Rehab Diver Manual

Published by Disabled Divers International

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Version: 2012 – 1.1

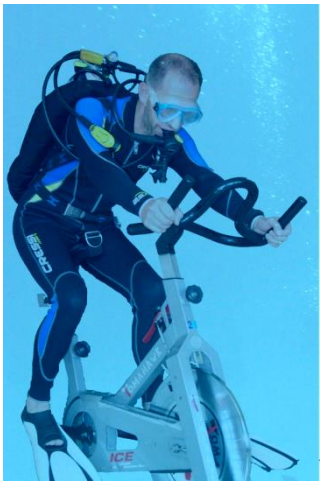
Introduction

The notion of physical activity and exercise as having crucial health benefits for body and mind – and thus as a therapy modality, is ancient. In some languages physiotherapists are even titled "Gymnasts for the sick" for their assumed competence in applying exercise therapy as part of a rehabilitation process. Modern science does support the dogma of us being built to be physically active, and that not only our physical life – but both our psychological life, social life and maybe even our spiritual life profit from it, if we are.

As a health professional you know this. You also know that we have a multitude of tools to administer suitable doses of exercise-stimulus to weak bodies – including:

- Machines that move in a horizontal direction so that bodyweight is of no consequence, and/or use counterweights
- Harness system that makes walking on a treadmill possible in spite of palsy (a helping hand to guide the affected leg is often necessary)
- Electro-stimulus of weak muscles
- Pool therapy
- Etc

So why bother the practical and liability hassle of taking exercise therapy under water?



Well if you look at the examples above (and feel free to include any extra you can think of), the only one that are even close to natural full-body use - where balance and stability and coordination is a vital part of the equation – is pool therapy. And pool therapy is great. It is however somewhat limited by either making use of just 2-D (surface plane) or by keeping what's being done down there (under the surface) hidden from view – both from the therapist and the one trying to take back ownership of his/her body.

If both therapist and patient were to immerse themselves totally, then all senses are present and the process of re-mapping the disturbed motor-skills ought to have a higher likelihood of succeeding.

The fact that diving is regarded as an action sport by the general public – and most people who try finds it fun and gratifying, can be a crucial self-esteem and motivation booster for your patients.

The purpose of this Specialty Course for therapists is to stimulate creativity and supply some basic tools and understanding for diving health professionals to open up a new branch of medicine, by applying established physical rehabilitation modalities in a realm where the effect of gravity can be adjusted at will.

Acknowledgements

The **DDI** wish to extend its thanks and gratitude to the following organizations, institutes and persons, whose help and information has contributed towards the contents of this manual.

Skogli Helse- og Rehabiliteringssenter AS, Norway

Totenbadet AS, Norway

Anders Orpana, Norway

Cressi diving equipment, Italy

In addition to the above we would also like to thank all the other individuals not named whose support, information or materials we have drawn upon, in developing our training programs.

Pictures:
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What is the DDI?

The **DDI** is an association whose aim is to promote, develop and conduct programs for the training of the disabled in scuba diving. Since its introduction in 2010 the **DDI** has conducted numerous Professional and Non-professional programs at locations all around the world. The People behind the **DDI** has more than 20 years experience with disabilities and scuba diving.

Contents

Knowledge Development

Underwater exercise is of course not about VO_2-max stimulus, or finding the optimal hypertrophy exercise for the long head of triceps… In many ways underwater exercise is more about the central nervous system, than it is about muscles and joints. However the tissue level stimulus of exercising is also something to be considered – so even if underwater exercising has its biggest potential on function levels, the local tissues involved in that function should not be ignored.

So the "rules" of exercise physiology apply even under water (or in space for that matter…).

This manual has no aspiration of being a textbook about exercise physiology, or about physiotherapy, or about neurology, or about hydrodynamics or any other line of specific knowledge that would come in handy when administering exercise therapy under water. There is however some key factors from many lines of specific knowledge that this manual like to briefly comment – the point of course being to start an idea-framework of how to best take advantage of lowered gravity, increased postural stability, natural slow-motion, higher ambient pressure etc. when taking exercise therapy into a new frontier.

For those of you who would like to dig deeper into these key factors – and maybe some new ones you may come to think of – a list of recommended literature that might complement your old textbooks, is presented in the appendix section.

Exercise physiology

The seemingly eternal debate of what is a strength exercise and what is an endurance exercise – and what is the border between the two, have the potential of continuing under water. Our bodies are nevertheless happily unaware of academic turf-fighting and very often use the Winnie the Pooh approach: *"Yes please – both!"*… All cellular activity does demand energy transfer – even relaxing a muscle (making the actin-myocin bridge un-hook) costs energy. For all practical purposes we continuously choose between three types of energy systems:

Energy systems

Our cells have two choices – either to use energy with oxygen as a factor (aerobe activity), or without (anaerobe activity). With the possible exemptions of sleeping astronauts or divers in relaxed hover, both systems are in use at every given moment in our bodies. Living is (as a total-sum) an aerobe activity – since the long term energy system can handle the average workload of being alive. Diving is – and should be – an almost exclusively aerobe activity (being lazy when diving make good sense since it conserves breathing gas). Diving as a mean for increasing our aerobe capacity is however not very practical – hard breathing cold, dry air is not ideal for anyone (even if you dive with large double sets and have plenty of air to use…). If in-water activity is the arena of choice, why not skip scuba and go speed snorkeling instead!? With the fuel choices of carbohydrates or fat or protein (or even lactate…), the long term energy system have a hard time running out of fuel. To increase our maximum aerobe capacity (VO_2-max) we nevertheless have to

push our bodies harder than the long term energy system can handle (especially to stimulate our hearts into a better pump-capacity). By so doing we utilize - and push - our anaerobe energy systems. There are two options – when maximum power is asked for (or startup of every increase in activity) we use the direct energy system, where stored ATP and CrP are spent. At all-out level that is good for 5-10 seconds before it runs out. If we continue to try hard the power levels drop as we use stored glycogen as fuel at a still too high a level for the long term energy system to handle = no oxygen takes part in the energy transfer. And yes – that comes at the price of an increasing amount of the by-product lactate, which is the major time limiting factor in this; the short term energy system.

Since strength is the ability to develop (and take) a high force for a limited time, it is typically measured as the maximum resistance one can overcome (one repetition maximum (=1RM)). But explosiveness (like jumping) can be measured in fly-time and loads that are thrown can be measured in distance etc. (and it can all be boiled down to energy-release per time-fraction) – so it's really not the number of repetitions an exercise can be sustained until exhaustion that define whether it's a strength exercise, but whether the direct energy system is depleted within 5-10 seconds, or not.

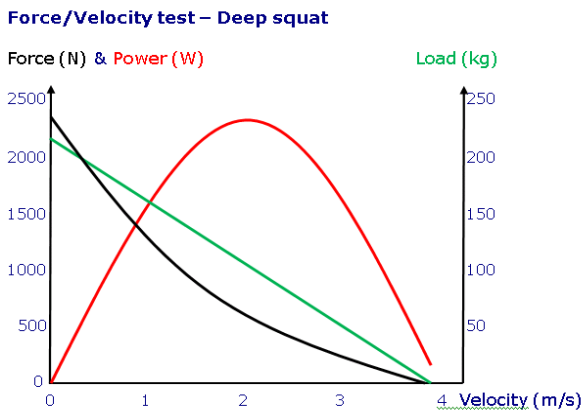
Cautious/"kind" strength exercises that can be sustained way beyond 10 seconds can be preparatory for trust in ones abilities, coordination and warm-up. If sustained until exhaustion they do have the potential of increasing our tolerance to high levels of lactate and give a very obvious short-time "pump" (better for self esteem than physical ability…). Lactate is not dangerous, but it's painful – and that is not something pain-patients need more off – so strength-endurance exercises and VO_2-max training (like 4x4min close to max-pulse intervals) could actually be considered contra-indications for people with a sensitized central- and peripheral-nervous systems. "Pure" strength exercises are actually less symptom-provocative – if done with quality. Shorter bouts have also the advantage of being easier to fulfill with a high enough degree of focus and motivation. After all - the foundation for strength-endurance is strength! An increase in power capacity can make a specific endurance task that earlier led to lactate caused fatigue in minutes, into a no-stop task the long term energy system can handle. It's easier to see in dynamic endurance, but also a possibility in static endurance!

Even though water does impose a very noticeable degree of forced slow-motion to physical activity – and it's a good thing as we will see later – speed is something to consider under water as well as on dry land:

Force x Velocity = Power

Especially in throwing sports, it's a stated fact that the person with the highest power output at the resistance (load) level of the object to be thrown, will throw it the farthest (when the throwing technique is equal) – and not necessarily the one with the highest 1RM capacity at a similar movement! If you and I shall compete in a stone-throwing contest we intuitively pick a stone that suit our ability – too heavy and the velocity we can muster is so low that we risk dropping it on our foot, too light and the very high velocity we produce will more likely dislocate our shoulder than fling the pebble very far…

The obvious improvement mantra: "If you're stronger than fast – go for speed training. If you're faster than strong – go for strength training", does have implications for underwater exercises as well:



Example of output from actual testing:
Theoretical 1RM is found were the force curve and load curve intersect = 210kg (inkl 90% of bw). Max power is achieved (at a velocity of 2,2m/s) when a gravitational load of 50kg is overcome by administered possible force.
For optimal power training this (stronger that quick) 80kg guy would benefit from jumping from deep squat assisted by helium balloons pulling with 22kg… Or maybe he could put on scuba gear and do it under water as effective?!

In high density surroundings like water, an increase in speed comes with a heavy price – as a hydrodynamic rule of thumb state: If the speed is doubled, the resistance from the water is quadrupled. In other words – explosive movements under water will be exponentially resisted. The harder you try the more obvious you are resisted. That is especially felt in movements with a large "broadside" – like a swing punch, compared to a straight punch.

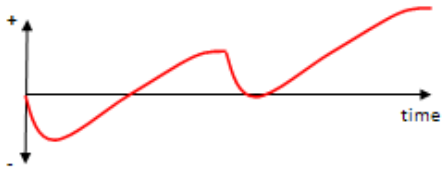
Strength- and speed-ability is therefore more blended under water and makes it very safe to progress with increased speed instead of increased resistance in weightlifting/pulling exercises and (lowered) gravity defying exercises like squat jumps and pushups with a clap. Although in low gravity, the demand for core-stability is nevertheless very present - also in an exponential fashion.

There is no reason whatsoever to be frustrated over the lack of snap in underwater explosive exercises – the forced slow motion makes it much easier to analyze the quality of the movement (both for the one doing it and for you the therapist). For a pain patient with a sensitized central and peripheral nervous system that could be a crucial possibility, not to be missed!

However - at whatever speed we move and whatever energy system we push we can consider us lucky that our bodies and brain try to accommodate the "market demand" for increased physical ability - The cue for a measurable effect over time is of course to administer:

Progressive overload

Exercising is on a cellular level really about pushing energy systems and tissues into a state of overload. After being pushed, the cells/systems need time to adjust/replenish and when the function has not only recovered, but over-recovered (= the function is now performable with a higher output), the next exercise session can be administered, and so on in an ever increasing upward aiming wave…



So it is about quantity, but to avoid injury and make the output greater than the sum of what the involved tissues can produce – quality is of at least equal importance. Coordination, balance, stability are labels that define some higher levels of physical performance that not only enhance output into the realm of esthetics, but do it within the capacity-zones of the weakest links. Also psychological factors like motivation, trust and joy should be baked into the quality factor. Progressive overload where quantity and quality are hand-in-hand is not only safe to administer, but it's also as effective as it can get! Especially if we choose a brain-friendly approach on how the body is worked out – extra obvious when the extremities are in focus:

Closed/open kinetic chains

When we move with a distal fix-point (with more or less weight bearing) that movement is done in a closed kinetic chain. Most our daily weight bearing leg use are done in closed kinetic chain - like squats (both feet simultaneously) or walking (alternatively). Unless climbing, our upper body is mostly in open kinetic chain use – like raising a glass of water to drink. Two major advantages with exercises in closed kinetic chain are well worth taking into consideration:

1. Higher degree of co-contraction around joints.
2. Easier for the brain to manage since the fix-point also is a point of reference.

The co-contraction part is really about making it possible for the (in the anatomic atlas) antagonistic muscles to become synergists. If we look at a knee example: Open chain hamstrings use makes it a knee-flexor (regardless of hip or knee position). In close chain, a backward pull at the proximal tibia (in a bent position) will not move the foot – you're standing on it… - but since the knee is movable it will extend and by so doing help the quadriceps in its effort to do the same! Apart from becoming (almost) twice at strong in knee-extension, the translatorical forces in the knee are also much smaller. *This is the reason behind post cruciate ligament surgery exercises to have "closed kinetic chain ONLY!" policy.*

Since a closed chain movement comes with a point of reference from outside the body, it's easier for the brain to figure out the actual body position in regard to gravitational forces and position in the 3-D environment.

Pushups versus chest press are good examples of closed versus open kinetic chain exercises that seem almost identical, but really aren't…

Both factors come in handy for all of us, but can prove essential for people with neurological insufficiencies and/or a sensitized nervous system.

Also semi-closed kinetic chains can be easier to handle than pure open chained equivalences. Pedaling on a bike is not a closed chain movement – even in full weight bearing (like standing up), but the movement is very predictable for the brain– so even if the point of reference is constantly changing it is usable as reference none the less. Even weight lifting that uses some kind of trajectory – like kettle bell swing, or snatch lift – makes the weight a predictably moving reference point the brain can use to prepare the upcoming stability/balance and possibly raw-power tasks.

And since raw-power is mentioned there is no way outside:

Eccentric muscle activity/exercise

Muscle activation while that muscle is being elongated is eccentric muscle activity. To become an eccentric exercise per se, the opposing force has to be larger than not only the max-concentric capacity, but also larger than the static max-capacity – at least in part of the movement.
Example: Eccentric squats are possible to achieve from half-bent position down to deeeep squat. If you would try to apply enough load to buckle from a straight standing position, your upper body would collapse long before your legs…

Since eccentric exercise has the highest grade of strength stimulus - it might sound tempting to choose also under water – but is it possible?

In-water movement in open kinetic chain (like swimming etc) is of course all concentric activity – unless you struggle against a weight pulling down or a floating device pulling up. If you are weak enough, eccentric exercising is very possible under water – both in open and closed kinetic chains.

Open kinetic chain lifting or pull-down can be administered as eccentric exercises by simply using both hands (or feet, or an assistant) during the concentric phase and one hand/foot during the eccentric phase (- as on land).

Closed kinetic chain exercises can easily be load differentiated during the rep.cycles by our good old diving skill; buoyancy control! If breath control alone is not enough to do the trick, BCD adjustment can be done as well. This is of course most obviously possible in gravity defying exercises like squats and pushups.

Since we all managed not only one-armed pushups, but zero-armed pushups during our entry-level dive course (the fin-pivot…!), it's easy to see how much help there is in breath control alone. When you consider the many syndromes and disabilities where breathing exercises/breath control exercises is regarded a very important factor, you may want to consider closed kinetic chain eccentric exercises as key parts of most cases of underwater exercise programs.

If SCR/CCR equipment is being used – switching over to open circuit bailout mode, or using BCD adjustment, is needed to allow independent concentric/eccentric load control. Buddy breathing from an open circuit scuba system (long hose) is of course also an alternative.

Exercise-therapy – Local tissue effect, or neuromatrix effect, or both?

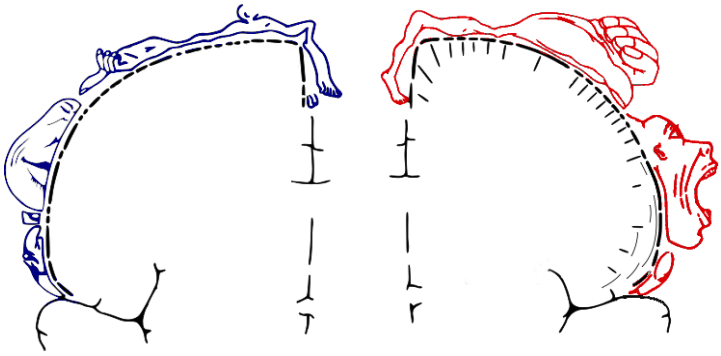
Underwater we have the possibility of choosing any functional movement that includes weak muscles/stiff joints/bad coordination/etc. and choose a workload that makes the exercise focus on the least functional part - without sacrificing focus on the total function – that is pretty awesome in itself!

As mentioned earlier – exercising underwater is in many ways more about graded exercises for the central nervous system, than it is about graded exercises for muscles and joints. This is obviously true for rehab efforts on neurological insufficiencies (as on dry land), but the last decade of evolved understanding of long time pain (and related symptoms, like fatigue, dizziness etc.) also point toward the central nervous system as the major source of origin – and thus a natural rehab focus area.

CNS – The central nervous system

Mind-blowing in complexity and with an amazing plasticity – our understanding of our CNS is at best frameworks of simplified models that try to describe – and predict – the observable manifestations on both tissue level and function levels.

Incidentally that it how the CNS seems to do things as well…



Sensory cortex Homunculus *Motor cortex Homunculus*
Wikipedia Commons

Mapping of what regions (or centers) handles what kind of function (different senses, motor tasks, memory, feelings etc) is basic neurology class knowledge. The sensory- and motor-Homunculus are a good example on how both we and the CNS use map-representation to best describe and support ambient reality and as a base to predict upcoming needs. And as with our electronic navigational aids, the maps need regular updates to function flawless…

To handle multiple parallel tasks the CNS seems to operate in networks – and since many (all?) centers are part of many networks a constant state of "network-competition" looks like the norm, rather than the exception (as we know from how we humans operate our organizations and countries).

Networks with a direct rehab link may include:

- Motor skills - like balance, coordination etc.
- Threat assessment – or "pain neuromatrix"
- Perception alertness
- Task concentration

The obvious task for networks is to come up with fast and functional judgment calls by having "member centers" evaluate received input with the current "maps" in our memory, so thus create a broad multidisciplinary platform for conscious or automated choices (duck for cover, kiss the girl, raise the pulse, fall asleep etc. etc). By the very nature of this task - this is advanced pattern recognition. Especially for physical tasks this is not only a real-time process, but a before-real-time process – since choices have to be predictive (it's too late to react to balance needs at the instant you kick the ball – to be able to both stay on your feet and score a goal, the sequence of motor tasks leading up to the kick – and beyond – have to be prepared and executed before they are actually needed.

The practical "blessing" of our CNS's being hardwired to be predictive – and by so strive to make our very existence and interactions with the physical world make sense… - can sometimes become more of a "curse"… This is especially true in assessment of possible threats to our health and life. Threat assessment is given the highest priority (as we tend to do in society) and otherwise normal small input variations can start a spiral of self magnifying threat handling – that may grow way out of proportion (anyone see a parable to the gunshot in Sarajevo in 1914 or some more modern threat handling…?).

Modern understanding concerning the mechanisms of pain, place it squarely as a judgment call within CNS and not as a straight forward perception of pain-signals from tissue damage (as the main understanding were before). Since the "maps" doesn't only update from ambient input, but also from what actions are judged to be prudent with that input – the whole system may become more and more sensitized. A sensitized threat assessment system does not only cause us to tense up in a higher degree of fight/flight mode than what is actually needed – we are much more likely to feel pain. Since the threat assessment system network almost monopolizes the "network resources", typical accompanying symptoms are lowered motor control, feeling of fatigue, lack of concentration etc. Even normal input – like a light touch on the skin - might in some cases (like CRPS – Complex Regional Pain Syndrome) be perceived as being on fire! When in pain and very tired and stiff and weak and dizzy and the memory is bad and the IQ feels cut in half – we tend to drastically reduce our activity levels (physical, psychological and social activity levels) – not only creating a large gap between what we want our lives to be about – and what we actually take part in, but we also rob our CNS of normal "activity of daily living signals" so that the "map update" does not

include them. Walking up some stairs after not doing it for a long while, does not only be strenuous because of a weakened fitness level, it might hurt badly because the CNS interprets the increased heart rate, increased lactate levels and "new" proprioceptive signals as a threat! The "map update" is actually so literal that underused body parts are diminished in representation in the homunculus by the neighbor regions growing into them. Interestingly the "troubled region status" seems to stick harder than the body part that was represented earlier, so that a very obvious pain spreading can be linked to this mechanism.

A CNS trauma (be it from direct injury, compromised circulation, tumor or whatever) hampers or destroy regions, senses, skills and networks literally – were lots of both causes and consequences are basic neurology class knowledge. We also know that the plasticity of the CNS opens a window of opportunity for rehab – especially the first weeks after the trauma. Even if one choose to focus rehab on quality step-by-step approach (like Bobath therapy) or focus on returning to ADL functions as fast as possible – or something in between – the key to success is re-learning by repetitive re-use, whether it's gaining full control of the left biceps muscle or managing going to the toilet by yourself. The plasticity is so great that surprisingly many functions may be re-routed into function again - And yes – that includes "map updating" as well.

So the principles of "classic" neurologic rehab are also the cornerstones of "modern" long term pain rehab!

The previously mentioned underwater environment peculiarities of low/no effect of gravity, density based stability, natural slow-motion for movements and - if the water temperature is comfortably warm – almost "silent" skin signals (that gives a sensitized nervous system less to freak out about…), makes it close to an ideal rehab environment, whether it is neurological insufficiencies and/or long term pain that is in focus.

But - Since the function levels are reduced, the re-use program has to start at lighter/easier levels and progress to higher levels when mastery on the lower ones is achieved.

Graded re-activation = baseline and pacing

Graded re-activation – whether it is on physical, psychological and/or social factors – is really what rehabilitation is all about. The key is of course not only the progression in intensity, but on what level to start = find the appropriate baseline. Since underwater exercises can not only be downgraded to zero, but to negative-gravity (with positive buoyancy…) - the possibility of finding a start-level were the quality of the movement (or non-movement if static stability is the challenge) is do-able, should be endless. The process of progression in intensity/demand – or pacing, if you prefer a popular term – can then start.

Functional weakness due to neuro-muscular disability and/or pain-inhibition

A functional weakness is a functional weakness – regardless if there is a stated neuro-muscular impairment or if pain/fear/bad coordination etc. inhibits that function. The odds of improving that function does however wary a lot according to what the cause of weakness most likely is… Since underwater exercises may more safely include a tougher trial-and-error regime than one should on land (since falling, or loosing grip isn't dangerous), focus on the chosen function as such is much easier to maintain.

A total disregard for what might be the causes for the dysfunction is not recommended…, but is it possible that we therapists can help the patients better if we can put aside some of the pathology labeling – at least underwater? Scuba diving is regarded as a great equalizer regarding consequences of body types and fitness levels. By adjusting the effect of gravity at will when trying to regain ownership of ones body, we might push that equality process even further!

Zero gravity – low gravity – negative gravity

As our entry level dive course manual stated; buoyancy comes in three varieties - as does "gravity modes". However if we in zero gravity (=hover) add some pull - or push - physical challenges to the side, we create a kind of gravity in the horizontal plane. That "gravity" also switches direction as we change from pushing to pulling. "Gravity" in the form of a handheld (footheld?) weight, countering otherwise positive buoyancy, opens the opportunity to struggle against resistance in the form of asymmetric gravity while hovering. Although a hover is the ultimate state of open kinetic chain, holding "gravity" in your hand gives it a point of 3-D reference - and thus make it into a sort of semi-closed kinetic chain nonetheless!

So even if adjusting the effect of gravity at will is one of the beauties of underwater exercises – do not limit your creativity by only thinking of gravity/buoyancy in the vertical plane, or by keeping it symmetrical!

Therapeutic effect of diving

(Hopefully this section will need updating regularly)

Of both traditional and practical reasons it's perhaps natural to divide the holistic approach into two groups:

1. Psycho-social effect
2. Physical effect

1. Even though handicapped diving always have had the notion of being a good and positive arena for both physically and mentally challenged people to participate in an activity that is largely regarded as an action-sport, no quantity studies of psycho-social effect seems to have been done to date. Positive mentioning in the media and tales of life-changing experiences (and some small interview based quality studies) has not changed that - yet.

2. Up to the summer of 2011 reports of direct positive physical treatment effect from scuba diving were at best personal testimonies, but mostly anecdotal. Two varieties emerge:

    2.1 Increased neurological function – sensory and/or locomotion – the so called "zingers"
    2.2 Pain reduction

Both share the same characteristic of the effect wearing off during the following days/weeks(?), and a new "treatment session" is needed.

In May 2011 a pilot study was conducted by medical expertise from Johns Hopkins Hospital and Kennedy Krieger Institute – initiated and sponsored by First Step Foundation. Both physical and psychological data were gathered and even though it was a pilot study it included a control group. Preliminary findings and explanation hypotheses have been reported[1] and some more in-depth thought were also presented at a conference the autumn of 2011[2]. At the time of writing the pilot study is not yet officially published, but a larger study is planned.

The spinal-cord injured soldiers - many with psychological wounds as well - that took a PADI Open Water Diver course did respond physically and psychologically at a level above the control-group the study team describe as "dramatic advances". Especially an increase in sensory-function and a decrease in symptoms of Post Traumatic Stress Disorder (PTSD) were seen.

The hypotheses of how this might happen include:

1. Increased ambient oxygen pressure
2. General movement-resistance
3. Increased breathing function
4. Increased ambient nitrogen pressure
5. Mastery of stressful situations

[1] The Johns Hopkins University Gazette, October 10 2011.
http://gazette.jhu.edu/2011/10/10/scuba-diving-improves-function-in-vets-with-spinal-cord-injury/
[2] Paralyzed Veterans of America Summit 2011 + Expo, September 2011, Orlando, Florida, USA

1. Hyperbaric Oxygen Therapy (HBOT) is very much on the rise – and is being administered on many conditions beyond DCI. As with HBOT in a pressure chamber, an elevated PO_2 level while diving enhances the oxygen level in the blood beyond the transport capacity of the hemoglobin, by making the serum capable of holding oxygen as well. Tissues with low blood vessel levels/capacity have then a higher chance of enough oxygenation. The notions of nerve cells being dormant, but alive (due to enough metabolism to avoid cell death, but not enough to function) - challenges some dogma of neurology, but is a promising explanation of many reported HBOT effects.

2. Zero-gravity activity in a dense medium makes every movement a graded exercise – and as we know: the effects of exercise therapy go way beyond muscle stimulus.

3. Spinal cord injured people either lay down or sit most of the time – neither position is beneficial for optimal breathing function when gravity is added. While scuba diving, the breathing has the potential of being freer and (like with HBOT) have the potential of creating a better tissue oxygenation status.

4. The theory of elevated nitrogen levels as being beneficiary is more of a "bomb". Nitrogen (due to problems like nitrogen narcosis and DCI risk) has so far been something of a "public enemy #1" when it comes to diving. The mechanisms within nitrogen narcosis do nevertheless have some very therapeutically interesting factors. One of the causes elevated PN_2 levels induce is an increase in serotonin levels – and a massive increase that is - up to 350% measured! Serotonin is important in signal transmission in the spinal cord and perhaps even more crucial in an injured spinal cord – for an improved short term function, but hopefully also for repair processes (animal studies indicate that possibility).

An increase in serotonin levels is also very interesting for long time pain sufferers. For especially syndromes like fibromyalgia, the measured low level of serotonin was once even proposed as the very reason for it. Long time pain sufferers often use pain relief (and low mood relief) through anti-depressants (like Prozac etc.) that mainly work by artificially keeping the serotonin level up. *Apart from upsetting a multibillion dollar industry…* with all the side effects and extreme addictiveness in these pills, wouldn't it be nice if scuba diving actually induced the same effect (at least)?

5. Task mastery – especially of stressful tasks, boost self-esteem

Diving medicine in general also show a slight shift from solely working towards controlling risk factors to reduce possible health hazards in diving – and how to best treat dive related injuries, toward building evidence based data on what conditions where scuba diving could actually be a recommended activity during the recovery phase (and beyond)[3].

[3] Example: A 2004 DAN survey on breast cancer surviving divers are being followed up by Project Pink Tank http://rubicon-foundation.org/Projects/project-pink-tank/

Measurable effect of underwater exercise is yet to be gathered. Your contribution is needed – and might be crucial (whether it's a case report or a major RCT).

Psycho-social effect is being documented from DDI programs (including Try-dives). The outcome measure is level of psychological flexibility (the ability to choose according to ones values in spite of a handicap or other problems). Anonymous and voluntary data are gathered pre- and 3-weeks post dive-program participation and are questionnaire-based (the validated and multiple language available "Action and Acceptance Questionnaire – AAQ-II 7-items").

If you and/or DDI and/or "medical giants" like Johns Hopkins hospital/university can falsify the null-hypotheses that nothing of any healing kind can take place when visiting the aquatic realm as scuba divers – therapeutic diving may soon become an accepted and esteemed new branch of medicine!

Specific Diving and Training Considerations

Equipment considerations

Regulator / instruments

All equipment should be secured and tucked in so that movement freedom is not hampered by dangling equipment and hoses - especially a consideration when arm exercises are intended.

In stationary positions - removal of the scuba unit and just breathing from a long-hose might prove the most efficient solution.

Weights

Weighting is of course a very important part of achieving neutral trim, not only to counter positive buoyancy. Ideally the trim should be neutral in full 3-D so that relaxed hovering is possible in any position (we would all become much better divers if we could achieve this…).

Since low-G exercises can demand a higher degree of grounding than the practical level of total negative buoyancy can apply, chosen asymmetric weighting can be necessary. As an example a person with very weak legs needs heavy feet to stay put on the bottom, at the same time as he needs very low-G to be able to do squats etc. Neutral trim with extra leg weights added, makes this an easier task to perform with the necessary high enough levels of intensity and quality.

"Buoyancy increasers"

Finding the right trim for the exercise intended can be challenging, but the use of buoyancy increasers can make the task easier. Consider fastening/putting on something that float on locations that needs to be lighter – a piece of an old wet-suit on the lower part of the cylinder, a wet-glove worn on the weak arm etc.

Cylinders

Small bottles (pony) are recommended – the more the natural center of gravity of the body can be maintained, the better. Exercises that include an asymmetric force that needs to be actively countered and balanced is of course something to be considered, but being able to stand straight up when resting in a standing position is recommended (both on land and on the bottom…). If a small cylinder contains too little air and a normal cylinder is too heavy – consider two small cylinders in side-mount configuration.

Breathing gas

Even if the absolute majority of rehab.diving is done in shallow water and for limited time (to avoid fatigue (concentration- and body-), NITROX use could be considered. Not so much for NDL reasons, but for increased oxygen part-pressure reasons. As with HBOT (Hyperbaric Oxygen Therapy) an elevated PO_2 level enhances the oxygen level in the blood beyond the transport capacity of the hemoglobin, by making the serum capable of holding oxygen as well. Tissues with low blood vessel levels/capacity have then a higher chance of enough oxygenation.

Swimming/balance/walking aids

Webbed gloves are an ideal swimming aid for the lower body disabled, but they also make balancing easier. Other types of standing/walking aids can be considered (balance pole, crutches (if crutch walking is (so far) too hard on land – why not do some underwater…) etc.

Training gear

Gymnastics/exercises with (reduced) body weight as resistance is probably the most obvious area of focus in rehab.diving. The use of weight lifting exercises – including "pull-down" exercises in the form of pulling down floating objects – is of course also a possibility. Pool training/play equipment of many kinds can be used under the surface as well.

A word of caution: Dropped weights are also a danger in water – both for people and for the floor. Some kind of pool-bottom protection is highly recommended if non-padded weights are being used in a pool.

Important notice!

General and local rules for scuba diving AND general and local rules for therapy apply:

Non-licensed divers need to be in an established try-dive program to be allowed under water in scuba gear – including the necessary paperwork and direct supervision by a teaching-status dive-professional – minimum a DDI DM.

Unless a holder of an autonomous dive-license, divers need to follow possible limitations on their type of license regarding type and number of accompanying divers, depth, type of dive-conditions (pool/CW/OW) etc.

You as a therapist need to be licensed and insured to treat patients – even if you do volunteer work outside established health-care networks.

Apart from you being a licensed therapist (of B.Sc degree (or equivalent) or higher), the minimum requirements of you being a licensed (and liability insured) DDI Assistant Diver is just that – a minimum requirement for having the diving skills of a Rescue Diver (or equivalent) and understanding of planning, skills and techniques for diving with disabled people. To be able to take your patients underwater without the task of involving a supervising dive- professional – DDI recommend you to consider becoming a dive-professional yourself! Many of your patients will probably want to get licensed divers too…

Overview of Training

Dive 1 – Play time!

The objective of the first dive is to familiarize you to how it feels to walk and jump and stand on your head and do all the circus/gymnastic tricks you've dreamt of managing – but since it's done in forced slow-motion it is not all straight forward possible…

If available, do try different configurations (small tanks, side-mount etc). At least try to find some exercises that function without wearing the scuba unit (a long hose makes it less stationary).

Try to do squats with the tank in a horizontal position in front of your torso (some creative use of stage-bottle straps ensures you won't have to hold it…). Is it easier than with the tank back-mounted?

If railings (or other form of underwater hand/foot-holds) are available – try horizontal push/pull exercises in different angles, and see what physical demand more or less buoyancy creates.

Try exercises while hovering – what does it take to rotate around different axis? (A small weight, or small floating device, or both… might make it possible without flapping about)

Since weighting is more than just a peak performance buoyancy issue, ask the DDI instructor to assist you in trying out different solution/challenge configurations.

After the dive – do a debrief of how it felt and of what options might be useful for your kind of patients.

Dive 2 – Work shop!

Prepare case(s) in pairs/threes – with planned weak link assessment to find a baseline (the resistance/difficulty level at which the chosen function is doable above a defined minimum quality level), and with planned progression within chosen exercise and/or planned progression in exercises.

If possible – interact with real patients, with real weaknesses. Proper paperwork and medical approval is of course mandatory. The DDI instructor handles it as a DDI Try Scuba Diving program – including the 2:1 student to DDI professional ratio. So unless patients are certified divers a maximum of two can be exercising underwater simultaneously with one DDI pro in direct supervision.

If none diving patients are used the DDI instructor goes through the Trydive-program with them while you prepare the work shop.

If no real patients are available – or the DDI Instructor deems them to need more dive-training before they have the minimal dive-skills necessary to safely participate in exercises under water – you are in for a work-out.

It is recommended to use some kind of function that is actually challenging to you, because faking weaknesses under water in a convincing matter is hard…

If you are alone as a Rehab.diver student you now have the option to make the DDI Instructor really work for the money… Otherwise take turns in assessing/instructing/progressing each other.

After the dive – debrief your experience. And if real patients were included remember to assess the function level on dry land now after the treatment session – you did check it before you went under water, didn't you?!

Appendix

Recommended reading

- Exercise physiology – McArdle, Katch, Katch – Fifth edition, Lippincott, Williams & Williams, 2001
- Explain Pain - D.Butler, L.Mosely, Noigroup Publications, 2003
- Targeting Cortical Representations in the Treatment of Chronic Pain: A review, L.Mosely, H.Flor, Neurorahabilitation and Neural Repair, xx(x) 1-7, 2012
- Bodily illusions in health and disease: Physiological and clininal perspectives and the concept of a cortical 'body matrix', L.Mosely et al, Neuroscience and behavioral reviews 36 (2012) 34-46
- Central sensitization: Implications for the diagnosis and treatment of pain, C.Woolf, Pain 152 (2011)s2-s15
- A pain neuromatrix approach to patients with chronic pain. L.Mosely, Manual therapy 2003, 8(3), 130-140
- Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art. J.Vlaeyen, S.Linton, Pain 85 (2000) 317-332