

**Appendix B:**  
**The Recommendations**

**Recommendation Title:** Gait Assessment and Clinical Decision Making

**Recommendation Code:** A1

**Category:** Research

### **Recommendation**

#### **Background**

The National Center for Medical Rehabilitation Research has encouraged the use of movement analysis to aid clinical decision-making and guide the selection of appropriate treatment. Currently, clinicians are using the disability model as a format for clinical decision making. A number of questions, however, need to be addressed to better understand the association between measures of gait and the disability model (i.e., pathophysiology, impairment, functional limitations, disability, and societal limitation). Gait abnormalities have been described for a variety of medical conditions, but their use in guiding clinical decision making has not been documented. This is related, in part, to a lack of knowledge about which gait variables correlate most strongly to improved functional capacity. If different levels of physical impairment could predict a greater likelihood of locomotion disability, this would provide clinicians with objective information to develop effective treatment interventions. In the case of chronic progressive disorders which increase in severity over time, there may be critical periods when intervention may be more efficacious in maintaining or improving functional movement.

#### **Objectives**

Improve the efficacy of clinical decision making so that the relationship between gait assessment and various components of the disability model can be established.

#### **Recommended Actions**

Establish research funding to develop predictive models that describe the association between gait variables and components of the disability model.

Fund research to identify gait variables which are most useful for clinical decision -making.

Fund research to develop test protocols which are valid and sensitive in describing gait in a wide variety of patient populations.

Obtain funding for fellowship training programs that will provide clinicians with extensive training and experience in making clinical decisions using the disability model.

**Recommendation Title:** Gait Assessment and Functional Outcomes

**Recommendation Code:** A2

**Category:** Research, Training and Education

### **Recommendation**

#### **Background**

According to data from the 1989 National Health Survey at least 7.7 million adults are physically disabled and approximately 2.4 million people have difficulty walking or performing other functional mobility tasks. Current gait assessments do not necessarily reflect what locomotive difficulties may exist for a given individual in her/his environment. The usefulness of gait assessment in identifying functional limitations will depend to some extent on the specific protocols or testing conditions used. Moreover, the ability of gait profiles to predict future functional status has not been determined. The NCMRR has encouraged the use of movement analysis to establish meaningful functional outcome measures. The specific relationship between gait assessment and functional outcome measures, however, has not been determined.

#### **Objectives**

- 1) Determine those gait parameters/variables and protocols which are the best predictors of functional outcomes.
  - a) Identify gait related measures which relate most directly to improved functional outcomes in a wide array of disease conditions and populations.
- 2) Determine those gait parameters/variables and protocols which are the best predictors of future functional mobility status.
  - a) Conduct epidemiological and longitudinal studies to determine/identify gait parameters that are predictive of future functional mobility status.
- 3) Transfer this information to appropriate locations including:
  - a) Training gait assessment personnel  
Develop fellowship training programs that will provide extensive training and experience in conducting gait assessment which most directly relates to improved functional outcomes.
  - b) Educating referral sources  
Disseminate information regarding the established relationship between gait assessment and improved functional outcomes.
  - c) Educating reimbursement agencies and policy makers  
Provide and disseminate information regarding the established relationship between gait assessment and improved functional outcomes and lobby for appropriate reimbursement.

#### **Recommended Actions**

Develop long-term funding for the above objectives.

**Recommendation Title:** Is Gait Analysis Efficacious in Improving Treatment Outcomes?

**Recommendation Code:** A3

**Category:** Validation

### **Recommendation**

#### **Background**

The majority of clinical decisions for improving motor function in individuals with disability are made in the absence of clinical gait analysis. However, a small percentage of rehabilitation professionals (clinicians in the fields of orthopedics, pediatrics, OT, PT, physiatry) routinely utilize gait analysis in their clinical practice.

The primary reason for the inconsistent utilization of clinical gait analysis is the lack of efficacy data demonstrating that functional outcomes are improved as a direct result of gait analysis. The consequence of this uncertainty is that individuals with disabilities are either deprived of a useful assessment tool or are subjected to a time consuming and unnecessary evaluation.

#### **Objectives**

To demonstrate that clinical gait analysis alters treatment decisions so as to improve functional outcomes within specific diagnostic categories.

Research must accomplish the following:

- 1) Compare and contrast the effectiveness of clinical practice in the presence or absence of gait analysis.
- 2) Identify which patient categories objectively benefit from clinical gait analysis.
- 3) Replicate the findings to determine whether the results from particular studies are consistent and generalizable.

#### **Recommended Actions**

Support research that documents that clinical gait analysis improves functional outcome within specific diagnostic categories. This research is of relevance to NIH, the VA and private funding agencies.

**Recommendation Title:** Accuracy, Precision and Validity of Movement Analysis Techniques

**Recommendation Code:** A4

**Category:** Validation

### **Recommendation**

#### **Background**

Recent advances in instrumentation and computer technology have substantially increased the accuracy and precision of the fundamental data collected in movement analysis. However, this technological progress has not necessarily produced corresponding improvements in the information that is available for clinical interpretation. This is because relatively few studies have comprehensively identified the real and potential artifacts inherently involved in transforming the basic collected data set (e.g., spatial location of body markers) into assessment variables (e.g., joint angles). These include the errors associated with the placement and use of "instruments" on patients, the adequacy of data reduction approaches (e.g., models), and patient performance variability. Consequently, the clinical team is often faced with the dilemma in data interpretation of distinguishing measurement artifact from movement abnormality without sufficient confidence in the data collection and reduction processes. Moreover, it is important to appreciate that the usefulness of future developments in clinical movement analysis (e.g., simulation using musculoskeletal modeling) can be substantially enhanced by an explicit treatment of these issues.

#### **Objectives**

To document the inherent limitations and uncertainties associated with clinical movement analytical protocols and techniques, to investigate their effects on the information made available for clinical interpretation, and to develop new approaches that improve the quality of movement information with respect to accuracy, precision, sensitivity, and reproducibility. This is to include the systematic examination of:

- 1) The application of movement analysis instruments and protocols.
- 2) The processes and models used to reduce the collected data.
- 3) The variability of patient task performance.

#### **Recommended Actions**

- 1) It is recommended that NCMRR make funds available to support the objectives stated above.
- 2) It is also recommended that issues of accuracy and precision be considered as part of any movement analysis laboratory accreditation process.

**Recommendation Title:** Evaluation of Clinical Interventions Using Functional Movement Analysis and Disability Measures

**Recommendation Code:** A5

**Category:** Clinical Research

### **Recommendation**

#### **Background**

Rehabilitation interventions such as surgery, therapies, and assistive devices are widely recommended in treatment of patients with disability. Currently, there are very few quantitative data to justify treatment recommendations to patients, health professionals, and third party payers. For interventions impacting mobility, functional movement analysis is one quantitative tool which can be useful both in designing clinical trials to validate clinical practices, and in treating individual patients.

Movement analysis has the ability to quantify the mechanics of movement and demonstrate how interventions alter mechanics. However, movement analysis alone does not adequately describe the overall functional and disability status of the patient. Consequently, in the evaluation of treatment alternatives it is important to include a variety of quantitative functional assessment approaches which include both descriptors of the mechanics and pathophysiology of movement and activity, and disability measures. The simultaneous use of these assessment strategies moves gait analysis beyond the laboratory setting and, thus, further elucidates the relationship between underlying mechanisms and function.

Using gait analysis to answer clinically relevant questions will define its role in the clinical and investigatory armamentarium; likewise its thoughtful and discriminating application can strengthen the role of rehabilitation in its broadest sense by providing firm data to justify management approaches.

#### **Objectives**

Objectively evaluate treatment alternatives in the clinical management of persons with a variety of impairments using functional movement analysis and disability measures.

#### **Recommended Actions**

Fund clinical protocols addressing efficacy of rehabilitation interventions which incorporate functional movement analysis measures and disability measures as clinical evaluation tools.

**Recommendation Title:** Development of Standards for Management of Clinical Movement Analysis Data

**Recommendation Code:** A6

**Category:** Standardization

### **Recommendation**

#### **Background:**

In the field of clinical movement analysis there are variations in nomenclature and technique for data acquisition and reduction. A variety of acceptable data acquisition and reduction techniques exist. This makes quality control difficult. It is not necessary for all laboratories to use the same data acquisition and reduction technique, but the technique used should be identified when clinical results are disseminated, and should conform to quality control standards. Unfortunately, such standards are presently not available.

A second concern is the large variety of methods for presenting clinical results. This may lead to misinterpretation of results, as well as poor communication between laboratories and among movement analysis specialists. If a uniform presentation method were used, then results could be more effectively interpreted by all movement analysis specialists, and results from laboratories could be directly compared to published results.

#### **Objectives**

- 1) Establish quality control standards for data acquisition and reduction.
- 2) Establish standards for nomenclature in movement analysis.
- 3) Establish a uniform method for presenting clinical parameters and movement analysis results.

#### **Recommended Actions**

Fund a workshop to provide a consensus regarding standardization of quality control for data acquisition and reduction, nomenclature, and uniform presentation methods. This workshop should result in the publication of these standards.

**Recommendation Title:** Development of Timely and Objective Methods of Acquisition, Reduction, and Interpretation of Movement Analysis Data

**Recommendation Code:** A7

**Category:** Technological Development

### **Recommendation**

#### **Background**

The future of movement analysis lies in the ability to process data quickly, and objectively interpret movement analysis data. Currently the manual labor needed to acquire, reduce, and interpret data is time consuming. Furthermore, the time availability of clinicians to perform this task is often limited adding to the delay in report processing. This drives the cost of analysis up and increases the turn around time for clinical decision-making. Another issue is that considerable subjectivity exists in the interpretation process. The quality and effort needed to properly define abnormalities and compensatory processes, as well as the identification of relationships between deviations and their functional significance often vary widely with the education and expertise of the clinician. Current methods for visualization of movement analysis data are not intuitive to health professionals. All of these factors serve as a deterrent to the widespread use of clinical movement analysis. Computer and electronic based technology may provide the means to address these inadequacies.

#### **Objectives**

- 1) Decrease the cost and expand the field of movement analysis by developing techniques which will provide movement analysis data in a timely fashion (real time).
- 2) Develop new techniques for acquiring and reducing movement analysis data.
- 3) Develop innovative methods for displaying movement analysis data which will be intuitive to clinicians.
- 4) Provide opportunities for educational training for those who interpret movement analysis data.

#### **Recommended Actions**

- 1) Provide a funding mechanism for the development of movement analysis systems which will:
  - process data in a timely fashion.
  - utilize new techniques for acquiring and reducing movement analysis data.
  - incorporate accurate and objective interpretation methods.
  - display the information in a way that is intuitive to the clinician.
- 2) Provide a funding mechanism for the development of educational methods, which may include interactive computer-based training approaches, to ensure highly qualified personnel for data interpretation.

**Recommendation Title:** Development of a System Network for Sharing Movement Analysis Data Files

**Recommendation Code:** A8

**Category:** Standardization and Interpretation

### **Recommendation**

#### **Background**

Movement analysis laboratories have limited data to draw on for experience. Movement analysis data transfer is difficult because of differences in methods of data acquisition and reduction, and differences in data formats. Diagnostic analysis is difficult because of limited populations at each laboratory. There is currently no system network for sharing movement analysis data between laboratories.

#### **Objectives**

- 1) Transfer movement analysis data to assist in diagnostic assessment.
- 2) Document differences in data acquisition and reduction.
- 3) Maintain patient and clinician confidentiality.

#### **Recommended Actions**

- 1) Establish a system network of transferring movement analysis data files.
- 2) Establish the need for continuing support of the system network.
- 3) Establish rules and safeguards for participation in and access to the data.
- 4) Establish data file formats, discuss formats with different vendors, and consider the need for format conversion software.
- 5) Require documentation of data acquisition and reduction techniques of participating laboratories.
6. Insure patient and physician confidentiality.

**Recommendation Title:** Education and Training of Personnel Involved in Gait Analysis

**Recommendation Code:** A9

**Category:** Education

### **Recommendation**

#### **Background**

The proper performance and analysis of movement disorders by objective measures of movement analysis requires a broad range of basic knowledge in a variety of fields. Such areas include an understanding of medical disorders and its pathophysiology, fundamental physiology and neurocontrol of human movement, and basic principles of physics and engineering mechanics. Applying the knowledge in each of these areas in an interdisciplinary manner to the field of movement analysis is also essential. There is no opportunity to obtain this diverse training by current educational training approaches and limited time availability in already crowded personnel and academic schedules. Furthermore, the availability of highly trained individuals to provide the appropriate educational experience is limited. Therefore, emphasis must be placed on the provision of new alternative educational opportunities.

#### **Objectives**

To provide adequate cross-disciplinary education and training in the fields of medicine and engineering to both those engineers and clinicians as well as the medical community at large who provide care for persons with locomotion disabilities

#### **Recommended Actions**

It is recommended that NCMRR provide research funding for supporting the development of new educational opportunities and approaches, including computer-based teaching tools, research training fellowships, and instructional teleconferencing workshops and courses to insure that movement analysis is fully utilized and optimally applied. Funding recipients would require excellence in medicine, engineering, movement analyses as well as advanced methods in education.

**Recommendation Title:** Determinants of Gait-Related Pathology

**Recommendation Code:** A10

**Category:** Research

### **Recommendation**

#### **Background**

Gait analysis often involves numerous types of assessments such as pressure measurements, kinematics and dynamic electromyography. These result in potentially thousands of numbers which represent various aspects of one's gait. There is a lack of clear understanding of which parameters are most relevant in the etiology of a specific pathology. For example, loading rates of force, rather than peak forces may be more critical to the development of a lower extremity stress fracture. The identification of commonly used variables, along with the development of new biomechanical variables which characterize gait is needed. In addition, a person's structure is inherently related to their mechanics. Yet the exact manner in which abnormal structure impacts mechanics is yet to be understood. A greater knowledge of the structural and biomechanical variables related to a pathology will improve the efficacy of gait analysis and provide clinicians with a clearer focus on how to direct their clinical interventions.

#### **Objectives**

Increase the understanding of the structural and biomechanical causes of gait-related pathology so that enhanced treatment interventions and preventative measures can be developed.

#### **Recommended Actions**

Develop funding mechanisms to support research aimed at the identification of relevant structural and biomechanical variables which are correlated to pathologies associated with locomotion.

**Recommendation Title:** Development of Models to Study the Relationship Between the Observed Abnormal Gait, Lower Extremity Structure, and Underlying Etiology

**Recommendation Code:** A11

**Category:** Research

### **Recommendation**

#### **Background**

The vast majority of individuals with neuromusculoskeletal pathologies present clinically with aberrant activities of daily living (ADL), posture and/or locomotion. Currently clinical gait analysis does a good job identifying what the abnormalities are in a patient's gait for a limited subset of neuromusculoskeletal pathologies. Abnormalities in movement patterns, joint moments and timing of muscle activity can all be measured and documented. Gait Analysis does less well, however, at definitively identifying the underlying cause or long-term consequences of a specific abnormality in the gait pattern. In specific, distinguishing compensation from primary problems often depends highly on the experience and intuition of the interpreting clinician.

The role of lower-extremity structure in biomechanical function and pathomechanics also needs to be evaluated. The particular alignment and orientation of the joints within the lower extremity is critical to the overall function of the kinetic chain. For example, is the alignment and orientation of the knee important to the etiology, severity and treatment of knee Osteoarthritis (OA)? Does foot and ankle malalignment contribute to knee OA?

The difficulties in establishing a cause and effect link between gait abnormalities, aberrant structure, and pathology stem from deficiencies in the knowledge of the mechanics and neural control of normal and pathological gait. Neuromusculoskeletal models can provide a theoretical framework from which to study this relationship for a given pathology. This knowledge and objective gait data will enhance the assessment, treatment planning, and prognostic capabilities of clinicians who manage patients with impairments, functional limitations, and disabilities.

#### **Objectives**

- 1) To improve models of the neuromusculoskeletal system and their validity for simulating lower extremity function, pathomechanics, and neural control. These models may be comprehensive or pathology specific and include but not be limited to; osseous geometry, soft tissue material properties, muscle dynamics, skeletal dynamics, and neural control.
- 2) To utilize these models to improve our knowledge of how the structure, control, and neuromusculoskeletal dynamics contribute to the pathomechanics of patients with impairments, functional limitations, or disabilities.
- 3) In conjunction with movement data utilize these models to develop techniques to definitively identify the underlying cause and long-term consequences of a specific abnormality in a patient's gait pattern.

#### **Recommended Actions**

It is recommended that agencies develop funding mechanisms to support research to meet the above objectives.

**Recommendation Title:** The Scope of Movement Analysis

**Recommendation Code:** A12

**Category:** Overall

## Recommendation

### Background

Historically, the term "gait analysis" has been used in a number of different contexts. The use of kinematic analysis, kinetic analysis, and dynamic EMG in the setting of cerebral palsy has been the application that most observers would associate with gait analysis. However, a wide-range of possibilities exists - in terms of the indications, instrumentation, candidate movements, and candidate pathologies to which movement analysis can be applied.

### Objectives

To broaden the scope of gait analysis to include the multifactorial analysis of movement in the many contexts that have rehabilitation medicine as their common denominator.

### Recommended Actions

It is recommended that the following be included as being within the scope of gait analysis:

#### Indications:

- Prevention
- Diagnosis
- Treatment planning
  - Medication
  - Surgery
  - Rehabilitation
  - Exercise prescription
  - Footwear prescription
  - Orthotic and assistive device prescription
- Use as an outcome measure
- Treatment *per se* (feedback)
- Evaluation

#### Instrumentation:

- 2D kinematic analysis (where appropriate)
- 3D kinematic analysis
- Ground reaction force measurement
- Accelerometry
- Electromyography
- Metabolic measurement
- Plantar Pressure measurement
- Instrumentation of walking aids
- Instrumentation of stair rails
- Long term gait monitoring
- Muscle force estimates
- Inverse dynamic models
- Forward dynamic models

Virtual reality  
Visualization  
Speed and timing parameters  
Candidate Movements:  
Gait  
Upper extremity motions  
Trunk motion  
Lifting  
Wheelchair propulsion  
Non straight line walking  
Non steady speed walking  
Chair rise  
Posture and balance  
ADLs  
Instrumental ADLs  
Grade locomotion  
Ramps  
Stairs  
Load Carrying  
Fall prevention  
Feedback as a treatment  
Prosthetic and orthotic fitting and familiarization  
Return to full activity (including athletics and sport)  
Transfers

Candidate Pathologies:  
Cerebral palsy  
Stroke and all other UMN diseases  
LMN diseases  
Arthroplasty  
Amputation  
Fall risk assessment  
Sports injury  
Cumulative trauma disorders  
Diabetic foot disease  
Arthritides  
Sarcopenia  
Orthopedic trauma  
Basal ganglia disorders  
Other disorder affecting movement

**Recommendation Title:** Expand the Clinical Application of Gait Analysis

**Recommendation Code:** B1

**Category:** Application

### **Recommendation**

#### **Background**

Gait analysis has been demonstrated to be effective in guiding the selection of orthopedic surgical procedures for individuals with cerebral palsy. Other neuromusculoskeletal and medical pathologies that have not adequately responded to standard forms of care addressing functional limitations and disability may also benefit from gait analysis. For example:

- 1) In patients requiring surgery after ineffective non-operative management of medial knee compartment osteoarthritis, gait analysis can select the appropriate patients for high tibial osteotomy vs. total knee replacement.
- 2) Gait measurements of plantar foot pressure in individuals with diabetes mellitus suggests that it may be an effective method for both identification and load relief prescription in those individuals where standard tissue management have failed.
- 3) Focused treatment following the identification of specific hip and ankle weakness via gait analysis in patients post stroke, demonstrated significant improvement in gait. Gait analysis used in this manner should be explored to identify specific treatment focus.
- 4) The custom of using comprehensive analysis by most laboratories presents a model which may not be appropriate for use in all pathologies. Therefore, new models need to be developed for other pathologies. The use of gait analysis to improve clinical decision-making should inevitably improve individuals outcome.

#### **Objectives**

- 1) To demonstrate the contributions of gait analysis to treatment planning, decision-making functional outcome and subsequent reduction in long-term cost.
- 2) To target appropriate populations, identify their functional limitations and select treatment interventions which require assessment and reassessment.

#### **Recommended Actions**

- 1) Federal Government should support research that documents effectiveness of gait analysis in identifying functional limitations in new populations (specific testing for specific diagnoses).
- 2) Federal Government and third party payers should support research that delineates specific gait analysis techniques/tools for specific diagnostic groups (DRG's).
- 3) Federal Government should support dissemination of findings from research to consumers as well as professionals.

**Recommendation Title:** Gait Analysis as a Cost Effective Patient Management Tool

**Recommendation Code:** B2

**Category:** Finance and Policy

### **Recommendation**

#### **Background**

Gait analysis has been shown to be an effective assessment tool. Nonetheless, the cost effectiveness of the tool has yet to be demonstrated as it relates to an individual's functional limitation and disability level. The lack of information on cost effectiveness over the life-span of individuals has impeded our ability to justify the benefits of gait analysis to the consumer, medical community, insurance and insurance providers. As an example of a potential cost saving benefit, a preliminary study has shown that gait analysis intervention which identifies lower limb dysfunction can break the cycle of recurrence in patients with low back pain. Thus lifetime expenditure due to work loss can be diminished. High medical and social costs in this and other pathologies may be positively impacted by proper gait analysis awareness and utilization.

#### **Objectives**

To determine cost effectiveness for optimum patient management by identifying selective gait analysis utilization and enhancing both professional and consumer awareness.

#### **Recommended Actions**

- 1) Support research that demonstrates the clinical effectiveness and cost effectiveness of gait analysis for neuromusculoskeletal and medical problems.
- 2) Fund educational mechanisms to disseminate information to consumers, medical / health professionals, scientists and insurance providers on the appropriate uses of gait analysis and financial cost effectiveness.

**Recommendation Title:** Use of Gait Analysis Technology as Treatment

**Recommendation Code:** B3

**Category:** Applications

### **Recommendation**

#### **Background**

Gait analysis has traditionally been used for treatment planning and assessment. One possible area of clinical usefulness could be in the treatment arena, through biofeedback, virtual reality, sensory augmentation, etc. Use of biofeedback has frequently been noted to be an effective treatment tool. Today's technology would permit the investigation of real-time feedback of biomechanical gait variables.

#### **Objectives**

To identify areas in which biomechanical analysis may provide treatment options for individuals with various disabilities.

To develop the technology to generate biomechanical information in real time.

#### **Recommended Actions**

Support investigations of the use of biomechanical analysis as a treatment tool for individuals with various neuromusculoskeletal disorders.

Sponsor studies that compare clinical outcome of treatment strategies that include biomechanical analysis with established treatment strategies.

**Recommendation Title:** Clinical Motion Analysis Data Bank with Patient Profiles

**Recommendation Code:** B4

**Category:** Resources and Collaboration

### **Recommendation**

#### **Background**

Currently, long-established laboratories enjoy the benefit of large individual gait data repositories for comparison of individuals to past experience. Newly developing laboratories could benefit from this past experience if there were a mechanism for data sharing. The Ohio State University (OSU) has a database with the results of initial gait studies on patients with cerebral palsy-spastic diplegia. These data have been accessible, with permission from OSU, only to members of the five laboratories that contributed to the database. These groups found the process useful in developing a process for sharing data and standardizing measurements. Another database with patient problems and responses to treatment for patients with myelodysplasia exists at the University of Washington. Although this database does not contain the motion analysis results per se, it has still proven a valuable national resource for treatment planning in these cases. There are other databases at gait laboratories around the country, and in addition, databases on spinal cord injury and traumatic brain injury exist at model systems that could be studied. Development of a motion analysis database that combines the motion analysis results with the patient problems and treatment outcomes for a variety of diagnoses would prove a valuable resource for existing and developing gait laboratories. This database would facilitate treatment planning and implementation and could serve as a valuable multi-site research tool.

#### **Objectives**

Develop a data bank to be shared among participating motion analysis laboratories. At a minimum, this data bank should be designed to allow input specifying the following: lab of origin and equipment and procedures used, patient's diagnosis, patient classification by NCMRR disability scale, results of the history and physical exam, patient demographics, gait studies done, anthropometric parameters used in the analyses, results of the analysis, treatment recommendations, treatments performed, and treatment outcomes. Determine exactly what items within these categories to include and set standards for data collection, input, and access for the database. Estimate necessary computer and personnel resources and provide necessary support. Advertise database development and enlist cooperation among existing laboratories. Develop rules for inputting, sharing and utilizing the data. Determine rules for handling outside requests for database access.

#### **Recommended Actions**

The NIH should establish the database at its biomechanics laboratory.

**Recommendation Title:** Standards for Reporting the Results of Clinical Gait Analysis

**Recommendation Code:** B5

**Category:** Standardization

### **Recommendation**

#### **Background**

There are multiple opportunities for standardization in the reporting of gait analyses. Differences in the reporting of gait studies typically fall into one of two formats depending on the preference of the lab. For example, this can result in graphs of angular joint kinematics going in opposite directions or joint moments being reported as external or internal. There are also a multiple systems of terminology for describing parts of the gait cycle and other parameters. This situation causes needless confusing during the training and education of students and colleagues and complicates data sharing among laboratories. Increased uniformity of reporting gait analysis would streamline the education of students and technicians, facilitate sharing of data among laboratories, and in the long run, reduce confusion during the interpretation of results. In the long-term, more intuitive, user-friendly ways of reporting the results utilizing three-dimensional graphical displays, etc., would improve our ability to communicate the results with colleagues and users of our services.

#### **Objectives**

- 1) Members of the clinical gait analysis community will develop a standardized reporting format for the results of gait analysis.
- 2) Priorities for standardization: terminology, internal vs. external moments, orientation and units of measurement for graphical displays, procedures for normalization.
- 3) The mechanism for selecting the standards will be fair and engender a spirit of cooperation.

#### **Recommended Actions**

- 1) Publish position papers from two invited experts with opposing viewpoints on controversial issues in Gait and Posture, with commentary in subsequent issues.
- 2) Poll the clinicians providing or regularly utilizing the services of gait laboratories to select standards. Include a copy of the printed debates and commentary from Gait and Posture along with the ballot.

**Recommendation Title:** Collaboration via Telecommunications / Telemedicine

**Recommendation Code:** B6

**Category:** Resources and Collaboration

### **Recommendation**

#### **Background**

Individual gait laboratories have their areas of special expertise. If gait laboratories could quickly and inexpensively share information, collaboration and consultation would be facilitated and recommendations could be improved. This could be especially beneficial for newly developing laboratories and facilitate the rapid development of local expertise as gait laboratories expand into underserved areas. Although this raises difficult legal and ethical questions concerning practice across state lines and without actual clinician-patient contact, the potential benefits warrant the exploration of this technology.

#### **Objectives**

- 1) Study the CAMARC system and use the experience of our European colleagues in establishing the North American System.
- 2) Take advantage of technology typically existing in gait laboratories (video cameras, computers with frame grabbers, etc.) and integrate them into the system design wherever possible.
- 3) Study the legal and ethical issues to ensure appropriate and defensible utilization of the resource.

#### **Recommended Actions**

Demonstration project grant funding for this capability should be a federal funding priority.

**Recommendation Title:** Improved Sensors of Neuromusculoskeletal Activity in Gait Analysis

**Recommendation Code:** B7

**Category:** Technical Development / Research

### **Recommendation**

#### **Background**

Subdermal EMG and pressure measurements are valuable tools of gait analysis, but difficult, expensive and painful to utilize. Non-invasive sensors of neural signals, muscle and ligament forces and bone stresses would be of great value to modeling and gait analysis. Means to extract such data from deep structures are not known today. However, opportunities to innovate such sensors may be offered by X-ray CT MRI, PET, ultrasound, radioactive tracers and microtransducers or magnetic or specific-chemicals-sensitive particles parentally injected into the vascular system.

#### **Objectives**

- 1) Identify, research and qualify non-invasive sensors for gait analysis.
- 2) Remove sufficient risk so that private manufactures will develop robust and cost-effective products.

#### **Recommended Actions**

Support research on non-invasive sensors to measure the variables of gait.

**Recommendation Title:** Automated Protocol for Determining Joint Centers

**Recommendation Code:** B8

**Category:** Technical Development / Assessment

### **Recommendation**

#### **Background**

Currently available software that uses a passive or active marker system to determine the joint center has many problems in clinical use.

For example, the movement of the skin on which the marker is attached over the bony landmarks makes the joint center determined by software not match the true joint center and vary from time to time during the gait cycle. If the marker position from serial studies (e.g., preoperative and postoperative) differ, the data from serial studies can not be compared. Also, the data from studies utilizing different software can not be compared because the protocols to determine joint centers differ.

#### **Objectives**

Develop an automated method and protocol for determining joint centers regardless of the position of the surface markers (i.e., a small difference of marker position does not affect joint center determination).

- 1) Create a "gold standard."
- 2) Develop uniformly acceptable software and marker placement protocol.

#### **Recommended Actions**

Government agencies and commercial organization support research to achieve objects.

**Recommendation Title:** Identify the Relationship Between Impairments, Functional Gait Limitations, and Disability

**Recommendation Code:** B9

**Category:** Research

### **Recommendation**

#### **Background**

A causal relationship between specific physical impairments, functional gait limitations, and disability has not been well established. Rehabilitation treatment plans often focus on physical impairments (e.g., weakness, contracture, spasticity) with the hope that minimizing impairments will minimize disability. In cases where impairments cannot be changed, rehabilitation teaches compensatory strategies for existing impairments to minimize functional limitation and disability. Through gait analysis, thresholds for levels of impairment could be identified that predict a greater likelihood of disability and provide clinicians with objective information from which to develop goals with their clients and prioritize treatment plans. It is likely that the relationships between impairment, functional gait limitation and disability are patient population-specific. Additionally, in the case of chronic progressive disorders with increasing severity and number of impairments over time, these thresholds could help to identify critical periods when rehabilitation intervention is essential to maintain ambulation ability.

#### **Objectives**

- 1) Determine the relationships between impairments, functional gait limitations, and disability.
- 2) Determine optimal treatment strategies via outcome studies to reduce the impairments or compensate for those impairments that cannot be changed.

#### **Recommended Actions**

Funding agencies should support research...

- 1) That includes measures of impairments, functional limitations, and disability and their interrelationship.
- 2) That utilizes direct experimentation or computer modeling and simulation.
- 3) That develops biomechanical and neural models that predict the relationship between impairments, functional gait limitations, and disability.
- 4) That assesses the efficacy of the application of existing treatment methods and development of new treatment methods based on these conceptual models.

**Recommendation Title:** Toward Routine Utilization of Gait Analysis

**Recommendation Code:** B10

**Category:** Technical Development

## **Recommendation**

### **Background**

Gait analysis is under appreciated by health care professionals, health care payers (managed care), and the community at-large. One reason is that gait labs require large space, multiple personnel, and high-cost equipment that prohibits its accessibility and utilization. Secondly, gait data is voluminous and its presentation so complex to be incomprehensible to most health care professionals and the community in general. A third reason is the limited availability of software to simulate locomotion that is useful to gait assessment and treatment. Cutting edge hardware (e.g., insole force measurements, advanced treadmills, laser imaging) has the potential to simplify and compact the gait lab. State of the art animation (e.g., Kaufman, herein) and simulation (e.g., Zajac, herein) software technology can improve the assessment and treatment of gait disorders.

Because the gait lab community is relatively small, the availability of private capital to facilitate the diffusion of this technology to end users is limited.

### **Objectives**

To optimize gait data acquisition, processing, interpretation, and presentation in order to improve utilization by healthcare professionals and appreciation by the public.

Specifically, this would include:

- 1) Development of user-friendly software for healthcare professionals that can be utilized to analyze, design, and validate patient-specific gait outcomes.
- 2) Development of data presentation software, including animation technology, which can be readily understood by both members and nonmembers of the gait community.
- 3) Development of a low cost, dependable, easily operated, mobile, gait analysis system that can produce accurate output for both clinical and nonmedical utilization in the community.
- 4) Promotion of the awareness of the utility of gait analysis amongst healthcare professionals and the community at large.

### **Recommended Actions**

Interagency funding sources need to be designated and private sector participation sought.

**Recommendation Title:** Educate Clinicians in the Use of Gait Analysis in Treatment Planning and Implementation

**Recommendation Code:** B11

**Category:** Education

### **Recommendation**

#### **Background**

The appropriate application of gait analysis can have a significant impact on the lives of people with disabilities. A major barrier to optimal referral and utilization of results in treatment planning and implementation is the lack of a basic understanding by physicians, therapists and orthotists/ prosthetists regarding its capabilities, benefits and limitations. Despite mounting evidence that gait analysis can provide valuable information in directing interventions such as surgery, it is not widely utilized.

#### **Objectives**

To improve the appropriate utilization of gait analysis in treatment planning through education based on scientific evidence.

#### **Recommended Actions**

- 1) Professional organizations such as the North American Society of Gait and Clinical Movement Analysis should provide funding for instructional courses targeted at relevant professional disciplines.
- 2) Government and industry should provide funding to develop educational tools which utilize easily understood representations of the data obtained from gait analysis.
- 3) Government and private training grants or other sources should fund fellowships for clinicians in gait analysis facilities.
- 4) Accreditation agencies of appropriate professional groups should require inclusion of gait analysis material in professional education curricula.

**Recommendation Title:** Effectiveness of Gait Analysis

**Recommendation code:** B12

**Category:** Research

### **Recommendation**

#### **Background**

There is limited evidence to suggest that the results of gait analysis can be used to guide rehabilitation treatment planning and improve walking ability of people with functional gait limitations and disabilities. However, the contribution of gait analysis to the rehabilitation process and its potential benefit has not been systematically documented in an adequate number of research studies. Treatment decisions may be improved by more complete objective information provided by gait analysis, and may result in more effective and efficient interventions.

#### **Objectives**

Conduct research aimed at determining whether the use of gait analysis influences treatment decisions, improves treatment outcomes, and reduces the cost of treatment.

#### **Recommended Actions**

- 1) Granting institutions should provide funding to conduct research that determines if gait analysis improves the ability of clinicians to classify patients into appropriate treatment groups.
- 2) Granting institutions should provide funding to conduct controlled randomized research studies to document the impact of gait analysis on treatment and outcome.

**Recommendation Title:** Advance Research Evidence for the Clinical Utility of Movement Analysis Across a Broad Range of Pathophysiologies

**Recommendation Code:** C1

**Category:** Research

### **Recommendation**

#### **Background**

Movement analysis has been proven a useful tool for evaluating functional limitations. Most of the existing literature has focused on the application of gait analysis in pediatric patients with cerebral palsy. Movement analysis can quantify functional limitations associated with a variety of impairments. For example, three dimensional kinematic and kinetic evaluations have the potential to identify motor patterns and strategies of an individual and compare that profile to normative data, or identify primary problems versus adaptive mechanisms. Combining this information with electromyographic data can allow one to distinguish spasticity from weakness and provide information regarding agonist and antagonist muscle synergistic patterns.

While the benefit of identifying and quantifying specific movement impairments have been demonstrated in the cerebral palsy population, there exists potential in other areas that have not been addressed such as; spina bifida, amputees, stroke, spinal cord injury, arthritis, low back pain, arthrogyrosis, post polio syndrome, Multiple Sclerosis, etc. It would be desirable to develop biomechanical models and testing guidelines which would lead to protocols to measure functional limitations specific to these pathophysiologies.

#### **Objectives**

To increase the specificity of movement analysis in a variety of pathophysiologies.

#### **Recommended Actions**

Funding from NIH and other agencies such as, Department of Defense, Muscular Dystrophy Association, and the Veterans Administration, in the form of RFAs for research applying movement analysis to a variety of functional limitations in various pathological conditions.

**Recommendation Title:** Scope and Availability of Gait Analysis Facilities

**Recommendation Code:** C2

**Category:** Policy / Training

### **Recommendation**

#### **Background**

Clinical gait analysis has established a strong beachhead particularly in hospitals that serve children, especially children diagnosed with cerebral palsy. It is now important to make a breakout so that gait analysis techniques and knowledge can be applied to a wide spectrum of movement pathologies and to a wide-range of patients. Until movement analysis facilities are placed in rehabilitation hospitals and general hospitals on a wider basis, people with locomotion disabilities may be prevented from receiving movement and pathokinesiological services. These laboratories or departments should not be focused on particular instruments or pathologies but should provide needed services appropriate to the patient referral base. Services might go beyond gait analysis to encompass more generally movement analysis.

#### **Objectives**

The objective is to make clinical movement analysis services much more widely available and more generally applied in medical care facilities. More specifically:

- 1) Facilitate the access of movement analysis labs to clinicians. Foster partnerships between clinicians and people in academia engaged in movement science.
- 2) Examine and evaluate working models of the application of movement science in general medical practice.
- 3) Open up access to existing movement analysis labs to practicing clinicians. Encourage publication of case studies using movement analysis techniques to assist in clinical decision making.

#### **Recommended Actions**

- 1) Fund clinical scholars programs to bring clinicians into research facilities that perform movement analysis. Additionally, fund research fellows and faculty from centers of excellence to train staff in clinical facilities while gaining appreciation of clinical issues.
- 2) Fund a study of the efficacy of open access European and Canadian clinical movement analysis labs associated with hospitals.
- 3) Peer reviewed journals, particularly Gait and Posture, should publish case studies and compilations of cases which use movement analysis data.

**Recommendation Title:** Establish Comprehensive Gait Analysis (GA) as a Standard of Care in Pre-Surgical Decisions for Ambulatory Children with Cerebral Palsy (CP)

**Recommendation Code:** C3

**Category:** Policy

### **Recommendation**

#### **Background**

The traditional treatment for children with diplegic and hemiplegic pattern CP consisted of multi-staged surgical procedures. Complex GA consisting of 3D kinematics, electromyography, and kinetic analysis has produced more specific information leading to directed surgeries. Numerous published studies have demonstrated that patients who have undergone such comprehensive GA have had fewer surgical procedures and have demonstrated improved outcomes. Despite these demonstrated clinical improvements, the majority of children with CP continue to undergo surgery without the benefit of pre-operative GA.

#### **Objectives**

Establish comprehensive GA as a part of the standard of care for ambulatory children with CP prior to surgery.

#### **Recommended Actions**

Several actions be taken regarding the following statement:

Pre-surgical decisions for ambulatory children with CP should be based, in part, on data acquired in a comprehensive GA carried out in a laboratory with demonstrated ability to collect and interpret 3D kinematic, kinetic, and EMG data in children with complex movement disorders.

- 1) Gain consensus regarding this statement at meeting on Gait Analysis in Rehabilitation Medicine sponsored by NCMRR, Sept. 26-28, 1996, Arlington, VA.
- 2) NCMRR endorse this statement.
- 3) To gain wider acceptance for this statement, established authorities in this area (e.g., Jim Gage, Jacqueline Perry, David Sutherland, etc.) need to generate a consensus statement supporting the above position at a national forum such as the annual meeting of the North American Society of Gait and Clinical Movement Analysis (NASGMA).
- 4) Accepted authorities will publish this statement with appropriate supporting documentation in peer-reviewed journals and disseminate it at appropriate meetings such as NASGMA and the American Academy for Cerebral Palsy and Developmental Medicine (AACPDMD) and interested consumer groups.

**Recommendation Title:** Role of Three-Dimensional Computerized Gait Analysis in Treatment Decision-Making and as an Outcome Measure and its Cost Effectiveness

**Recommendation Code:** C4

**Category:** Limited Access/Outcomes

### **Recommendation**

#### **Background**

A major barrier to the clinical implementation of gait analysis technologies in some surgical and most rehabilitation settings, and therefore access to these technologies, is the paucity of quantitative research documenting the advantage of computerized gait analysis over traditional clinical evaluations (static physical examination and observational gait analysis) in treatment decision-making, outcome assessments, and cost-effectiveness. Historically, most orthopaedic surgeons and rehabilitation specialists have relied primarily on static examination and observational gait analysis to make treatment decisions. Single level surgeries and other ineffective treatment strategies may have resulted from these diagnostic approaches. Treatment outcomes have either not been performed or have relied on more qualitative methods, that are not as valid or reliable. Furthermore, the costs of ineffective treatments and staged single level surgeries have not been closely scrutinized. Computerized gait analysis can provide valid, reliable, and quantitative information, but it has not been demonstrated to be a superior tool in well controlled studies.

#### **Objectives**

Test the hypothesis that three-dimensional gait analysis is:

- 1) Superior to traditional methods of evaluation used by surgeons and rehabilitation specialists in treatment decision-making for specific diagnoses.
- 2) It can provide superior quantitative outcome measures of treatment.
- 3) It is cost effective.

#### **Recommended Actions**

Provide funding to centers of excellence to design well controlled studies to:

- 1) Compare the effectiveness of computerized gait analysis to traditional methods of evaluation used for locomotion impairments in treatment decision making.
- 2) Study the outcomes of treatments of locomotion impairments using computerized gait analysis in order to determine the most appropriate gait measures to be used as outcome measures.
- 3) Study the cost effectiveness of utilizing computerized gait analysis as an evaluation and outcome measure tool.

**Recommendation Title:** Time/Distance Analysis for Use in Group/Multicenter Outcome Studies

**Recommendation Code:** C5

**Category:** Research/Outcome/Limited Access

### **Recommendation**

#### **Background**

A major barrier to gait analysis in large clinical trials is the expense of a complex study. Functional measures of ambulation/ mobility however are often lacking in precision to capture the benefit from improvements in strength and stability due to the use of a specific intervention such as drugs, exercise etc. A low cost, reliable measure of walking is a time/distance analysis which includes gait velocity, cadence, step and stride length, base of support, time in single and double support, percentage stance, and percentage swing.

#### **Objectives**

Establish norms for time/distance analysis for specific groups of impairments as a simple, reliable, quantitative and low cost test of walking.

#### **Recommended Actions**

Develop studies on group of impairments/diseases in which drugs, exercises and other interventions are shown to have a superior outcome for walking by time/distance analysis.

**Recommendation Title:** Define the Components of Gait Analysis.

**Recommendation Code:** C6

**Category:** Access/Utilization Barriers

### **Recommendation**

#### **Background**

The vast majority of patients with impaired locomotion are effectively denied access to objective locomotion analysis, even in its most rudimentary form. These patients are only assessed visually by clinicians, who must then make decisions about treatment or outcome based on this impression. It may be that this has no real consequence on the outcome, for example, an athlete presenting with an antalgic gait pattern resulting from a sprained ankle, will almost certainly not undergo a course of treatment or attain an outcome that would be any different even had a locomotion analysis been performed. Here a subjective assessment would be sufficient. At the other extreme a negative outcome may result if a comprehensive locomotion analysis is not done before a multilevel surgical procedure is undertaken on a patient with cerebral palsy, for example. Between these two extremes are patients that could benefit from having their walking pattern analyzed in some objective manner but who probably do not need a comprehensive, highly sophisticated and expensive analysis. As an example, the patient with diabetic neuropathy would benefit from an analysis of the distribution of forces under the foot either as a diagnostic procedure or as an outcome measure. There is a need therefore to clearly define objective locomotion measurements, the technologies used to obtain them and an indication of their implementation in clinical-decision making. This would result in a list of the components used in clinical locomotion analysis together with codes to identify them. From this list could be selected one or more measurements which would best meet the needs of a given patient. This selection would be helped by the provision of clinical indications, including clinical practice guidelines for the most effective use of these measurements and technologies. The use of the codes should be used by clinical facilities to clearly define the level of locomotion analysis that they have used thereby maintaining the integrity of the term Locomotion Analysis.

#### **Objectives**

- 1) Develop a list of objective locomotion analysis measurements and technologies and assign codes to them.
- 2) Determine under what conditions and for what purposes these measurements and technologies should be used.

#### **Recommended Actions**

Provide funds to:

- 1) Develop a list of locomotor measurements and technologies (a sample list of these is attached) and assign to these identification codes such as CPT codes.
- 2) Develop guidelines for clinicians that indicate the technologies and measurements most appropriate for given pathologies, impairments or functional limitations.

**Recommendation Title:** The Development of Interactive Software to Assist Professionals in the Interpretation, Synthesis and Use of Locomotion Data.

**Recommendation Code:** C7

**Category:** Technology Development

### **Recommendation**

#### **Background**

A barrier which prevents people with locomotion disabilities from accessing gait analysis relates to the difficulties which many professionals have in understanding the data. New and emerging technologies provide the power to present and share complex data sets in more clinically relevant ways. These technologies exist and now need to be synthesized into a meaningful software package.

#### **Objectives**

- 1) Create a system which will enhance the presentation of gait analysis data and assist the practitioner in the interpretation and use of these data.
- 2) Design a system or package which will integrate chart information, expert systems and linguistic phrases, interactive graphics, and predictive simulations. This system will take advantage of emerging technologies for transparent data transfer, confidentiality and access to established data bases.

It is anticipated that these objectives will be addressed by developing:

- a) Charting procedures for presenting summary results of objective gait analysis in a form which practitioners find useful and which compliments existing subjective reporting procedures.
- b) Interactive graphics systems to assist the professional in the understanding and interpretation of motion analysis data.
- c) Expert systems to assist the professional in the decision-making questions which arise from the gait analysis data and which can be utilized to capture interesting data which does not meet a priori expectations.
- d) Predictive simulation models that can answer the what if question.

#### **Recommended Actions**

- 1) Convene a workshop to reach consensus among gait experts and interested professionals on: the process by which experts currently interpret, synthesize and utilize data in clinical decision-making, prioritizing the development of interactive software to assist clinicians in the interpretation, synthesis and use of locomotion data.
- 2) Put out an RFA to implement the recommendations of the workshop. This RFA should emphasize collaboration and cooperation between disciplines and centers involved in motion analysis.
- 3) Host a second workshop to establish testing and implementation procedures, to provide training for the new software package, and prioritize areas for subsequent development.

**Recommendation Title:** Standardization of Gait Analysis

**Recommendation Code:** C8

**Category:** Policy

### **Recommendation**

#### **Background**

Lack of standards are a critical factor limiting access to gait analysis by people with locomotion disabilities. For example, a physician may not refer a patient for a gait analysis study because of a lack of understanding of how the evaluation could improve treatment and document outcome. Standards are needed to facilitate sharing of clinical and research data, for ensuring the quality of services provided, for education of and communication between various health care providers and consumers, and for improving reimbursement. Standards will also enhance interfaces between rehabilitation technologies, facilitate the inclusion of technological innovation outside of rehabilitation medicine, and encourage communication with common biomechanical parameters. Standards will allow all pertinent stakeholders, including physicians, other healthcare providers, third party payers and consumers, to be educated about the indications for a gait analysis study and what is provided as part of a gait analysis evaluation. Standards will also allow these individuals to be consistently educated so the results of the gait analysis study are meaningful to them and the value of gait analysis is understood. Standards will facilitate multicenter research studies to document the impact of gait analysis in rehab medicine and to establish a consensus of outcome measures. Standards will also allow transparent exchange of information using advanced telecommunication and computer technologies.

#### **Objectives**

Establish standards to ensure consistency in the provision of clinical services and information exchange, and facilitate multicenter research.

#### **Recommended Actions**

The NASGCMA should take the lead in a proactive process directed toward establishing comprehensive voluntary standards that address the needs discussed above. This process should include the following stakeholders: members of the NASGCMA standards committee, government (FDA and NIH), the AMA, the APTA, the ISB standards committee, the disabled community, the information technology industry and the equipment manufacturers. The process of establishing standards will require workshops that bring together these stakeholders. Funding will need to be identified to effectively carry out these workshops.

**Recommendation Title:** Accreditation of Diagnostic Clinical Gait Laboratories

**Recommendation Code:** C9

**Category:** Standardization

### **Recommendation**

#### **Background**

Individuals with locomotion disabilities and their third party payers have difficulty determining which gait laboratory is appropriate to evaluate their specific disability. There currently are a large number of different types of equipment ranging from simple home video cameras to very expensive multiple time synchronized camera systems to evaluate three dimensional kinematics and kinetics. Gait laboratories are also operated by many different individuals with different levels of training and backgrounds. Many of these diverse laboratories claim to do diagnostic analysis, however they provide very different levels of useful information. This large diversity of clinical gait laboratories makes it difficult for individuals and insurance companies to evaluate what is being done and how it positively contributes to the individuals care. This confusion leads to individuals not obtaining appropriate studies because they nor their third party payers can be sure that the laboratory data will be valid and useful. Further more there are studies being performed in laboratories where the data is probably of marginal use. Impairment and diagnosis specific evaluations also vary widely leading to decreased cost- effectiveness through over and under utilization of specific elements of the analysis.

#### **Objectives**

To make available clinically useful gait analysis to individuals with locomotion disabilities in a cost effective manner. Use a multidisciplinary approach to define algorithms, methods, and appropriate personnel to provide useful clinical information in assisting in planning treatment of individuals with disabilities.

#### **Recommended Actions**

The gait laboratory community should establish a process for individual laboratory accreditation. This accreditation should consider the impairment and diagnosis to be tested, appropriate techniques to be used, and the level of sophistication appropriated to the individual to be tested. The training and competence of personnel staffing gait laboratories should be considered as part of this accreditation. This process should be coordinated with a standardization process.

**Recommendation Title:** Medical Education Models for Health Care Professionals

**Recommendation Code:** C10

**Category:** Education

### **Recommendation**

#### **Background**

The fact that health care professionals have a lack of knowledge and education regarding the scope and clinical relevancy of gait analysis is a major barrier that prevents people with locomotion disabilities from accessing gait analysis. Gait analysis provides the technology that can measure, describe, quantify, and identify movement deviations and functional limitations. When interpreted by a skilled individual, gait analysis can provide additional clinically relevant information that is not available by any other method. This information can mean the difference between successful outcome and poor result. Despite this, as a measurement tool it is under used and not widely accepted for treatment planning. Just as x-ray is one of the definitive diagnostic procedures in the treatment of fractures, so gait analysis should be one of the definitive procedures for the assessment and treatment of locomotor disability and treatment planning. In current professional instruction and training programs locomotor disabilities are neither understood nor taught.

#### **Objectives**

- 1) Institute a change in professional education of health care professionals in the area of gait analysis.
- 2) Promote the use of gait analysis in the diagnosis and treatment of locomotor disabilities.
- 3) Improving interprofessional understanding of gait analysis as a clinical tool.
- 4) Promote the idea of an intradisciplinary team for gait analysis interpretation in an attempt to improve clinical usefulness.
- 5) Advocate for "centers of excellence" in the treatment of complex gait disorders.

#### **Recommended Actions**

- 1) Through an appropriate Board, accredit regional "centers of excellence" which will train professionals and treat of complex neuromuscular disorders.
- 2) Provide funding to the "centers of excellence" for the development of programs which train health care educators so that the principles of normal locomotion and motion analysis are incorporated in the basic science curriculum.
- 3) Government agencies will mandate the incorporation basic science training in math and engineering into the residency or professional programs of health disciplines which treat locomotor disorders.
- 4) Government agencies will mandate the incorporation of training in both gait analysis and the principles of normal and pathological gait into residency or professional programs of health disciplines which treat locomotor disorders.
- 5) Develop fellowship training programs at "centers of excellence" which will provide training in both gait analysis and the principles of normal and pathological gait to health disciplines which treat locomotor disabilities.

6) Provide funding to develop educational materials in the field of gait and gait analysis which could include electronic media, CD-ROMs, internet websites, etc.

**Recommendation Title:** Consumer and Patient Education

**Recommendation Code:** C11

**Category:** Education

### **Recommendation**

#### **Background**

Because consumers are not widely aware of the availability of locomotor analysis, consumers do not routinely advocate for referral to locomotor centers of excellence. If parents were made aware that their children's surgical outcome might be improved by preoperative gait analysis, physicians and third party care payers would more frequently refer these children. Similarly, if persons with locomotor disabilities were aware of the benefits conferred by locomotion analysis, they would stimulate demand for high quality, objective locomotion analysis. By analogy, people with migraine headache request referral for MRI to attempt to determine the headache cause. The popular media, including newspaper articles, NOVA and other TV shows, routinely feature MRI and other "high tech" medical investigations for common problems. Articles in consumer magazines such as Abilities Unlimited, Accent on Living, Paraplegia News, Exception Parent and others might reach consumers directly if the material were written in consumer-oriented language. If the gait analysis community were to obtain similar media coverage, the public would be better informed and better served by locomotion analysis. World wide web sites, information provided to, eg, local UCP, MDA, Easter Seals and PVA branches, schools and stroke clubs are other venues for information dissemination. Centers of excellence would educate consumers, and stimulate consumer demand, by word of mouth.

The New England Journal of Medicine, Journal of the American Medical Association, and other leading medical journals frequently inform the popular press about medical discoveries. Physicians must then read the journal to intelligently answer their patients' questions about the "news." A similar approach from gait related professional journals would better inform the public, and, not incidently, increase demand for these publications among care providers.

#### **Objectives**

Increase public awareness of and demand for high quality locomotor analysis.

#### **Recommended Actions**

Provide funding mechanisms that stimulate the development and dissemination of locomotion related material to the popular media, parents, and local consumer organizations. North American Society of Gait and Clinical Movement Analysis and other interested societies should provide to consumer groups pamphlets describing the benefits, locations and advantages of locomotor analysis.

Encourage professional journal editors to provide to the popular press breaking news about locomotion research and clinical applications.

**Recommendation Title:** Universal Access to Gait Analysis Services

**Recommendation Code:** C12

**Category:** Policy/ Research

### **Recommendation**

#### **Background**

In the current managed care market place, individuals with locomotor disabilities have limited access to gait analysis because of policy and lack of payment. Access is denied by managed care organizations that restrict access based on artificial geographic boundaries and who restrict care to network providers. Gait analysis is often denied by third party payers and managed care organizations as an experimental procedure which is not cost-effective. Individuals without expertise are dictating which services are necessary or not necessary for treatment. Rather than resulting in decreased cost, this situation results in increased costs and/or suboptimal outcomes because of unnecessary and inappropriate treatments. Centers of excellence should be identified and individuals have the right to care at these centers to maximize their function in society.

#### **Objectives**

1) Institute a change in the health care delivery system to assure that patients with locomotor disabilities have access to gait analysis services.

#### **Recommended Actions**

1) The field of gait analysis should promote legislation that mandates third party payers and managed care organizations to provide individuals with locomotor disabilities access to care at accredited laboratories and/or centers of excellence with gait analysis.

2) The field of gait analysis should promote legislation to prohibit third party payers from being the gatekeeper of the care of individuals with locomotor disabilities, and promote the use of centers of excellence to be the gatekeepers of their care.

3) Funding for research should be made available in the area of gait analysis which illustrates the cost-effectiveness of its use as a tool that optimizes care.

4) Promote research and provide funding for outcome studies which illustrates the efficacy of gait analysis.

5) Appoint a task force made up of individuals from multiple disciplines/agencies to investigate and determine the regional clinical centers of excellence for specific movement disabilities that all third party payers in that region use for treatment. Promote the concept that all centers of excellence for locomotor disorders should be associated with an accredited gait laboratory.

**Recommendation Title:** The Development of Information Resources Which Will Help New Gait Laboratories to Develop Successfully

**Recommendation Code:** C 13

**Category:** Education

### **Recommendation**

#### **Background**

One of the major limitations in the access to gait analysis by individuals with locomotion disabilities is the limited number of clinical laboratories. Establishing laboratories requires appropriate equipment, space, personnel and referral base. Administrative decisions to build new laboratories are often made without thorough consideration of all these issues. Some, or all of these needs are may be over looked by administrators. Manufactures have at times been more interested in selling equipment than developing successful functional laboratories.

#### **Objectives**

To provide complete and accurate information to facilities who are interested in building new laboratories. Allow potential laboratories to make informed decisions about their function and decrease the incidence of failure.

#### **Recommended Actions**

- 1) Equipment vendors work with the North American Society of Gait and Clinical Movement Analysis (NASGCMA) to develop information concerning all aspects of the basic operation requirements of a clinical gait laboratory. We encourage vendors to provide this information to administrators interested in developing new laboratories.
- 2) Identify and refer volunteers from the NASGCMA who would be willing to serve as consultants to new laboratories.