

ABSTRACTS OF RECENT LITERATURE

by

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Abstracts are drawn primarily from the orthotics and prosthetics literature. Selections of articles were made from these journals:

American Journal of Physical Medicine and Rehabilitation

American Journal of Sports Medicine

Assistive Technology

Canadian Journal of Occupational Therapy

Ergonomics

International Journal of Rehabilitation Research

Journal of Biomechanics

Journal of Bone and Joint Surgery

Paraplegia

Physical Therapy

Scandinavian Journal of Rehabilitation Medicine

PROSTHETICS, ORTHOTICS, AND RELATED TOPICS

Benefits of Sport and Physical Activity for the Disabled:

Implications for the Individual and for Society.

Shephard RJ, reprinted from *Scand J Rehabil Med* 23:233-241, 1991.

An increase of physical activity is commonly recommended to those with physical disability, but it is necessary to distinguish competitive sport from fitness programmes, remedial gymnastics and active recreation. Potential benefits of enhanced activity are reviewed. Likely psychological gains include an improvement of mood-state, with a reduction of anxiety and depression, an increase of self-esteem and feelings of greater self-efficacy. Sociological gains include new experiences, new friendships, and a countering of stigmatization. Perceived health is improved, and in a more long-term perspective there is a reduced risk of many chronic diseases. Finally, there is a greater likelihood of employment, with less absenteeism and enhanced productivity. Both the health and the industrial benefits have a potential to yield cost savings that could make an

important contribution toward the expense of suitably adapted physical activity programmes. It is concluded that the physically disabled should be encouraged to engage in physical activity, although further large-scale longitudinal studies are needed to determine the optimal type of programme for such individuals.

Biomechanical Analysis of the Influence of Prosthetic Feet on Below-Knee Amputee Walking.

Gitter A, Czerniecki JM, DeGroot DM, reprinted from *Am J Phys Med Rehabil* 70:142-148, 1991.

Although energy storing prosthetic feet have achieved widespread clinical acceptance, the effect of these components on the biomechanics of below-knee amputee gait is poorly understood. The purpose of this study was to determine the biomechanical adaptations used by the below-knee amputee while wearing a conventional prosthetic foot and to assess the influence of energy storing prosthetic feet on these adaptations. Mechanical power outputs of the lower extremity in five normal and five below-knee amputee subjects using the SACH, Seattle and Flex feet were studied. Ground reaction forces and kinematic data were collected at a walking speed of 1.5 m/s and were used to determine the muscular power outputs of the lower extremity during stance. Consistent patterns of muscular power output at the hip and knee of the residual limb occur. While wearing the SACH foot, negligible energy generation occurs at the prosthetic foot during pushoff. A decrease in energy absorption at the knee during the first half of stance and an increase in energy generation by the hip extensors were the major adaptations noted in the proximal muscle groups. Compared to the SACH foot, the energy storing feet demonstrated increased energy generation during pushoff. Despite the improvements in the performance of the energy storing prosthetic feet, no significant differences were found in the pattern or magnitude of knee and hip power outputs compared to the SACH foot.

Biomechanical Model of the Human Shoulder Joint—II.

The Shoulder Rhythm. Hogfors C, Peterson B, Sigholm G, Herberts P, reprinted from *J Biomech* 24:699-709, 1991.

A method to investigate the rhythm of the human shoulder, i.e. the interplay between the motion of constituent parts of the shoulder, has been devised and tested. The method is based upon numerical evaluation of low dose roentgenstereophotogrammetric motion pictures of subjects equipped with radiation dense implantations in the bones. Evaluation of the method shows that it may be used in determining motion patterns and that the employed interpolation techniques can be used to simulate motions not actually performed in the laboratory. The shoulder rhythm has been previously poorly investigated and quantified results published pertain to one plane only. Our results on motion patterns correlate with previous investigations. With this method, we show that the absolute position of the bones varies significantly between individuals while the relative displacement of the bones during motion exhibit similarities. In particular the results show that, under normal conditions, the individual rhythm is very stable and insensitive to small hand-loads.

Conductive Differences in Electrodes Used with Transcutaneous Electrical Nerve Stimulation Devices.

Nolan MF, reprinted from *Phys Ther* 71:746-751, 1991.

The purpose of this study was to document conductive differences among commercially available electrodes used with transcutaneous electrical nerve stimulation (TENS) devices. Impedance within a model system involving a human subject was calculated from oscilloscopic tracings of the pulse waveform for each of 25 different electrode types. Impedance values ranged from 1,000 to 7,800 Ω . Possible reasons for these differences are discussed. The observation that electrodes vary in their impedance and can thereby affect the stimulus applied to the skin raises the question of whether electrode choice might affect the clinical effectiveness of TENS. Attention is drawn to the skin electrodes as a variable that may affect the results of clinical and basic studies involving TENS.

Development of an Integrated Wheelchair Tray System for Augmentative Communication. Blackstein-Adler S, Ryan S, Naumann S, Parnes P, reprinted from *Assist Technol* 2:142-150, 1991.

This paper describes the development of a wheelchair tray system for persons with physical disabilities who require an augmentative communication system. The tray

system offers advantages over existing systems by providing a convenient anterior/posterior tilt feature, a means for stowing the tray when not in use, and a method of accommodating communication systems and powered wheelchair controls. Caregivers of seven subjects fitted with the prototype system assessed its performance through the completion of questionnaires provided at the end of 6-week field trials. The technical performance of the system was also monitored. The prototype system was favorably received by six participants. Several recommendations are made to further increase consumer acceptance of the final tray design.

The Effect of Ankle Constraint on the Torsional Laxity of the Knee During Internal-External Rotation of the Foot. Quinn TP, Mote CD, Skinner HB, reprinted from *J Biomech* 24:511- 525, 1991.

The *in vivo* torsional laxity and stiffness of the knee joint are usually determined by rotating the foot and measuring the torque generated at the knee. However, when rotation is applied to the foot, significant three-dimensional forces and moments are produced at the knee. These forces and moments depend upon the external constraint of the ankle complex, and as a result, the observed laxity of the knee also depends on the ankle constraint. Tests are conducted with the foot of a subject in a shoe, with and without the ankle taped, and in a buckled and unbuckled (ski) boot that can effectively constrain ankle rotation. The average laxity of the primary (linear) region of the axial moment vs internal-external rotation is 30% greater when the ankle is constrained by the buckled boot than it is in three other cases of lesser ankle constraint.

Effectiveness: A Neglected Dimension in the Assessment of Rehabilitation Devices and Equipment. Conine TA, Hershler C, reprinted from *Int J Rehabil Res* 14:117-122, 1991.

Effectiveness is a term used by research methodologists when referring to the attributes of a new health care intervention (e.g. device, medication, or procedure) which if lacking may result in its rejection despite its efficacy and efficiency. Administrators and consumers increasingly require evidence to ensure that a proposed new product or manoeuvre not only 'works' (efficacy, efficiency) but is 'practical' (effective). Yet, effectiveness data are rarely described in research literature or adequately measured. Common effectiveness qualities that might be considered in the formal evaluation of new rehabilitation devices and equipment are cost, convenience to the user ('user-

friendliness'), and compliance with the local standards. This article identifies some of the most important variables related to these attributes and suggests strategies for appropriate data collection and analysis. A comparison of two products evaluated in an institutional setting is used to illustrate the suggested method.

Effectiveness of Orthotic Shoe Inserts in the Long-Distance Runner. Gross ML, Davlin LB, Evanski PM, reprinted from *Am J Sports Med* 19:409-412, 1991.

Five hundred questionnaires were distributed to long-distance runners who had used, or who were using orthotic shoe inserts for symptomatic relief of lower extremity complaints. Three hundred forty-seven (69.4%) responded (males, 71%; females, 29%). The mean age of the respondents was 36 years (range, 15 to 61). The average distance run per week was 39.6 miles (range, 5 to 98). The mean duration for use of the orthotic inserts was 23 months (range, 1 to 96). The predominant (63%) type of orthotic device used was flexible. The presumed diagnoses in the population studied were excessive pronation (31.1%), leg length discrepancy (13.5%), patellofemoral disorders (12.6%), plantar fasciitis (20.7%), Achilles tendinitis (18.5%), shin splints (7.2%), and miscellaneous (4.9%).

Of the runners responding, 262 (75.5%) reported complete resolution or great improvement of their symptoms. Results of treatment with orthotic shoe inserts were independent of the diagnosis or the runner's level of participation. A high degree of overall satisfaction was demonstrated by the finding that 90% of the runners continued to use the orthotic devices even after resolution of their symptoms. Orthotic shoe inserts were most effective in the treatment of symptoms arising from biomechanical abnormalities, such as excessive pronation or leg length discrepancy. Along with other conservative measures, orthotic shoe inserts may allow the athlete to continue participation in running and avoid other treatment modalities that are more costly and time consuming, and therefore less acceptable to them.

The Effects of Splinting on the Spastic/Hemiplegic Hand: Report of a Feasibility Study. Langlois S, Pederson L, MacKinnon JR, reprinted from *Can J Occup Ther* 58:17-25, 1991.

Hand splints are used by occupational therapists as a method of reducing the increased muscle tone of the upper extremity following stroke. However, the paucity of

research and inconsistent findings examining the effects of splinting on spasticity has resulted in this technique being a controversial one. Many parameters of splinting need to be investigated, such as the type of splint, the duration of use, and wearing schedules. This feasibility study was conducted to pretest instruments and procedures investigating the effects of a finger spreader on the spastic musculature of the wrist and to examine trends in spasticity associated with variables, including a splint wearing schedule, expectations and satisfaction with the splint, and compliance.

Nine subjects were randomly assigned to three groups defined by wearing schedules of twenty-two, twelve, and six hours per day. The greatest change in the level of spasticity was noted in the group wearing the splint for twenty-two hours. However, this trend was not statistically significant. A statistically significant relationship was found between expectations of the splint and compliance to the wearing schedule. Satisfaction with the splint outcome and therapeutic interaction was also observed to have a statistically significant relationship with compliance. This indicates that the procedures and measures designed for this study are worth pursuing in future research.

Hand Strength: The Influence of Grip Span and Grip Type. Fransson C, Winkel J, reprinted from *Ergonomics* 34:881-892, 1991.

The maximal force from each of the fingers II-V (FF) and the resultant force between the jaws of the tool (RF), due to contribution from all fingers, were measured using a pair of modified pliers. The RF was measured at 21 handle separations and the FF was measured at seven handle separations for each finger. A traditional grip type was compared with a 'reversed' grip where the little finger was closest to the head of the tool. Sixteen subjects (8 females and 8 males) participated in the study.

Both the RF and FF varied according to the distance between the handles. For both grip types, the highest RF was obtained at a handle separation of 50-60 mm for females and 55-65 mm for males. For wide handle separations, the RF was reduced by 10% (cm increase in handle separation)⁻¹. The force-producing ability of the hand was influenced by the grip type and the highest RF was obtained when using the traditional grip. An interaction was found between the fingers, i.e., the maximal force of one finger depended not only on its own grip span, but also on the grip spans of the other fingers. About 35% of the sex difference in hand strength was due to hand size differences.

International Wheelchair Standards: A Study of Costs and Benefits. Hartridge M, Seeger BR, reprinted from *Assist Technol* 2:117-123, 1991.

We hypothesized that extra costs incurred in meeting the requirements of wheelchair standards are recouped within the life of the wheelchair. We selected standards-quality and non-standards-quality electric wheelchairs of the same make and subjected them to accelerated life tests in a laboratory to simulate 1 year's active use. Expenses and lost time incurred due to breakdowns were monitored, and the costs of upgrading were documented. Our results support the hypothesis, within the limits imposed by the availability of only a small number of makes of electric wheelchairs of recognized standards quality. The significance of this finding is that wheelchair standards can be used to upgrade wheelchair quality in a cost-effective manner.

Invariant Characteristics of Gait Initiation. Brunt D, Lafferty MJ, McKeon A, *et al.*, reprinted from *Am J Phys Med Rehabil* 70:206-212, 1991.

Studies were undertaken first to describe the invariant characteristics of gait initiation and second to better understand the function of each limb in the process of gait initiation. Analysis of variance indicated significant main effects for speed for time to onset of EMG activity and force plate recordings, time to swing toe-off and heel-strike and stance toe-off. However, when the dependent variables were expressed as a percentage of the initiation cycle, no significant main effects were noted. For the second study, two force plates were utilized, and reflective markers were placed on the sacrum and anterior superior iliac spines. The timing of heel-strike of the swing limb and toe-off of the stance limb showed a high degree of coordination in both experiments ($r=0.95$ and 0.98). It was concluded that the relative invariance of selected parameters indicates that gait initiation is centrally programmed. It also appears that the swing limb, although forces were very small, is responsible for the initial weight shift to the stance limb and that the stance limb is then primarily responsible for the generation of momentum.

Occupational Performance of Activities of Daily Living among Elderly Canadians in the Community. McKinnon AL, reprinted from *Can J Occup Ther* 58:60-66, 1991.

Sociocultural role expectations for occupational performance by individuals and groups differentiated on the basis of age, gender, and other social characteristics are of cen-

tral interest to occupational therapy practice based on the occupational performance model. Data analysed from the public use microdata file of the 1985 General Social Survey of Canadians reveal important differences in social role expectations and patterns of occupational performance among a representative sample of elderly Canadians ($N=3,130$), as evidenced by their social support for certain activities of daily living. Significant gender and age differences are identified in the types and sources of social support provided and received, with elderly men much more likely than elderly women to receive help with housework, meal preparation, and grocery shopping. Such information contributes to the development of a broad national context for the client-centred practice of occupational therapy with elderly Canadians, and points to the need for further research on sociocultural influences on occupational performance across the lifespan.

Physiological Responses to Maximal Exercise on Arm Cranking and Wheelchair Ergometer with Paraplegics. Martel G, Noreau L, Jobin J, reprinted from *Paraplegia* 29:447-456, 1991.

The study describes the responses of 20 paraplegic athletes (mean age: 26.8 ± 1.6 years) to a continuous incremental workload test until exhaustion on an arm cranking ergometer (ACE) and on a wheelchair ergometer (WCE). Both ergometers used the same electromagnetic braking device allowing a fair comparison between results. Tests were conducted at a 24 hour interval at the same time of the day. Oxygen uptake (VO_2), heart rate (HR), workload (W), blood pressure (BP), Borg index, and mechanical efficiency (ME) were measured at every minute during the effort and the cool down periods of both tests. The purpose of this study was to analyse the different responses obtained on ACE and on WCE during maximal effort by paraplegics, and also to determine which ergometer permits the higher ME. Results indicate that paraplegics reached the same max HR on ACE and on WCE (97% of the predicted max HR). The lack of significant difference ($p < 0.05$) between ACE and WCE in terms of maximal values of VO_2 , VE and HR suggests that the subjects reached their maximal capacity on each test regardless of the type of ergometer. Nevertheless, W max (in Watts) was 26% higher on ACE than on WCE. Maximal ME values were respectively 16% and 11.6% on ACE and WCE. Results suggest that ergometers and protocol used in this study are appropriate to measure physiological responses of paraplegic athletes during arm cranking and wheelchair exercise without excessive or early arm fatigue.

Postural Load and Back Pain of Workers in the Manufacturing of Prefabricated Concrete Elements.

Burdorf A, Govaert G, Elders L, reprinted from *Ergonomics* 34:909-918, 1991.

In a population of male workers in a concrete manufacturing plant (n=114), the occurrence of back pain was studied in relation to a control group of maintenance engineers (n=52). The prevalence of back pain in the 12 months preceding the investigation was 59% among the concrete workers, and 31% among the controls. After excluding persons with existing back pain before starting work in the present factory, a comparison between concrete workers and maintenance engineers showed an age-adjusted odds ratio for back pain of 2.80 (1.31-6.01). Postural load of workers in both plants were measured using the Ovako Working Posture Analysis System. During 4009 observations working postures concerning the back, lower limbs, and lifting activities were recorded. The average time spent working with a bent and/or twisted position of the back was found to contribute to the prevalence of back pain. The results of this study also suggest that exposure to whole-body vibration, due to operating vibratables, is a second risk factor for back pain.

Prediction of Amputation After Severe Lower Limb Trauma. Robertson PA, reprinted from *J Bone Joint Surg* 73-B:816-818, 1991.

The Mangled Extremity Severity Score was applied to 152 patients with severely injured lower limbs. All cases with a score of seven or more required amputation; some with scores of less than seven eventually came to amputation. These observations are discussed.

Prosthetic Replacement of the Distal Femur for Primary Bone Tumours. Roberts P, Chan D, Grimer RJ, *et al.*, reprinted from *J Bone Joint Surg* 73-B:762-769, 1991.

Over a 16-year period, 135 custom-made distal femoral prostheses, based on a fully constrained Stanmore-type knee replacement, were used in the treatment of primary malignant or aggressive benign tumours.

Survivorship analysis showed a cumulative success rate of 72% at five years and 64% at seven years. Intact prostheses in 91% of the surviving patients gave good or excellent functional results. Deep infection was the major complication, occurring in 6.8% of cases; clinical aseptic loosening occurred in 6.0%. Revision surgery was carried out for loosening and infection, and the early results are encouraging.

We conclude that prosthetic replacement of the distal femur can meet the objectives of limb salvage surgery.

Social Role Functioning Following Spinal Cord Injury.

Stambrook M, MacBeath S, Moore AD, *et al.*, reprinted from *Paraplegia* 29:318-343, 1991.

The Katz Adjustment Scale—Relatives Form was completed by the wives of 27 hospital-discharged spinal cord injured (SCI) patients. Their ratings of the spouses' social adjustment and behaviour were compared to available community and psychiatric norms. Overall, spouses rated their SCI husbands as performing significantly more socially inappropriate behaviours compared to ratings of 'normals' but as engaging in significantly less socially inappropriate behaviours compared to the ratings of psychiatric patients. SCI patients were perceived as performing the same levels of social activities as 'normals,' but engaging in less free-time activities compared to both 'normals' and psychiatric patients. These results mirror similar analyses comparing moderate and severe head injury victims with normal and psychiatric norms. The implications for rehabilitation and counselling of families of traumatically disabled patients are discussed.

Special Facilities and Services for University Students with Mobility Impairment: A Demographic Study (U.S.A.). Huer MB, reprinted from *Assist Technol* 2:125-130, 1991.

The purpose of this study was to collect demographic information in 1988-1989 regarding the use of technology in disabled student services programs in higher education. Two different methods were selected: (a) the frequency of availability of 21 special services was tallied in 593 university programs across the United States, and (b) a self-administered mail questionnaire was used to gather information from 150 randomly selected programs. The rate of response to the survey was 65%; 98 questionnaires were returned from programs in 38 states. The results of the studies summarize the special services and facilities generally accessible to disabled university students, the technological assistance available, the numbers of university students having disabilities of mobility, the numbers who need assistance for computer access, and the percentage of programs identifying disabled students using electronic devices. These demographic data may shed new light on current practices related to rehabilitation technology in university settings.

Spinal Injury Rehabilitation: Do Staff and Patients Agree on What They are Talking About? Glass CA, Krishnan KR, Bingley JD, reprinted from *Paraplegia* 29:343-349, 1991.

The psychological effects of spinal cord injury on patients themselves have been discussed in a number of articles, but few studies have been made of patients and staff, perceptions of the effectiveness of the treatment they receive and supply.

An earlier investigation by the present authors showed that there were differences between the views of staff and of patients in terms of their understanding of rehabilitation. As a consequence, a number of procedural changes were implemented in the Spinal Unit, in an attempt to improve the information provided for patients and their relatives, and the selection and support of staff.

Reanalysis of the staff and patient views of rehabilitation were carried out 12 months later using a standardised questionnaire and any changes in response were noted.

The present findings are analysed, and the potential implications for other units are noted.

Talocrural and Talocalcaneal Joint Kinematics and Kinetics During the Stance Phase of Walking. Scott SH, Winter DA, reprinted from *J Biomech* 24:743-752, 1991.

The purpose of this investigation was to study the kinematics and kinetics of the joints between the leg and calcaneus during the stance phase of walking. The talocrural and talocalcaneal joints were each assumed to act as

monocentric single degree of freedom hinge joints. Motion at one joint was defined by the relative rotation of a point on the opposing joint. The results, based upon the gait of three subjects, showed that the hinge joint assumption may be reasonable. A discrepancy in the kinematics was shown between the talocrural joint rotation and its commonly assumed sagittal plane representation, especially during initial flatfoot. This discrepancy is due to the fact that the sagittal plane rotation is created by the combined rotations of the talocrural and talocalcaneal joints. The talocalcaneal joint showed a peak 25-30 Nm supinatory moment at 80% of stance. The talocrural joint moment was qualitatively similar to the commonly measured sagittal plane moment, but the present results show that the sagittal plane moment overpredicted the true moment by 6-22% due to the two-dimensional assumption.

Upward Displacement of the Centre of Gravity in Paraplegic Patients. Duval-Beaupere G, Robain G, reprinted from *Paraplegia* 29:309-317, 1991.

The centres of gravity of 44 complete chronic spinal cord injured patients and 24 normal subjects were measured using a gamma ray scanner (Barycentremetre). The results are expressed as a percentage of body length and as anatomical level. The mean weight of paraplegic patients was 12 kg less than the controls. The centre of gravity was 5% of body length higher in the paraplegic patients than in the controls, equivalent to 3 to 4 vertebrae level. The importance of such changes in the centre of gravity for the design of stable wheelchairs is discussed.