

A person wearing a bright green t-shirt and white shorts is walking away from the camera on a sandy beach. They are holding a leash for a large, fluffy white dog. The background is a vast, flat expanse of sand under a bright sky.

FES EDUCATION DAY

WELCOME

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Clinical Director

Neurological Physiotherapy Services *PhysioFunction*

Independent FES Service

- Started in 2004 with ODFSIII
- Outreach service for National FES Centre from 2007
- Walkaide from 2008
- Bioness L300 from 2009
- Actigait Trained March 2011
- Bioness L300 Plus Trained August 2011

Beyond Beyond Boundaries



Hands on when we're with you, technology when we're not

Overview

- Foot drop – central and peripheral causes
- Neurophysiology of Functional electrical stimulation (FES)
- Evidence of effectiveness of FES
- FES systems with surface electrodes:
 - ODFS Pace and O2CHSII Channel (*OML*)
 - Walkaide (*Innovative Neurotronics*)
 - L300 and L300 Plus (*Bioness*)

Overview

- FES systems with implanted electrodes:
 - STIMuSTEP (*OML*)
 - ActiGait (Otto Bock)
- Cost-effectiveness
- Sources of funding

Inability to lift the foot at the ankle



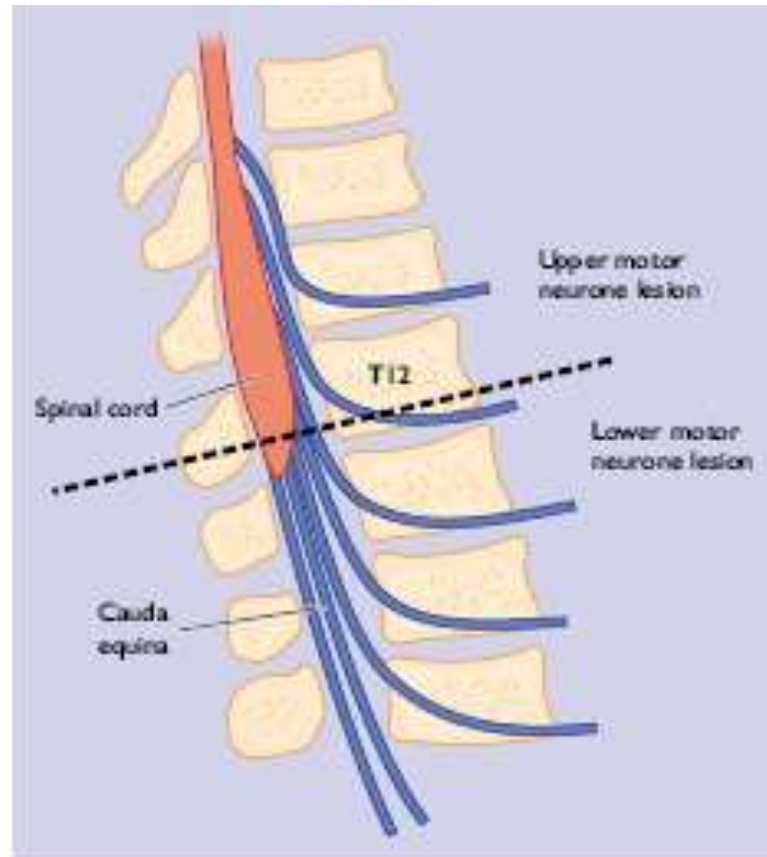
Problems associated with Foot Drop

- Reduced mobility and independence
 - reduced speed of walking
 - increased risk of trips and falls
 - increased fatigue
 - reduced confidence

Causes of Foot Drop

- Central Neurological
 - Stroke
 - Multiple Sclerosis
 - Parkinson's Disease
 - HSP
 - Spinal Injury (above T12)

Spinal Cord versus Cauda Equina





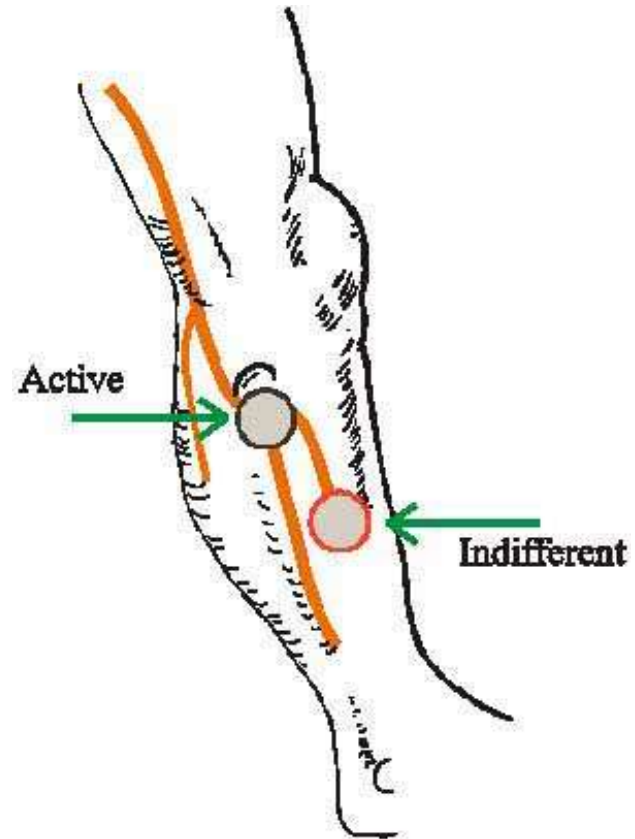
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Causes of Foot Drop

- Peripheral Neurological
 - nerve injury (including Cauda Equina)
 - Neuropathy
- Muscular
 - trauma
 - structural muscle changes

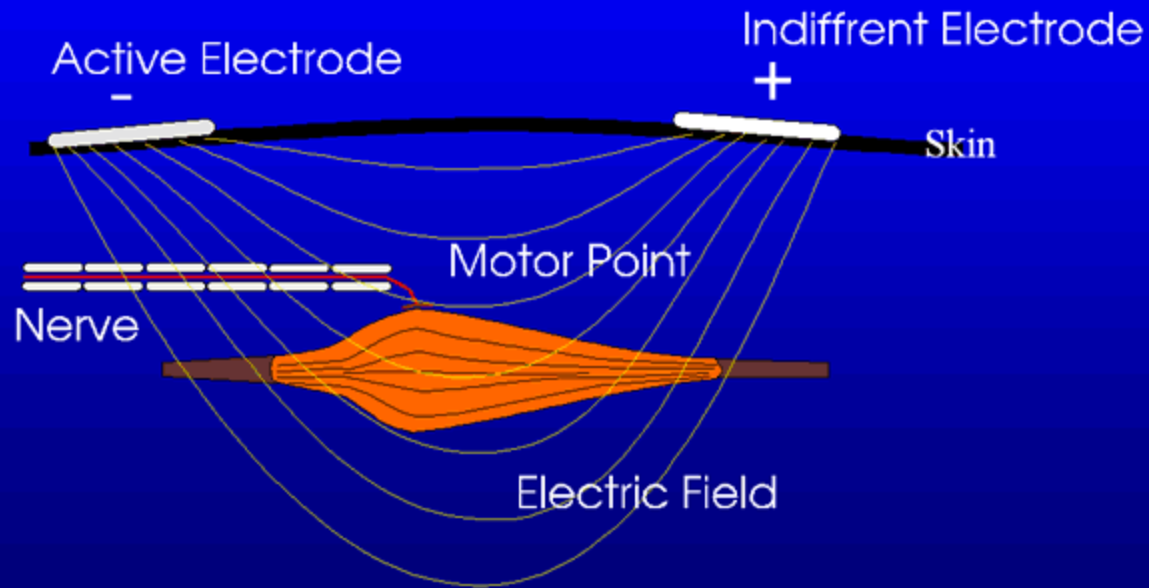
What is FES?

Method of applying low level electrical currents directly to the motor nerves of the body to restore function.



Neurophysiology...

As the nerve passes through the electric field it is depolarised, this triggers an action potential which leads to a muscle contraction .



FES

The first commercially available FES system in the UK was developed by the medical physics department at Salisbury District General Hospital – the Odstock Drop Foot Stimulator (ODFS)



“Go Compare.fes”



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“Go Compare.fes”



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Who can benefit?

- Foot drop caused by
 - Multiple Sclerosis
 - Stroke
 - Incomplete Spinal Cord Injuries
 - Cerebral Palsy
 - Familial/Hereditary Spastic Paralysis
 - Head Injuries
 - *Orthopaedic injuries*
 - *Incomplete peripheral nerve injuries*

Who is suitable for FES?

- Able to stand up from sitting independently
- Able to walk about 10m +/- appropriate aid
- Absence of contractures in the calf muscle

Who is NOT suitable?

- Complete lower motor neuron/ peripheral nerve lesions
- Polio
- *Motor Neuron Disease*
- Fixed contractures

Benefits of FES

- More normal walking pattern
- Improves balance during walking
- Increases speed of walking
- Reduction in effort
- Reduced falls
- Reduction of freezing in Parkinson's Disease
- *Greater confidence when walking, greater independence and participation and an overall improvement in quality of life.*

FES v AFO

- Gait pattern
- Stairs
- Compliance and participation
 - In a recent trial of dropped foot intervention 30% had rejected their AFOs¹
 - Preference of FES over AFO for primary management²
- Additional cost for patients
- Carry-over

¹JE Esnouf, PN Taylor, GE Mann, CL Barrett. Impact on falls and activities of daily living of use of a Functional Electrical Stimulation (FES) device for correction dropped foot in people with multiple sclerosis. *Multiple Sclerosis* accepted for publication 10th Feb 2010

² Bulley C, Shiels J, Wilkie K, Salisbury L User experiences, preferences and choices relating to functional electrical stimulation and ankle foot orthoses for foot-drop after stroke. *Physiotherapy*, 97 (2011) pp 226-233

What the Users say...

“Walking without FES is liking dragging a bag of potatoes along with my weak leg. FES makes me my leg feel normal”

Lynn M, MS

What the Users do...



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Precautions

- Diabetics
- Controlled Epilepsy
- Cardiac problems
- Cognitive impairment
- Intolerance to level of stimulation
- Pacemakers

Contra-indications

- Pacemakers
- Uncontrolled Epilepsy
- Pregnancy
- Broken skin
- Tone increasing in agonists

EVIDENCE

NICE January 2009

“This procedure can be offered routinely as a treatment option for people with drop foot caused by damage to the brain or spinal cord...”

NICE January 2009 1.1

Current evidence on the safety and efficacy (in terms of improving gait) of functional electrical stimulation (FES) for drop foot of central neurological origin appears adequate to support the use of this procedure provided that normal arrangements are in place for clinical governance, consent and audit.

NICE January 2009 1.2

Patient selection for implantable FES for drop foot of central neurological origin should involve a multidisciplinary team specialising in rehabilitation.

NICE January 2009 1.3

Further publication on the efficacy of FES would be useful, specifically including patient-reported outcomes, such as quality of life and activities of daily living, and these outcomes should be examined in different ethnic and socioeconomic groups.

Evidence for Increased Walking Speed and Reduced Effort

- Burridge et al (1997)
 - 32 subjects > 6 months stroke
 - 3 month study
 - Increase in Walking speed of 20.5 %
 - Reduction in effort of 25%

Literature: Effect of FES on walking speed

**Speed
(% Change with FES)**

Author	Stimulator	Comparison	Condition	N#	FES Use	Orthot.	Therap.	Comb.
Stein, 2010	WalkAide	On/Off	Stable	14	11 mo	14	29	43
			Progress.	19		5	7	12
Kottink, 2004		Meta-analysis	Stroke	116				38
Burrige, 1997	ODFS	PT/FES+PT	Stroke	32	3 mo	6-22	0.1	20.5
Burrige, 2000	ODFS	On/Off	Stroke	18	3 mo	7	16	23
Taylor, 1999	ODFS	On/Off	Stroke	111	4.5 mo	12	14	27
			MS	21	4.5 mo	16	-7	10
			SCI	8	4.5 mo	7	12	19
Wieler, 1999	Unistim	On/Off	SCI	31	3 mo-1yr	19-21*	28*	54
	Quadstim		Cerebral	9	3 mo-1yr	2-10*	8*	18
	WalkAide							
Kim, 2004	WalkAide	Nothing AFO/FES FES+AFO	SCI	19	1 session	10		
Sheffler, 2006	ODFS	Nothing AFO/FES	Stroke	14	1 session	8		
Burrige, 2007	ActiGait (I)	On/Off	Stroke	13	11.6 mo**		12^	22^
Kottink, 2007	STIMuSTEP (I)	FES/AFO	Stroke	14	6.5 mo			23
Kottink, 2008	STIMuSTEP (I)	FES/AFO	Stroke	14	6.5 mo		0*	
Burrige, 2000	ODFS	On/Off	MS	21	4.5 mo	16	-7	10
			SCI	8	4.5 mo	7	12	19

Comparison of FES and AFO effect on walking speed

Speed
(% Change)

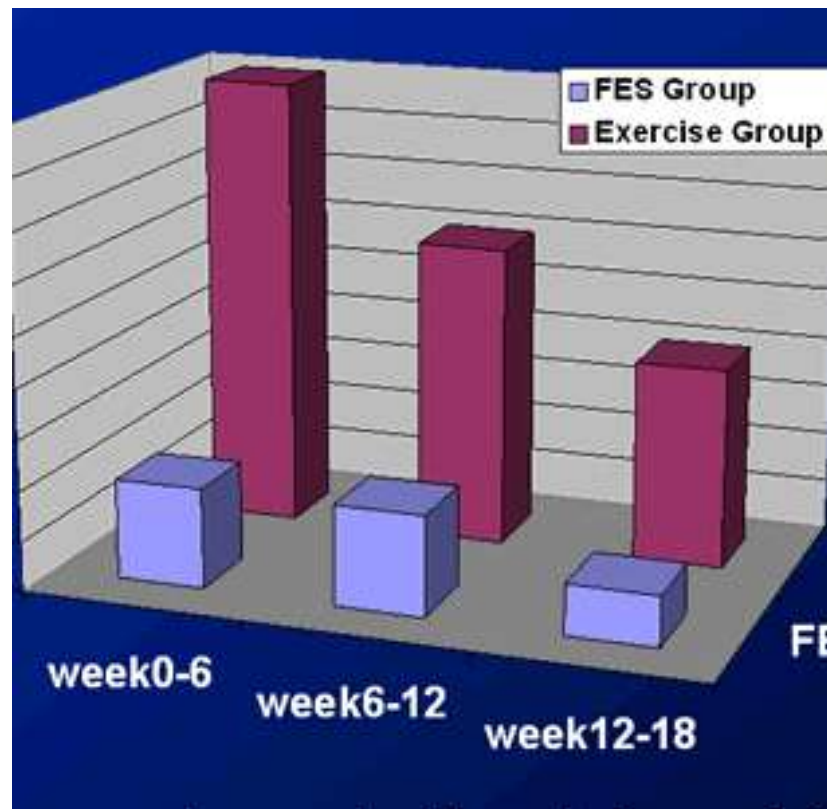
Author	Stimulator	Subjects	N	FES Use	Conditions	Orthot	Therap
Stein, 2010	WalkAide	SCI, Stroke MS, FSP	14 19	11 mo	FES FES	14 5	29 7
Kim, 2004	WalkAide	SCI	19	1 session	AFO FES FES+AFO	8 10 18	
Sheffler, 2006	ODFS	Stroke	14	1 session	AFO FES	19 8	
Kottink, 2007	STIMuSTEP (Implanted)	Stroke	14	6.5 mo	AFO FES		3 23

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Evidence for Reduction in Falls

- Mann et al. (2005)
 - Group 1 (n=21) FES group
 - Group 2 (n=24) Exercise group
 - 18 week study

FES group experience fewer falls at all stages than the exercise group

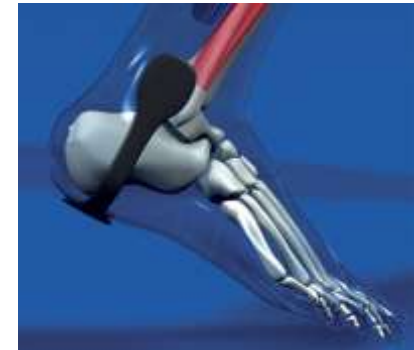


Selection Considerations

- Sensitivity to stimulation parameters
- Triggering
- Paediatric or Adult
- Requirement for secondary muscle groups to be stimulated
- Skin irritation
- Budget

Triggering

- Footswitch/sensor



- Tilt Sensor

FES Systems using Surface Electrodes

- ODFS Pace and O2CHSII Channel
- Walkaide
- Bioness L300 and L300 Plus

ODFS Pace and O2CHSII



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O2CHSII Channel System

- Two ODFS' in one box
- Able to work simultaneously, independently or interact with each other
- Bilateral drop foot
- Stimulation of other muscle groups in conjunction/independently of the foot

Walkaide

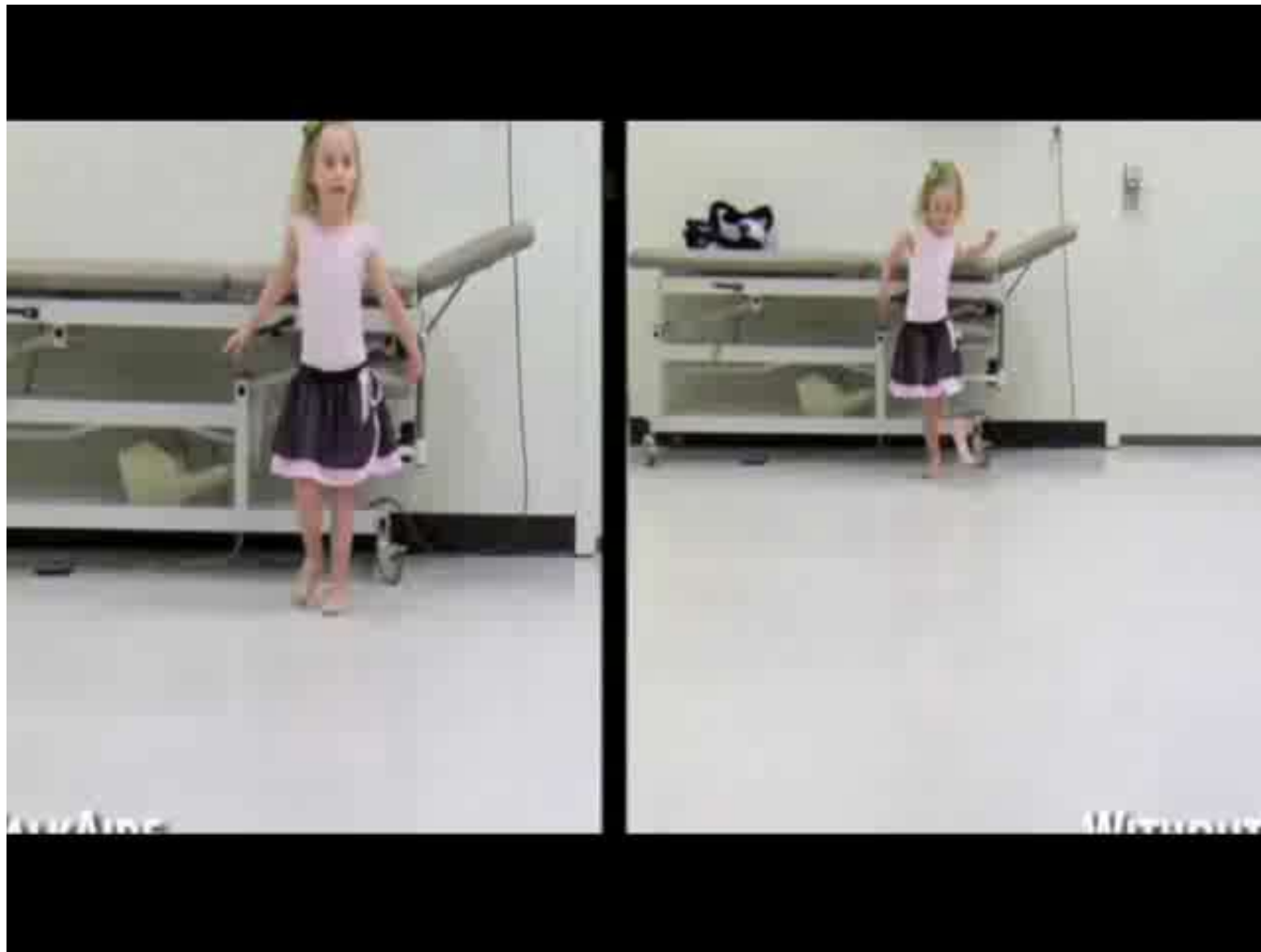


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Walkaide Paediatric Cuff



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Hands on when we're with you, technology when we're not

Bioness L300



Bioness L300 Plus



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Triggering

ODFS Pace	Walkaide	L300
Foot switch •Heel-rise •Heel- strike	Inclinometer & Accelerometer <i>Foot switch</i>	Foot sensor •Heel-rise only

Programming/ Setup

ODFS Pace	Walkaide	L300
Internal menu system	Laptop via Bluetooth and Walklink	PDA via proprietary wireless communication
	Requires training data	

Electrodes – Placement & Specifications

ODFS Pace	Walkaide	L300
Manually positioned	Contained within the cuff	Contained within the cuff
Large variety of electrodes and positions	Small and medium size electrodes	Medium size Cotton Large Cloth
Symmetrical & Asymmetrical Biphasic	Asymmetrical Biphasic	Symmetrical & Asymmetrical Biphasic

Home Training and Clinical Therapy

ODFS Pace	Walkaide	L300
<ul style="list-style-type: none">• Time-based• direct wired triggering	<ul style="list-style-type: none">• Time-based• Walklink (wired)	<ul style="list-style-type: none">• Time-based• Remote clinician/ user trigger

FES Implanted Systems

- STIMuSTEP (OML)
- ActiGait (Otto Bock)

STIMuSTEP (OML)



ActiGait (Otto Bock)



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FES Implanted Systems

	STIMuSTEP	ActiGait
Stimulator Electrodes	Two-channel <i>2-poled</i> stimulating deep and superficial branches of Common Peroneal	Four channel single cuff electrode on common peroneal nerve

FES Implanted Systems

	STIMuSTEP	ActiGait
Programming	External unit	Personal Computer
Triggering	Heel switch	Wireless Heel switch

Cost-effectiveness

- Cost per quality adjusted life years data of supplying FES
- Cost from risk of *NOT* supplying FES
 - Secondary complications e.g. back pain
 - Fracture risk from avoidable falls
 - Litigation

Funding

- NHS FES services
 - National FES Centre plus Outreach Clinics
 - NHS Hospital FES Services eg Selly Oak
- NHS via Specialist Commissioning and Extraordinary Equipment requests
- Access to Work
- Private / self-funded
- Interim or settlement payments

“ABSOLUTELY FABULOUS,
thankyou so much for yoday,I want to tell the world I
CAN WALK AGAIN I realize I have grieved for my
legs,they died and have come to life again,what a
stupendous gift you have given me using this
wonderful aide,I walked up the stytep into the
butchers, bought some lovely sirloin steak for supper
this evening...

...it has certainly pressed a button somewhere, walking up the ramp and step into the house was more like a jump, so easy I haven't been this happy for nearly 6 years.”

18 Months Later

morning jon ,I am walkklking everywhere up loads of steps easily ,thank you for helping me I never thought I would ever be this happy again ever my son wants to know "what are you on mum"it's called happiness ,I can dress myself , walk where ever with or with or without the walk aid.

This last weekend we visited friends for a christening in a very old house full of horrid steps but I managed on my own! ... life **is fantastic** thank you for making this possible with the walk aide.

www.bmycharity.com/jongraham



different **Strokes**

Support for Younger Stroke Survivors



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