Title : Aquatic Therapy – Effects on Neuroinflammation and Executive functions

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Exercise and especially high-intensity interval training (HIIT) can alleviate various symptoms in neurodegenerative conditions (e.g. persons with MS) and may also have disease-modifying effects. Therefore it represents an established component of rehabilitation programs Motl et al. (2017). Especially when considering physical fitness and biomarkers that are potentially involved in disease pathophysiology (e.g. matrix metalloproteinase-2, neutrophil-to-lymphocyte ratio) exercise training consisting of higher intensities (HIIT) leads to greater improvements than classical moderate continuous training (MCT)(Zimmer et al., 2017) independent of the training environment (overland va aquatic).

Exercise in water uses immersion through buoyancy, hydrostatical pressure, thermal impact and water resistance (Kamioka et al., 2010). Aquatic therapies for patients will vary from motor learning methods with low impact on the cardiovascular system to endurance exercises (Wiesner, Birkenfeld, & S, 2010). For neurodegenerative conditions the main rationale is the reduction of body temperature through water temperature and prolonged training sessions (Roehrs & Karst, 2004). The thermal influence on immunological functioning is significant but only few studies have performed systematic investigations. However, a general observation of the existing aquatic studies is that they are small, of short duration, often inappropriately designed with regard to the target mechanisms, and never combine measures of explanatory factors (e.g., cytokines and neurotrophic factors) with measures of neuroprotection (e.g., brain MRI outcomes).

Main effects of aquatic exercise:

- *Inflammatory responses (cytokines and endocrines)*
  Several studies investigated the influences of immersion on endocrine reactions in healthy normal trained persons (Krishna G, Danovitch, & Sowers, 1983),(Grossman, Goldstein, Hoffman, Wacks, & Epstein, 1992). They conclude that immersed conditions led to lower adrenalin and noradrenalin serum concentrations compared to equal intensities performed on land. This indicates that immersion dampens sympathetic pathway activity and further dominates parasympathetic influences, with a consequent up-regulation of anti-inflammatory proliferations. Also, in neurological conditions (Multiple Sclerosis) studies show upregulations of neurotrophins when performing aquatic cycling (Bansi, Bloch, Gamper, & Kesselring, 2013).

- *Cognition / Executive functions*
  The effects of water immersion on executive functions is sparse – only two studies (Schaefer, Louder, Foster, & Bressel, 2016); Sato et al., 2017) show a decrease in errors in the recognition of a mental task (auditory vigilance). Literature shows that physical exercise carried out straight before performing cognitive tasks, increases the effects of those tasks (Bae, 2019). This implicates that aquatic movement programmes should begin with moderate to high-dosed exercises before performing activities that need more concentration like problem solving or memory. These three domains belong to executive functions and are relevant for training balance during posture and gait (metadata behind sensor-motor planning).

- *Immersion and brain vascularization*
  Performing aquatic exercise immersion will always directly impacts on hemodynamic variables in producing an increase of cerebral blood flow. Simultaneously the enriched environment of a pool enhances afferent information, supportive in priming the motor cortices (see future webinars by Daisuke Sato and Javier Güeita).

Aquatic exercise will always be safe and when training with neurological conditions is NOT the cause of relapses – this also goes for high-intensive exercises! Evidence shows that individually-tailored exercise sessions – independent if performed overland or in water – have the potential to target and improve many components outlined in the ICF model.

In summary, the combination of the mentioned concepts is aquatic exergaming. This is the (non-task-oriented) approach that includes high-dose playful movement exploration (Krakauer 2018) with a focus on individual specific elements of impaired balance control and include challenging executive elements. The second part of the webinar will show practical examples and suggestions for aquatic practice.

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