





**The International Society for Prosthetics and Orthotics**

**“RECENT CONSENSUS ON DEVELOPMENTS IN THE  
MANAGEMENT OF CEREBRAL PALSY”**

**Thursday 14<sup>th</sup> and Friday 15<sup>th</sup> January 2010**

**The Centre for Life  
Newcastle upon Tyne  
UK**

A major national multi-disciplinary meeting on the findings of an international consensus conference on cerebral palsy.

In autumn 2008, the International Society for Prosthetics and Orthotics (ISPO) organised its second international consensus conference on cerebral palsy. The full published report is available at [http://www.ispoweb.org/HTML/2009/ispo\\_cp\\_report.pdf](http://www.ispoweb.org/HTML/2009/ispo_cp_report.pdf). This detailed report covers the wide ranging findings of the multi-disciplinary group of experts who reviewed current evidence on the major therapy, medical and surgical interventions in use today.

This event brings together an international faculty who will be reporting the conclusions and continuing the dialogue. It will be instructive but also provide a forum for exploring remaining unsettled issues. Topics to be covered include:

- Surgery
- Medical management
- Therapy
- Orthoses
- Seating
- Posture management

This event will be of greatest appeal to multidisciplinary teams involved in the management of cerebral palsy.

Cost: £200 – ISPO members    £230 – Non-members

For further details of the programme, registration forms and travel information visit:

[http://www.ispo.org.uk/events\\_meetings-W.html](http://www.ispo.org.uk/events_meetings-W.html)

<http://www.cpconsensus.org.uk/>

## WELCOME

It gives me great pleasure to welcome you to the ISPO UKNMS Annual Scientific Meeting and Exhibition. I trust you enjoy your stay at Chester and find the meeting to be educationally and professionally enriching.

If this is the first ISPO scientific meeting you have attended, I hope you will enjoy the experience so much that it will become a regular entry in your diary. To all of you who regularly support our scientific meeting, I thank you for your continued support. I cannot stress enough how much ISPO UK NMS relies on your continued support.

The scientific sub-committee has worked very hard on your behalf since our last meeting and I believe we have a scientific programme which you will find both stimulating and interesting. I am also pleased to announce the meeting is again sponsored by a commercial exhibition. This will allow all delegates to see the most up to date components, manufacturing materials, equipment and treatment devices.

We are grateful to Chas A Blatchford & Sons Ltd for providing sponsorship for the Blatchford Lecture and I am looking forward to hearing Jean Paysant. We are equally grateful to the Orthotic Education and Training Trust which has generously sponsored the session on terminal stance.

The choice and range of subjects for the free paper presentations have allowed us to provide a varied programme. Thank you to all of the authors and presenters. Once again, BLESMA and the Limbless Association have generously provided prizes for papers judged to be the best. Remember, it is no too early to think about preparing free papers for 2010.

The scientific meeting could not take place without the support and sponsorship of the companies taking part in the exhibition and I would like to express my sincere appreciation to them. Please ensure that you take time to visit the exhibition and familiarise yourselves with the latest developments and products in prosthetics and orthotics.

I would especially like to thank Otto Bock Healthcare plc for sponsoring wine at our Conference Dinner. We do hope you have made plans to attend the dinner and enjoy fine food and wine in a relaxed setting.

The ISPO UK NMS Annual Scientific Meeting and Exhibition is run for *your* benefit and I would be happy to hear any thoughts you may have on how we might improve it.

Finally, may I express my thanks to you all as without your interest and commitment this event could not continue.

*Joe Wilkinson*

Joe Wilkinson  
Chairman, Scientific Sub-Committee

## PROGRAMME

### Friday 9<sup>th</sup> October

- 10.00 hrs Registration
- 11.00 hrs Welcome – Paul Charlton, Chairman ISPO UK NMS
- 1100 hrs *Chair: Paul Charlton*  
**Developments in Prosthetic & Orthotic Products – 1**
- 11.30 hrs Free Paper Session *Chair: Paul Charlton*  
 11.30 hrs **“A study of stability biomechanics in prosthetic foot design and rehabilitation outcome”**  
 D Moser, Chas A Blatchford & Sons Ltd, Basingstoke
- 11.45 hrs **“Motivations and Barriers to Participation in Exercise & Sport: a review of the literature”**  
 S A Deans, NCPO, University of Strathclyde, Glasgow
- 12.00 hrs **Developments in Prosthetic & Orthotic Products - 2**
- 12.30 hrs *Buffet Lunch in Exhibition Area*
- 13.30 hrs Free Paper Session *Chair: Rory O’Connor*  
 13.30 hrs **“Myoelectrode amplifiers: isolation and common mode”**  
 A Poulton, The Open University, Milton Keynes
- 13.45 hrs **“Comparison between the i-Limb hand and Otto Bock myoelectric prosthesis – a single case study”**  
 C Trethowan, Musgrave Park Hospital, Belfast
- 14.00 hrs Blatchford Lecture  
**“Objective Measurement in transfemoral amputee with microprocessor controlled knee”**  
 Professor Jean Paysant, MD, PhD, Physical Medicine & Rehabilitation, Institut Regional de Readaptation, Nancy, France
- 14.45 hrs *Coffee in Exhibition Area*
- 15.15 hrs Concurrent Interactive Sessions:  
*Co-chairs: Rebecca Beltran & Tom Wickerson* *Chair: Paul Charlton*
- |                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                |
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| <p><b>Prosthetic: Meningitis – from acute care to prosthetic rehabilitation in the young adult</b></p> <p><i>Guest Speakers:</i><br/>         S Sooriakumaran - Queen Mary’s Hospital, London<br/>         J Norton - Chelsea &amp; Westminster NHS Foundation Trust, London<br/>         M Uden – Queen Mary’s Hospital, London<br/>         J Sullivan – Queen Mary’s Hospital, London</p> | <p><b>Orthotic: Results of the ISPO cerebral palsy consensus conference</b></p> <p><i>Guest Speakers:</i><br/>         R Bowers – NCPO, University of Strathclyde, Glasgow<br/>         J Becher – VU University Medical Center, Amsterdam<br/>         D Condie - Glasgow</p> |
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- 16.45 hrs Free Paper Session *Chair: Laura Burgess*  
 16.45 hrs **“Swing to Improve your Walking and your Mood”**  
 D May, Kings College Hospital Rehabilitation Centre, London
- 17.00 hrs **“Dysvascularity and cognition in lower limb amputees”**  
 K Samsam, University of Leeds, Leeds
- 17.15 hrs **“Outcome measures in amputee rehabilitation: on-going service development and review”**  
 T Collins, Douglas Bader Rehabilitation Centre, London
- 17.30 hrs **“An audit of pre, post amputation & primary prosthetic rehabilitation phase for patients attending the Regional Prosthetic Unit, Musgrave Park Hospital, Belfast”**  
 L Graham, Musgrave Park Hospital, Belfast
- 17.45 hrs Annual General Meeting
- 18.30 hrs Exhibition Closes
- 20.00 hrs *Conference Dinner followed by after-dinner entertainment*

## Programme

### Saturday 10<sup>th</sup> October

- 08.30 hrs Registration
- 09.00 hrs Free Paper Session *Chair: Fergus Jepson*
- 09.00 hrs ***“The 1<sup>st</sup> year amputee experiences in use of Echelon, the stance control self-aligning ankle-foot”***  
S Zahedi, Chas A Blatchford & Sons Ltd, Basingstoke
- 09.15 hrs ***“The effect of using three different designs of plastic spinal jackets on gait”***  
B S Alqaroot, University of Salford, Salford
- 09.30 hrs OETT Sponsored Interactive Session: ***Terminal stance – “roll-off” or “push-off” and its impact on orthotic and prosthetic design***
- Guest speakers:*  
G Ramdharry – St George’s University of London & Kingston University  
B Meadows – WESTMARC, Southern General Hospital, Glasgow  
A Shortland – Guy’s & St Thomas’ Foundation Trust, London  
D Moser – Chas A Blatchford & Sons Ltd, Basingstoke
- 11.00 hrs Coffee in Exhibition Area
- 11.45 hrs Invited Speaker *Chair: Fergus Jepson*
- “Neurolinguistic Programming for the Clinician”***  
Candy Bamford, Counselling Psychologist, SMRC, Preston
- 12.15 hrs Award of Prizes
- 12.30 hrs Close

## GUEST SPEAKERS

### **Jean Paysant**

Jean Paysant is a leading French researcher in amputee rehabilitation. A professor at the Institut Regional de Readaptation in Nancy, France, Jean's main specialties include ***gait analysis*** (normal and pathological: lower limb amputation, cerebral palsy & polytraumatism); kinematics, kinetics and kinesiology, ***ambulatory monitoring*** (accelerometry, electrogoniometry) for motor performance; and ***amputation and prosthesis*** (technology, compensatory mechanism, capacity and activity). He is author of numerous publications, including "Compensatory mechanism involving the hip joint of the intact limb during gait in unilateral trans-tibial amputees", J Biomech 2008; "Exercise training for lower limb amputees", Ann Readapt Med Phys 2008; "Influence of terrain on metabolic and temporal gait characteristics of unilateral transtibial amputees." J Rehab. Res. Dev. 2006, "Increasing shoe instep improves gain dynamics in patients with a tibiotalar arthrodesis" Clin. Orthop. Relat. Res. 2006.

### **Sellaiah Sooriakumaran**

Having worked as a junior surgeon for five years, Dr Sooriakumaran underwent training and gained accreditation in the field of rehabilitation medicine. He was appointed a Consultant at Queen Mary's Hospital in 1990 and specialises in prosthetics, orthotics, wheelchairs, special seating, neuro-rehabilitation and assistive technology, with further responsibility for the in-patient amputee management unit. Working in a team-based environment, Dr Sooriakumaran has been actively involved in introducing innovations in the field of amputation surgery and prosthetic rehabilitation. He is a member of various professional bodies including BSRM, SIGAM and ISPO and is a regular contributor to training courses for both doctors and therapists.

### **Maggie Uden**

Maggie Uden is a specialist physiotherapist with over 16 years' clinical experience of lower limb amputee rehabilitation at Queen Mary's Hospital, Roehampton. Her particular interests are in assessing and providing rehabilitation programmes for those with complex needs, in particular the multiple limb loss amputee. Since 1997 Maggie has been the Lead Physiotherapist for the Transfemoral Osseointegration programme and is the co-author of two osseointegration published articles. Maggie has given presentations at the ISPO World Congresses in Glasgow, Hong Kong and Vancouver. She is a member of BACPAR and in recent years has had increased involvement in the promotion of sports and exercise for amputees of all ages.

### **John Sullivan**

John Sullivan is a Clinical Specialist in prosthetics based at Queen Mary's Hospital, Roehampton. He has held a number of roles at the centre, primarily in assessing and managing amputees of all ages and levels. His particular interests are also in student education and the development of the prosthetic technician role. Since 1997 John has been the lead Prosthetist for the transfemoral osseointegration programme and has completed a research MSc with UCL linked to this project.

### **Roy Bowers**

Having qualified as a prosthetist/orthotist from the University of Strathclyde in 1980, Roy worked as a clinician in Belfast and Dublin before joining the staff of the National Centre as a lecturer in 1988. He is currently a senior lecturer in the department. He was an “expert reviewer” on the subject of non-articulated ankle-foot orthoses for the ISPO consensus conference on the orthotic management of stroke patients in 2003, and on lower limb orthotic management of cerebral palsy for the ISPO update consensus conference on CP in 2008. Since 2000 he has been a regular faculty member on ISPO instructional courses on the management of both cerebral palsy and stroke, which have been delivered in the UK, the Netherlands, El Salvador, Vietnam, Tanzania, Chile and Argentina. His main clinical and research interests are in the lower limb orthotic management of neurological conditions.

### **Jules Becher**

Professor Jules Becher is a graduate of the University of Amsterdam and currently based in the Department of Rehabilitation at the VU University Medical Centre in Amsterdam. His speciality is patient care, in particular CP children in regard to orthotics, botulinum toxin treatment, intra-Thecal Baclofen therapy, selective dorsal rhizotomy and single event multi level orthopaedic surgery. He also has an interest in gait analysis and movement analysis for the upper extremity. His research projects have involved the multi-level botulinum toxin treatment, intra-Thecal Baclofen therapy for dystonic CP children and a cohort study in children with CP (9 to 15 year olds) with regard to functional prognosis. His pediatric rehabilitation research involves clinical trials, quality care/functional assessment, functional prognosis, functional biomechanics and translational research.

### **David Condie**

David Condie, is an engineering graduate of the University of Strathclyde and until 2002 was the manager of the NHS Rehabilitation Engineering Services in Tayside, Scotland. He is a Past Chairman of the UK National Members Society of ISPO, served on the Executive Board of ISPO from 1992 to 1998, was the Secretary General of the ISPO World Congress 2001 and the organiser of two consensus conferences on the management of cerebral palsy in 1995 and 2008. His personal interests include biomechanics, gait analysis and orthotics and he has published and lectured extensively on these topics. Throughout his career he has contributed on a regular basis to the undergraduate and post-graduate education of all the professions involved in P & O service delivery both in the developed and the developing world. Since retiring from the NHS he has worked as a Consultant Clinical Engineer while maintaining his interest in the field of standards as the Convener of the Working Group of the International Standards Organisation/Technical Committee 168, responsible for the development of prosthetic and orthotic terminology standards.

### **Barry Meadows**

Barry is a bioengineer who has worked in the National Health Service in Scotland for over three decades. In his early work in Dundee he was involved in the development of the use of ankle-foot orthoses in the management of young CP children. Since those days he has moved around Scotland, with positions as Head of the Rehabilitation Technology Centres in Edinburgh and then Glasgow. More recently he has escaped from the role of manager and returned to being a clinician at Westmarc, Southern General Hospital, Glasgow. Driven by the desire to ensure that patients benefit from being treated by clinicians with a basic and relevant understanding of biomechanics, he finds himself doing a lot of in-service training, particularly with physiotherapists.

Barry is intrigued by the interaction of biomechanics and neurology and is now involved with colleagues in the management of gait problems in adults and children with neurological disorders. This work has led to the development of “neurobiomechanics”, a concept which combines biomechanics and neurological interventions in the development and implementation of individual treatment plans.

### **Adam Shortland**

Adam Shortland is a consultant clinical scientist and manager at the One Small Step Gait Laboratory in Guy's and St Thomas' Foundation Trust. He is also a senior lecturer at King's College, London. He has over 30 full original articles published touching nearly every field of biomechanics and biomaterials. His main current field of research is muscle morphology in children with cerebral palsy.

### **David Moser**

Dr David Moser is research engineer at Chas A Blatchford & Sons Ltd and a visiting lecturer at the University of Surrey. His PhD research work was in the field of gait analysis and amputee biomechanics. He also holds Bachelor Degrees in Mechanical Engineering and Mechatronics. More recent research work includes work in the area of “self-aligning prostheses” culminating in the development of the Echelon Foot, the world's first commercial application of a hydraulic ankle-foot system which can automatically adapt to different walking gradients. A member of the ISO/CEN working group for the structural testing of prostheses, current responsibilities include championing design projects for new advanced prostheses. Previous winner of the Thranhardt lecture prize, he is author and presenter of numerous scientific papers in the fields of prosthetics, gait analysis and rehabilitation engineering.

### **Candy Bamford**

Candy Bamford is a Counselling Psychologist working at Preston SMRC. She has worked in limb centres since 2001 running counselling, hypnosis and trauma service. She is a specialist in pain management using clinical hypnosis and has written a research paper, published in 2006, entitled “A Multifaceted approach to the Treatment of Phantom Limb Pain using Hypnosis” ([www.interscience.wiley.com](http://www.interscience.wiley.com)). Candy is also a specialist in trauma currently training as a consultant in eye movement desensitisation and reprocessing (EMDR). Her time is divided between the NHS and her private practice ([www.arielleps.co.uk](http://www.arielleps.co.uk)).

**ABSTRACTS** *(in order of presentation)*

**Title:**                    **A study of stability biomechanics in prosthetic foot design and rehabilitation outcome**

**Presenter:**            Dr David Moser, Biomechatronics Engineer

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Science ultimately is the key driver bringing about the latest technological advances in the O&P field. Biomechanical research and understanding has over many years built up many, often competing theories on aspects of normal and pathological locomotion. However fundamentally for amputees and health professionals, it is what happens at the socket interface that is of most crucial importance for long term success. In this study a new biomechanical stability concept directing prosthetic foot design which is to ensure the prosthesis acts on the body only by the “right amount at the right time” for all conditions is examined.

The Echelon self-aligning foot was conceived to provide amputees with a foot that has a natural adaptive capability mimicking the adaptive control of muscles to providing stability on a wide variety of terrains. Practical implementation has been brought by a unique combination of conventional spring and keel design coupled with new viscoelastic “self-aligning” hydraulic ankle technology. The aim of the study reported in this paper was to relate gait analysis measurement with real world rehabilitation outcomes experienced by amputees.

Collectively over 500 hundred echelons are now in use, several gait analysis studies on the socket interface loading effects have been carried out comparing conventional foot designs with the Echelon. Various measurements were used in these studies, including GRF video vector, pylon loadcell measurements, and amputee questionnaire feedback. The gait analysis results indicated improved loading symmetry between limbs and a bending moment profile which is closer to the natural ankle joint moment. Feedback and testimonials from amputees indicates considerable improvement in stump-interface comfort, stability and mobility. In many instances the adaptive qualities of foot and the reduction of socket interface pressures is reported as having been life transforming.

The collective conclusion from the gait analysis results and from hundreds of fitting experiences supports the medical benefits brought by the unique “self-aligning” ankle foot design, moreover that biomechanical “instability” in conventional designs is a major issue having a detrimental effect on function. Independent study at a number of leading research institution is now underway to provide further scientific evaluation. Longer term follow up trial and analysis of outcome measures is required to build up a more detailed picture of biomechanical performance and rehabilitation outcome measures. This will continue to stimulate evolution of subsequent self-aligning ankle-foot generations.

**Title:**                   **Motivations and Barriers to Participation in Exercise & Sport: a review of the literature**

**Presenter:**           Mrs Sarah A Deans, MSc, Lecturer

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### **Background**

In considering a strategy for research development at the National Centre for Prosthetics and Orthotics, the importance of making accessibility and involvement in sport to those athletically inclined has become apparent. Preparation for the 2012 Paralympic Games in London and the 2014 Commonwealth Games in Glasgow highlights a need to champion sport for people with lower limb deficiency and empower those who might never have participated to become involved (Gold & Gold, 2007). We are all athletes in our own way; each individual has the right to fulfil their exercise potential. The White Paper on Sport (2007) by the Commission of European Communities stated that "Sport has a greater influence than any social movement as a tool for health enhancing physical activity". Importantly, the UK population with limb deficiency is predominantly elderly and has a sedentary lifestyle (Davies and Datta, 2003). Although there has been an increase in opportunities for these people to participate in sports due to better prosthetic components, the number of sports prostheses' users remains relatively low. This appears to be linked to limited skills specific to disability sport within the rehabilitation and sports professional communities.

### **Objective and methodology**

The objective was to investigate the motivations and barriers to participation in physical activity and sports in a group of people with lower limb deficiency. A review was carried out by examining literature from a number of different sources. Articles were limited to those written in, or translated into English, and which focused on established users of lower limb prostheses. In future, the review will underpin ongoing doctoral research into how exercise and sport participation can be increased for our patients and how exercise concepts and knowledge can be enhanced in the undergraduate curriculum and professional communities. The work examines the motivations and barriers to exercise within the normal population, and how these issues might be compounded within the prostheses user population. The work also examines the type of psychological benefit the user can derive from physical activity and how patients can be encouraged to implement a healthy lifestyle change.

### **Conclusion**

In conclusion and because of its dynamic nature, increasing physical activity in all populations is challenging. The challenges of lower limb loss can seem insurmountable when compounded by an alteration in body image. Factors such as self-efficacy, social support, and perceived health benefits are all mutable and show potential for an increase in the chance of individual behaviour change in people with lower limb amputation. Integrating an achievable, realistic exercise regime into hospital based rehabilitation and importantly continuing this into community based sports initiatives for people with limb loss would capitalise on the clear relationship between physical activity and improved health and well-being.

### **References:**

Davies, D, and D Datta, (2003). Mobility outcome following unilateral lower limb amputation. *Prosthetics and Orthotics International*, 27: 186-190.  
Gold, JR & MM Gold (2007) Access for all: the rise of the Paralympic Games. *Journal of the Royal Society for the Promotion of Health*, 127:3, 133-141.

### **Acknowledgements**

This work has been made possible from funding gratefully received from the Engineering and Physical Sciences Research Council through the University of Strathclyde's Collaborative Training Account.

**Title:** Myoelectrode amplifiers: isolation and common mode

**Presenter:** Adrian Poulton, Dr., Lecturer

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Electromagnetic interference is a common concern in myoelectric prosthesis control, particularly in electrically noisy environments. The active electrodes of a myoelectric amplifier are very sensitive to differential EMG signals, but tend to reject outside interference because of their close proximity and low electrode impedance, when correctly fitted. However there is another entry path for interference that is often overlooked, known as common mode interference. This arises from changes in the earth potential with respect to the active electrodes. The common mode rejection ratio (CMRR) of an amplifier is a measure of its sensitivity to common mode interference. The CMRR is high (low sensitivity to common mode) for commercial myoelectric amplifiers. Winter and Webster (1983) distinguish between the CMRR that is intrinsic to the amplifier itself, and another common mode effect that is due to an imbalance between the impedances of the two active electrodes. In practice it is unlikely that these will be exactly balanced, due to variations in skin contact. Common mode effects may be exacerbated if the input and output of the amplifier are not isolated from each other. The user earth potential, represented by the centre inactive electrode, may be affected by interference through the battery and output leads, which can act as antennas.

Measurements were made on a commercial myoelectric amplifier (Otto Bock 13E125) to quantify the effects of electrode imbalance and isolation, and compare with theoretical models. This amplifier had excellent isolation at d.c., but the a.c. isolation was limited due to the use of capacitors in its construction. The measurements were repeated with the amplifier additionally isolated by means of an isolation amplifier (Burr-Brown ISO124), and a d.c.-d.c. converter (Murata MEA1D0505SC) to provide isolated power. Although this still did not provide perfect isolation, it improved the intrinsic CMRR by 20 dB and also significantly reduced the sensitivity to electrode impedance imbalance.

While this study confirmed the benefits of good isolation, the d.c.-d.c. converter used was inefficient with such a low load, and so the power required was much greater than for the myoelectric amplifier alone. Future improvements through appropriate low power circuit design could resolve this problem. The ultimate in isolation is to use wireless electrodes, as are already available for telemetry. Apart from being convenient and avoiding the reliability problems associated with wiring, as this study shows they also eliminate a major gateway for interference. Power management is again the main outstanding problem here, but solutions may soon emerge from the fast growing field of wireless sensor network technology.

#### **Reference**

Winter B. and Webster J. 1983. Reduction of interference due to common mode voltage in biopotential amplifiers. IEEE Trans Biomed Eng BME-30:58-62.

**Title:** Comparison between the i-Limb hand and Otto Bock myoelectric prosthesis - a single case study

**Presenter:** Claire Trethowan, Head Occupational Therapist

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Miss Lynne Chalmers, Prosthetist  
Dr Suzanne Carson, Clinical Psychologist

**Background:** The i-Limb, by Touch Bionics, a myoelectric hand with 5 individually powered digits, is marketed as transforming the lives of everyday people.

**Aim:** To explore the everyday functioning and psychological effect with the i-Limb prosthesis to an Otto Bock hand.

**Design:** Single patient cross over trial.

**Subject:** One male with bilateral transradial amputations, a competent user of 2 site electrode Otto Bock prostheses who also uses body powered prostheses.

**Outcome measures:** SHAP (Southampton Hand Assessment Procedure); a clinically validated hand function test. The repertory grid; a qualitative technique exploring individual values and preferences regarding specific choices.

**Method:** The right side was assessed as patient was right dominant. He continued to wear the left Otto Bock prosthesis during all assessments. The run in period & training for the use of the i-Limb was 5 months. Wearing initially the i-Limb, SHAP was completed. The Otto Bock hand had SHAP assessment 2 months later. The Rep Grid was completed after 8 months of i-Limb availability.

**Results:** Functionality profile has shown for spherical grip both prostheses performed the same, the i-Limb performed better with tripod, tip and extension grips and the Otto Bock performed better with power grip. Activities of daily living tasks, i-Limb performed better with tasks that required the lateral, tip and extension grips. Otto Bock performs tasks well that require the power grip. Overall SHAP 4 points higher for i-Limb.

**Repertory Grid:** the patient rated both his Otto Bock and i-Limb favourably. The important differentiating constructs were functionality, independence and comfort satisfaction. Should the perceived practical difficulties with the i-Limb be overcome this would bring him closer to his notion of 'ideal self'.

**Conclusion:** the i-Limb achieved a slightly higher overall score for function. Psychologically the i-Limb rated similar to the Otto Bock Prosthesis.

The Belfast team are currently starting to trial the i-Limb with unilateral upper limb amputees who have lost their dominant hand using the same outcome measures.

**The Blatchford Lecture 2009**

**Title:** Objective measurement in transfemoral amputee with microprocessor controlled knee

**Presenter:** Professor Jean Paysant

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The objective is to discuss the contribution of “in-lab” and “out-lab” objective measurement in transfemoral amputee (TFA), in the light of International Classification of Functioning. The lecture is based and illustrated by two research studies about microprocessor controlled knee in TFA.

*Part 1: The lengthened swing phase of prosthetic limbs in TFA : microprocessor controlled knee versus swing phase controlled knee*

**Objective:** To analyze lengthened swing phase of the prosthetic limb in unilateral TFA as compared with a group of asymptomatic subjects; and to identify a latency period in the TFA between the full extension of the prosthetic knee and the initial ground contact of the ipsilateral foot. To compare this latency period in amputee with microprocessor controlled knee and swing phase controlled knee

**Design:** Three-dimensional gait analysis with an optoelectronic device.

**Population:** 39 TFA and 15 able-bodied subjects.

**Main Outcome Measures:** Spatiotemporal, kinematic, and kinetic gait parameters.

**Results:** The swing phase and the latency period of the prosthetic limb, associated with a consequently longer single-limb stance phase in the healthy limb, were significantly longer than those measured in the healthy limbs of these subjects, as well as those measured on both lower limbs of the able-bodied subjects ( $p < 0.05$ ). The latency period is significantly reduced in microprocessor controlled knee population (48%,  $p < 0.05$ )

**Conclusion:** The lack of muscular effectors and proprioceptive afferences in the prosthetic knee of unilateral trans-femoral amputees could explain the longer latency period at the end of the swing phase for the prosthetic limb. This latency period appears to be necessary to insure the stability of the prosthetic knee. We suggest calling this time, "confidence time". The microprocessor control of the knee reduce significantly this latency period.

*Part 2: The locomotor capacity and performance in daily life of TFA : microprocessor controlled knee versus conventional knee*

**Introduction:** The plus-value of microprocessor controlled knee is demonstrated in lab conditions. Despite the satisfaction of C-Leg users, the amputees aren't more active with C-Leg.

**Objective:** To compare the walking characteristics of active transfemoral amputee by C-Leg versus Conventional knee, both in semi-natural controlled conditions and in daily life conditions.

**Design:** Semi-natural conditions (asphalt normal and fast walking, grass, slope up and down, stairs up and down) and Natural conditions (12 hours monitoring during a weekday)

**Population:** Randomized crossover (Microprocessor controlled C-Leg knee versus non microprocessor conventional knee) ; 8 TFA, daily user of well fitted prosthesis, active in professional or vocational daily activities.

**Main Outcome Measures:** Prosthetic Profile Amputee- LCI, Houghton scale, Quebec User Evaluation of Satisfaction with assistive Technology  
Accelerometry Monitoring Vitaport : step rate, walking speed, heart rate response, Physiological Cost Index, duration of activities.

**Results:** High level with both prosthesis for PPA-LCI and Houghton scale ; Semi-natural conditions : significant improvement with C-Leg for QUEST, PPA-LCI (uneven ground, stairs), Walking Speed and Physiological Cost Index (fast walking, grass, slope and stairs down) ; Natural conditions : no difference (C-Leg versus Conventional) in locomotor performance during daily life monitoring.

**Conclusion:** First, microprocessor controlled knee improve locomotor capacities and metabolic efficiency just in exigent conditions. Patient needs must be precisely analysed before microprocessor medical prescription. Second, these results exhibit the dissociation between capacity (semi-natural conditions) and performance (natural conditions). The hypothesis of an “sparing behaviour” in front of exigency is discussed.

### **Concurrent Interactive Sessions**

<b>Meningitis – from acute care to prosthetic rehabilitation in the young adult</b>	<b>Results of the ISPO cerebral palsy consensus conference</b>
<p>Meningitis will often present the rehabilitation team with multi-faceted and complex problems to solve. If anything this challenging condition highlights the need for a specialist multi-disciplinary approach and holistic assessment and planning; from the acute care through to prosthetic rehabilitation and follow up.</p> <p>This session aims to bring together several disciplines to give an overview of management and ultimately stimulate discussion amongst the delegates.</p>	<p>In September 2008, ISPO organised an international consensus conference on “Recent developments in healthcare for the treatment of cerebral palsy”. Whilst the full report is available at <a href="http://www.ispoweb.org">http://www.ispoweb.org</a>, this is a three hundred page document.</p> <p>This session brings together several of those involved to present some of the key findings of the conference and gives us a preview of a major two-day event in January which will fully disseminate the findings of this extensive piece of work.</p>

**Title:** Swing to Improve your Walking and your Mood

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**Introduction:**

Seven Upper Extremity Amputees have been referred for Clinical Gait Analysis to assist in their Prosthetic Rehabilitation. Six of these patients were analysed where the only difference between runs was 'With' or 'WithOut' their prosthesis. Two Patients were TR. HL 46-year-old Female Congenital amp. Wearing an R Cosmetic Arm. RS 52-year-old Male RTA amp. Wearing an R Myoelectric Arm. Two were TH amps. YT 33-year-old Female Congenital amp. Wearing an L Cosmetic Arm. SE 52-year-old Male Crush Injury amp. Wearing an L Cosmetic Arm. Two were SD amps. IA 26-year-old Male RTA amp. Wearing an L Cosmetic Arm. DS 42-year-old Male Crush Injury amp. Wearing an L Cosmetic Arm. Two 'Normal' Students were also analysed where the only difference was a Natural Swing of the Dominant Arm and dominant arm held rigidly still.

**Method:**

Strict protocols are always adhered to for comparison between runs and patients. GRFs were compared to see if any differences could be found between 'W' and 'WO' and 'NS' and 'RS' and these were randomised. The M/L, A/P and Vertical GRFs were compared for the Dominant and Ipsilateral legs and the Torsional stability (Polar Rotations) were compared.

The Foot Positional Accuracy were also compared and Fast Fourier Transformations FFTs were computed to assess the Balance and Stability of Locomotion.

**Results:**

Dominance plays an important role in all normal and amputee gait, but in the upper extremity this is very much more significant and differences occurred between Congenital and Acquired amputees, and Occasional and Habitual wearers. All the amputees, however, said the arms were too hot and too heavy, and the 'normals' said walking with the rigid arm felt 'funny' Generally the lateral stability improved when wearing the arm. The initial loading response at first rocker increased and the torsional stability improved. The velocity (V) power (W) and work done (J) all reduced and the FFTs showed marked improvements. Similar trends were found in the Students with the arm held rigid. In the SD level where the arm swing translates from the normal flexion-extension mode to an Ab-Adduction mode this improvement was not seen in the saggital plane.

**Conclusions:**

Clinicians seem to be totally unaware of the importance of training the upper extremity amputee to walk with their Prosthesis. Remember that gait is controlled by the Limbic System, which also controls our mood: If we feel good we walk well, and visa versa. The importance of Natural Arm Swing and energy exchanges for a better-balanced and stable locomotion in U/E gait. Just as in the Lower Extremity (where there are many SP devices) a Simple, Light weight Swing device is required which can be individually tuned to provide a similar Inertia to the contralateral limb, particularly at SD level and at TH level as well.

**References:**

May DRW (1998) Kinematic and Kinetic Analysis of Function. Chapter on Gait Analysis. *Sciences Basic to Orthopaedics*, edited by SPF Hughes and ID McCathy. WB Saunders & Co pp 277-296.

**Title:**                    **Dysvascularity and cognition in lower limb amputees**

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**Aims and Objectives:**

Superior performance on cognitive testing is associated with better walking ability following lower limb amputation.<sup>1</sup> The aim of this study is to investigate whether dysvascular lower limb amputees perform less well on cognitive testing than non-dysvascular amputees.

**Methods:**

59 lower limb amputees with a mean age of 63 years attending the Leeds Amputee Rehabilitation Service for provision of their first prosthesis were recruited to this cohort study. 38 had their amputation due to dysvascularity. Subjects completed the Addenbrookes Cognitive Examination (ACE-R) and Trail Making Test. The Mini Mental State Examination (MMSE) score was derived from the ACE-R. Age specific Z-scores for the Trail Making Test were calculated to correct for age. Statistical analysis was performed using the Mann-Whitney U Test.

**Results:**

More subjects in the dysvascular group were classed as cognitively impaired using the MMSE and ACE-R than in the non-dysvascular group, although the number of non-dysvascular amputees in the impaired categories were too small to allow statistical comparison. The dysvascular group took significantly ( $p \leq 0.05$ ) more time to complete parts A and B of the Trail Making Test. However, when those with known cerebrovascular disease were excluded and age was corrected for only part B scores remained significantly different between the groups.

**Conclusion:**

There was a trend for the dysvascular group to perform less well in all tests. However, when cerebrovascular disease and age were corrected for in the Trail Making Test only part B scores remained significant. This tendency to poorer cognitive function in dysvascular amputees may contribute to reduced walking potential and therefore warrants further investigation.

Sansam K, Neumann V, O'Connor R, Bhakta B. Predicting walking ability following lower limb amputation: a systematic review of the literature. *J Rehabil Med.* 2009 Preview. DOI:10.2340/16501977-0393.

**Title:** Outcome measures in amputee rehabilitation: on-going service development and review

**Presenter:** Tom Collins, Pre-registration Clinical Scientist, Mr

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SIGAM grading is well established in the Centre for classifying amputees according to functional mobility, giving a quantified outcome, but there are concerns locally that it is subjective and lacks sensitivity to change. In 2007 the Timed Up and Go (TUG) test and Two Minute Walk Test (2MWT) were adopted by the Physiotherapy team as outcome measures for primary amputees at discharge, three week and six month follow-up, and for established amputees attending for new prescription or 'top-up' therapy. TUG provides a measure of overall basic functional mobility, and 2MWT assesses higher functional performance (Condie et al. 2006). After two years of data collection (over 400 episodes of care) a review was conducted. This paper presents the information shown by the data so far, and the work conducted to develop use of outcome measures in the light of problems highlighted by the review.

Results of review:

- SIGAM shows weak relationship to both measures, supporting concerns over subjectivity.
- TUG and 2MWT results show a strong non-linear relationship, giving a sense of mutual validation and supporting use of both measures rather than only one.
- Trends seen by cause or level of amputation may be useful for informing amputees' expectations and for supporting management decisions.
- Individual cases highlight the value of objective measures to prompt questioning of rehabilitation progress and potentially indicate further therapeutic or prosthetic intervention.

A multi-disciplinary team is working to address limitations that were identified:

- Communication and coordination across disciplines is being promoted to improve consistency in assessment and data entry at each stage of follow-up.
- A method has been developed to record the measures in each amputee's prosthetic notes so that all clinicians can easily access the information to inform treatment.
- Graphical reference cards have been developed to put individual scores in context; showing the range of scores across the amputee population.

This work has shown the value of outcome measures to inform rehabilitation progress, but TUG and 2MWT are very specific (limited set of tasks in a controlled environment) so the Locomotor Capabilities Index is being pilot-tested to quantify overall function. Options are also being considered to evaluate quality of life, however use of tools must be balanced with the practicalities of implementation. For less frequent, more detailed investigation of individual cases a bank of evaluation tools is being developed, along the lines of that proposed by Kahle et al. (2008).

It is hoped that the experiences from this Centre will be useful for the wider community, informing work towards achieving national consensus in use of outcome measures through groupings such as the British Association of Chartered Physiotherapists in Amputee Rehabilitation and the national Prosthetic Centre Managers Forum.

### References

- Condie E, Scott H, Treweek S. 2006. Lower limb prosthetic outcome measures: a review of the literature 1995 to 2005. *J Prosthet Orthot* 18(1S):13-45.
- Kahle JT, Highsmith MJ, Hubbard SL. 2008. Comparison of nonmicroprocessor knee mechanism versus C-Leg on Prosthesis Evaluation Questionnaire, stumbles, falls, walking tests, stair descent, and knee preference. *J Rehabil Res Dev* 45:1-14.

**Title:** An audit of the pre, post amputation & primary prosthetic rehabilitation phase for patients attending the Regional Prosthetic Unit, Musgrave Park Hospital, Belfast

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### **Aim**

The British Society of Rehabilitation Medicine encourages preamputation consultation, the use of a standard referral form for communication and the offer to all amputees of an appointment at the Prosthetic Centre.<sup>1</sup>

Musgrave Park Hospital is the Regional Prosthetic Unit for all patients in Northern Ireland. In this audit we have explored the frequency of preamputation consultation, if patients are referred to the centre promptly for consideration for rehabilitation, the use of appropriate referral forms and if they are seen equitably regardless of which hospital is referring. Waiting times for first appointment, and outcome of primary assessment & prosthetic rehabilitation (as appropriate) were also obtained.

### **Method**

Using the Opcare SIMS computer data system the names of all patients referred to the Regional Prosthetic Unit from April 2008 - March 2009 were generated. All patient notes were checked by LG to record referral times, date to first appointment and presence of a completed referral form. Verification of dates of referral and the outcome of primary prosthetic rehabilitation was also recorded.

### **Results**

161 referrals were made to the centre over this period. Six patients died prior to their first appointment. Thirty-one referrals were for preamputation consultation - 30 out of 31 from hospitals close geographically to the RPU.

93 % of referrals were for patients with lower limb amputations. 52% of charts had the appropriate referral form, 40 % had a referral letter and 8% had no referral letter at all. The median time for referral to RPU was 28 days with a range from 1day to 71 days. The median time for first appointment at RPU was 30 days with a range from 7 days to 84 days. In 32 % of primary patient referrals a prosthesis was not provided. The remainder to the lower limb amputees had the following SIGAM grading at the end of the primary prosthetic phase 9% A, 6%B 25%C 53%D.

### **Conclusion**

Preamputation consultation referrals were fewer than expected from orthopaedic units where there is usually time to do so. All referrals are not being made on the standardised form which has all information which is needed itemised by the RPU to process appointments quickly. Speed of first referral was slower for the more peripheral hospitals. Mobility outcome is similar to previous studies in other centres.

### **Reference**

1. Amputee and Prosthetic Rehabilitation – Standards and Guidelines (second edition). British Society of Rehabilitation Medicine. Oct. 2003

**Title:**                    **The 1<sup>st</sup> year amputee experiences in use of Echelon, the stance control self-aligning ankle-foot**

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Over 500 Echelon ankle-foot devices have been fitted in the first 12 months since its launch in September 2008. The amputee's reactions collected so far has been remarkable, being seen as one of the most effective prosthetic devices provided in the last century to reduce the impact of their disability. Most immediate feedback and after a relatively short period of use is summed up as having a life transformative effect in providing remarkable comfort in walking, standing balance on both limbs on flat and slopes, ease of getting out of chair without undue high pressure in stump socket interface, sitting down and going up and down the stairs safely and in a more natural and realistic manner.

The concept of Echelon was based on quantification and deeper understanding of amputee compensation mechanisms at a muscular level dealing with their disability and limitations imposed by conventional prosthesis design. Conventional prostheses cause undue muscular fatigue, excessive joint loading of sound limb in order to accommodate for the deficiencies of dealing with simple daily tasks such a standing, and walking safely on slopes and uneven terrain. A hydraulic ankle capable of providing controlled viscoelastic damping in plantar and dorsi flexion phase of stance combined with independent dynamic response heel and toe composite springs, provides a means of self alignment for amputee centre of mass to naturally follow the centre of pressure during walking and standing.

This paper will describe various amputees' reactions through a series of questionnaires and interviews. Criteria including the type of prosthesis they were using before, the level of amputation, different activity levels, the benefits in increased comfort and mobility for different group will be reported. Through collection of kinetic and kinematic parameters, the biomechanical evidence for increased symmetry in walking and equal balanced loading during prolonged standing on level and inclined on selected samples will be shown.

A review of independent research studies already started by various universities on stump socket interface, biomechanics of stance phase self-alignment, impact of dorsiflexion during swing phase to assist clearing the ground, and reduction of metabolic energy expenditure of walking as part of progress report will be presented. Preliminary outcome measures suggest increased confidence for amputees in outdoor walking which is associated with reduction in risk of falls. These have highlighted the need for further quantification of substantial benefits of this device over existing ones, including more cost effective health economics through providing self- alignment that result in reduced socket interface pressure and subsequent reductions in number of visits for adjustment as some of the benefits to practitioners in the fitting process.

**Title:** The effect of using three different designs of plastic spinal jackets on gait

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**Introduction:** Various pathologies can cause vertebral column deformation. If the body is unable to compensate for this, a spinal orthosis can help to contain the deformation by restricting movement of the torso (Konz et al. 2006). Many investigators have tried to quantify the extent of restrictions imposed by spinal orthoses and their effects on gait in general (Konz et al. 2006; Wong et al. 2008). A number of publications give a reasonable insight into these aspects, but there are still gaps in the literature, which the current study attempts to fill. The aim therefore is to measure the gait kinetics and whole body kinematics, specifically of all major upper and lower limb joints, as well as the pelvis, torso and head during walking with three different spinal orthosis designs and no orthosis.

**Method:** One healthy, asymptomatic, 27-year-old male participated in this study, which involved gait analysis of four conditions. Each condition was tested over 45 walking trials at a comfortable, self-selected walking speed along an approximately 10-meter movement laboratory walking path. The four conditions were based on walking without an orthosis and with the three orthoses to be tested:

- lumbosacral orthosis (LSO);
- thoracolumbosacral orthosis (TLSO);
- thoracolumbosacral orthosis with shoulder extension (TLSOW).

**Discussion of Results:** While wearing a spinal orthosis:

A) Shock absorption during weight acceptance was decreased due to a substantial decrease in pelvis obliquity, which was to some extent compensated for by a considerable increase in knee flexion.

B) Forward lean of the thorax was increased either to avoid discomfort at the posterior distal skin-orthosis interface or to restore the centre of mass position, which may have been shifted posteriorly due to the additional and more posteriorly located weight of the orthosis.

C) Hip flexion and ankle dorsiflexion were decreased as foot clearance was more easily achieved during swing phase due to decreased pelvis obliquity (more specifically less pelvis drop).

D) Increased hip extension during late stance phase positioned the shank further posteriorly and hence further away from the ground, which increased ankle plantarflexion in order for the foot to stay on the ground for as long as required.

E) Hip abduction decreased, but the stride width, which is commonly associated with hip abduction, did not, due to decreased pelvis obliquity, rather than thigh abduction movement.

F) Compared to an LSO, a TLSO and a TLSOW was more efficient in restricting relative transverse rotation between the pelvis and the thorax.

**Conclusions:** Using a spinal orthosis changed the movement pattern of a number of body segments either at specific times of the gait cycle or throughout. In particular, a number of unrestricted body segments increased their movement to substitute for the decreased movement of restricted body segments. Overall, the effectiveness of a spinal orthosis for restricting spinal motion was greater the further it extended proximally, which can be attributed to the increased encapsulation of the torso and hence the lengthened lever arm for restricting motion.

## References

Konz R, Fatone S, Gard S. 2006. Effect of restricted spinal motion on gait. *J Rehabil Res Dev* 43:161-70.

Wong S, Cheng Y, Ng K, Lam P, Sin W, Lee-Shum F, Chow K, Tam P. 2008. The effect of rigid versus flexible spinal orthosis on the gait pattern of patients with adolescent idiopathic scoliosis. *Gait & Posture* 27:189-195.

***OETT Sponsored Interactive Session***

**Terminal Stance – “roll-off” or “push-off” and its impact on orthotic and prosthetic design**

What actually happens at terminal stance is not clearly understood. This session brings together differing views and the potential impact on orthotic intervention along with a review of current literature. There is also consideration on how this may impact on prosthetic design. This session provides a platform for consideration and debate relating to current understanding.

**Title: Neurolinguistic Programming for the Clinician**

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This presentation will provide an overview of neurolinguistic programming, looking at what NLP is as well as its different applications in today's society.

The focus of the presentation is to assist clinicians by looking at how NLP can benefit you personally by putting you in the driving seat of your life. It will also look at how you communicate more effectively, noting how people think by the language they use, by their body language and what it means.

NLP can provide tools and techniques to help you in your work assisting you to get people to listen in challenging situations or helping you to work with difficult people.

The presentation will conclude by looking at ways to learn these techniques for yourself.

## Exhibitors

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