

# Ita. J. Sports Reh. Po.

1989

Italian Journal of  
Sports Rehabilitation and Posturology

Physical treatment ( Hydrotherapy) by  
individuals with and without dementia.  
Aquatic exercising. Part 1.

**Authors : Jan van de Rakt<sup>1</sup>, Steve McCarthy-Grunwald<sup>21</sup>**

<sup>1</sup> Physical Therapist NDT teacher IBITA, Course Leader and teacher on the Dutch Institute for Allied Health Sciences. Nursing Home “Waelwick” in Ewijk. The Netherlands

<sup>2</sup> MSc BSc RMN Senior Lecturer in Mental Health Nursing with Dementia Specialty. University of Cumbria, Bowerham Road, Lancaster, LA1 3JD England



## Abstract.

*It still today “not done”, aquatic exercising with people with an neurological disease and especially people with an form of dementia.*

*Why not? Is it the amount of work to transport undress them and escort them in the water? Or is it the cost for all this work and the cost for the swimming pool? Or is there still an culture problem that elderly with or without an neurological disease cannot participate as others in an swimming pool?*

*The interest of science in this kind of therapy is long standing on an low level. Mid years 50-60 of the foreign century all rehabilitation centre must have an swimming pool and often more than that.*

*Even Nursing homes were built with an pool inside, but when the sciences has discovery other things as robotica with an higher amount of cost, the positive elements of exercising in water were lost and swimming pools were closed. The great performance of an J.MacMillan to train disable girls in an swimming pool according the rules of water was introduced in several countries but now this knowledge and especially the skills are decreasing, an pity. The content of people with an neurological disease and especially dementia that have learn to swim is increasing and the possibilities for an better live, better quality, by exercising is growing. From science there are more investigations that discover that exercising in water has great benefit and that this is better than exercising on land.*

**Conclusion** .*The investment in training in water has an significant influence on the quality of people with neurological disease and also on people with dementia. The environment –water- makes movement normal, it push people to move and search for the best way to handle the up thrust. And it give an aerobe boost that is essential to decrease the speed of dementia, certainly when is combined with cognitive games. Furthermore is has all kinds of anaerobe elements that can use to increase the balance performance of this people. Therefore why we don’t do it !!* **Authorship credit** : “Criteria authorship scientific article” has been used “Equal Contribution” (EC) **Citation** : Jan van de Rakt, Steve McCarthy-Grunwald *Physical treatment ( Hydrotherapy) by individuals with and without dementia. Aquatic exercising. Part 1 ta. J. Sports Reh. Po. 2022; 9 (19); 1;3 ; 1989-2017 ; ISSN 2385-1988 [online]; IBSN 007-111-19-55; CGI J OAJI 0,101]*. Published online. **Correspondence for author:** Jan van de Rakt e mail : jan@vanderakt.nl

1990

**Keywords:** Halliwick, capacity, hydrotherapy and dementia.

## Aquatic training for elderly with and without an neurological disease

### Introduction.

Exercising in water ask for an lot of things, we know.

An pool, people that will help with the ADL and enough wheelchair that can go into the water. It can be dangerous to enter the pool with an rollator frame and then down on such bad stair.

The environment around the pool is the most dangerous place on earth and therefore put the people in an wheelchair and drive them into the pool.

Than the exercises can start and there are an lot of possibilities but with an few volunteers we can give an program of one hour in which all elements are there, aerobe and anaerobe. James MacMillan is one of the founders of the Halliwick approach [1,2,3] with the combination of the water rules , gravity change and turbulence reaction etc. but also the approach to learn people to copy with movement in water – the 10 points program.

The investigation that has be done about the effect of water on the cognition of older people with and without dementia is increasing and the evident is obvious[5,6].

But also the program to stimulated the balance an give task specific resistance treatment is possible and water is the only environment in which falling is allow [7,8,9]. There is only one “border” and that is that the individual must be able to get his head up above the surface of the water.

But there is somethings else that water do and air not. We know that the perception by people with dementia is decreasing and we know not why. Also we know not how to decrease that loss.

An research team [10,11,12,13] has investigated what happen in water with the perception and he discovered that the input that go via the hair follicles to the brain is great in water when the individual moves. That means that the perception in water is stimulated by moving through the water and we have experienced what water does when we walk as fast as we could. Than the resistance is increasing and we are tired in our whole body and in our muscles that we use for this walking /running part.

Use it and we have an program that will end with an tired individual at home and asking for an good nap!!

Of course all kinds of exercising in water are possible and especially the approach of aquamentia are perfect because here is the combination of exercising with cognition stimulation and that is according the sciences the best way to stimulated the damaged brain and get an plasticity starting.[15,16]

Important is that the quality of life is investigate, because that is often the most important issue and an very strong evidence how well people react on exercising in water. There are the DQOL[18], but also the pain scales for people with dementia [19,20]or the ordinary V.A.S.-scale.

But also the investigation of the sleep behaviour after swimming or by people with dementia the behaviour after participated with the aquatic therapy will people see that exercising in water is of great benefit.

Even people that are on land almost apathy and need passive elevators to move from bed to chair can give an tremendous change after exercising in water [22].

Still this group of patients asked for an well trained therapist that know what he can expected and know that he must build up the experience of this patient with water.

First we start with an exercising programme that is pointed on two issues:

1. Training of the aerobe part.
2. Training of an better balance performance
3. Combination of aerobe or anaerobe with exercises that asked for cognition involvement.

Second part is ;

The patient with an neurological disease and cannot move on land on his own.

### Water Program including aerobe, anaerobe and cognition participation.

This programme is for all person that will exercise to get an better balance performance and all persons with pathology can participated in this program. All group therapy [23] has a problem that this session must be built on the weakest person in the group and only by more assistance in the group is this problem lesser.

In hydrotherapy is the environment for everyone an problem which this person must deal. That is an personal problem and when the person has mastered that every change can be an exercise. That makes group therapy in water so special and is the rule here not present that the group must adapt on the level of the weakest person.

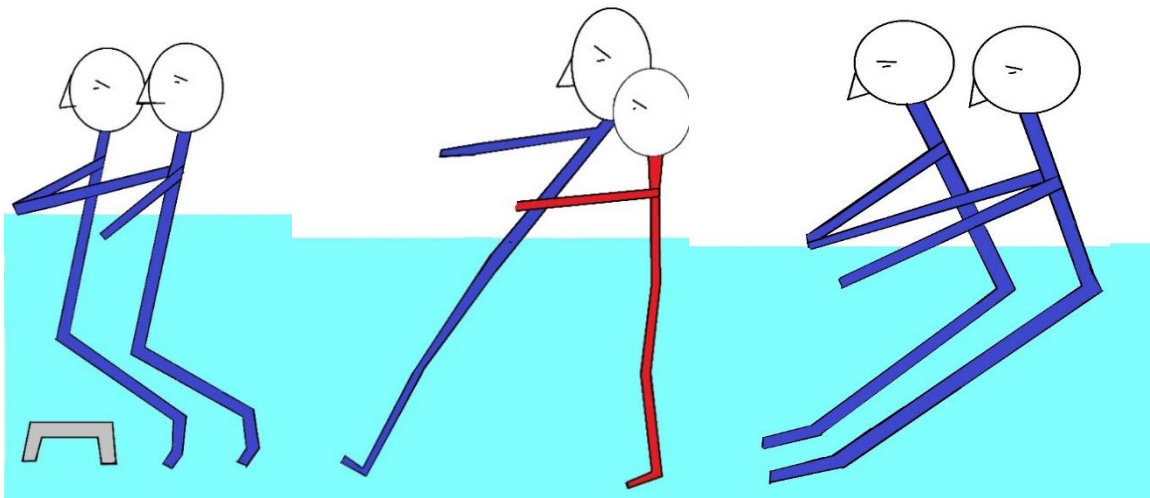
Still there are elements that asked for an personal attendance and that is possible to work in pairs.

1992

#### 1. "Fall exercises."

Teach people to get on their knee to the front but also dare to fall back and try to get the head to the front. This back falling can we slowly directed to the fall sideways. Back falling can be done in an task for two group members, one do the exercise the other has some coordination.

Falling to the front in an group be aware that the water level isn't too high because everyone is than submersed and that isn't the purpose. We can also using step bench to make the decline less deep. But always do it with the group members hold each other hands. This look safer but is more difficult. Even starting with the hand on the edge of the pool can be useful because so many people are afraid to get on the knee. And what is done in the pool as an exercise can help to kneel in their home and get up again and help with the fair for falling and especially the fair not getting on the feet after an stumble and lie in their home without help.



Picture 1.

Picture 2.

Picture 3.

#### Picture 1,2 and 3.

An impression what falling to the front and back is in water. For the front we use an step bench to make the decline less deep but at the end the people must kneel on the floor of the pool and coming back in an standing position and hold each other hand.

Falling back is learning the upper trunk to move to the front, the first time this must be exercise with the therapist because this is an learning process to move with the head to the front, but the water will help trough the resistance. Than this movement isn't so difficult and there is more time to react. After that they can to it together with others and then falling back an little bit to the left and that is the start to learn to fall side way.

*Pictures 1, 2 and 3 published with the responsibility and permission of the author by j.v.d.Rakt.*



Be aware that falling in water isn't the same with falling on land and when people must learn this than this will be almost never be possible on land when this individual will fall. That means learn to fall will almost never generalized.

1993



**Photo 1.**

**Photo 1.** Backward falling with the group members holding each other by the hands. That makes this much more difficult because now people must use more upper trunk movement to the front and must adapt to do this without the hand and often the other is slower or larger and then can this hand holding be working as an brace.

Older people find holding hands often fine, this gives them security but makes the performance difficult. Nice aspect of group therapy !!

*Photo 1 published with the responsibility and permission of the author by j.v.d.Rakt.*



**Photo 2.**

**Photo 2.**

Starting with kneeling down on the edge of the pool and very important the joy that is present.

Using an "step-up" bench for the first kneeling down can this be the start that is needed to go back on the knee.

In the home situation [24] this was continued by kneeling down for the chair and standing up. The exercise has for fill his purpose and make people an feeling that they can perform.

*Photo 2 published with the responsibility and permission of the author by j.v.d.Rakt.*



**Photo 3.**

**Photo 3.**

Forward falling on the knee with the hands holding. There is a difference between the moment of falling and that gives the effect that at the end the last one has only the choice – fall or let the hand loose –

Falling to the front, back and sideways is very important therefore start with it every time and do an rehearsal and see what people find difficult and make an good adaptation because this part is very important.

*Photo 3 published with the responsibility and permission of the author by j.v.d.Rakt.*

Be aware that people with an neurological disease have often an higher tone and that means that synergy will dominant. That makes kneeling down an different approach because the knee on the affected side of the stroke patient will bend much more difficult. He will feel that when he moves his upper trunk to the front that the affected leg goes in extension to the back and he don't come down on his knee but on only one knee and that for an short time because his trunk is too far to the front. Here the edge or an person in front of him can teach him to hold his upper trunk more in extension and go immediately through both knees in flexion and to the step-bench.

Even then be aware that holding this flexion in the knee van be difficult because sometimes the flexion is gone through and goes the buttock to his heel. Now an support in the back is necessary to get this selectivity good. And the last point be careful with the affected foot. Often the mobility isn't optimal, therefore feel in front what the mobility but be sure that the foot is right in position immediately after the forward falling and when the foot is vulnerable let people wear water shoes.

People with Parkinson disease will often freeze when the go in to the water and often is that on the point that the weight on the feet is so little that an trunk movement is decisive what the leg do.

The immersion around vertebrae Thoracic 11 ( Panic curve [1]) is an point that the control must come more from the upper trunk than from the feet.

Parkinson will freeze often before that point is reached. The changing of the environment give them but also patient with dementia an perception in the brain that the damaged brain cannot copy with and the feet won't listen anymore. Sometimes can this reaction be so strong that the get the feet not on the floor [22]. But by both problem is the solution often very simple. Do in the water on the edge



of the pool an small assessment – Statiek - [25,26], feel what the reaction are and decide how to handle.

One hand on the edge and kneeling sideways along the edge or both hand on the edge and kneel. Or stand in front of him an use cue's to go to the knee and give some control. Backward falling is sometimes too difficult because the upper trunk cannot correct it or better, try to correct it with the lower trunk but that don't work in water. ( on land also not) but in water it is down under. Holding an swimming tool in front and asked to pushed to another in front of him will give often the cue to change the trunk attitude. And always use rhythmic.

## 2. Double tasking .

1995

Double tasking [27] means that beside the walking part also another task must be done. The meaning of this is that the attention that is needed for the other task is so high that the “walking” part is exercising on an automatic way.

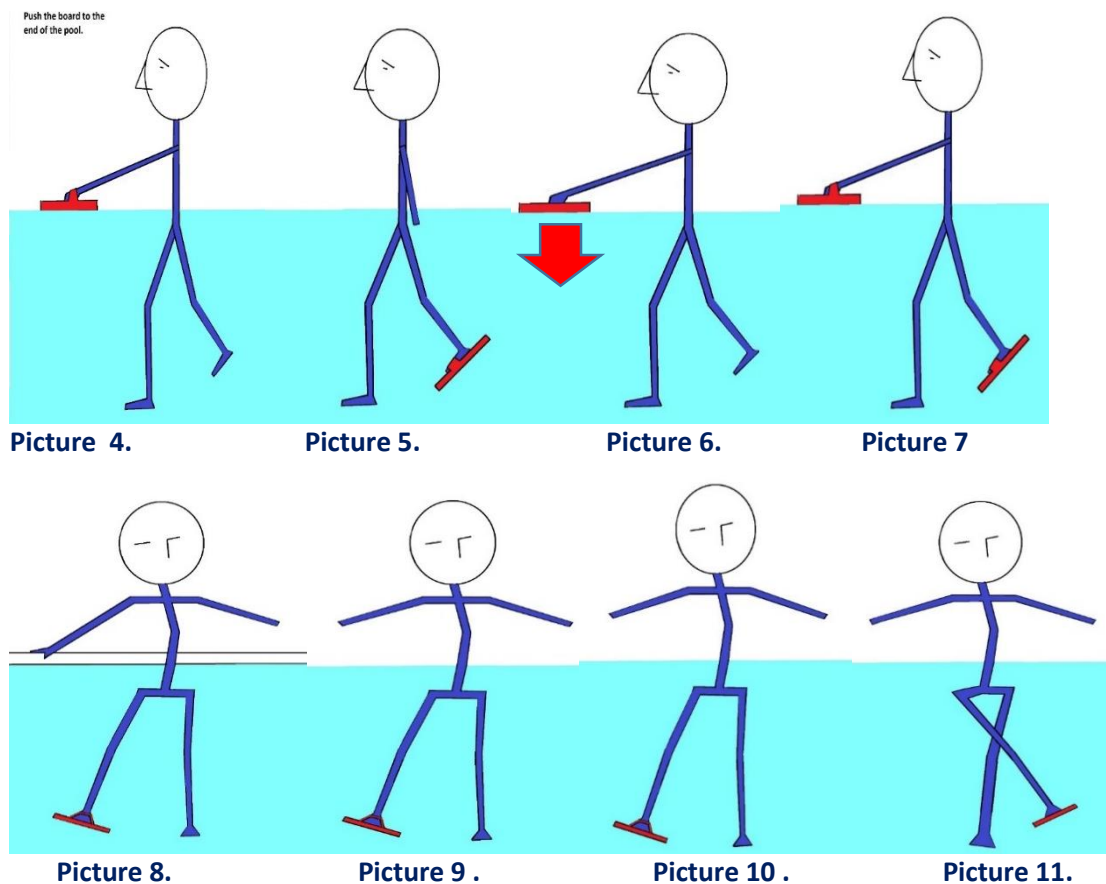
This extra task can be :

1.Walking in the water in all kind of directions along the wall or in the mid of the pool, with holding something in the hand and hold this below the surface of the water or push it through the water. And when people are good than put an board under the one foot and give as the task to hold the board there and walk to other end of the pool, forward, sideways and backward. All is right but the focus must lie on the board not on the walking and this can also be done in groups of two person.

Walking along the wall of the pool gives an kind of safety and when than the focus is on the board, people are not so focussed on the walking and we see often an walking pattern that is with more relaxation and that is the reason for exercising on double tasking.

Holding the board under the surface is also difficult but often in an group one great show of joy and laughing and that is very important by individual with dementia!!

This are double tasking that makes the first task walking in all direction difficult and will give an boost to the increase of power and coordination because this also an task specific resistance therapy.



**Picture 4- till – 10.**

Double tasking, here with board than can be done around the foot/hand with and without fixation. Holding the board with the hand on the surface but below or even straight is also an opportunity. The only thing that must be achieved is that the people are watching on their board and have almost no attention on the walking.

And that walking performance can also be changed.

With an ball or... can also and there will be an lot of fun.

*Pictures 4 till 10 published with the responsibility and permission of the author by j.v.d.Rakt.*

1996

But this are exercises that makes directly the walking procedure more difficult because there must be more delivered that before.

And other form is that the exercise is staying the same but that we asked people to count backwards or do exercising in mathematics. This asked more of the cognitive function of the brain and stimulated the brain on two ways.[15,16]. The plasticity will be now the greatest but the focus lies on the cognitive possibilities and less on the body possibilities.

We can asked the question what we want to achieve, better body performance or better cognitive performance. In the literature is the cognitive performance almost always the prime investigation certainly when it involves people with mild cognitive impairment of dementia in the early stage.



**Photo 4**



**Photo 5.**

The question remain: “Is this an good level of performance of the body”. Of course there is movement , more than normal, but is this body movement near the edge of the performance possibilities of the person? The body performance especially the aerobe part will increase the blood flow in the brain and makes better cognitive performance possible.

The anaerobe part especially task specific resistance treatment will stimulated the coordination and power of muscle pattern and when performed as in pictures 4 till 10 has that also an aerobe component but there is no direct cognitive stimulus.

To get on both fronts the highest performance and an aerobe component to we must go to the Ai Chi performance. Here we asked attention – cognition- to master the diversity on figures and the body performance to master this balance asking figures and doing this we will get tired. An investigation by Parkinson patients was dancing superior comparing with conventional physical therapy [28] because

**Photo 4 and 5.**

Photo 4 gives an impression of other way of double tasking [14] in water. Here is the choice to maintain the position with help of the wall of the pool and try to get the ball in the right “chair”. The focus is therefore especially on the result – goal – and the position holding is of an minor interest.

Of course is there always the possibility to make the position difficult. Here we can place the question: “is the performance of the body well of the right level “ ?.

Photo 5 gives an impression of an activity in an wheelchair and there the focus lies complete on the screen and not on the body control.

*Photo 4 and 5 published with the responsibility and permission of the author by j.v.d.Rakt.*



of this two elements cognition and body performances. Still this article makes the problem of replicability great because the conventional physical therapy was poor explain and therefore it is impossible to do the same investigation again and copy the results [29].

But here is an investigation of Dr. Nez[15,16] and he see the greatest possibilities for brain plasticity.

1997



**Photo 6.**

**Photo 6.** Gives an impression of Ai Chi ( the water variant of Tai Chi).

*Photo 6 published with the responsibility and permission of the author by j.v.d.Rakt.*

Still we must asked our self the question why we do the treatment. Is the focus on the body and want we that this performance is heavier but also with outer focus ( pictures 4 till 10) or want we a performance on cognitive level or both.

This asked for an investigation prior on the treatment in water because many of the patients will have cognitive problems but also body performance problems.

Example balance is often an body performance failure that is present because the adaptation of the system is at his end. All strategies including the cognitive ones are use and the problem isn't reparable by training on cognitive level and we must seek problems in the body performance.

An investigation [30] compared heathy young people ( about 20-30 ) and healthy older people ( about 70 ) give an suppressing outcome !

They must walk on treadmill with an trace of glasses felt with water and with an restriction of the eyes. The older group was able to do it but the walking speed, the step length and width and the variation of steps was significant different with that of the younger group.

The restriction – double tasking and visual restriction was not directly the reason but the muscle power of the legs was the greatest and significant difference.

The power of the dorsal flexors and plantar flexors was measured and this was the result:

**Table 1.**

Power difference	Young	Older
Dorsal flexors right	11.7	8.2
Dorsal flexors left	11.6	8.6
Plantar flexors right	19.2	11.3
Plantar flexors left	21.7	12.2

Especially the difference between the power of the plantar flexors was great and the muscle play an important role in the bracing of the forward fall.

The loss of muscle power by older people is present and that loss is compensated by all kinds of “cognitive” strategies but when that system isn’t able to compensated the loss of muscle power will be the cause that the fall occur.

That means that the focus must lie on the muscle power chain that are necessary to prevent falling and that also the treatment must focus on strengthening of this chains and then is the approach as in pictures 4 till 10 the best approach to stimulated the muscle chains.

Still this asked for an assessment for the treatment to know what are the weakest part of the balance muscle chain.

Statiek [25,26,31,32,33] assessment is than an very useful instrument and it can also be done in water but with an low water level.

1998


**Photo 7.**
**Photo 7.**

Assessment technique in water at the edge of the pool.

The “patients” stand till the hip height in the water , the “therapist” is sitting against the edge of the pool. Here the assessment of the “Statiek “[33] is done through an pull on hip-height and feel the resistance and the reaction. The stand on their toes with an trunk in extension. The power of the plantar flexor can be tested by standing on one leg and give resistance and ask for 10 times push up and give than again the resistance. Normal no difference will be observe.

So can be forward, backward and sideway on hip and shoulder height be assessed. And we can tested this after an while again to see or the treatment gives progression.

*Photo 7 published with the responsibility and permission of the author by j.v.d.Rakt.*

By CVA patients we will see the differences between the affected side and the not affected side. The power but especially the coordination will be different. There can be an synergy pattern in the affected leg and that will give an poor foot placement and an extension to early in the stand phase and make the movement over the affected hip very difficult. The foot placement can be helped by wearing an shoe with support or through an facilitation technique on hip height[34].

But the level of the water can also help the movement over the hip. Water level on the level of the processus xiphoideus will change the load on the affected leg and by using the edge of the pool and pull on this the diagonal will be activated and will give an movement over the hip.[35,36,37]

That walking exercises in water are very good , has Dr, Tripp [7] investigated and makes walking therapy with balance training possible for very severe stroke patients.

Parkinson patient will use the board as an rollator frame but an little bit under water will change the whole attitude and makes movement different.

Especially walking with greater steps is very good and we can asked this by asking for an kicking movement that will the resistance of the water do the job.

Kicking asked immediately an longer standing time on the other leg and the resistance will asked for more extension in the trunk.

1999

### 3. Walking in all his diversity.

And now is water an surrounding that is must better than air. Here when we give speed there is an resistance that is building up according the height of the speed and gives an lot of information about the legs and that body that is submersed.

Be aware of the reaction on the water level :

Below TH 11 this is still an job for the legs to give the resistance and controlled the balance but when it going wrong, the same resistance will take care off that there is no damage.

When the level is TH11 than balance must be managed by legs and trunk and that is the balance performance that older people with and without dementia must make to get enough time to make an step strategy[24,25]. Above TH 11 the trunk must be do more and the legs will react controversial.

The variation what we can give on walking exercises is unlimited. Forward , backward, sideways with and without crossing , along the wall in the mid of the pool , with great steps, small steps , fast , with high lifted legs , with the hand on the head etc.

An game ; Placed an few of the group in the mid of the pool and ask the others to run as fast as possible along this part of the group. The turbulence of the water makes it for the people that stand still almost impossible to stand on the pot and no balance must be exercises[1].

The use of obstacles in the water makes it often more exciting and therefore can this be an good stimulus.

In the group people can assist and with an good water level this can be fun.

This is an balance training that require all attention to stand or walk over the obstacles and hold the balance and is therefore an exercise to train on the trunk movement that must brace the balance disruption. That time is needed[38] to get the weight good on one leg and have the other leg ready for an good step strategy.

The small beam is difficult especially for older people, but when there is an neurological disease will this very difficult.

Still every older people will tell you that walking in the gym- class in the past , this was one of the most common exercises. Therefore the recognition will be high and people will try it, but be aware that especially people with dementia don't fail. That harm the mood often very much , therefore help that this not occur![39]

Sideway balance is one of the first that is going bad because the trunk is the key-player and the reaction must be fast . To get the balance back there are different strategies but when the trunk isn't capable to an elongation that will crossing of the leg be impossible . That elongation will be trained on the beam because otherwise is crossing over the beam not possible.





2000



Photo 8.



Photo 9.



Photo 10.



**Photo 8,9 and 10.** Give an image what the reaction are when we walk over an beam and the last one we see that the must assistance to get to the other side. This assistance can also use as facilitation to get an better elongation.

*Photo 8,9 and 10 published with the responsibility and permission of the author by j.v.d.Rakt.*

Here we can use speed to get an aerobic stimulus. The heart-rate must be 50-75% higher to get an good stimulus for the circulation in the brain. That means monitoring what the heart-rate is and what we want. The fatigue after the exercises in the pool are not the same as this stimulus of the heart-rate to get an better brain stimulation. This fatigue will have an effect on the whole body and will give the patients an good sleep and that is an important effect for processes in the brain [40]

Be aware that by people with neurological disease an increase of speed asked for more selectivity and that isn't available, certainly not by all variation of walking and search for other opportunities to get this done.

Walking with load or task specific resistance exercises can give also an heart-rate increase but monitored it. To be sure that the stimulus is correct.[41,42,43]

#### 4. Task specific resistance treatment.

This is an important part of all balance treatment and is in water perfect to do. Also is it possible to determine the right R.M. and make an good treatment scheme that will lead to an higher coordination and power in the muscle pattern[44.45.46].

We know that resistance exercises are not popular because it is often done by apparatus and the approach in which people together or against the therapist must act is much better and more fun. **And remember let them win!!**

The principle of this task specific resistance treatment is that ;

1. That muscle that are used in that task are also use in this exercise.
2. That the movement as an connection with the movement that we want to improve.
3. That the amount of energy that is needed is the same and better is that this amount is higher.
4. The sensory trach that is asked by the movement must be in the exercise have an strong relation with that original movement.
5. The purpose of the movement must be clear.

That means when we want the balance or walking improve by task specific resistance therapy, the exercise must be have an relation with balance and walking. That is often not there when she exercising with an apparatus.

This is often done in an sitting position and has than no relation with walking and balance training.

Only the muscle pattern are exercised but also not in the movement pattern that has an resemblance with the task.

Better is than exercising on an treadmill but there isn't mostly no resistance and doing this in the water, gives by increasing of speed this resistance certainly.



**Photo 12.**  
Running on an treadmill in the water. Gives more freedom and an lot of resistance through the water. *Photo 7 published with the responsibility and permission of the author by j.v.d.Rakt.*

**Photo 12.**

But can we be sure that this lead to an increase in power and especially coordination and this is by most of the patient not possible !

To get an good task specific resistance treatment we must know the Repetition Maximum (R.M.) That means that we must assessed what the maximal action of the muscle ( chain) is because that means 1 R. M. Of course it is an standard measurement for one muscle but by do the assessment for the muscle chain the translation to an task specific resistance treatment is easier.

When we asked 75% of this 1. R.M. and we do this in an rehearsal of 10 times we will find that at the end ( by 8) there is less power than by one.

This is important because that is the stimulus that create an power and first an coordination increase. This we must do 3 times, every time 10 actions and the muscle fatigue will occur sooner. This must be done after an short break because muscle fatigue is fast lesser.

When we do this 2-3 times an week the progression of the coordination and power will increase and we need for an greater resistance to continue this progress.

Of course when the amount of resistance is lower than the number of rehearsal must be more [46].

This can be done by every patient also patients with an neurological disease. But when the tone is increased and the selectivity decrease the chain that this person can activated is different , especially in open chain.[48]

Working with the diagonals and hold the affected arm or leg in an closed chain gives the best possibilities to create an task specific resistance therapy. The resistance than can be give on the other diagonal that has an open end and also the selectivity ot do this and that will create an action in the affected side that we needed.

For the walking muscle chain, we can therefore give resistance to the swing leg to treat the standing leg. Not only standing but also make the movement over the hip all away to the push off.

In the water this can be done in standing and lying position.



Photo 13.



Photo 14.

**Photo 13 and 14.**

Photo 13 the person hold the edge of the pool ( left ) and the resistance is given against his left leg. Start with an R.M. and then with 75% of that R.M. asked him to swing the left leg to the front. And that swing can with so much variation , from very small to very big and with small variation in the direction.

Photo 14 is an exercise that is only possible in the water and gives an reaction through the whole body. It can be necessary that one of the members of the group give support under the upper trunk ( not on the head)

Lying in the water and pressing the heel of one leg down gives automatically an lift of the other leg in the air.

It is therefore necessary to give resistance on both legs but one leg extension than the other flexion.

One leg abduction than also the other leg abduction etc.(Raimiste phenome) [48]

*Photo 13 and 14 published with the responsibility and permission of the author by j.v.d.Rakt.*



Photo 15.

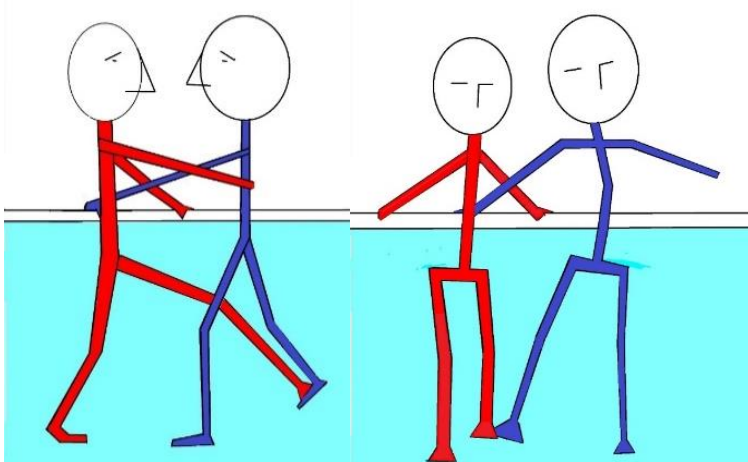
**Photo 15.**

This is so intensive especially when we give also load in the hand and it is an aerobic and anaerobic exercises. Of course the measurement of the R.M. isn't not equally with a load or dynamometer [49]. But this can be done by the start on land and after a week to measure what the effects are. Your measurements on this way gave by all participants an increase of power but the progression was the smallest by people with dementia.

*Photo 15 published with the responsibility and permission of the author by j.v.d.Rakt.*

2004

All resistance against one leg in every direction asks for a full cooperation of the other leg – diagonals- [31,32] and look of there is a co-contraction in the standing leg. Of course is this also an exercise for the swing leg but the standing leg is the important part in the balance exercise therefore change the resistance to the other leg to exercise the stand phase of the other leg.



**Picture 12.**

**Picture 13 .**

**Picture 12 and 13.**

How to give this resistance against the swing leg. The variation also in standing position is huge. Still the chain muscle must work also with this little variation and that improves the coordination.

*Pictures 12 and 13 published with the responsibility and permission of the author by j.v.d.Rakt.*

When it is possible try to stand on the foot that dorsal flexion is necessary to control the resistance that makes the chain complete.

This can also be done in the lying position by giving the resistance on the forefoot and be sure that the dorsal flexion is a part of the chain and we can also apply a resistance against the forefoot to stimulate the plantar flexion together with the complete flexion or extension movement in the hip with an extension in the knee.

By patients with a stroke will this be difficult but the resistance against the ankle on the one leg on the upper side and by the other on the heel will give by both legs almost every time extension in the knee and that is a dissociation of the synergy movement pattern.[47]

The importance of a task specific training has been investigated by many people and a systematic review and meta-analysis out of 2019 give a picture that this must be the base of the treatment and that resistance is the best way to get a good result.[50]

This part is essential because now the focus lies on the strengthening of muscle patterns and when we want an influence on the balance that is the strength of the muscles a must.[30] To long have many therapists taught that only exercising of task specific elements is enough but it is clear that the greatest decrease has to do with muscle power and tone increase and a loss of selectivity. Of course are the cognitive elements important but the decreasing of the strength is often all a long time present and was adapted by all other systems that the brain has, till the strength is not there anymore to be compensated.

That means also that the focus on re-learning must be adapted. Often this motor re-learning is a part of the training in which we try the compensation systems to be activated and often these systems are activated



on his highest level. By an focus on the training on this part we asked something what isn't possible anymore and we forget that the muscle power is too low.

Still part of motor learning must always present because the system – the brain- must be activated to search for solution with this more power and implicit learning is the best way to stimulated the brain for searching solution.

All the part that we have discussed till now is every time an demand on the brain to be flexible and search for an solution and the two elements – cognition and exercising- together give the greatest plasticity.[15.16]

Therefore it is important to obey the rules for motor learning as given to us by Prof.W. Schöllhorn and others [51,52,53]

2005

##### 5. Motoric learning situation.

“Noise “as Schöllhorn[51,53] this called. The brain must be challenged also an brain that is damaged. We know that the border by people with dementia is smaller and that the capacity isn't so large as by older people without dementia. Therefore we must be aware of the capacity and do everything to avoid that the feel that they cannot perform.

Therefore the rule , they always win !! **Don't let them fail !!**

But the learning rules for movement and here especially when there are possibilities to create more coordination and power, still count. We have all elements that increase the stimulating of the brain in this aquatic program but investigations of Prof. Schöllhorn[51,53] and Prof. Beek[52] have shown that is very important that an person do something total different during the exercise program.

And our experience have shown us, that this is an moment with great impact. Not exercising but go for an swim or go do something total different par example throwing an ball to each other or in an group.

We say that there were more people in that game under water without fear than in the start with the falling exercises and all element of the program were used.

But this part was often the part with the most joy and laughing !!

The chaotic condition is often very important for the brain to be refreshed for the official elements of the program and makes the brain more suitable for the remaining part of the program in the water !! Schöllhorn called this element “noise” and in his investigation was clear that always the focus on movement makes the brain less capable to “learn” or seek for solution and therefore he create an moment with an total different moment “Noise”!

His approach is called : Differential Learning “and his an form of implicit learning with an focus on the goal and with great amount of variation.

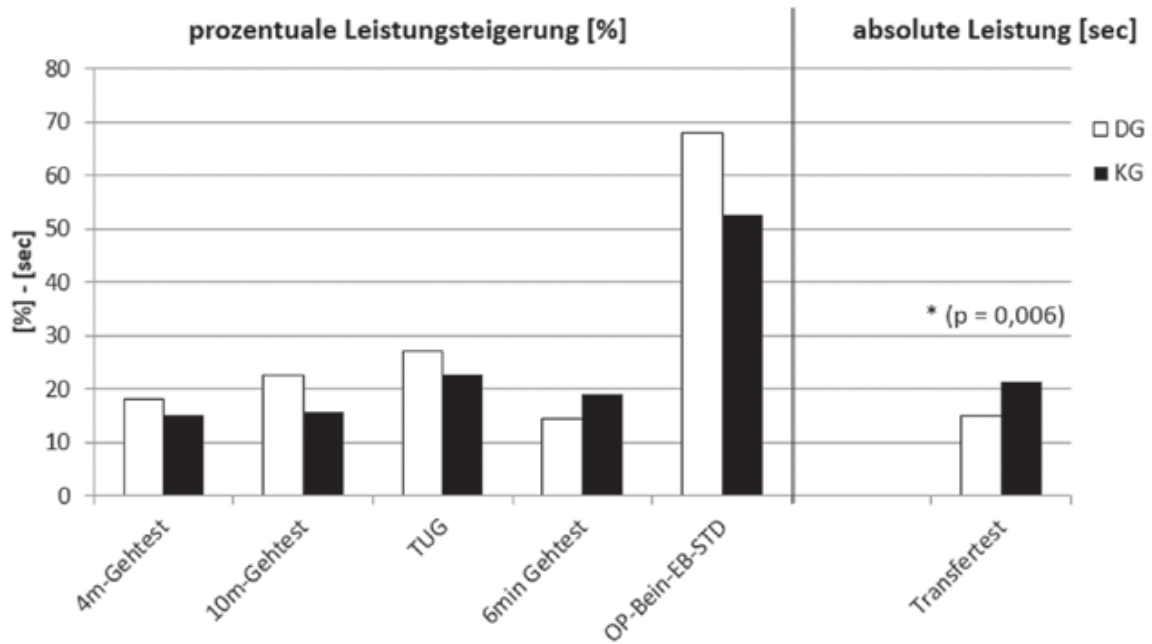
Variation is essential for the brain because do always the same isn't the good way to stimulated the brain. Only doing the same movement is “deadly “ for the brain and almost impossible because we don't do the same movement always the same.

Therefore not the focus on the performance but on the result.

Water will of his own create an environment that is always different and that alone create an situation that has many variation. Even at the end when the fatigue is there the variation is still present because we move different when we are tired.

Table 2 Give the result of the Differential learning walk treatment (DG) and the classic walk treatment (KG) and the measurements were the 4 meter walk test, 10 meter walk test, Time up and Go-test, 6 min. walk test and one leg standing test. The transfer test is an test as the TUG but now the people must walk on difficult underground and was the time in the DG faster than in the KG.

2006



**Table 2** .Table 2, by J.Kurz [54] ( published with the responsibility and permission of the author by j.v.d.Rakt. )

Conclusion was that the power to recovery from this operation was faster with the DG approach than with the classic approach. Classic approach was beside muscle strengthening much walk exercises with aid according an program. The muscle strengthening was done on an leg-press.

6. One leg standing exercises [55,56]

Standing on one leg is an test but also an exercises that is very important. The senso- motor track [25,26]that is necessary to stand on one leg is almost gone by people that walk with an aid and especially those that walk with an rollator frame.

There isn't necessary to get with the hip over the foot because the trunk makes an movement from the upper trunk. This gives an different perceptual problem and the brain learn that the hip must stay in the same place and let the upper trunk compensated.

When we test this, when this has not be there for 3-4 months, we see that this people dare not to move over the foot to the lateral direction and when this is gone one with support on the rollator frame, this will end with an atrophic of the abductors and the stability of the pelvis is gone and also the possibility to stand on one leg without support.

Of course we see also people that move far over there "foot" but that is mostly an reaction on loss of power of the abductors and they have receive no treatment for this and were only walking with an aid.

**Photo 16.****Photo 16.**

Walking in the forest with an rollator frame.

Great that is possible and we must do everything to hold this possible as long as possible.

But we see that standing on his right leg, he moves with his upper trunk further lateral and the hip stay less to lateral.

Further we see that the diagonals walk not trough his hip and that the adductors are dominant and create the endorotation/adduction of his legs ( kissing knees)

*Pictures 16 published with the responsibility and permission of the author by j.v.d.Rakt.*

**Photo 17.****Photo 17.**

Here is the perceptual trach present but the power of the abductors to low. We see that the hip too far to lateral and over the foot and that the stability to hold this must come from the arms and upper trunk.

We see than that the front wheels are not straight forward but turn through the pressure and correction that must de bone through the arms/shoulder and upper trunk .

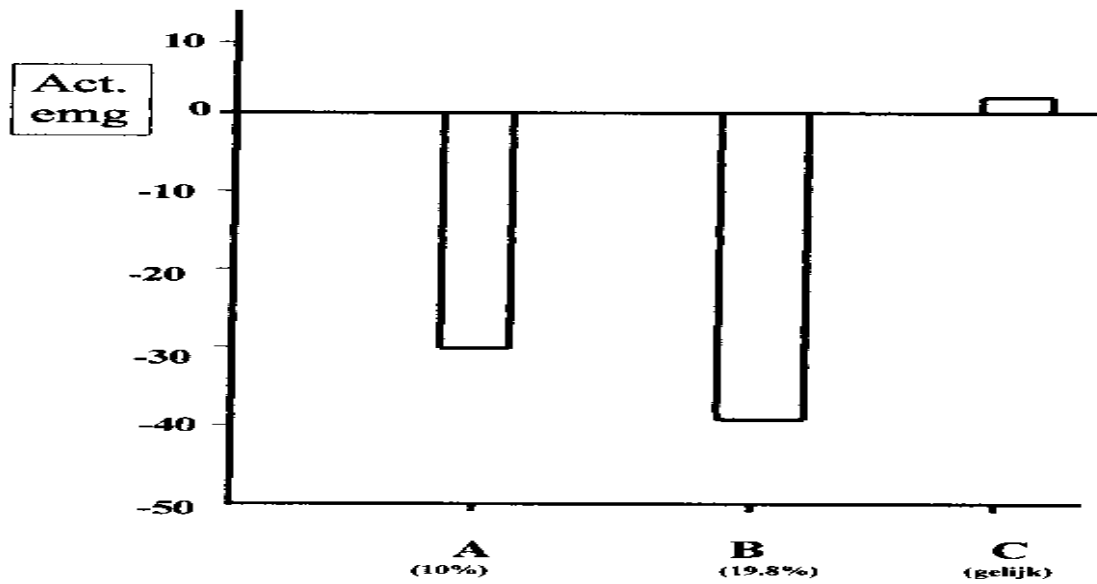
Walking on this way will not strengthening the abductors because the amount of action of the upper trunk and the arms is so much that an negative E.M.G. signal will occur [57] Again the diagonals that normal ended in the hip, will now ended in front the hip and activated the hamstrings and adductors.

Walking will not solve the problem!

*Pictures 17 published with the responsibility and permission of the author by j.v.d.Rakt.*

Task specific resistance treatment for the abductors is crucial to get the power and coordination back and create an less far lateral movement over the hip.

2008



**Table 4.** by Neumann 1998 [57] (Table 3 published with the responsibility and permission of the author by j.v.d.Rakt. )

We see in this table 3 support with an stick and the abductors are measured with an E.M.G. signal.  
 A = Walking with one stick on the other side and an load on that stick of 10% , gives an negative E.M.G.-signal of almost -30.  
 B = The same as in A but now is the load 19,8% and the negative E.M.G. is almost -40  
 C = now is the stick on the same side and we see now an positive E.M.G. of 2-4 % by an equal ( gelijk) load.  
 To get an E.M.G. signal that can lead to improvement of the strength, this signal must lie above the 10 E.M.G.

Therefore walking with an stick on the other side will lead to an lowering of the strength of the abductors on the other side and even on the same side will not give enough stimuli to give an increase of strength. Walking with two sticks or an rollator frame will give on both sides an negative E.M.G. signal and no strengthening on the contrary, this will lead to an wakening of the muscle – atrophic. That one leg standing is so heavy has therefore two major reasons that are connected which each other.

To little power will lead to use an aid and an aid can change the body scheme perception and that will have an negative influence on the muscle power and coordination of the abductors.

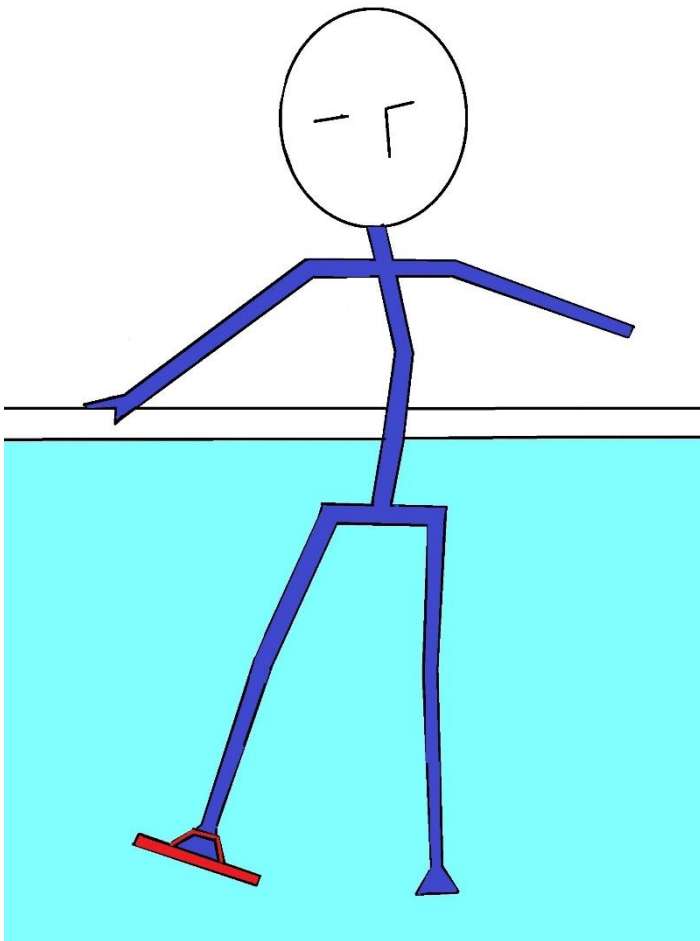
Walking - even great distance- will not change this , therefore be aware that the perception will change and this can be present in 3-4 months and that the power in the abductor isn't increasing.

Therefore take this part in the treatment in the water because there the environment can be so helpful that one leg standing is possible again.

Know that the water will help the loss of power to overcome and that the surrounding is so good that the problems with the body scheme is to change but to get this on land there must be an increase in power and coordination and an better perception.

That means that starting on TH 11 depth with assistance will be this test possible but never on land . This need an task specific resistance therapy with an part motor learning to create an better senso-motor track.



**Picture 14.****Picture 14.**

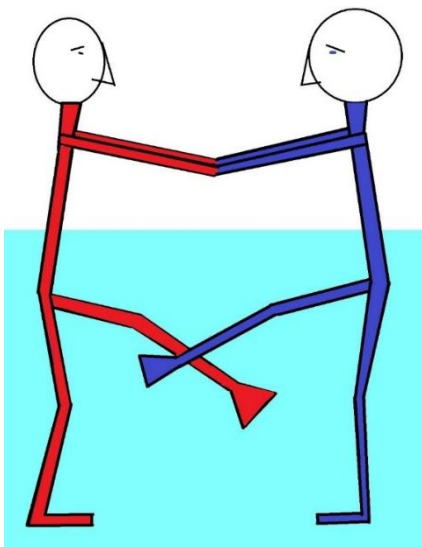
Start with a focus not on one leg standing but by holding an board under the foot with an support on the same side.

Lifting and has control over this board asked that the person stand on the other leg and that he must move his hip over the foot what we need to get the trunk over the other foot on the ground.

Because the board is somewhat fixated on the foot, the next step is to move this board through the water and the resistance will stimulated the muscles.

But be aware that the support on the edge has an negative E.M.G-signal and that is cannot lead that the muscle around the hip , where he standing up, increase in power but there will be an activation on both side and the most important fact is that the movement of the hip over the foot is re-learned.

*Picture 14 published with the responsibility and permission of the author by j.v.d.Rakt*

**Picture 15.****Picture 15.**

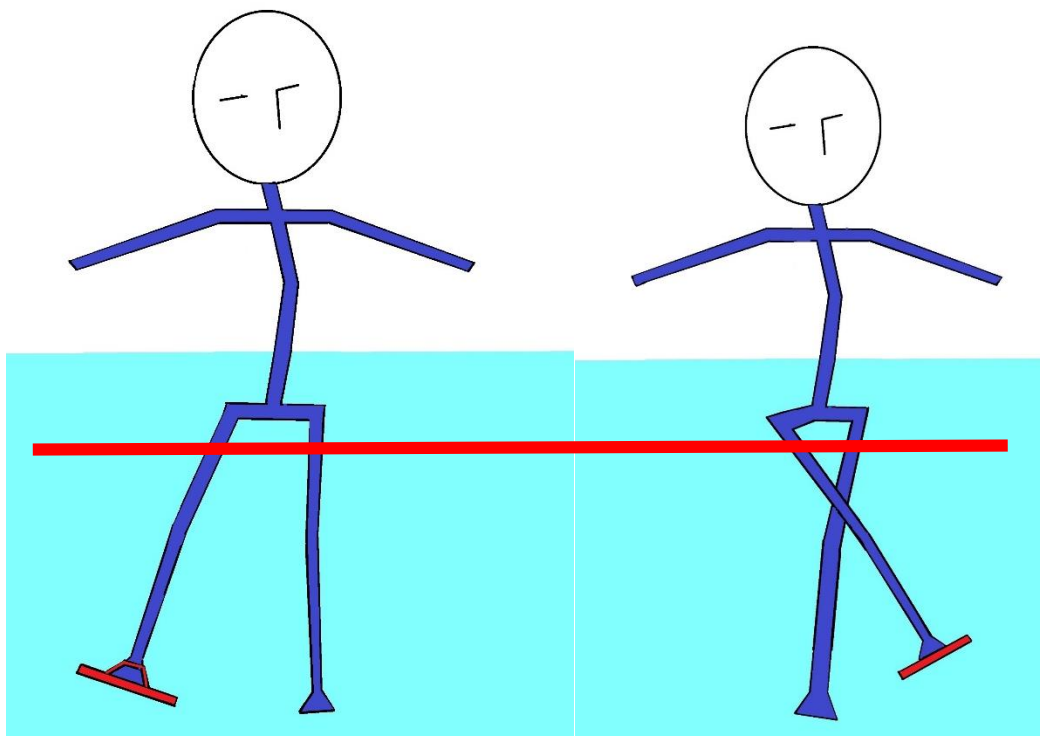
This is an example with an individual and an therapist but the therapist can be replaced by another individual and then are two people exercising one leg standing.

Here they person hold each other by the hands but that can all be changed. Here we can give resistance against the leg that is free of the floor but be can also asked for movement that the leg may not touch each other.

Or makes circles around the leg. You have placed the attention on the leg that moves but the leg that stands must work to hold the body on one leg and there is support of the hand but when we use an board between the hand this will be an total different world and an new experience. Distance to each other can be change and again the water will help or resist.

*Picture 15 published with the responsibility and permission of the author by j.v.d.Rakt.*

2010



Picture 16.

Picture 17.

**Picture 16 and 17.**

Again we can train without an assistance and that can be walking with great sideway steps this asked for an movement of the hip over the standing foot and the moment that the free foot is crossing over the balance on the standing leg is restored. When the water level is down to the red line that the power and the senso –motor track are so good that one leg standing on land is possible. But the muscle co-contraction must be correct ( see photo 18.)

*Picture 16 and 17 published with the responsibility and permission of the author by i.v.d.Rakt.*



Photo 18.

**Photo 18.**

To get the optimal co-contraction that is necessary to get the pelvis stabile and good above the foot, we need to see that when there is an strengthening exercise that the pelvis goes up on the side of the swing leg. Of course is it important to work toward an muscle fatigue that is the stimulus to get this muscle pattern stronger and with more coordination. Still this example is an task specific resistance therapy but to hold the motivation on the right level we must do more . Personally we do this with resistance with our own foot and make it competitive. Through the resistance with the foot is more variation possible but on this way with an apparatus the measurement is better.

*Photo 18 published with the responsibility and permission of the author by j.v.d.Rakt.*

After this strengthening part we must take care that this is within the walking pattern. And it is therefore wise after this strengthening program and program in the water that is focus on walking with the resistance of the water or with an object that give resistance.

And take care of all kinds of walking especially great step and backward or great steps and sideway or with crossing.

#### 7. Rocking.

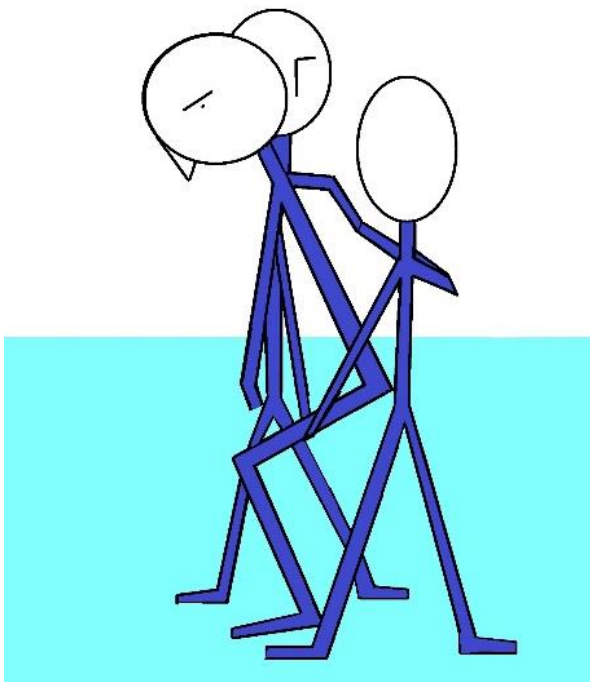
An element that always gives total unexpected changes and lot of surprises [34]. This is an activity in which elements of standing up and sitting down come together with 3 people of the group. Two members build an chair by putting each other hand and make an sit part and an part of the spine.

The third can sit in this chair and must try to stand up out of this chair and now are the possibilities unlimited and will this exercises sometimes more like as an rocket start than on the exercise of standing up out of an chair.

That means everyone can do this exercise because the amount of assistance can be very great but the opposite is also possible. And one of the last performance of this exercise at the end people were not sitting in the chair but falling on the stomach by the neighbours.

Or the "chair-people- manoeuvre someone in another chair, to throw this person into the next chair and every one was going along all "chairs" through the pool . Old people with an dementia are sometimes capable of total new inventions.

2011



**Picture 18.**

#### **Picture 18.**

Two persons make an "chair" in which one individual can take place. Sitting on two arms , he can lean against the other two arms.

The possibility to give assistance is present by moving the arms the sit down movement will be assist and the standing up movement can also be facilitated.

But beside assistance there are also possibilities to make the movement difficult through an difference in high and also in speed in this assistance .This great variation and the difference in water level makes that this kind of exercises give so much joy !!

*Picture 18 published with the responsibility and permission of the author by j.v.d.Rakt.*

Of course we can also exercise with an normal chair but the problem is that the level of the water between standing and sitting is very great, therefore is "rocking" an simple but effective solution to counter that level difference and when it is possible we can use that level difference to create more resistance and make the exercise difficult.

Again here an combination of aerobe and anaerobe exercises and that combination is in water very often the case and make it so great to exercise for older with and without dementia.

All this exercises can be changes and rehearsed but the main items are present to give an treatment that will stimulated the cardio pulmonic system and give task specific resistance treatment.



To end the hour in the water it is nice to use the “snake”. People will hold each other and run through the water and make a lot of curves and the water with its turbulence will make it difficult for the people to follow the leader.

8. Snake

2012



Photo 19.

**Photo 19.**  
The snake.  
Even in this workshop of young people the snake was a great success and there were a lot of ruptures in the snake .  
And the creation of new little snakes and that is the purpose.  
*Photo 19 published with the responsibility and permission of the author by j.v.d.Rakt.*



Photo 20.



**Photo 20.**

An snake that hasn't a curve, not yet.

The group with the Parkinson disease was so clever that they made a snake that was perfect straight because the lady in the front was lying on her back and she must give the direction. The lady that assisted her was not capable to get the speed high enough and she wasn't on the end of the pool.

But after the lady was at the edge standing up and waiting on the end of the snake and the pool was small but the amount of curves was great and the snake was fast ruptured in all kinds of small snakes.

*Photo 20 published with the responsibility and permission of the author by j.v.d.Rakt.*

2013



**Photo 21.**

**Photo 21.**

The same group but now in a circle snake and exercising backward floating or lying on the back all together.

This are the fun moments that are so important because there is the motivation to do this every week. And this will lead to a better quality of life.

*Photo 21 published with the responsibility and permission of the author by j.v.d.Rakt.*

9. In and out the pool.

At the end of the swimming session no difficult solution with getting out of the pool but take an wheelchair and drive the people out of the pool. Often the drying and dressing is difficult enough.

**DON'T TAKE RISK!**

But of course when people progress use the stairs that are present. But the surrounding of the pool is often the most dangerous place and therefore take no risk, it isn't necessary.

Not all patient can exercise in an group and there are people that have more on an treatment with the therapist in the pool.

Especially people that are not capable to move and walk on land will give the water the opportunity to learn to move again and that asked for other skills in the water from the therapist.

This will be further explained in part 2.

**Conclusion.**

Working with an group in the pool is more than group-therapy on land. There all must focus on the weakest person in the group. In water the possibilities to move are for everyone different and will everyone stimulated to an higher level. The aerobic part will be present for every member and through an good management will also the anaerobic part be present through task specific resistance therapy. That means that group- therapy in the has an great beneficial effect on people with all kind of diseases but especially people with neurological diseases that have difficult to move because of the gravity. Make hydrotherapy an important part of your treatment !!

## References

1. J. Lambeck. Hydrotherapie . Uigave N.P.I. 2001. ISBN; 9076986096.
2. J. van de Rakt en Johan Lambeck. Therapeutisch zwemmen met " verpleeghuis" patiënten? N.V.F.G.2004.
3. J. Lambeck. Het Tien-Punten-Programma van het Halliwick Concept. Samenvatting cursus hydrotherapie 2019.
4. A. Fedor. The effect of a brief water based exercise intervention on cognitive function in older adults . Thesis 2015. Kent State University .
5. A. Fedor. S. Garcia and J. Gunstad. The Effects of a Brief, Water-Based Exercise Intervention on Cognitive Function in Older Adults. Archives of Clinical Neuropsychology (2015) .
6. U. Camper. Wasserspezifische bewegingstherapie und training ; Gustav Fisher verlag. 1995.
7. W. Tripp. effekte der Bewegungstherapie im wasser auf die funktionelle mobilitat bei Schlaganfallpatienten – Eine kontrollierte, randomisierte studie. Thesis 2011. Frankfurt am Main.
8. L. Cugusi. A Manca. M Bergamin. A Di Blasio. M. Monticone. F Deriu. G Mecuro. Aquatic exercise improves motor impairments in people with Parkinson's disease, with similar or greater benefits than land-based exercise: a systematic review. Journal of Physiotherapy 2019.
9. E. Martinez. L Burgess. T Immins. A. Martinez and T Wainwright. Does aquatic exercise improve commonly reported predisposing risk factors to falls within the elderly? A systematic review BMC Geriatrics 2019
10. M. Sato, J. Miyake, Y. Hashimoto, and H. Kajimoto. , Tactile Perception of a Water Surface: Contributions of Surface Tension and Skin Hair. A.M.L. Kappers et al. (Eds.): EuroHaptics 2010
11. D. Sato, H. Onishi, K. Yamashiro, T. Iwabe. Y. Shimoyama, A. Maruyama. Water Immersion to the Femur Level Affects Cerebral Cortical Activity in Humans: Functional Near-Infrared Spectroscopy Study. Brain Topography 2011.
12. D. Sato, K. Yamashiro, H. Onishi, Y. Shimoyama ,T. Yoshida, A. Maruyama. The effect of water immersion on short-latency somatosensory evoked potentials in human. BMC Neuroscience 2012.
13. D. Sato, C. Seko, T. Hashitomi, Y. Sengoku & T. Nomura. Differential effects of water-based exercise on the cognitive function in independent elderly adults. Aging Clinical and Experimental Research. ; 2015.
14. C. Niks. P. van't Hooft. Aquamentia©, introducing a Newly developed swimming intervention for people with dementia. Journal of Psychological sciences 2017.
15. Y. Netz. Is There a Preferred Mode of Exercise for Cognition Enhancement in Older Age?—A Narrative Review. Frontiers in Medicine 2019.
16. R. Sobral. C. Vagheti. O. Nascimento. J. Laks. A. Deslandes. Exergames: neuroplastic hypothesis about cognitive improvement and biological effects on physical function of institutionalized older persons.. NEURAL REGENERATION RESEARCH 2016.
17. Brabant Zorg. Pilot: Bewegen met water. Team Bewegingsagogie en Psychomotorische therapie. NHV nieuwsbrief 4 2019.
18. M. Brod. A. Stewart. L. Sands and P. Walton. Conceptualization and Measurement of Quality of Life in Dementia: The Dementia Quality of Life Instrument (DQoL). The Gerontologist. 1999.
19. S. Zwakhalen. Pijn meten bij ouderen met dementie. TVZ-verpleegkunde in praktijk en wetenschap. Uitgave 4/2018.
20. V. Warden, A. Hurley, L. Volicer. Development and psychometric evaluation of the Pain Assessment in Advanced Dementia (PAINAD) scale. J Am Med Dir Assoc. 2003.
21. J. Waterfield, J. Sim, Clinical assessment of pain by the visual analogue scale, Brit J of Th and Rehab, 1996.
22. L. Collins, A. Moore, H. McQuary. The visual analogue pain intensity scale: what is moderate pain in millimeters, Pain, 1997.

2014

23. B. Weening-Dijksterhuis. Physical exercise to improve or maintain activities of daily living performance in frail institutionalized older persons. Thesis 2014 Groningen: Research Institute SHARE.
24. J. van de Rakt, S. McCarthy-Grunwald Physical treatment of individuals with dementia. Part 2 in progress.
25. J. van de Rakt, S. McCarthy-Grunwald Physical treatment of individuals with dementia. Part 1 A. Ita. J. Sports Reh. Po.; 2020 ; 7 ; 2 ; 1546 -1581 ISSN 2385-1988 [online]
26. J. van de Rakt, S. McCarthy-Grunwald Physical treatment of individuals with dementia. Part 1 B. Ita. J. Sports Reh. Po.; 2021; 16;(8); 3; 1694– 1730 ; DOI: 10.17385/ItaJSRP.21.16.080103
27. Hyndman D, Ashburn A. Stops walking when talking. as a predictor of falls in people with stroke living in the community. J Neurol Neurosurg Psychiatry. 2 ; 2004 Jul;75(7):994-7.
28. K. Rehfeld and others. Dance training is superior to repetitive physical exercise in inducing brain plasticity in elderly. Plos one 2018.
29. T. Yamato. C.Maher. B. Saragiotto. A. Moseley. T. Hoffmann. M.Elkins. P. Camargo. The TIDieR checklist will benefit the physical therapy profession. Braz J Phys Ther. 2016.
30. F. Tafti and others. Strength of plantar- dorsiflexors mediates step regularity during a high cognitive load situation in a cross- sectional cohort of older and younger adults. Journal of Geriatric physical therapy.2019.
31. J. van de Rakt , S. McCarthy-Grunwald Diagonals : Part Two. Italian Journal Sports and Rehabilitation and Posturology 2; 3; 146 -169 :2015 ; ISSN 2385-1988 [online] - IBSN 007-111-19-55
32. J. Van de Rakt ,S. McCarthy-Grunwald Diagonals Part Two : Assessment and Trunk Rules Ita J Sports Reh Po 2015. 2015 ; 2; 3; 262 -298 ; doi: 10.17385/ItaJSRP.015.3002
33. J.v.d.Rakt. Statiek. Nieuwsbrief NHV. 2011.
34. P. Davies. Steps to follow. The comprehensive treatment of patients with hemiplegie. Second edition. Completely revised and updated.Springer-Verlag1999
35. J. van de Rakt, S. McCarthy-Grunwald - Diagonals Part 7 Stroke 5 Walking: What say the scientist and what is best practice. Ita. J. Sports Reh. Po. 2018; 5; 2 ; 1013 – 1062 ;
36. J.van de Rakt. S. McCarthy-Grunwald. Diagonals Part 8 Stroke 6 analysis of walking pattern and treatment. Ita.J. Sports Reh. Po.;2019 : 6; 2; 1191 -1238. ISSN 2385-1988 [online] IBSN 007-111-19-55 CGI J OAJI : 0,101).
37. J. van de Rakt, S. McCarthy-Grunwald . Diagonals Part 9 Analysis of walking pattern. Learn to assess. , Ita. J. Sports Reh. Po.; 2019 ; 6 ; 2 ; 1253 -1294 ; ISSN 2385-1988 [online] IBSN 007-111-19 -55
38. J.v.d.Rakt. Balanstraining bij ouderen. Physios 2013.
39. A. Van der Plaats. De wondere wereld van dementie. ISBN 9 78035 230194 Elsevier 2008.
40. Nielsen J. Willerslev-Olsen M. Christiansen L. Lundbye-Jensen J. Lorentzen J. Science -based Neurorehabilitation : Recommendations for Neurorehabilitation from Basic Science Journal of Motor Behaviour vol. 47 No. 1 2015
41. K. Erickson K and others. Physical therapy , Brain plasticity and Alzheimer disease. Archives of Medical Research 2012
42. C. Groot, A.M. Hooghiemstra, The effect of physical activity on cognitive function in patients with dementia. A meta-analysis of randomized control trials Aging Research Reviews 2016 Jan;25:13-23.
43. W. Bossers, L. Van der Woude, F. Boersma, T. Hortobagyi, E. Scherder, M.van Heuvelen. Comparison of effect of two exercise programs on activities of daily living in individuals with dementia. J Am Geriatr Soc. 2016 Jun;64(6):1258-66. doi: 10.1111/jgs.14160.
44. S.Dong –iland others, 1.R.M. repetition maximum .J.Sports SCi. Med.2012.
45. A.Wang and others. Reliability of the one-repetition maximum tested based on muscle group. Journal of exercise Physio 2002.
46. T. Van de Goolberg T. De Reha boom. Uitgever Publish & More ISBN 9789082535174. 2017.
47. J. van de Rakt , S. McCarthy-Grunwald; Rehabilitation of the upper limb after an stroke. Part 1. The Flexion Attitude Synergy. An multi-eclectic approach. Ita. J. Sports Reh. Po. 2021; 8 (17); 2; 4 ; 1829 – 1867 ; DOI: 10.17385/ItaJSRP.21.17.080204; ISSN 2385-1988 [online] ; IBSN 007-11119-55; CGI J OAJI 0,101)]. Published online.

48. Burnstromm. Movement therapy in hemiplegia. Harper & Row. 1970 pag.24. Card number 70106334.
49. J.Langius. W.Visser. H.Kruizenga. N Reijven . Meetprotocol handknijpkracht m.b.v. hand Dynamometer Standard Operating Procedures versie 1 4/7/2016.
50. S. Valkenborghs and others. Interventions combined with task specific training to improve upper limb motor recovery following stroke. A systematic review with meta analyses. Physical therapy Reviews 2019.
51. W. Schöllhorn. Time scales of adaptive behavior and motor learning in the presence of stochastic perturbations. Human Movement Science, 2009.
52. P.J.Beek. Nieuwe, praktisch relevante inzichten in techniektraining Motorisch leren: het belang van een externe focus van aandacht (deel 1 tm10 ) Sportgericht 2011.
53. Henz D. Schollhorn W. Differential training Facilitates Early consolidation in Motor learning . Frontiers in Behavioral Neuroscience 2016
54. J.Kurz. A.Gosenheimer. B.Schumann. F. Steimetz. W. Schollhorn. Differenzielles Gangtraining in der stationären Rehabilitation bei Knie- oder Hüft-TEP. B& G Bewegungstherapie und Gesundheitssport. 2016.
55. Michikawa T, Nishiwaki Y, Takebayashi T, Toyama Y. One-leg standing test for elderly populations. Journal of Orthopaedic Science 2009; 14(5): 675-685.
56. M. Van Eijk M. CRAMPS proefschrift 2012 ISBN 978-94-6169-299-3
57. Neumann D.A. Proefpersonen met een heupoperatie die op verschillende manieren lopen met een stok 1999 Stimulus 4 387-394
58. F. Bosch. Krachttraining en coördinatie. 2012 Uitgevers. 2010 . ISBN 978-94-90931-10 .

2016

Ita. J. Sports Reh. Po.

Italian Journal of  
Sports Rehabilitation and Posturology

Ita. J. Sports Reh. Po.  
Italian Journal of  
Sports Rehabilitation and Posturology



2017

