



**International Society for Prosthetics and Orthotics
United Kingdom National Member Society**

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

Thursday 14th and Friday 15th January 2010

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

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WELCOME & BACKGROUND - John R Fisk, MD

In 2006, David Condie wrote (edited for presentation here)

“In 1994 ISPO organised and funded a Consensus Conference on the Orthotic Management of Cerebral Palsy, the report of which was published in 1995 and remains one of the most frequently requested ISPO publications. The content and recommendations contained in this report have formed the basis for the programmes of the six ISPO CP Instructional Courses on this topic which have subsequently been delivered at sites in Europe, the Americas, Africa and Asia.

Happily clinical practise in this field has progressed significantly in the 12 years since the consensus conference. As a consequence I have recommended to the ISPO EB (in my reports to their meetings in Hong Kong in August 2004 and in Copenhagen during 2005) that ISPO should organise a further consensus meeting to update the recommendations contained in the original report in the light of these clinical developments.

The minute of the Executive Board (EB) meeting of 30/7/2005 (Paper EB75 Minute) reports that the EB consider “that developments in this area did not justify a consensus conference”...

I would be failing in my duty as Task Officer if I did not respond to these statements. Firstly, as I have previously stated, since 1994 there have been a number of significant developments in the management of cerebral palsy encompassing the areas of functional assessment, treatment planning protocols, surgical, chemotherapeutic and orthotic treatment and importantly outcome assessment. Also importantly, the scientific quality of the published research on this topic has improved substantially.

It is my view that it is simply inaccurate to state that these developments do not justify an update consensus meeting. I have discussed all these matters with the Short Course Co-ordinator and after taking his advice have decided to resubmit to the EB my recommendation that ISPO should organise this meeting.

In conclusion, the challenge which the management of the ambulatory problems resulting from cerebral palsy represents has, over the past ten years, stimulated the development of a whole range of improved assessment and treatment techniques, all of which have some bearing on the role of orthotics for this group of patients. During the same period the methods of orthotic management have also progressed due both to improved scientific understanding of their effects and technical advances. Many of these developments are now finding applications in the management of other patient categories with similar or related problems.

The 1994 ISPO Consensus Conference was a landmark event in the evolution of orthotics as a scientifically based field of clinical practice. The report of the conference focussed attention on both the successes and the limitations of the management methods available at that time and provided inspiration and encouragement to many practitioners of all disciplines.

The current challenge to ISPO is to build upon this achievement by providing a credible modern successor to that original report.”

As a result of David's commitment and pursuit of the importance of this project, an ISPO sponsored Consensus Conference was held at Wolfson College, Oxford on 8 – 11 September 2008. The report of that meeting has been made available to all through its posting on the ISPO website. It is entitled

“Recent Developments in Healthcare for Cerebral Palsy: Implications and Opportunities for Orthotics, An Update of a Consensus Conference” edited by David Condie, BSc C Eng and Christopher Morris, MSc DPhil.

This Instructional Course is the first to be developed after that Consensus Conference. ISPO International felt it fitting that it be held in the UK, the location of the work that has led to its content. Most of the speakers participated in Bristol and are expanding on their papers presented there. Others are filling slots to help economise on long distance travel. Everyone has been asked to represent the conclusions of the consensus conference. If, however, they disagree with those conclusions, they have been asked to indicate where and why their differences are being presented.

A fundamental conclusion of both the 1994 Consensus Conference and the more recent update in Bristol held last year was that research in the field of orthotic management in cerebral palsy is inadequate or lacking. This meeting will therefore conclude with a panel discussion by four individuals actively involved in orthotic research addressing these issues and the way forward. Your participation will be encouraged.

PROGRAMME

Thursday 14th January 2010

08.30 hrs	<i>Registration & Refreshments</i>	
09.00 hrs	Welcome	Dan Blocka
09.15 hrs	ISPO and Consensus Conference Background	John Fisk, MD
09.30 hrs	Over-riding Theme, Global Perspective	John Fisk, MD
10.00 hrs	Definition, Classification, GMFCS, MACC	Jan Willem Gorter, MD, PhD
10.30 hrs	<i>Refreshment Break</i>	
11.00 hrs	Physiotherapy	Wayne Stuberg, PhD
11.30 hrs	Occupational Therapy	Jane Chantry
12.00 hrs	Patterns of Gait	Gordon Ruder, CO, MSc
12.30 hrs	Discussion	Mary Gibson, MD
13.00 hrs	<i>Lunch</i>	
14.00 hrs	Medical Management	Jan Willem Gorter, MD, PhD
14.45 hrs	Orthopaedic Management – The Ambulatory Child	John Fisk, MD
15.30 hrs	<i>Refreshment Break</i>	
16.00 hrs	Orthopaedic Management – The Non-Ambulatory Child	John Fisk, MD
16.45 hrs	Discussion	Mary Gibson, MD
17.00 hrs	Close	
18.00 hrs	Reception/Dinner	

Friday 15th January 2010

09.00 hrs	Welcome and Setting the Agenda	John Fisk, MD
09.10 hrs	Orthotic Management CC Conclusions (LL & UL)	Roy Bowers, CO
09.45 hrs	Orthotic Biomechanics Principles and Research	Barry Meadows, PhD
10.15 hrs	Orthotics: Hip & Spine	Bryan Malas, CO
10.40 hrs	<i>Refreshment Break</i>	
11.10 hrs	Seating	Jane Chantry
11.30 hrs	Discussion	Mary Gibson, MD
12.00 hrs	<i>Lunch</i>	
13.00 hrs	Orthotic Research – What is the Future?	John Fisk, MD
13.00 hrs	- Point 1	Elaine Owens, PhD
13.20 hrs	- Point 2	Bryan Malas, CO
13.40 hrs	- Point 3	Gordon Ruder, PhD
14.00 hrs	- Point 4	Diane Damiano, PhD
14.20 hrs	The Future of P & O Research	Chris Morris, Co, PhD
14.45 hrs	Floor Q & A Session	
16.30 hrs	Adjourn	

GUEST SPEAKERS



John Fisk, MD

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Dr Fisk grew up in Western New York and after his undergraduate education at Grinnell College in Iowa, returned to SUNY at Buffalo for his medical education. He completed his orthopaedic training at the University of Minnesota in 1974. The next two years were spent with the United States Army in Seoul, Korea and had a major impact on setting the priorities for the remainder of his career. In Korea he had an opportunity to teach and consult about the needs of persons with disabilities in developing countries.

Dr. Fisk has held academic positions at Emory University in Atlanta; Loyola University in Chicago; and Southern Illinois University School of Medicine, in Springfield, Illinois where he is currently Professor and Chief of the Division of Pediatric Orthopedic Surgery. From 1982 to 1989 he was Chief of the Limb Deficiency Clinic at Shriners Hospital for Crippled Children in Chicago. He was President of ACPOC from 1988 to 1990 and edited JACPOC for many years. For the past six years Dr. Fisk has been Vice-President of the International Society for Prosthetics and Orthotics and Task Officer for Short Courses and for courses dealing with the Management of Polio in the developing world. He is a member of the Medical Advisory Board of Health Volunteers Overseas. He is co-editor (with John Hsu and John Michael) of the 4th Edition of the Atlas of Orthotics and Assistive Devices.

Dr. Fisk has been honored by his medical school with the Humanism in Medicine Award; by his city with the Greater Springfield Interfaith Association Humanitarian Service Award; and by his State with the Illinois State Medical Society Service Award. He has traveled to more than eight developing world nations, largely under the sponsorship of ISPO to teach and upgrade patient assessment skills in prosthetic and orthotic schools in those countries. Last month he initiated a sustainable clubfoot care program in Tanzania, a project he will continue to support after retiring in July of this year.

He is the father of six and the grandfather of eight wonderful children and enjoys sailing with his wife, Diane.



Jan Willem Gorter, MD, PhD, FRCP(C)

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Dr. Jan Willem Gorter is an Associate Professor in the Department of Pediatrics and the School of Rehabilitation Science at McMaster University, Hamilton, Canada. He is an investigator at the [CanChild](#) Centre for Childhood Disability Research and a member of the [McMaster Child Health Research Institute](#).

He has training in rehabilitation medicine with a special interest in paediatric and adolescent rehabilitation. He has a breadth of experience working with children and youth with developmental and acquired disabilities (cerebral palsy, spina bifida, acquired brain injury) and their families. His research interests include family, function and fitness to enhance participation of children and youth with developmental disabilities and facilitating transition to adulthood.



Wayne Stuberg, PhD

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Wayne Stuberg, PhD, PT is Professor, Associate Director of Education and Director of Physical Therapy and the Motion Analysis Laboratory at the University of Nebraska's Medical Center Munroe-Meyer Institute for Genetics and Rehabilitation (MMI) in Omaha. He has practiced as a physical therapist working with individuals with developmental disabilities for the past 30 years.

Dr. Stuberg is board certified in paediatrics by the American Board of Physical Therapy Specialties. He is a past president of the Nebraska (NE) Physical Therapy Association and the current chair of Board of Physical Therapy for the NE Department of Health and Human Services Division of Licensure and Credentialing. He has served as a consultant for the state of Nebraska on the NE Childhood Interagency Coordinating Council and as a member of the NE Department of Education's Special Education Advisory Council.

Dr. Stuberg has presented at numerous state, national and international conferences on the topic of management of individuals with developmental disabilities. He teaches in the entry-level doctorate of physical therapy curriculum at the University of Nebraska Medical Center and works with graduate students through the University's Graduate College. His research interest is in the areas of motion analysis and outcomes of physical therapy treatment

Jane Chantry MSc

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Jane has been working as an Occupational Therapist in the field of complex Neuro-disability, both in adults and children, for approximately the last 10 years, but has recently chosen to focus on Paediatrics since coming to work at Chailey Heritage Clinical Services in 2007. Chailey Heritage Clinical Services provides a specialist outpatient service for children and young people with complex disabilities as well as providing clinical support to Chailey Heritage School, which is an independent non-maintained special school for children of all ages who have complex disabilities.

Areas of particular interest and speciality to Jane are in postural management and special seating, assistive technology and functional upper limb management. An active member of the Posture and Mobility Group executive committee enables Jane to be pro-active in the development of services and research and knowledge base in this field.

Jane is a recent MSc graduate in Health Professional Studies including specialist modules on spasticity management, postural management and the use of Assistive Technologies to enhance participation in children with disabilities (with an article on this now approved for publication in the British Journal of Occupational Therapy).

Prior to working at Chailey Heritage Jane was Clinical Specialist Occupational Therapist at the Royal Hospital for Neuro-disability in Putney working with adults and young people with profound neurological conditions including low awareness states following brain injury and Huntington's disease. She also worked for a number of years as a lead clinician specialising in special seating at Bristol Wheelchair and Special Seating Service which was where she developed a key interest and passion for this area of work.

Mary Gibson, MBBS, DCH, FRCP

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Mary is an emeritus consultant paediatrician whose particular interest is in childhood neurodisability. She has had a regional role as consultant paediatrician in the Child Development Centre in Newcastle and a particular interest in children with cerebral palsy. She has developed specialist services such as spasticity management clinics and feeding and nutritional clinics and has also been medical director at the Percy Hedley Regional Special School. She has enjoyed working in a multidisciplinary team and collaborating with orthotists over management of children with cerebral palsy. In addition to teaching, her research interests have been in clinical aspects of cerebral palsy including the regional cerebral palsy survey (NECCPS).



Roy Bowers, CP

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Roy Bowers is a senior lecturer in the National Centre for Prosthetics and Orthotics at the University of Strathclyde in Glasgow. His main clinical and research interests are in the lower limb orthotic management of neurological conditions.

He was an 'expert reviewer' on orthotic management of the lower limb for the ISPO consensus conference on cerebral palsy in 2008, having previously reviewed the literature on AFO use for the ISPO consensus conference on stroke in 2003. Since the year 2000 he has been a regular faculty member on ISPO instructional courses on the management of cerebral palsy and stroke. Roy is co-author of chapters on "Biomechanics of the hip, knee and ankle" and "Lower limb orthoses for persons who have had a stroke" (Atlas of Orthoses and Assistive Devices, 2008) published by the American Academy of Orthopedic Surgeons. He recently acted as specialist clinical advisor and project lead for the development of a best practice statement on the use of AFOs following stroke, published by NHS Quality Improvement Scotland (2009).



Barry Meadows, PhD

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Barry Meadows is a bioengineer who has worked as a clinician in the National Health Service in Scotland for over three decades. In his early work he was involved in the development of the use of ankle foot orthoses in the management of young CP children. He was particularly intrigued by the fact that an AFO, appropriately designed and tuned, could influence the kinetics at the hip joint and conducted some biomechanical research in this area. He completed his PhD on the influence of AFOs on gait in 1984.

He is driven by the desire to ensure that patients benefit from being treated by clinicians with a basic and relevant understanding of biomechanics. To this end he undertakes many in-service education sessions locally and nationally. He remains intrigued by the interaction of biomechanics and neurology and is now also involved with colleagues in the management of gait problems in adults with neurological disorders. This work has led to the development of an innovative concept, "Neurobiomechanics", which combines biomechanical and neurological interventions in the development and implementation of individual treatment plans. Barry is currently Head of Neurobiomechanics at Westmarc at the Southern General Hospital in Glasgow.



Bryan Malas, MHPE, CO

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Bryan is the current director of the Orthotics/Prosthetics department and Moira Tobin-Wicks Orthotics Program at Children's Memorial Hospital in Chicago, Ill. USA. Prior to this he was director of Orthotics Education at Northwestern University Feinberg School of Medicine and was there for twelve years.

He received his orthotics training at Northwestern University and a Master's in Health Profession's Education from the University Illinois Chicago. He is the past Chair of the National Commission on Prosthetic Education and Past President of the Midwest Chapter American Academy of Orthotist Prosthetist. He currently serves on the board for the Center for O&P Learning and Evidence Based Practice and ISPO Education Board.



Elaine Owens, PhD

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Elaine is Superintendent and Clinical Specialist Physiotherapist at the Child Development Centre in Bangor, UK. She has been practicing as a physiotherapist for 35 years. She has postgraduate qualifications in Lower Limb Orthotic Biomechanics and Clinical Gait Analysis and has also undertaken the basic and advanced 'Gait Analysis Instructional Course' of the European Society of Movement Analysis of Adults and Children (ESMAC).

She has an MSc in Rehabilitation studies, which included a thesis about normal and pathological standing and gait, and the orthotic management of neurological conditions. For 12 years she has used the Orthotic Research and Locomotor Assessment Unit (ORLAU) video vector gait laboratory at Bangor for gait analysis, orthotic and physiotherapy management of children and adults.

She is regularly invited to teach her course and undertake other lecturing, both in the UK and internationally, including, the International Society for Prosthetics and Orthotics (ISPO) Triennial World Congress, Hong Kong 2004, Vancouver 2007, Leipzig 2010; the Annual meeting of the European Society of Movement Analysis of Adults and Children (ESMAC), Leuven 2002, Warsaw 2004, Barcelona 2005, London 2009. She has recently been awarded the ISPO UK, George Murdoch Prize for 2008 and has co-authored a chapter in the recently published American Academy of Orthopaedic Surgeons, Atlas of Orthotics and Assistive Devices 4th Edition, 2008.

Publications

- Owen E (2002) Shank angle to floor measures of tuned 'ankle-foot orthosis footwear combinations' used with children with cerebral palsy, spina bifida and other conditions. *Gait & Posture* 16: Supp 1, S132-S133
- Owen E (2004) The point of 'point-loading rockers' in ankle-foot orthosis footwear combinations used with children with cerebral palsy, spina bifida and other conditions *Gait & Posture* 20S, S86
- Owen E (2004) Tuning of ankle-foot orthosis combinations for children with cerebral palsy, spina bifida and other conditions. *Proceedings of ESMAC Seminars 2004*
- Owen E, Bowers R, Meadows CB (2004) Tuning of AFO-Footwear Combinations for Neurological Disorders. In: *Conference Proceedings. International Society for Prosthetics and Orthotics (ISPO) 11th World Congress, Hong Kong: ISPO: 278-279*

Owen E (2004) "Shank angle to floor measures" and tuning of "Ankle-foot orthosis footwear combinations" for children with cerebral palsy, spina bifida and other conditions. MSc thesis. Glasgow: University of Strathclyde.
 Owen E (2005) A clinical algorithm for the design and tuning of ankle-foot orthosis footwear combinations (AFOFCs) based on shank kinematics. *Gait & Posture* 22S: S36-S37
 Owen E (2005) Proposed clinical algorithm for deciding the sagittal angle of the ankle in an ankle-foot orthosis footwear combination. *Gait & Posture* 22S: S38-S39
 Jagadamma K, Coutts F, Owen E, Herman J, Yirrell J, Van der Linden M (2007) Effect of the tuning of ankle foot orthoses-footwear combination (AFO-FC) on gait of a hemiplegic patient – a case study. *Physiotherapy* 93(S): S362
 Meadows CB, Bowers R, Owen E (2008) Chapter 22 "Biomechanics of Hip Knee and Ankle" In: American Academy of Orthopaedic Surgeons, Atlas of Orthoses and Assistive Devices. Elsevier
 Owen E (2009) How should we define the rockers of gait and are there three or four. *Gait & Posture*. September 30S: S49.

Gordon Ruder, MSc

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Gordon Ruder is the Co-ordinator of the Prosthetic and Orthotic educational programs at George Brown College in Toronto, Canada and has been one of Canada's main teachers for those individuals entering the Prosthetic and Orthotic profession over the past two decades.

Gordon also has extensive clinical experience as a practicing Certified Orthotist, with a particularly strong focus around the lower limb orthotic management of pediatric cases with developmental disorders.

Gordon acquired his Masters Of Science, Biomechanics from the University of Waterloo in 1989 and had the privilege to work under Dr. David Winter resulting in several significant publications in the area of human gait and balance control. Following this, his professional career has had a strong focus around issues involving gait and biomechanical applications to the direct management of those persons requiring orthoses.

Gordon, has contributed and presented at many national and international meetings, and continues to work on many professional and educational publications. He was also the Chief Examiner in Orthotics for the Canadian Board for Certification from 2001 to 2004.

Gordon is very interested in the relationship between prosthetic and orthotic education, the technical and clinical aspects of orthotic practice, and research. Ideally, each of these focus points should be intimately linked, help & support each other to optimize prosthetic and orthotic treatment.

Diane Damiano, PhD

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Diane Damiano, PhD PT, is Chief of the Functional and Applied Biomechanics Section in the Rehabilitation Medicine Department at the National Institutes of Health Clinical Center in Bethesda, Maryland. Her current research interests include investigation of the effects of strengthening and other intense forms of physical training on muscle and neural plasticity and on improving mobility and quality of life in those with developmental and adult-onset brain injuries. She is a Past President of the AACPD and of the Gait and Clinical Movement Analysis Society.

ABSTRACTS *(in order of presentation)*

Over Riding Theme, A Global Perspective – John R Fisk

With a paucity of scientific literature concerning the adequacy of services for the care of persons with cerebral palsy in low and middle income countries few recommendations on best practices can be made. The World Health Organization Task Force on Medical Rehabilitation Guidelines met in Geneva in October of 2005. One of the clear recommendations coming from that session was the need for accurate country by country data on the incidence and types of disabilities as a starting point in stimulating local governmental organizations to address service needs. Few Ministries of Health will act without identified needs and top down guidelines.

All who have had the privilege to work in low income countries as know of the inadequacy of the orthotic services seen there. The fabricator is rarely a consultant, only a technician. Materials are clumsy. Design is with a poor biomechanical understanding and there is very little understanding of cerebral palsy as a clinical entity. Most of the time treatment is aimed at deformity rather than function.

This paper attempts to identify available resources on these issues. Clearly they are lacking. A nonscientific survey was added as a means of reporting on some current available trends. The primary conclusion that can be drawn from it is that the needs are great. There is need of infrastructure, education, and public awareness. All of these take money. The most concerning theme however was the expressed need for a societal change in attitude to over-come the stigma of cerebral palsy specifically and disabled persons in general. We must not lose sight of that goal as we consider the medical needs of persons with cerebral palsy and the importance of inclusion of those persons in their society.

Definition of cerebral palsy and functional classification – Jan Willem Gorter

Cerebral palsy (CP) has been and still is the most common childhood neurodevelopmental disability that is seen and managed by child health professionals with a prevalence of 2.0 – 2.5 per 1000 live birth in the developed world. Since the first publication on ‘cerebral palsy’ by Little (1862) up to the most recent publication on the revised definition of CP the picture of children and adults persons with CP has changed: from a child with deformities due to asphyxia to a developmental childhood onset disability requiring a lifespan perspective in the context of family needs, values and abilities. These concepts are reflected in the most recent definition: “CP describes a group of permanent disorders, effecting the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain. The motor disorders of CP are often accompanied by disturbances in sensation, perception, cognition, communication, and behaviour, as well as epilepsy and secondary musculoskeletal problems”.

As CP is a heterogeneous condition, further classification of its types and severity is fundamental in research and clinical practice. The predominant subtypes of motor impairment are spastic, dyskinetic (dystonia and choreoathetosis) and ataxic. The spastic type can be further classified according to the distribution as either unilateral or bilateral. The traditional terms hemiplegia, diplegia and quadriplegia are commonly used to describe distribution and/or severity of CP. However, they are clinically imprecise as they lack reliability among observers, and, moreover, the relationship between topographical distribution of CP and functional status is not as sound as has usually been assumed. Functional status at the person's activity level can be best categorized using reliable and valid systems such as the five-levels of the Gross Motor Function Classification System (GMFCS) for usual mobility, the five levels of the Manual Ability Classifications System (MACS) that has been developed to classify how children with CP use their hands when handling objects in daily activities (see Table). The time is ripe to apply a uniform and multidimensional classification in clinical practice that includes functional, topographical (limb distribution) and motor impairment information in combination with associated conditions.

The functional classification can also serve as a framework for planning rehabilitative therapies for cerebral palsy by GMFCS level. Good examples can be found for orthotic management by GMFCS level.

Physiotherapy – Wayne Stuberg

This presentation focuses on appraising the evidence for physiotherapy in the management of children with cerebral palsy (CP) and with an emphasis on gait training using orthotic devices. The following key issues are included:

- Description of the overall approach and rationale for treating children with cerebral palsy within physiotherapy and any developments recent developments over the past ten years,
- Provision of a structured review of the evidence of common physiotherapy interventions used in CP,
- Mention of the utility of commonly used adjunct interventions,
- Consideration of pertinent outcomes and how they are typically measured and
- Discussion of the implications for orthotics - clinical practice and research.

Occupational Therapy – Jane Chantry

One of the fundamental theoretical constructs of Occupational Therapy (OT) is that participation in meaningful occupation is essential to health, emotional well being, and development of both adults and children alike. Therefore the primary role of the Occupational Therapist is to enable individuals to participate in meaningful occupations and activities in their everyday life, in children this is likely to be in play and leisure activities, self care activities and education.

In this presentation I aim to give an overview of the evidence supporting a number of

interventions used by OT's working with children with Cerebral Palsy, to facilitate function and enhance participation. These will include established interventions used by OT's, where the supporting evidence has predominantly been anecdotal (such as splinting) as well as newly emerging interventions (such as the use of virtual reality in therapy). The current supporting evidence for these interventions will be presented, discussed and recommendations for future research made.

Patterns of Gait – Gordon Ruder

Numerous studies, from many reputable research institutions and individuals, ranging from the very technical and detailed, to the practical and applied have been published. Far more respected researchers than myself have reviewed and been involved in the study of gait patterns in the Cerebral Palsy population.

End result:

- A reliable, accurate Cerebral Palsy gait classification system could assist in diagnosis, decision making, and communication.
- Several Gait Pattern studies have been reviewed, none are comprehensive, scientifically robust, clinically applicable, and tend to be kinematically and confined to the sagittal plane.
- Even if and when these limitations could be addressed, a classification system of gait, only organizes the patient population, it does not offer the clinician a means of understanding the cause, improving the treatment or prognosis. In short, there is a large gap that exists between the gait lab/research side and the individual with Cerebral Palsy.

From my perspective as an educator & clinician, with past and current gait research opportunities:

- Clinical decisions are made *qualitatively* (Observational Gait Analysis, functional tests, Q&A with patient, family, other healthcare members), but should be based on a good understanding of gait *quantitatively* (kinematics, kinetics, EMG, energetics).
- As a clinician we treat each patient as an individual, recognizing that the final treatment plan will be influenced by many factors, some of which far outweigh the gait classification category the patient may fall into.
- It is the responsibility of our schools to educate prospective clinicians in the quantitative aspects of normal and pathological gait, and begin to develop experience with the qualitative aspects of treatment design justification.
- Research is the tool by which curriculum can be validated, and orthotic treatment plans tested.
- Before research can become clinically applicable, it may have to go through an evolutionary process, where it may become very complex, abstract, and seem to have little clinical significance. But eventually, as our understanding and technology advance, trends and relationships will become apparent that are simpler, clinically relevant, allowing clinicians/educators to treat/teach more effectively.

Finally, if we want Prosthetic and Orthotic clinicians to become part of this process, then we as a profession need to support them from the recruitment of interested applicants to our schools, right through the remainder of their professional life. This means ensuring through the development of competent Prosthetic and Orthotic clinicians, they are able to qualitatively & quantitatively understand gait, and can appropriately respect the importance of gait alongside all the other factors employed in developing the optimal treatment plan.

Medical Management – Jan Willem Gorter

The primary goals of a rehabilitation program for children, young adults and adults with CP and their families are:

- 1) to prevent CP and its additional impairments; prevention of life threatening complications in particular
- 2) to prevent and treat impairments; to relieve distress
- 3) to promote growth and development
- 4) to improve and optimize daily functioning, engagement in life and well being

Medical treatment, including primary, secondary and tertiary prevention of the effects of cerebral palsy, therefore is an essential and integral part of the rehabilitation program and will be discussed in the presentation according to different functional (GMFCS) levels.

Functional Classification Systems in Cerebral Palsy	
Mobility	<p>Gross Motor Function Classification System (GMFCS)</p> <p>LEVEL I - Walks without Limitations LEVEL II - Walks with Limitations LEVEL III - Walks Using a Hand-Held Mobility Device LEVEL IV - Self-Mobility with Limitations; May Use Powered Mobility LEVEL V - Transported in a Manual Wheelchair</p>
Manual Ability	<p>Manual Ability Classification System (MACS)</p> <p>LEVEL I - Handles objects easily and successfully LEVEL II - Handles most objects but with somewhat reduced quality and/or speed of achievement LEVEL III - Handles objects with difficulty; needs help to prepare and/or modify activities LEVEL IV - Handles a limited selection of easily managed objects in adapted situations LEVEL V - Does not handle objects and has severely limited ability to perform even simple actions.</p>

More information: GMFCS: www.canchild.ca; MACS: www.macs.nu

Orthopaedic Management of Cerebral Palsy, The Ambulatory Child – John R Fisk

The role of the Orthopaedic Surgeon when treating an ambulatory child having Cerebral Palsy is stated in the most basic terms, **to preserve or improve function**. That is accomplished by facilitating movement, maintaining a functional posture, preventing deformity, and preventing and relieving discomfort. The orthopaedic surgeon has many modalities to utilize when managing these goals. He or she must begin with a clear understanding of the pathophysiology, the natural history, and the consequences of non-intervention. A systematic understanding of functional issues helps to formulate an approach to the child with spasticity.

A clear understanding of normal gait and how gait is altered by spasticity is the logical starting point. These considerations must however be placed in the context of the functional needs of the individual and the expectations of his or her family and community, i.e. other health care providers and educators. There needs to be an appreciation of the biomechanics on gait, how the mechanics are altered by spasticity and how those alterations can lead to deformities. Function can be improved and deformity either prevented or treated by a clear understanding of these principles.

The intervention armamentarium is large and varied in importance with regard to the age of the child and the degree of impairment. Choices include judicious observation, orthotics, medical management and surgery. Often the surgeon is called on to be the team leader although this is not a role that should be assigned a priority to any single individual. In all circumstances the surgeon must be an involved member of the treatment team and be prepared to participate in all decision making processes with the recognition that the patient is at the center of that team and their needs are primary.

Often there is a poor understanding or poor degree of communication between the orthopaedic surgeon and the orthotist. Each needs to take responsibility for listening to and informing the other of the principals for their role in a given child's management. This presentation will help serve as a basis for such an understanding between all of the members of the team.

Orthopaedic Management of the Non-Ambulatory Child – John R Fisk

An understanding of the care of a non-ambulatory child having cerebral Palsy begins with the appreciation that such involvement truly is a total body involvement. Unlike the approach to the ambulatory child where the focus can (albeit not always) be on function making decisions for the non-ambulatory child must take into consideration all organ systems that may be affected by spasticity. There is a long list of potentially involved or associated conditions. The priorities for the care of these children include not only the needs of the patient but also the family, other health care providers and educators,

Potential problems are more easily prevented than they are managed after they arise. It is therefore imperative that there be continual observation throughout growth and beyond with a clear understanding of early signs of problems. Those potential problems can be categorized into concerns for function, health, comfort, and ease of care. Each is important but may not be apparent to all involved in the care of the child. It is often helpful to discuss the potential for problematic issues before they occur so that they are not viewed with surprise when they arise

and when difficult choices must to be made for intervention.

There are specific functional areas of concern; posture for feeding, respiratory hygiene, bowel function, sitting and communication. There are specific anatomical areas of concern; hips, upper extremities, lower extremities and spine. There is a keen need of awareness for the natural history of progressive problems if they are not addressed early and for the different role for intervention modalities at different times of growth and development. There is also a need for discarding ineffective interventions even though to do so may lead to discouragement on the part of the family for they are often expensive, time consuming and lead to ignoring more effective alternatives.

The total body involved child with cerebral palsy requires a coordinated approach to care where all members of the health care team begin with the needs and priorities of the individual and progress to a consensus of what needs to be done or not done.

Orthotic Management CC Conclusions (LL & UL) – Roy Bowers

This presentation will review the recommendations and conclusions of the ISPO consensus conference regarding orthotic management of the lower limb (including the hip) and the upper limb. These recommendations were based on two systematic reviews of the literature conducted by Roy Bowers and Karyn Ross (lower limb) and by Phil Stevens (upper limb and hip), and on the group discussion sessions that took place at the conference following presentation of these reviews. A total of 74 papers were reviewed relating to the orthotic management of the lower limb (ankle-foot orthoses), and twenty three papers were reviewed on the orthotic management of the hip in cerebral palsy. Thirteen papers on the orthotic management of the upper limb were reviewed. As well as summarising the evidence for the effectiveness of various orthotic interventions, the shortcomings of the existing literature will be discussed as a basis for discussion on the need for improvements in future research.

Orthotic Biomechanics Principles and Research – Barry Meadows

Orthoses have many biomechanical properties which can influence the outcome of any intervention. Selection of a design of an orthosis with appropriate biomechanical properties is usually crucial if treatment of a child with cerebral palsy is to be successful.

An orthosis will have both *direct* and *indirect* biomechanical effects. Direct effects are the force systems and moments applied to the body segments and joints contained within the orthosis. Indirect effects are the biomechanical influences on the parts of the body which are not contained within the orthosis.

For example, an AFO may apply a number of three point force systems to the structures of the ankle-foot complex. However the alignment and stiffness of the AFO will also influence the

external moments applied to the knee and hip joints, thus influencing the demand on the neuromuscular system at these joints and the resulting kinematics.

This paper will outline the fundamental biomechanical principles relating to orthoses, the gaits of children with cerebral palsy and their interaction. A relatively simple approach to biomechanical analysis and reasoning will be presented to assist with clinical decision making and to suggest areas for biomechanical research.

Orthotics: Hip & Spine – Bryan Malas

Orthotics research in the arena of Cerebral Palsy continues to be troublesome. At the conclusion of two consensus conferences on CP the same issues continue to resurface. The limited number and quality of papers make it difficult to draw conclusions about the efficacy of orthotic management. The purpose of these talks is to identify the areas of greatest deficiency and offer strategies to address these areas in the future.

Seating – Jane Chantry

Seating and positioning in children with cerebral palsy is an important and complex issue. The seated position of the child can affect the child's potential for future development and functional independence in daily life.

Historically there has been little substantial evidence supporting the use of specialised and adaptive seating to improve the functional abilities of children, yet it is a costly intervention that is commonly used.

In this presentation I aim to present the available literature and evidence surrounding the use of seating with cerebral palsy children and will particularly focus on the use of seating to improve upper extremity function, pulmonary function and overall posture.

The current evidence will be presented, discussed and recommendations for future research developments will be made.

Orthotic Research – What is the Future?

Point 1: How should we improve the art and science of ankle-foot orthosis footwear combinations? – Elaine Owens

No one design of AFO-Footwear Combination (AFOFC) will be optimum for all children. AFOFC design will vary between individuals and over a childhood and the percentage of the day, week and year that a child wears an orthosis will vary. In effect the 'drug', the 'dosage of the drug' and the 'frequency of administration' will all vary, according to the agreed short and long term objectives of the clinical team, the parents and the child. It is often helpful to look at objectives from an inside out approach. They may relate to bone and joints, musculotendinous unit length strength and stiffness, neurology, development of postural control and locomotor skills, function and other factors.

Awareness of all the possible design features of both the AFO and the footwear, the AFOFC 'jigsaw pieces' that may be selected, is essential to enable selection of the appropriate pieces of the jigsaw for any prescription and understand all the relevant variables for research. The variables relating to the design of the heels and soles of the footwear are largely ignored in the literature, as are two important sagittal variables, the alignment of the ankle joint in the AFO, the Angle of the Ankle in the AFO (AAFO) and the alignment of the shank segment relative to the vertical when standing, the Shank to Vertical Angle (SVA) of the AFOFC. Prior to evaluations of effectiveness, AFOFCs are rarely optimised by tuning and it is never stated whether the AAFO is known to be optimal and how this has been determined⁵. Formulation of algorithms will help the selection of the appropriate 'pieces of the jigsaw' and clarify the process used in studies. A 'Proposed algorithm for deciding the sagittal AAFO'⁷ and 'An algorithm for designing, aligning and tuning AFOFCs based on shank kinematics'⁶, provide a logical process for selection of the AAFO and the design of AFO, design of heels, soles and pitch of footwear and SVA.^{1,2,5}

We must fully understand the kinematics, kinetics and muscle actions of normal standing and the gait cycle if we are to intervene successfully. Inaccurate myths about normal gait are widely held¹⁰. We must give equal importance to segments and joints, acknowledge their independence in gait and that distal segment kinematics dictates proximal segment and joint kinematics and kinetics^{5,6,10}. A focus on segment kinematics provides easy categorisation of gait abnormalities, understanding of abnormal gait and the selection of optimum prescriptions^{3,5,6,9,10,11}. Recognition of four, rather than three, rockers in normal gait also helps^{10,11}.

We must understand musculotendinous unit (MTU) length strength and stiffness. This is an emerging science and therefore a challenge to us all. Optimised orthotic interventions provide a tremendous opportunity for lengthening, strengthening and reducing stiffness in MTUs, both within and outside the orthosis, especially when they are a repetitive influence in gait cycles. Repetition of normalised standing and gait also has implications for training improved postural control and motor learning. 'Therapy as you stand and walk' kills several birds with one stone and provides functional training.

The short and long term effects of intervening in this way needs evaluation but first the art and science of prescribing optimal AFOFCs must be improved. A wish list for improving both the art and science will be presented.

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4. Owen E, Bowers R, Meadows CB (2004) Tuning of AFO-Footwear Combinations for Neurological Disorders. In: *Conference Proceedings. International Society for Prosthetics and Orthotics (ISPO) 11th World Congress, Hong Kong: ISPO: 278-279*
5. Owen E (2004) "Shank angle to floor measures" and tuning of "Ankle-foot orthosis footwear combinations" for children with cerebral palsy, spina bifida and other conditions. MSc thesis. Glasgow: University of Strathclyde.
6. Owen E (2005) A clinical algorithm for the design and tuning of ankle-foot orthosis footwear combinations (AFOFCs) based on shank kinematics. *Gait & Posture* 22S: S36-S37
7. Owen E (2005) Proposed clinical algorithm for deciding the sagittal angle of the ankle in an ankle-foot orthosis footwear combination. *Gait & Posture* 22S: S38-S39
8. Jagadamma K, Coutts F, Owen E, Herman J, Yirrell J, Van der Linden M (2007) Effect of tuning ankle-foot orthosis-footwear combination (AFO-FC) on gait of a hemiplegic patient – a case study. *Physiotherapy* 93(S): S362
9. Meadows CB, Bowers R, Owen E (2008) Chapter 22 "Biomechanics of Hip Knee and Ankle" In: *AAOS Atlas of Orthoses and Assistive Devices*. Elsevier
10. Owen E (2008) The importance of being earnest about shank kinematics especially when using ankle-foot orthoses. *ISPO-UK George Murdoch Prize winning essay*.
11. Owen E (2009) How should we define the rockers of gait and are there three or four? *Gait & Posture*: 30S: S49

Point 3: Gordon Ruder

One of the over-riding themes to come out of the CP conference's in 1994 & 2008, was the need for improved Orthotic research. I have been asked to provide a new perspective on the needs and directions for orthotic research. My perspective would be primarily from that of a clinician and an educator, but also of a researcher involved in several gait lab studies.

As a Clinician:

- The only time I consume research, is when I need it to prepare for a presentation (literature review, acknowledge the current level of understanding), or am attending a conference.
- This constitutes a negligible amount of time, compared to my other clinical responsibilities.

As an Educator:

- Whenever curriculum is being newly developed or revised, research consumption occurs.
- Assisting current or post graduate students in conducting research (soft to MSc/PhD).
- This constitutes a slightly more time than the clinical perspective, but is still quite a bit less than my teaching/coordinating responsibilities at the school.

As a Researcher:

- Consume research to assist in the development of a methodology, study design, introduction, and hypothesis.
- Conduct research to test the validity of a clinical treatment or technical design that anecdotally

(clinical experience, patient feedback) has been shown to be effective or an improvement on current techniques.

- Share research by presenting findings, and incorporating the findings into school curriculum. Strive to publish once a clinically and scientifically valid study has been completed.

What yet needs to be done in this area? How we can better teach our students to conduct research? What suggestions can be made so that in another ten years if there is another CP Consensus Conference the conclusions about the adequacy of research in the field will be different?

As a Educator, our curriculum needs to continue to support and develop research. With many schools evolving to a Masters or Phd level, this is becoming is becoming a reality. At my school, there is a department that is dedicated to research and innovation for it's staff - this means grant applications, funding support, covered time, paid part-time positions for current students, statistical analysis, etc. Over time, it is hoped that the graduates of these higher credentialed programs will produce future clinicians and educators that can consume, conduct, and share research.

As a Clinician, either by stick, by carrot, or both - there has to be a way (or several ways) to encourage clinicians to become more involved in orthotic&prosthetic research. My personal opinion is that the only way we can hope to address the inadequacy of research to date, is to have experienced clinicians involved in and part of the research effort.

Simply stating that current orthotic research is poor is not sufficient, otherwise we would've seen a significant difference between the '94 and the '08 Cerebral Palsy Consensus Conferences. I believe that ISPO has a role to play in moving beyond the Consensus Conference. These conferences have been an excellent means of taking stock of our current level of understanding of such topics as Cerebral Palsy, but what is needed to go beyond this is support and qualified guidance. Much like a school and its instructors teach students to become clinicians, we need ISPO to lead/guide/support clinicians to advance into professionals that are more involved in clinically/technically applicable research.

Point 4: Perspectives from a Physiotherapist – Diane Damiano

This short presentation will discuss the intersection between physiotherapy and orthotics which is the common goal to help children with cerebral palsy be more mobile – in both the short and longer term. The underlying premise here is to provide only as much support as needed while enabling or assisting useful muscle activity. Orthotics can do far more than provide optimal alignment when worn. They can provide deformity prevention and perhaps correction through prolonged stretching. They can position joints to optimize power production or assist muscles where needed by incorporating electrical stimulation into the brace design. Presentation of some of the newer braces that are now commercially available in the US for children with CP will be made and some of our ongoing research efforts with these orthotics will be discussed.

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