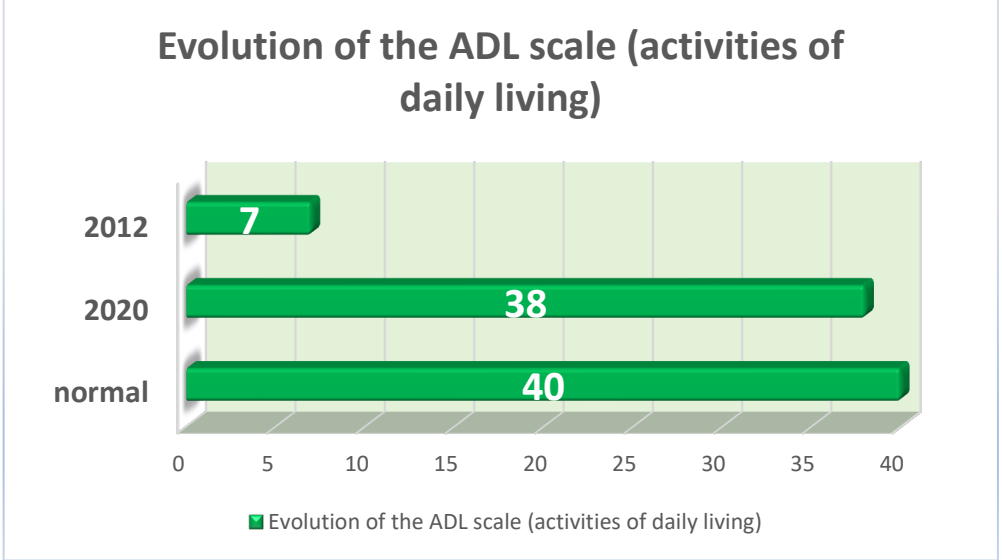

Figure 4. ADL scale evolution chart (daily life activity)

Evaluation of the patient after aquatic therapy

After a long aquatic therapy, but also after a complex physiotherapy program, continued at home, the patient has a good functionality of the limb muscles, but also an improved overall tone. The use of the physical properties of water, such as hydrostatic pressure, facilitated the mechanical work with medical devices (weights) that could not be easily used in the physiotherapy room. The conductivity and thermal conductivity of water especially when the water is at a temperature above 35^0 to 42^0 (thermal water) changes the perception of pain by facilitating work in the aquatic environment for a longer and more efficient time. When different water temperatures were applied alternately, an increase in muscle tone and strength was found, leading to the correction of most of the pre-existing motor disabilities with the improvement of the functionality of the limbs.

The data from the study were collected over a period of several years from the early stage (2011-2012) to the late stage of recovery which proves to be an intermediate one

due to the cessation of measurements due to the current Covid-19 pandemic, which will be resumed at a later favorable time.

8.Conclusions:

Following the study, we concluded that the action of recovery and rehabilitation of post-stroke neuropsychomotor is a complex of activities performed by the patient with stroke according to the literature [3].

The communication between the patient and the physiotherapist had favorable repercussions as follows: improvement of symptoms, improvement of balance and coordination, prevention of spasticity, prevention of another stroke, improvement of respiratory function, restoration of motor control and muscle tone, socio-professional reintegration, the use of *Gingko biloba* extract.

It is absolutely necessary for the family to be more involved in the recovery of the patient, thus helping her professional reintegration [30].

The reintegration in the family as well as in the society was done gradually, using the patient's skills, with results in accordance with the literature, specialty that shows that most of the progress made for motor function is achieved in the first 3 months after stroke [31,32], visual orientation after 5-6 months, and memory, language can be recovered in months, even years after the stroke [33], being influenced by the patient's quality of life [34].

To reduce muscle loss and alleviate dynapenia by increasing the influx of local vascularity, further optimizing spoken and written language, regular clinical-functional assessment to stage and update neurological status, improve self-care activity, continue diet, anti-hypertension; anti-DM, anti-dyslipidemic, permanent aerobic "training" at home, use of corrective protective orthoses or adjuvants if needed, conventional posture therapies and "stretching" exercises to improve coordination functions.

In addition to the assessment scales presented above, artificial intelligence and image processing modalities obtained with smartphones bring the rehabilitation of patients with neurological disorders to a higher level in terms of assessment and recovery plan. Silviu-Ioan Bejinariu et al. published 2021 a paper in which the evaluation of locomotion rehabilitation in patients with neurological disorders is performed with the help of video image processing recorded in fully rehabilitated neurological patients using Human Pose Estimation technology [35]. The method proposed by the authors is entirely non-invasive, based on the analysis of video sequences in which the neurological patient performs certain relevant activities using a preformed system convolutional neural network VGGNet [35]. The method is based on the calculation of joint angles between body segments, and the patient's condition is assessed by studying the variation of angles between leg segments during movement indicating the level of recovery [35,36].

Author Contributions: "Conceptualization, E.V. and C.P.; methodology, M.C.; software, M.C.; validation, E.V., M.C.; formal analysis, C.P.; investigation, M.C.; resources, C.P.; data curation, M.C.; writing—original draft preparation, E.V.; writing—review and editing, M.C.; visualization, E.V; supervision, E.V.; project administration, M.C.; funding acquisition. All authors have read and agreed to the published version of the manuscript."

Conflicts of Interest: "The authors declare no conflict of interest."

References

1. Alawieh, A.; Zhao, J.; Feng, W. Factors affecting post-stroke motor recovery : Implications on neurotherapy after brain injury**.** *Behav Brain Res* 2018, Mar 15; 340:94-101.

2.Birlutiu, V.; Stef, L.; Mitariu, S.I.C.; Antonescu, E.; Parlog, M.; Purnichi, T.; Silisteanu, S.C.; Manea, M.M. The Biochemical Biomarkers Determination in Alzheimer Dementia. *Revista de chimie* 2018, 69(11):4055-4059.

3.Kuriakose, D.; Xiao, Z. Pathophysiology and Treatment of Stroke: Present Status and Future Perspectives. *Int J Mol Sci.* 2020, Oct; 21(20): 7609
4.Duica, L.; Antonescu, E.; Totan, M.; Pirlog, M.; Silisteanu, S.C. Contribution of mechanical and electrical cardiovascular factors in patients with ischemic stroke. *Pakistan Journal of Pharmaceutical Sciences* 2020, 33:2455-2460.
5.https://www.world-stroke.org/assets/downloads/WSO_Global_Stroke_Fact_Sheet.pdf (accessed on 28.03.2022)
6.Rusu, V. Dictionar medical, Editura Medicala, Bucuresti, 2001
7. Mocanu, G.D. *Loisir / Activități motrice de timp liber*; Galati University Press: Galati, 2018; ISBN 78-606-696-121-6.
8. Mocanu, G.D.; Murariu, G.; Munteanu, D. The Influence of Socio-Demographic Factors on the Forms of Leisure for the Students at the Faculty of Physical Education and Sports. *International Journal of Environmental Research and Public Health* **2021**, *18*, 12577, doi:10.3390/ijerph182312577.
9. Pendenfunda, L. Neurologie practica, Editura Atma,1993, pp. 410-413
10. Ancuta, C. Esentialul in medicina fizica si recuperare medicala, Editura, Gr. T. Popa" 2010, pp.98
11. Băjenaru O, Ghid de diagnostic şi tratament pentru bolile cerebrovasculare, MO 608/2009
12.Danelciuc, F.T.; Silisteanu, S.C.; Danail, S. The increase of the life quality for patients who had a cerebrovascular accident by using the MBT physiotherapy device. *Balneo Research Journal* 2017, 8(2),pp:40-45.
13.Collaborators G.S. Global, regional and national burden of stroke, 1990-2016: A systematic analysis for the Global Burden of Disease Study 2016. *Lancet Neurol* 2019, 18, pp:439–458.
14.Boehme, A.K.; Esenwa, C.; Elkind, M.S. Stroke Risk Factors, Genetics and Prevention. *Circ. Res* 2017, 120, pp:472–495.
15. Girijala, R.L.; Sohrabji, F.; Bush, R.L. Sex differences in stroke: Review of current knowledge and evidence. *Vasc. Med* 2017, 22, pp:135–145.
16. Bevan, S.; Traylor, M.; Adib-Samii, P.; Malik, R.; Paul, N.L.; Jackson, C.; Farrall, M.; Rothwell, P.M.; Sudlow, C.; Dichgans, M.; Markus, H.S. Genetic heritability of ischemic stroke and the contribution of previously reported candidate gene and genomewidw associations. *Stroke* 2012, 43(12), pp:3161-7
17. Brambatti, M.; Connolly, S.J.; Gold, M.R.; Morillo, C.A.; Capucci, A.; Muto, C.; Lau, C.P.; Van Gelder, I.C.; Hohnloser, S.H.; Carlson, M.; Fain, E.; Nakamya, J.; Mairesse, G.H.; Halytska, M.; Deng, W.Q.; Israel, C.W.; Healey, J.S. Temporal relationship between subclinical atrial fibrillation and embolic events. *Circulation* 2014, 129, pp:2094–2099
18. Disertori, M.; Quintarelli, S.; Grasso, M.; Pilotto, A.; Narula, N.; Favalli, V.; Canclini, C.; Diegoli, M.; Mazzola, S.; Marini, M., Greco, M.D.; Bonmassari, R.; Mase, M.; Ravelli, F.; Specchia, C.; Arbustini, E. Autosomal recessive atrial dilated cardiomyopathy with standstill evolution associated with mutation of Natriuretic Peptide Precursor A. *Circ. Cardiovasc. Genet* 2013, 6, pp:27–36
19. NINDS Stroke Genetics Network and International Stroke Genetics Consortium. Loci associated with ischaemic stroke and its subtypes (SiGN): a genome-wide association study. *Lancet Neurol* 2016, 15(2), pp:174–184
20.Silişteanu, S.C.; Antonescu, E.; Duică, L. Strategies for the recovery of patients with post stroke sequelae in the context of the COVID-19 pandemic. *Balneo Research Journal* 2020; 11(4), pp:507-511
21. Silbernagl, S.; Lang, F. Fiziopatologie, Atlas color, Editura Callisto, 2011
22. Porter, S.R.; Kaplan L.J. Manual Merk, Simptome frecvente, Editura All, 2012
23. Yann, M. Aqua Fitness, Editions Amphora, 2016, ISBN 978-2-8518-=950-6, pp.93-95
24. Heimburger, F. Aquafitness, Editions Solar, Paris, 2016, ISBN 978-2-263-07160-7, pp.52-60
25. Heimburger, F. Aquafitness, Editions Solar, Paris, 2016, ISBN 978-3-95736-088-5, pp. 46-49
26. Adami, MR. Aqua Fitness, Published in the United States by DK Publishing, 2002, ISBN 0-7894-8949-X, pP. 64-77
27. Bădău, A.; Bădău, D. Aqua-pullpush-gym. O metoda inovatoare de gimnastica în apă
Universității "Transilvania" din Brasov, 2011, ISBN 2011 978-973-598-865-1
28. Raţă, E. Teoria şi practica în sporturile de apă: înot, Editura Ştefan cel Mare din Suceava, 2015, ISBN 978-973-666-427-4, pp. 16-20
29. http://www.atelierefarafrontiere.ro/noutati/modele-norvegiene-de-insertie, (accessed on 30.03.2022)
30. Silisteanu, S.C.; Antonescu, E.; Duica, L. The importance of balance and postural control in the recovery of stroke patients. Balneo Research Journal 2020, 11(3), pp: 372–378
31. Kwakkel, G.; Kollen, B.J. Predicting activities after stroke: what is clinically relevant? *Int J Stroke* 2013, 8(1), pp:25–32.
32. Chung, C.S.; Pollock, A.; Campbell, T.; Durward, B.R.; Hagen, S. Cognitive rehabilitation for executive dysfunction in adults with stroke or other adult non-progressive acquired brain damage. Cochrane Database Syst Rev. 2013, 4:CD008391
33.Cassidy, J.M.; Cramer, S.C. Spontaneous & Therapeutic-Induced Mechanisms of Functional Recovery After Stroke. Trans Stroke Res 2017, 8(1), pp:33-46
34. Hyun, P.J.; Joon, K.B.; Hee-Joon, B.; Jisung, L.; Juneyoung, L.; Moon-Ku, H.; Yoon, O.K.; Ho, P.S.; Yeonwook, K.; Kyung-Ho, Y.; Byung-Chul, L. Impact of Post-Stroke Cognitive Impairment with No Dementia on Health-Related Quality of Life. Journal of Stroke 2013, 15(1), pp:49.
35. Bejinariu S-I, Luca R, Onu I, Petroiu G, Costin H. "Image Processing for the Rehabilitation Assessment of Locomotion Injuries and Post Stroke Disabilities." *2021 International Conference on E-Health and Bioengineering (EHB)*, 2021, pp. 1–4, https://doi.org/10.1109/EHB52898.2021.9657714.
36. Sardaru Dragoș-Petrică, Onu Ilie, Matei Daniela-Viorelia "Evaluarea amplitudinilor articulare" Iași: Editura "Gr.T. Popa", 2021, ISBN 978-606-544-745-5