Title: Hyperbaric Oxygen Therapy combined with (LOKOMAT) Robotic Exoskelton assisting neuroplasticity in Brain and Spinal Cord disabilities.

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The Final Frontier – Repair and Functional Restoration
Almost 20 to 30 per cent of the body's consumption of oxygen occurs within 3 to 5 per cent of the body mass – the brain and spinal cord structures. These structures are extremely sensitive to oxygen deficiency and benefit from oxygen repletion.

The final frontier in the treatment of degenerative neurovascular disorders is focused on 'repair and functional restoration'. This involves the use of neural growth factors to promote axonal sprouting, activation of idling and non-functional neurons whilst promoting neovascularisation (new capillary formation) of the damaged (penumbra) areas.

Cells in a chronic hypoxic state overexpress pro-inflammatory cytokines including IL1, Il6, IL7, IL8, IL17, TNFa, MMP9, S100B. The smoldering 'cytokine storm' differs for each individual. Over expression of pro-inflammatory cytokines inhibit neuroplasticity and neurogenesis and promote secondary apoptotic cascades. The extent of both primary and secondary neurovascular deterioration can be significantly diminished with HBOT, which 'expands the therapeutic window'.

"Hyperbaric Oxygen Therapy creates a 'fertile neurovascular platform' for emerging stem cell, immunotherapies and nanotechnology techniques. The impact and success of these and future procedures are dependent on the integrity of the underlying supporting neurovascular bed." (Hooper 2005).

The benefits of HBOT in rehabilitation is well documented. Hyperbaric tissue oxygenation results in increased blood flow by fostering the formation of 'new capillary dynamics' (neovascularization) into the damaged regions of the body. Hyperbaric tissue oxygenation accelerates neuroplasticity, activating damaged and dormant nerve cells (penumbra state).

Increased Oxygenation significantly accelerates the rate of healing, stabilization and repair through numerous immune modulating effects, providing upregulation of anti-inflammatory cytokines, including: Granulocyte Macrophage Colony Stimulating Factor (GM-CSF), Interleukin-3 (IL3), Interleukin-4 (IL4), Interleukin-10 (IL10), Interleukin-13 (IL13), Interleukin-21 (IL21), Brain Derived Neural Growth Factors (BDNF, GDNF), Vascular Growth Factors (VEGF), TGFβ Signaling and IGF1.

From the *American Journal Physiology*, Heart and Circulatory Physiology (2005): Stem Cell Mobilization by Hyperbaric Oxygenation reports a single two hour exposure to HBOT at 2 ATA doubles circulating CD34+ progenitor stem cells (primordial cells targeted to salvage and restore damaged structures). At approximately 40 hours of HBOT, CD34+ cells increase eight-fold (800 percent).

LOKOMAT Robotic Gait Assisted Walking is a sophisticated exoskeleton technique where the patient is fitted with a harness, suspended from the wheel chair and strapped into the exoskeleton.

The LOKOMAT kinetic settings can be varied and specifically adjusted throughout the training session to "match the specific requirements of the individual". Some patients have high level spasticity and others have a complete loss of tone. Robotic assisted training can be constantly adjusted to provide numerous accurate repetitions necessary to restore activity, especially walking function for neurologic patients.

Improving a patient to the point that he or she no longer needs a wheelchair to move leads to reducing the economic burden associated wheel chair-associated complications that include pressure ulcers, circulatory disorders, osteoporosis and attendant care. LOKOMAT provides excellent opportunity to 'best-fit' a patient's specific capabilities and capacity to re-train function. LOKOMAT Gait Training not only improves the gait in neurological patients, it also positively effects cardiovascular performance and reductions in spasticity, bone loss and associated bladder or bowel complications

The combined benficial effects of Hyperbaric Oxygen Therapy and LOKOMAT Gait Training are explored in this presentation.

Summary of Benefits:

HBO effects Traumatic Brain Injury: Oxygen, Pressure & Gene Therapy (Harch 2015):

- Hyperbaric Oxygen Therapy provides the necessary fuel to 'kick-start' cells in a dormant hypoxic state.
- As many as 8101 genes are directly influenced for over 24 hours after a single exposure to HBOT.
- Upregulated genes are primarily growth and repair hormones and anti-inflammatory genes. Downregulated genes are the pro-inflammatory and apoptotic genes.
- HBO upregulates the patient's own target specific Stem Cells (with an 8-fold or 800 percent increase in circulating CD34+).
- HBO enhances Mitochondrial respiration.
- HBO proliferates Granulocyte Macrophage Colony Stimulating Factor (GM-CSF), Interleukin-3 (IL3), Interleukin-4 (IL4), Interleukin-10 (IL10), Interleukin-13 (IL13), Interleukin-21 (IL21), Brain Derived Neural Growth Factors (BDNF, GDNF), Vascular Growth Factors (VEGF), TGFβ Signalling, IGF1.
- HBO down regulates toxic intra and extra cellular inflammatory Cytokines (IL1, 2, 6, 7, 8, 17), Tumour Necrosis Factor Alpha (TNFα), GlycA, S100B.
- HBO inhibits opportunistic infections (viral, bacterial, parasitic), cell sepsis and more.

Robotically assisted Lokomat Exoskeleton training provides accurate repetition to promote functional changes and daily improvements to a patient's quality of life.

Biography

Malcolm Hooper
B.App Sci 1984, D.Acup 1985, Grad Cert 1993, Grad Dip 1995, M.App Sci 1999.

Author	*Hyperbaric Medicine: The Life is in the Blood* (2005, 2018 reprint). *Hyperbaric Oxygen Therapy combined with Lokomat (Robotic Gait Assisted Walking) assisting Neuroplasticity in Brain and Spinal Cord Injury* (forthcoming October 2018)
Founder	Australia's first Lokomat – Robotic Gait Assisted Walking (2006).

Malcolm is an International Executive Director serving on both the International Hyperbaric Medical Foundation (IHMF) and the International Hyperbaric Medical Association (IHMA). He is a regular speaker at international symposiums on the topic of Hyperbaric Oxygen Therapy applications in the modern era.

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