The Odstock Dropped Foot Stimulator

Each year in the UK over 100,000 people suffer a stroke. Of these 30,000 are left with a mobility deficit, typically manifested as a dropped foot. Additionally people who have other neurological conditions such as multiple sclerosis, spinal cord injury and cerebral palsy may also have a dropped foot. This means that the individual is unable to lift their foot on the affected side, during the swing phase of gait, leading to the foot being dragged forward, swung out to the side or hitched from the hip. Dropped foot can be due to either the inability to activate the muscles that lift the foot or excessive activity in the calf muscles, causing your foot to push downwards.

The ODFS

The Odstock Dropped Foot Stimulator (ODFS) was originally developed under funding from the Medical Devices Agency in the Department of Health between 1989 - 1995. The Odstock Dropped Foot Stimulator (ODFS) is a single channel neuromuscular stimulator that corrects dropped foot by stimulating the common peroneal nerve using self adhesive skin surface electrodes placed on the side of the leg. The electrical stimulation causes dorsiflexion (lifting of the foot) and when timed to the gait cycle using foot switches placed in the shoe, walking performance can be significantly improved. The device works by causing a contraction of inactive muscles but also may cause a relaxation of the calf muscles. Electrical stimulation feels like pins and needles and is found to be comfortable by most users. The device is designed to allow sufficient flexibility to cope with a range of problems that have been seen over some considerable clinical experience, while remaining simple to use and set up by the physiotherapist.

Between January 1993 and September 1995 a controlled trial was conducted. 32 subjects were randomly allocated to treatment and control groups. Both groups received equal amounts of physiotherapy while the treatment group also used the device. Measurements showed that the treatment group had a statistically significant increase in walking speed of 16% and a reduction in physiological cost index, which is an estimate of the amount of effort in walking, of 29%. In addition, a significant reduction in quadriceps spasticity, measured with the Wartenberg Pendulum Test was seen and also an improvement in Quality of Life measured using the Hospital Anxiety and Depression Index. QALY analysis of the results showed a cost per QALY of £10,307 over 5 years. The results were presented to the South and South West Regional Health Authority Development and Evaluation Committee who “recommended” the treatment for use within the NHS.

DEC Report

The Development and Evaluation Committee (DEC) approval has enabled the department of Medical Physics and Biomedical Engineering to offer a clinical service with patients from all over the UK being referred for treatment as Extra Contractual Referrals. To date approximately 1000 systems have been fitted in United Kingdom including people with multiple sclerosis, cerebral palsy, spinal cord injury and head injury as well as stroke. The department has run many training courses for physiotherapists from other hospitals in the use of the device and more are planned.
The course is mandatory before equipment can be purchased. Centres are now fitting the equipment in Birmingham, Hayle (Cornwall), Worthing, Poole, Shoreham, Glasgow, London, Aylesbury, Bath, Neath, Pontypool, Haverfordwest and Stoke, and more centres are being trained.

Recent studies based on results from 160 subjects have shown that the main benefit received from use of the device is that it reduces the effort of walking and increases the confidence of the users. Use of the device by people who have had a stroke leads to a therapeutic benefit, increasing their walking speed and reducing their PCI (Physiological Cost Index) even when the ODFS is not used.

The ODFS is CE marked and can be supplied to clinicians who have completed a training course in its use.

Clinical Procedure

Two clinic appointments are made on consecutive days for fitting of the ODFS. On the first day the stimulator is set up and its use explained to the user. On the second day the user is asked to attend wearing the device so the clinician can assess the users ability to set up the device independently. Further adjustments are made and training given as necessary. ODFS users are followed up after 6 weeks, after a further 3 months, 6 months and then yearly for as long as they continued to use the stimulator. Further visits to the clinic can also be made if difficulties are experienced between scheduled appointments. When setting up the stimulator for the first time, great emphasis is put on training the user, and their carer if appropriate, to correctly identify the movement produced by the stimulation and techniques used to modify it by changing the electrode positions. Instructions are also given in written form. The exact electrode position may vary from day to day, possibly due to the varying amounts of calf tone. It is necessary to have regular and frequent follow-ups, particularly in the early stages of using the device, to ensure its correct application.

Royal College of Physicians

The National Clinical Guidelines for Stroke

The Royal College of Physicians (RCP) has brought out guidelines for the treatment of stroke, which they describe as follows:

“These National Clinical Guidelines for Stroke sets out clearly and unequivocally the minimum basic standards for care based on graded evidence. The Guidelines have been compiled by the multidisciplinary Intercollegiate Stroke Working Party and have been extensively peer reviewed. Each aspect of stroke care covered includes main guidelines, extensive evidence on which they are based and suggestions for the development of local guidelines. Patients’ and carers’ observations, based on their first hand experiences of stroke care, have been incorporated throughout the text.”
Included in the section on rehabilitation is a section on FES (Functional Electrical Stimulation), recommending its use for correction of dropped foot and reduction of the pain associated with subluxed shoulder. The use of electrical stimulation to improve hand function is also reviewed but no recommendations made.

An extensive reference section provides a valuable source for evidence based practice that would be a valuable resource for any researcher in the field of stroke.

Copies of the report can be obtained from: Publications Department, Royal College of Physicians of London, 11 St Andrews Place, Regent’s Park, London, NW1 4LE price £22 including P&P. Alternately the document can be viewed on the RCP web page www.rcplondon.ac.uk (linked from our web page).

Potential cost of falls with Stroke patients

Patients who have had a stroke are at high risk of falling. In a study by Tutarrima et al the incidence of falls was 8.9 / 1000 per day. They found that 25% of falls lead to injury which ranged from slight to severe while 2% of falls resulted in hip fractures. These injuries obviously have a significant impact on the health service. In a separate study, Rizzo et al. showed that the impact of an average fall in the USA was $11,042 to the hospital while home nursing costs were $5,325 leading to a total cost of $19,440 (1996 prices). This does not include the impact on employment or on family members who have extra burden placed on them. While there is no objective direct evidence that use of a dropped foot stimulator reduces falls, Taylor et al found in a questionnaire survey of users of the Odstock Dropped Foot Stimulator that 70% of uses claimed that they used the device because they were less likely to trip. This is backed up by the observation by Granat et al that foot to floor contact was more reliable, correcting lateral border of the foot weight bearing in the early stance phase. This will lead to more stable gait, resulting in a reduced incidence of falls and a significant impact on costs to the NHS (National Health Service).

Potential cost saving to the NHS by reducing the number of falls

In order to calculate the cost benefit for the ODFS (Odstock Dropped Foot Stimulator), values quoted in references 1-4 have been used:

Without any aid, 89/ 1000 patients have a fall each day, hence each patient falls 3.2 times per year. However, only 25% of these result in injury, which means that patients injure themselves 0.8 times per year. An average cost to the NHS per fall is £13,000 (assuming the same cost as in the USA). Hence the total cost per patient per year is £10,368.

However, as the original fall data was from patients who were receiving inpatient rehabilitation following their stroke it is reasonable to assume that after that period falls would occur less frequently. Also not all patients would benefit from the device. Therefore the fall rate may be assumed to be one quarter of that stated, leading to on average, one fall in which an injury occurs being experience once every five years.
The cost per year would therefore be £2,592. This includes home care costs, which are not covered by the NHS. Excluding these the costs to the NHS will be approximately £1,472, or £1766 allowing for 20% inflation since 1996, which is 1.76 times the first year costs of the ODFS.

Therefore, it can be concluded on this analysis alone that the cost to the NHS in supplying stroke patients with the ODFS will be recovered in less than 8 months. After that there is significant financial savings to the NHS of around £1,566 per year.


Clinical Evidence and reports.

Patients' Perceptions of the Odstock Dropped Foot Stimulator (ODFS)

Paul N Taylor, Jane H Burrige, Anna L Dunkerley, Amanda Lamb, Duncan E Wood, Jonathan A Norton, Ian D Swain

Accepted for publication in the journal Clinical Rehabilitation to be published summer 1999 (Clinical Rehabilitation. 1999: 13: 333-340)

Objective: To determine the perceived benefit, pattern and problems of use of the Odstock Dropped Foot Stimulator (ODFS) and the users' opinion of the service provided.

Design: Questionnaire sent in a single mail shot to current and past users of the ODFS. Returns were sent anonymously.

Setting: Outpatient based clinical service. Subjects: 168 current and 123 past users with diagnoses of stroke (CVA), multiple sclerosis (MS), incomplete spinal cord
injury (SCI), traumatic brain injury (TBI) & cerebral palsy (CP).

Intervention: Functional Electrical Stimulation (FES) to correct dropped foot in subjects with an upper motor neurone lesion, using the ODFS.

Main Outcome Measures: Purpose designed questionnaire.

Results:

· Return rate 64% current users (mean duration of use 19.5 months) and 43% past users (mean duration of use 10.7 months).
· Principal reason cited for using equipment was a reduction in the effort of walking.
· Principal reasons identified for discontinuing were an improvement in mobility, electrode positioning difficulties and deteriorating mobility.
· There were some problems with reliability of equipment.
· Level of service provided was thought to be good.

Conclusion: The ODFS was perceived by the users to be of considerable benefit. A comprehensive clinical follow up service is essential to achieve the maximum continuing benefit from FES based orthoses.

Clinical Use of the Odstock Dropped Foot Stimulator. Its Effect on the Speed and Effort of Walking.

Paul N Taylor, Jane H Burridge, Anna L Dunkerley, Duncan E Wood, Jonathan A Norton, Christine Singleton and Ian D Swain.

Accepted for publication, Achieves of Physical Medicine and Rehabilitation, 1999;80:1577-1583

Objective: To assess the clinical effectiveness of the Odstock Dropped Foot Stimulator by analysis of its effect on Physiological Cost Index (PCI) and speed of walking. This Functional Electrical Stimulation (FES) device stimulates the common peroneal nerve during the swing phase of gait.

Design: A retrospective study of patients who had used the device for four and a half months.

Subjects: 151 patients with a dropped foot resulting from an upper motor neurone lesion.

Setting: The Medical Physics and Biomedical Engineering Department of a District General Hospital specialising in the clinical application of FES and a Neurophysiotherapy Department in a separate hospital.

Main outcome measures: Changes in walking speed and effort of walking, as measured by PCI over a 10m course.

Results: There was a 92.7% compliance with treatment. Stroke patients showed a mean increase in walking speed of 27% (p<0.01) and reduction in PCI of 31% (p<0.01) with stimulation and changes of 14% (p<0.01) and 19% (p<0.01) respectively whilst not using the stimulator. Multiple sclerosis patients gained similar orthotic benefit but no "carry-over".
Conclusions: The measured differences in walking with and without stimulation were statistically significant in the stroke and multiple sclerosis groups. In this study use of the stimulator improved walking. Those with stroke demonstrated a short term "carry-over" effect.

The efficacy of Functional Electrical Stimulation in improving walking ability for people with Multiple Sclerosis


Introduction
Multiple Sclerosis, MS, is a chronic disease of unknown cause which affects the central nervous system and is characterised by demyelination of nerve fibres in the brain and spinal cord. It affects over 85,000 people in the UK and between 250-350,000 people in the United States. It is five times more common in temperate climates than in tropical regions (1). It is an unpredictable disease making prognosis difficult and symptoms can range from relatively benign to devastating, as communication between the brain and the peripheral nervous system is disrupted. As MS affects the central nervous system it can cause muscular weakness, reduced sensation, spasticity, fatigue and ataxia in addition to pain, balance problems, bladder, bowel and sexual dysfunction, speech and visual disturbances and altered mental state.

The disease progression is variable and usually follows one of several patterns. Most common is relapsing-remitting (RR) which is a series of attacks followed by complete or partial remission only to reoccur after a period of stability. Primary-progressive (PP) is characterised by a steady decline with no distinct remissions. Secondary-progressive (SP) begins with a relapsing-remitting course followed by a later primary progressive course. Rarely patients may have a progressive-relapsing (PR) course in which the disease takes a progressive path followed by acute episodes. In addition 20% of the MS population have a benign form of the disease which shows little or no progression after the initial attack. As a result of this variability of symptoms and progression any clinical trials in MS are notoriously difficult.

Most people with MS experience muscle weakness in their extremities and difficulty with coordination at some time during the course of their disease which may be severe enough to affect walking (1). Foot drop is one of these effects and may occur either unilaterally or bilaterally. It may be characterised by an isolated weakness of the foot dorsiflexors but it is more usual for other movements to be affected as well, commonly reduced knee flexion. Spasticity may also be a factor which contributes to difficulty in mobility.

The ODFS III is a single channel, foot switch triggered stimulator designed to elicit dorsiflexion of the foot by stimulation of the common peroneal nerve, (max. amplitude 100mA, 350µs pulse, 40 pps). Skin-surface electrodes are placed, typically, over the common peroneal nerve as it passes over the head of the fibula bone and the motor point of tibialis anterior. The rise and fall of the stimulation envelope and extension
after heel strike can be adjusted to prevent a stretch reflex in the calf muscles and to prevent “foot flap” due to the premature ending of dorsiflexion.

The ODFS was the subject of a randomised controlled trial in which 32 stroke patients who had had a stroke for in excess of 6 months were allocated to a treatment group. This group used the device and received 12 sessions of physiotherapy and the control group received only physiotherapy (2,3,4). After three months of use the treatment group showed a statistically significant increase in walking speed of 16% and reduction in the Physiological Cost Index (PCI) of 29% when the stimulator was used while no changes were seen in the control group (3). No significant 'carry-over' effect was seen although a trend was present. Users of the ODFS showed a continuing reduction in quadriceps spasticity, which was only seen in the control group while physiotherapy continued (4). The treatment group also showed a reduction in depression score on the Hospital Anxiety and Depression index suggesting an improvement in quality of life. The trial results were presented to the South and West Regional Health Authority Development and Evaluation Committee who subsequently recommended the ODFS for use in the National Health Service.

**Methods**
After the ODFS is fitted the patient is seen the following day, after six weeks, after a further three months and then every six months as long as they continue to use it. Walking speed and PCI, which is an indication of the amount of effort expended, are measured at every appointment. The patients are asked to “walk briskly” over a 10m course with 1m at either end for acceleration and deceleration. Patients normally walk this course three times with stimulation and three times without, the order of stimulation / nonstimulation being varied to compensate for any fatigue. The mean speed and PCI for stimulated and non-stimulated walking is calculated. PCI being the change in heart rate (bt/min) / walking speed (m/min). The heart rate was measured using a Polar Heart Rate Monitor. The data in this study were obtained retrospectively from the records of these routine measurements kept in the patient’s notes.

In addition a questionnaire was sent to all current and former users of the ODFS, 168 and 123 respectively. A stamped addressed envelope was included to facilitate their return. The questionnaire consisted of 16 questions which sought to determine what advantages the ODFS gave; when, how and where it was used, if it made any difference to the patients use of other aids, whether the instructions, both verbal and written were satisfactory and whether the repair/advice service we were providing was responsive. Those who had stopped using the stimulator were asked why they had stopped.

**Results**
We have assessed 139 people with MS who have been found to be suitable for treatment, 24 of whom were bilateral. Their average age is 53.4 years SD 11.1. Of these 139 there is speed/PCI data on 112, as some patients have been assessed but have not started treatment. The reason that complete data is not available on all subjects is primarily due to the fact that some patients fatigue so rapidly that they are unable to complete all the tests. The figures presented below are only on those patients on whom complete data is available.
The longest any MS patient has been using the ODFS is over six years since commencing treatment on 29/3/94. Nine patients have used it, or a bilateral system for over three years.

Of the 139 patients only 16 have stopped treatment giving a compliance of 88%.

Initial orthotic effect (IOE) is defined as the mean % change in speed/PCI with and without stimulation at the start of treatment.

Final orthotic effect (FOE) is defined as the mean % change in speed/PCI with and without stimulation after a period of treatment. e.g. 4\(\frac{1}{2}\) months or 3 years

Total orthotic effect (TOE) is defined as the mean % change in speed/PCI with stimulation after a period of treatment compared to that without stimulation at the start of treatment.

‘Carry over’ effect (COE) is defined as the mean % change in speed/PCI without stimulation after a period of treatment compared to that without stimulation at the start of treatment.

Positive values of percentage change in walking speed indicate faster walking. Positive values of percentage change in PCI indicate an increase in effort, negative values a reduction in effort.

Table 1 Changes in Walking Speed and Energy Expenditure after four and a half months usage, ODFS (52 patients)
N.B. Patients who can not walk 10m without stimulation are not included.

<table>
<thead>
<tr>
<th>Pre use</th>
<th>Mean PCI No stim.</th>
<th>Mean PCI Stim</th>
<th>Mean Speed No Stim</th>
<th>Mean Speed Stim</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1.09</td>
<td>0.49ms(^{-1})</td>
<td>0.53ms(^{-1})</td>
</tr>
<tr>
<td>After 4.5 months use</td>
<td>1.03</td>
<td>0.84</td>
<td>0.51ms(^{-1})</td>
<td>0.59ms(^{-1})</td>
</tr>
<tr>
<td>Speed</td>
<td>PCI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IOE</td>
<td>10%***</td>
<td>-11%***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FOE</td>
<td>5%***</td>
<td>-6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOE</td>
<td>16%</td>
<td>-20%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COE</td>
<td>-1%</td>
<td>-4%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p<0.05, **p<0.01, ***p<0.001 paired t-test
Questionnaire
Of the current ODFS users 107 replies were received from the 160 questionnaires that were sent out of which 15 had MS. Of the former users 53 replies were received from the 123 questionnaires that were sent out, only 3 of who had MS, two stopped using the stimulator because of a deterioration in their general condition and the other had an increase in their spasticity. The replies received the current users were different from the rest of the respondents, the majority of whom had a dropped foot as a result of a CVA. Amongst those with MS by far the most common reason for using the ODFS was the reduction of effort, 100% (5)

Discussion
The results on the main group of patients, i.e. those who have used a stimulator for four and a half months show that electrical stimulation significantly improves both walking speed and walking efficiency. Unlike the initial work (6) it was also encouraging that some patients exhibit a ‘carry over’ effect over the four and a half month treatment period. Walking speed of >10% was seen to increase in 16 out of the 52 patients and PCI reduce by > 10% in 21 patients.

Table 2 Changes in Walking Speed and Energy Expenditure after three years usage (6 patients, includes patients using both the ODFS and two channel stimulator).
N.B. five of the subjects walked faster with the stimulator at the start of treatment but one subject walked considerably slower. Their walking improved after using the stimulator for some time.

<table>
<thead>
<tr>
<th>Pre use</th>
<th>Mean PCI No stim.</th>
<th>Mean PCI Stim</th>
<th>Mean Speed No Stim</th>
<th>Mean Speed Stim</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.03</td>
<td>1.05</td>
<td>0.44 ms⁻¹</td>
<td>0.47 ms⁻¹</td>
</tr>
<tr>
<td>After 4.5 months use</td>
<td>1.25</td>
<td>0.85</td>
<td>0.35 ms⁻¹</td>
<td>0.47 ms⁻¹</td>
</tr>
<tr>
<td>Speed</td>
<td>PCI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IOE</td>
<td>6%</td>
<td>-1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FOE</td>
<td>36%</td>
<td>-29%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOE</td>
<td>8%</td>
<td>-17%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COE</td>
<td>-10%</td>
<td>21%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3  Changes in walking speed and PCI due to two channel stimulator for bilateral footdrop (10 patients)

<table>
<thead>
<tr>
<th></th>
<th>Pre use</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean PCI No stim.</td>
<td>Mean PCI Stim</td>
<td>Mean Speed No Stim</td>
</tr>
<tr>
<td></td>
<td>1.57</td>
<td>1.13</td>
<td>0.27ms⁻¹</td>
</tr>
<tr>
<td>After 4.5 months use</td>
<td>1.65</td>
<td>1.25</td>
<td>0.30ms⁻¹</td>
</tr>
<tr>
<td></td>
<td>Speed</td>
<td>PCI</td>
<td>Speed</td>
</tr>
<tr>
<td>IOE</td>
<td>37%**</td>
<td>-25%**</td>
<td></td>
</tr>
<tr>
<td>FOE</td>
<td>40%*</td>
<td>-18%*</td>
<td></td>
</tr>
<tr>
<td>TOE</td>
<td>56%</td>
<td>-12%</td>
<td></td>
</tr>
<tr>
<td>COE</td>
<td>18%</td>
<td>11%</td>
<td></td>
</tr>
</tbody>
</table>

In the 3 year follow up group the numbers were small but showed that there was a marked final orthotic effect. Even after three years the majority of patients were walking faster and more efficiently with the stimulator than they were without the stimulator at the time they were referred for treatment. As the numbers are so small, statistical evaluation was not undertaken. Three patients were walking faster without stimulation after three years than they were initially and two were walking more efficiently.

The results obtained with the two channel bilateral foot drop stimulator (7) showed an improvement in both walking speed and PCI when using the stimulator which was statistically significant compared to the results obtained without stimulation. The readings taken after four and a half months showed no statistically significant difference compared to the initial readings, although the sample size was small.

The questionnaire showed that MS patients gave slightly different reasons for using the stimulator compared to the majority of patients who had had a CVA, in that reduction in effort was the main reason they used it. This can be seen in the final orthotic effect after three years use when it can be seen that it did make a considerable difference to their walking. It is also noticeable that the bilateral stimulator also makes a considerable difference. Therefore it might be inferred that as people with MS become more disabled by the progressive nature of the disease that the stimulator becomes more important in preserving their mobility and hence independence. It is probably not surprising therefore that we have had such a small drop out rate from MS patients with only 16 out of 139 stopping treatment.
It was disappointing that we were not able to report on more subjects when 139 had been assessed, although we will be able to over the next few years as the recent influx of patients’ progress through the system.

It is always difficult with any severely disabled group to record objective data taken at set times as the variable nature if the disease often means that clinic appointment are difficult for the patients to attend especially as we see patients from all over the United Kingdom.

References
1) National Institute of Neurological Disorders and Stroke - Multiple Sclerosis
www.ninds.nih.gov


7)Taylor PN, Wright PA, Burridge JH, Mann GE, Swain ID. Correction of bilateral dropped foot using the Odstock 2 Channel Stimulator (O2CHS). Ibid., pp. 257-260, August 1999

Abstracts On Dropped Foot Stimulation (for more detailed information, please refer to the webpage)

Patients' Perceptions of the Odstock Dropped Foot Stimulator (ODFS)

Clinical Use of the Odstock Dropped Foot Stimulator. Its Effect on the Speed and Effort of Walking.

The effects of common peroneal stimulation on the effort and speed of walking. A randomised controlled trial with chronic hemiplegic patients.
The effect of common peroneal nerve stimulation on quadriceps spasticity in hemiplegia

Correction of Bi-lateral Dropped Foot using the Ods tock 2 Channel Stimulator (O2CHS)

The Relationship between Abnormal Patterns of Muscle Activation and Response to Common Peroneal Nerve Stimulation in Hemiplegia

Different Muscle Activation Patterns, Identified During Walking, In People With Spastic Dropped Foot

Pilot Trial to Determine Control Algorithms and Patient Selection Criteria for Two-Channel Stimulation Following Stroke

The efficacy of Functional Electrical Stimulation in improving walking ability for people with Multiple Sclerosis

REPORT TO THE DEVELOPMENT & EVALUATION COMMITTEE: COMMON PERONEAL STIMULATION FOR THE CORRECTION OF DROP-FOOT

Publications

1. Taylor PN, Burridge JH. Development and experience in use of an electronic stimulator for correction of dropped foot in early gait re-education of subjects following CVA. Therapy weekly 1993


**Published Abstracts**


**Other areas where Functional Electrical Stimulation is used**

**Paraplegic Abstracts**

Electrical Stimulation To Enable Sit To Stand Following Paraplegia - A Case Report

Experience In Using Knee Angles as Part of A Closed-Loop Algorithm to Control FES-Assisted Paraplegic Standing

Results from bone mineral density scans in paraplegics

Apparatus to simultaneously measure fourteen isometric leg joint moments. Part 2: Multi-Moment Chair System

Wheelchair Accessory Standing Support


**Tetraplegic Abstracts**

Clinical Experience of the Neurocontrol Free Hand Neuro Prosthesis for Tetraplegic Hand Function

Deltoid Triceps Transfer and Functional Independence of People with Tetraplegia

A portable system for closed loop control of the paralysed hand using functional electrical stimulation
Clinical Experience of the NeuroControl Freehand System

Electrical stimulation of abdominal muscles for control of blood pressure and assisted cough in a C4 level tetraplegic.

Also:

Sensory Amplification by Cutaneous Electrical Stimulation for Retraining Proprioception

Electrical stimulation exercise to improve hand function and sensation following chronic stroke.

FES based training orthosis for hand function following stroke

Publications


Published Abstracts


The Range of Odstock Stimulators

All are CE marked and in addition we have BSI Registered Firm for our manufacture and fitting of Electrical Stimulators.

Contact Steven Crook for questions about our quality system.

Stimulators can only be purchased by clinicians who have completed training courses in their use.

The Odstock Dropped Foot Stimulator, mkIII

The Odstock Dropped Foot Stimulator is an electronic device, designed to assist people who have a dropped foot due to neurological damage to walk. By stimulating the common peroneal nerve at its most superficial point, passing over the head of the fibula bone, it is possible to cause dorsiflexion with degrees of hip and knee flexion. This is through excitation of the withdrawal reflex. If this is timed with walking using a foot switch worn in the shoe, walking can be significantly improved. The sensation of the stimulus is like ‘pins and needles’, which the user soon becomes used to. The Dropped Foot Stimulator is about the same size as a pack of playing cards and is worn on a belt clip or in the pocket. Wires, worn under the clothing, carry the electrical stimulus to self adhesive skin surface electrodes on the side of the leg. A small foot switch is placed in the shoe under the heel. Stimulation can be adaptive to walking speed, starting and ending with heel rise and strike or can be for a fixed time, initiated by heel rise. An adjustable extension to the stimulation output after heel contact is provided to allow the foot to be lowered to the ground. Additionally the stimulator can be initialise by heel strike for controlled by the contralateral side. Ramping of the output allows fine tuning of the timing parameters and helps prevent calf spasticity due to sudden stretching of the Achilles tendon. The flexibility in operation allows the ODFS to be successfully used by subjects with a wide range mobility problems. The device can be used as an assistive aid or as a training device to strengthen muscles and improve voluntary control. Additionally, the device has a role in physiotherapy gait re-education allowing isolated components of the gait cycle to be practised under therapist control.
Specifications

All specifications +/- 10%

Output: asymmetrical or symmetrical biphasic voltage driven wave form.

Output amplitude: 15 to 100mA into a 1k ohm load with a asymmetrical biphasic output, 10mA to 70mA in symmetrical biphasic mode.

Frequency: 40 Hz.

Pulse width: 3 to 350 microseconds.

Output time: 0.5 to 6 seconds.

Extension time: 0 to 1.5 seconds

Ramping times: 0 to 4 seconds.

Battery.  PP3, 9v.

Battery life: 2 to 3 weeks of average use for an alkaline battery. 3 to 6 days for a rechargeable battery.

Equipment type: Type BF.

The Odstock 2-channel Dropped Foot Stimulator

The Odstock Two Channel Stimulator (O2CHS) is essentially 2 ODFS in a single box but with additional circuitry to allow the two stimulators to interact. It can be controlled by one or two foot switches with all the same control features of the ODFS.
with the addition of an adjustable delay following initiation on the second channel and variable stimulation frequency. The device has been used for bilateral dropped foot, dropped foot with push off by adding calf stimulation, dropped foot with knee flexion by addition of hamstrings, dropped foot with hip extension by adding gluteus, dropped foot and knee extension adding quadriceps, bilateral quadriceps, dropped foot with triceps for reducing associated reaction and assisted cough for high level tetraplegia.

**Specifications**

Output amplitude: 0 to 100mA +/ - 10% into a 1k ohm load.

Frequency: 20 to 60 Hz. +/- 10%

Pulse width: 300 microseconds +/- 10%

Output times: 0 to 6 seconds. +/- 10%

Delay: 0 to 2 seconds. +/- 10%

Ramping times: 0 to 4 seconds. +/- 10%

Extension times: 0 to 2 seconds +/- 10%

Battery. PP3, 9v.

Equipment type: Type BF.

**The Microstim2 Exercise Stimulator**

The MicroStim2 neuromuscular stimulator is intended for the exercise of weak or paralysed muscle. It is designed to be simple to use with the minimum necessary user controls. The output stimulation intensity is ramped at the beginning and end of each cycle by pulse width modulation to produce a comfortable sensation. Powered by a standard 9V battery, this makes it ideal for use at home for regular exercise.
### Modes of operation

<table>
<thead>
<tr>
<th>Mode</th>
<th>Frequency</th>
<th>Format</th>
<th>Possible Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10Hz</td>
<td>CONTINUOUS</td>
<td>Setting up electrode positions and stimulation levels</td>
</tr>
<tr>
<td>1</td>
<td>10Hz</td>
<td>ALTERNATE</td>
<td>Exercise mode for possible improvement in muscle fatigue resistance</td>
</tr>
<tr>
<td>2</td>
<td>20Hz</td>
<td>CONTINUOUS</td>
<td>Setting up electrode positions and stimulation levels</td>
</tr>
<tr>
<td>3</td>
<td>20Hz</td>
<td>ALTERNATE</td>
<td>Normal quadriceps exercise mode</td>
</tr>
<tr>
<td>4</td>
<td>20Hz</td>
<td>SIMULTANEOUS</td>
<td>For simultaneous contraction of 2 sets of muscles e.g. hand stimulation</td>
</tr>
<tr>
<td>5</td>
<td>40Hz</td>
<td>CONTINUOUS</td>
<td>Setting up electrode positions and stimulation levels</td>
</tr>
<tr>
<td>6</td>
<td>40Hz</td>
<td>ALTERNATE</td>
<td>Normal common-peroneal exercise mode</td>
</tr>
<tr>
<td>7</td>
<td>40Hz</td>
<td>SIMULTANEOUS</td>
<td>For simultaneous contraction of 2 sets of muscles</td>
</tr>
<tr>
<td>8 &amp; 9</td>
<td>Reserved</td>
<td></td>
<td>Reserved for future expansion - currently default to mode 7</td>
</tr>
</tbody>
</table>

### Specifications

Output amplitude: Maximum 120mA with 1Kohm output load.

Stimulation frequency: Programmable (normally 10, 20 & 40 Hz).

Stimulation waveform: Passive charge balanced asymmetrical biphasic output

Stimulation pulse width: 300ms maximum.

Ramp time: 2.5s

Equipment type: Type BF.
**The Odstock 4 channel stimulator**

The Odstock Four Channel Stimulator is a neuromuscular stimulator intended for the exercise of weak or paralysed muscle. It is designed to be simple to use with facilities to vary exercise parameters. The output can be ramped at the beginning and end of each cycle to give a comfortable sensation and prevent stretch induced spasticity. Output can be continuous or alternating (Two channels can alternate with two channels, 1 channel with three channels or four channels against a rest period). Powered by a standard 9V battery, the unit is intended for home use to allow regular exercise. An optional accessory allows control of the stimulators pulse width and exercise cycle using a foot pedal.

All specifications to +/- 10%

Output amplitude: 0 to 115 mA into a 1k-ohm load.

Frequency: 12 - 50 Hz.

Wave form: Passively asymmetrically charge balanced.

Pulse width: 100 - 450 microseconds.

Period time: 12 - 60 seconds

On time: 1 - 12 seconds

Ramp time: 0 - 9 seconds

Equipment type: Type BF.

**Current price list**

ODFS – Odstock Dropped Foot Stimulator £272.25

O2CHS – Odstock Two Channel Stimulator £379.00

O4CHS – Odstock 4 Channel exercise Stimulator £295.40

MS2 – Microstim 2 exercise stimulator £267.75

All stimulators are supplied with all accessories necessary for their use. They are guaranteed for one year. There is a 10% discount on orders of 5 or more items.

Sounder £10

Wow pedal (for O4CHS) £75

Electrode leads (1.0 or 1.5m) £8.90
Foot switch leads (60, 75, 100 or 120, 150 cm) £11.20

Double Foot Switch Leads £22.40

Foot switch £22.40

Double foot switch £34.70

The above prices do not include VAT. VAT is not chargeable to purchases in the NHS or if a VAT exemption certificate is supplied with order.

Other lead lengths are available on request

Electrodes

Number Electrode 1-9 10-29 30+

879100 Pals 1¼" (32mm) £8.77 £7.89 £7.46
881150 Pals 1½ " (38mm) £6.70 £6.70 £6.70
879200 Pals 2" (50mm) £9.68 £8.70 £8.23
879300 Pals 3" (70mm) £13.61 £12.26 £11.57
891200 Pals 1¼ (30x50mm) £9.23 £8.30 £7.85
901220 Blue Pals 2"x2" (50x50mm) £9.68 £8.72 £8.23

Electrode prices include VAT. VAT can not be claimed back on these items.

**Equipment is CE marked and approved:**

CE marked and approved on 29 September 1998
Certificate Number: CE 02104
For the manufacture of Transcutaneous nerve and muscular Stimulators.