**Timothy Holdings MP**
**Stephen Palmer Assistant to Mr Holding**
**Malcolm Hooper (HyperMED)**
**Gary Allsop (Spinal Cure Australia)**

## Purpose of Meeting to Review

1. Adult and Paediatric Lokomat (Robotic Gait Assisted Walking) and its application with a range of neurodegenerative disorders i.e. spinal cord injury, traumatic brain injury, stroke, cerebral palsy, multiple sclerosis, movement and balance disorders

2. Hyperbaric Oxygenation (HBOT) and its application with orthopaedic and neurologic disorders

## Funding Considerations

1. TAC and WorkCover. (TAC EDO150 'Orientation and Mobility Training' $75.90)

2. Medicare inclusion similar to GP Care

## Function of Modalities

1. Hyperbaric Oxygenation enriches available Oxygen into deprived (hypoxic) neurovascular structures fostering neovascularisation (new capillary network increasing blood supply), reducing chronic swelling and inflammation, overcoming underlying infective agents and diminishes the cascade of hypoxic induced apoptosis (programmed cellular degeneration). Hyperbaric Oxygenation mobilizes the patients own 'target specific' circulating stem cells (CD34+) (American Journal of Physiology – Heart and Circulatory Physiology 2006). HBOT provides the necessary 'fuel' to promote recovery.

2. Lokomat Gait Assisted Training works to 'awaken' dormant neural pathways controlling standing, stepping, balance and the ability to walk. Experiments on spinalized cats demonstrate that treadmill walk was possible suggesting evidence of a central gait pattern generator which remain active after injury; these spinal generators drive the ability to re-learn function. When these generators are not activated the spinal circuits remain dormant and atrophy (waste); this inability to realize a movement combined with the neuroplasticity of the central nervous system may induce a secondary functional incapacity called 'learning non use'. Lokomat provides accurate step training stimulating specific neural reflexes and pathways within the patient's lower extremities, spinal cord and higher neurologic centers within the brain. The brain and spinal cord must learn to reconnect.

## Victorian Spinal Cord Service – Mission and Vision

*The Victorian Spinal Cord Service strives to deliver innovative programs based upon internationally recognised principles of spinal cord management using a team model that emphasises continuous improvement. The service aims to attract, retain and develop staff of the highest calibre in order to provide patient focused programs of world standing.*

*The Victorian Spinal Cord Service will be at the forefront of comprehensive spinal cord management. It will continue to be recognised for its contribution to:*

- *standards of clinical care*
- *clinical research that serves to increase the body of knowledge regarding spinal cord injury and to improve quality of life for people with a spinal cord injury*
- *community education related to prevention of spinal cord injury*
- promoting health and preventing complications *associated with spinal cord injury*
- *supporting patients' return to full and active lives in the community*
- *building partnerships with other agencies to achieve positive outcomes for people with spinal cord injury*

## What Happens Following Spinal Cord Injury?

- Spinal Injury may result in either complete or incomplete injury. Many patients informed they are 'complete' presume their cord is severed. The term complete is defined by total or near-total loss of motor function and sensation below the area of injury. However, even in a complete injury, the spinal cord is almost never completely cut in half. Many spinal patients classified as 'complete' may still re-gain functional responses even years after their injury.
- Scientific literature on spinal cord injury predicts that most recovery will occur in the first six months after injury and that it is generally complete within two years. Christopher Reeve's recovery commenced five to seven years after his injury. 'Reeve believed his improved function was the result of vigorous physical activity to re-train function and awaken dormant nerve pathways.' (American Association of Neurological Surgeons, Craig Hospital, Christopher and Dana Reeve Foundation, The National Institute of Neurological Disorders and Stroke)
- Surgical strategies at the time of injury are primarily orthopaedic focused with emphasis on reduction and stabilization of bony dislocation. All spinal patients require additional MRI within the following months to determine the integrity of the surgical procedure. Many spinal patients suffer additional complication due to progressive scar formation, bony fragments and lack of plate and screw integrity. These additional factors not only inhibit recovery but often contribute to additional cord and immune complications
- Laceration, extensive bruising, and massive swelling results in cord hypoxia. Cord hypoxia triggers a cascade of destructive cellular responses. Hypoxic damage causes destructive Apoptotic cells from the immune system to migrate to the injury site causing further damage to some neurons and death to others that survived the initial trauma. Immediate strategies are must be implemented to minimize this cascade of programmed cellular destruction. Hyperbaric Oxygenation impacts tissue hypoxia minimizing the cascade effects of progressive damage
- Within weeks of the initial spinal injury a fluid-filled cavity surrounded by glial scarring is left behind. Localized myelomalacia emerges (morbid softening at the injured site due to hypoxic necrosis of the spinal cord). Early HBOT intervention potentially has the greatest impact to the destructive spread of cord hypoxia
- Continuing progression of hypoxic induced apoptosis results in progressive hemorrhagic myelomalacia - spread of myelomalacia progresses above and below the injured site due to progressive intramedullary hemorrhage of the spinal cord. This can potentially lead to further loss of neurologic function and cord atrophy (wasting and thinning of the cord) severely inhibiting the capacity to regenerate and recover function. Comparison MRI post surgical stabilization is critical within the early months to evaluate this destructive process – functional changes an injured spinal patient may be getting does NOT rule out the potential cascade of secondary complications. Advanced Functional BOLD (Blood Oxygen Level Dependency) MRI measures progressive hypoxic damage and apoptosis

spread. Functional BOLD MRI also measures the impact of Hyperbaric Oxygenation intervention and Lokomat functional outcomes

- Experiments conducted on spinalized cats demonstrate that spinal circuitry (reflex generators) below the level of injury remains active (even years after injury) and functional neuronal properties can respond to peripheral input from *below* the level of injury. Treadmill cats can be trained to walk
- Lack of appropriate and 'accurate' stimulation induces functional incapacity called the ‘learning non-use’. Refer to the 'rat study' Do Wheel Chairs Inhibit Recovery?
- Motor cortex centers in the brain also show signs of functional loss due to spinal cord injury. Functional BOLD MRI demonstrate that the motor cortex and cerebellum parts of the brain 're-allocate functional capacity lost through spinal cord injury'
- Body Weight Support Treadmill Training (BWSTT) and more recent studies on Lokomat (Robotic Gait Assisted Walking) demonstrate the potential of functional neuroplasticity - the ability to re-learn and re-organize function. Functional BOLD MRI measures the capacity to retrain function in both the brain and spinal cord neural pathways. The injured spinal cord has capacity to 'wake-up' - salvage back tissue damage, re-activate and re-train dormant neural pathways improving functionality

## Background Information - Lokomat (Robotic Gait Assisted Walking)

For the past 15-years bodyweight supported treadmill training (BWSTT) has become a prominent gait rehabilitation method in leading rehabilitation centers throughout the world. This type of locomotor training has many functional benefits but the labor costs are considerable. To reduce therapist effort, Robotically Gait Assisted BWSTT (Lokomat) has been shown to be more accurate and financially feasible, compared to the other BWSTT modalities. Currently approximately 60-Lokomat systems are in use in large Neurorehabilitation hospitals in the USA and approximately 250 Lokomat systems found in 31 Countries.

In December 2006 HyperMED NeuroRecovery installed Australia’s first Adult and Pediatric Lokomat systems (Robotic Gait Assisted Body Weight-Support Treadmill Training) providing opportunity for adults and children with gait impairment due to spinal or cerebral motor disorder to improve functional outcomes.

The capacity of a patient with disability to access HyperMED is extremely difficult due to the lack of Government funding.

## Principles associated with Lokomat training

Neural plasticity refers to the natural ability of the neurons in the nervous system to generate and develop new connections aimed at repairing the neuronal damages. In the other word, they can learn new tasks. Based on this fact, locomotor training focuses on retraining the nervous system through simulating and repetition of walking gait, in order to regain their function and/or enhance their existing potentials. By repetitively stimulating the muscles and nerves in the lower body Lokomat Gait Assisted Training works to awaken dormant neural pathways controlling standing, stepping and balance.

Locomotor Gait Assisted Training refers to an intervention for retraining patients to walk after neurologic injury providing repetitive, intensive and task specific training that induces neuronal plasticity and subsequently cortical reorganization after brain and spinal cord damage. The goals of locomotor training are to capitalize on the intrinsic mechanisms of the CNS that respond to sensory input associated with walking to generate a stepping response and the ability of the CNS

to learn through intensive, task-specific repetition and practice. Task specific training such as gait assisted walking enables repair and reorganization of processes in the central nervous system. In order to walk or regain functional capacity the injured patient must 're-learn to walk'.

Activity based rehabilitation after neurological injury relies on three principles of motor learning.

- Practice is the first principle. All other things being equal, more functional learning will occur with more accurate practice
- Specificity is the second principle. The best way to improve performance of a motor task is to execute that specific motor task repeated many times
- Effort is the third principle. Individuals need to maintain a high degree of focus, participation and involvement to facilitate motor learning

These three principles are critical to promoting activity-dependent plasticity (i.e. altering the efficacy and excitation patterns of neural pathways by activating those pathways). With regards to neurological rehabilitation, it is important to emphasize that plasticity occurs in neural pathways that are active.

Over the past decades, extensive research studies have assessed and evaluated the use and benefits of body weight-supported locomotor training. These studies reveal that BWSTT can effectively improve walking parameters such as speed, limb coordination, distance, and level of independence. It has also been shown that BWSTT in incomplete SCI patients can also lead some positive neurological alterations namely stepping ability, corticospinal tract function, and increased electromyography activity. Manually assisted treadmill training has been used for more than 15-years as a regular training for patients with spinal cord injury and stroke.

The most extensive study published to date found that 80% of wheelchair bound patients with chronic incomplete spinal cord injury gained functional walking ability after functional training Spinal Cord Inj Rehabil 2005.

Unfortunately BWSTT has not found prominence in Australian hospitals or private rehabilitation clinics.

### What are the limits of Lokomat Gait Training?

Patients with spinal cord injuries who have been wheelchair bound for many years are still potentially able to ambulate. Improving a patient to the point that he/she no longer needs a wheelchair to move would definitely lead to reducing the yearly costs of his/her neurological disease as well as the financial burden of wheelchair-associated complications such as; pressure ulcers, circulatory disorders, osteoporosis and attendant care. Lokomat Gait Training also records improved cardiovascular performance and reductions in spasticity, bone loss and bladder/bowel complications.

The Lokomat has been suggested to be predestined for patients with complex neurologic disability who are too weak to walk over-ground without external support and thus require the assistance of several therapists to perform body-weight- supported treadmill training. Our experience (HyperMED NeuroRecovery) is that Lokomat Gait Training is highly adaptable for all patients with disability. Lokomat Gait Training can provide numerous accurate repetitions necessary to restore activity especially walking function with neurologic patients. Lokomat Gait Training kinetic settings can be varied and specifically adjusted throughout the training session intensifying functional outcomes.

Patients with incomplete spinal lesions and with stroke undertaking Lokomat Gait Training have measurable functional changes; reflex stiffness and spasticity are significantly reduced; range of

motion, peak velocity and acceleration of voluntary movements are increased with patients with incomplete spinal lesions and stroke. Therefore the walking ability improves as well as functional independence.

**HyperMED Lokomat (Robotic Gait Assisted Walking) Gait Training**

Patients receiving Lokomat are scheduled daily; initially 1-hour session and then as the patient builds we recommend up to 2-hours each day attending. An initial base line of between 40-60 hours Lokomat training is typical of most patients attending with disability. Functional changes are often evident within the first 20-hours of Lokomat training.

Lokomat is NOT passive involvement. The Lokomat is constantly adjusted to best assist the functional responses of the patient. Patients commence with passive assistance however as the patient compliancy builds the Lokomat settings and various programs are tailored to the patient's performance and capabilities. Some patients have high level spasticity and others a complete loss of tone. Each patient's presentation is different - Lokomat provides excellent opportunity to 'best-fit' the patient's specific capabilities and capacity to re-train function. And this is replicable on every separate training session!

In addition the support harness treadmill system is utilized independent of the Lokomat to promote functional changes. Functional changes being driven by 'man and machine' are then put to the test with the patient then able to implement strategies being focused on during each Lokomat session.

This combination effect is both unique and significant towards each neurologic patient developing a sense of supportive assistance whilst focusing on improving functional independence.

Walking requires a 'fluid like connection between spinal reflex generators and higher brain centres'. The combined approach is invaluable to promote functional changes - neuroplasticity (the ability to salvage back what has been damaged).

Additionally, it has been revealed that Lokomat Gait Training can lead to functional improvements in patients with different neurological diseases such as; Multiple Sclerosis, Chronic Stroke, Parkinson's Diseases, Cerebral Palsy (CP), as well as the other various types of idiopathic and secondary muscular dystrophies and neurological disorders in adult and children. In stroke hemiparetic patients BWSTT has been shown to improve balance, lower limb motor recovery, walking speed, endurance, and other important gait characteristics such as symmetry, stride length and double stance time.

Moreover, a number of research studies have shown that Lokomat Gait Training can not only improve the gait in neurological patients but also positively affect cardiovascular and general health regulations. For this reason, to keep a level of maintenance treadmill training after the initial period of intense training is highly recommended.