ABSTRACTS OF RECENT LITERATURE

by
Joan E. Edelstein, P.T.
Senior Research Scientist, Prosthetics and Orthotics, New York University
and
Jerome D. Schein, Ph.D.
Professor Emeritus of Sensory Rehabilitation, New York University, and David Peikoff Chair in Deafness Studies, University of Alberta, Edmonton, Canada

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

American Journal of Physical Medicine and Rehabilitation
American Journal of Sports Medicine
Archives of Physical Medicine and Rehabilitation
Canadian Journal of Rehabilitation
Ear and Hearing
Ergonomics
Journal of Medical Engineering and Technology
Journal of Speech and Hearing Disorders
Journal of Speech and Hearing Research
Journal of Visual Impairment and Blindness
Medicine & Science in Sports and Exercise
Paraplegia
Physiotherapy
Rehabilitation Psychology
Sports Exercise

PROSTHETICS, ORTHOTICS, AND RELATED TOPICS

Acquired Limb Loss in Patients with Traumatic Brain Injury. Stone LR, Keenan MAE, Shin DY, reprinted from *Am J Phys Med Rehabil* 69:135-139, 1990.

The outcome associated with long-term prosthetic use was evaluated in 12 patients who had a dual disability of severe traumatic brain injury and an extremity amputation. The incidence and nature of complications after limb loss was also reviewed. The 12 patients sustained 15 extremity amputations. Lower extremity amputations were the most common disability. Fifty percent of the patients had at least one postoperative complication after amputation. All patients (100%) had at least one complication documented on rehabilitation admission. No patient was using a prosthesis at the time of rehabilitation admission. At discharge six patients were able to use a prosthesis. Only one patient was considered independent. Patient follow-up averaged 28.6 months. At long-term follow-up six patients were using a prosthesis. Four were considered independent. One-third of the total group was considered able to use the prosthesis independently in the community. Of the lower extremity amputated population, only 40% became ambulatory. This is considerably less than can be expected to become ambulatory if there was no amputation. All three upper extremity amputees did not use a prosthesis. All efforts should be directed at salvaging a limb threatened by amputation after survival of traumatic brain injury. Early transfer to a facility specializing in traumatic brain injury rehabilitation may decrease complications, reduce total hospitalization and improve overall functional ability. [JEE]

Assessing Sincerity of Effort in Maximal Grip Strength Tests. Chengalur SN, Smith GA, Nelson RC, Sadoff AM, reprinted from *Am J Phys Med Rehabil* 69:148-153, 1990.

Injuries to the upper extremities sometimes result in a loss of work capacity. One of the methods for measuring this loss of work capacity is the grip test. Such measurements may be compromised by an insincere effort (faking) by the subject. Smith et al. (*Am J Phys Med Rehabil* 1989;68:73-80) developed a protocol to identify sincere and faking efforts with the use of a modified dynamometer. The present investigation was designed to evaluate the applicability of the previously developed protocol to subjects with hand injuries. The investigators also compared

the force-time characteristics for contractions at different percentages of maximum (100, 75, 50, and 25%). Sixty subjects (30 male and 30 female) were tested during two sessions while performing both faking and sincere efforts. The five discriminators previously developed were found to be good detectors for both noninjured and injured hands and provided the basis for cutoff values for the five discriminators. Single discriminator prediction gave at best an 85% faking detection rate (by using D3) for men, and a 79.2% detection rate (by using D5) for women. Better results were obtained when a multiple variable prediction was used. It can be concluded that the protocol developed by Smith *et al.* for detection of an insincere effort can be used successfully with persons who have sustained upper extremity injuries. Furthermore, sincere and faking grip strength "maxima" can be correctly identified across a wide range of applied force levels. [JEE]

Biomechanical Measurement of Fracture Healing. Cunningham JL, Kenwright J, Kershaw CJ, reprinted from *J Med Eng Tech* 14:92-101, 1990.

Three techniques for measuring fracture healing are presented. These techniques are: (1) use of strain gauge measurements of the forces in an external fixator to determine fracture stiffness, (2) measurement of the vibration modes of a fractured long bone compared to the unfractured contralateral, and (3) comparison of the ultrasound velocity across the fracture site with that for the normal unfractured bone. Examples of clinical results obtained using these techniques are presented, and the advantages and disadvantages of each technique are discussed. [JEE]

Changes in Ambulation Parameters in Spinal Cord Injury Individuals Following Rehabilitation. Yakura JS, Waters RL, Adkins RH, reprinted from *Paraglegia* 28:364-370, 1990.

The energy cost and gait parameters of 10 spinal cord injury patients (mean age = 21.7 $\pm$ 2.3 years) were measured at discharge from initial rehabilitation and at 1 year follow-up. At follow-up testing patients walked faster (59.5 m/minute vs 40.4 m/minutes; $p < 0.001$), more efficiently (0.26 ml O_2/kg.m vs 0.40 ml O_2/kg.m; $p < 0.05$) had slower heart rates (115 beats/minute vs 133 beats/minute; $p < 0.01$), and required decreased axial load on upper extremity assistive devices (18% body weight vs 26% body weight; $p < 0.03$).

At follow-up testing, those patients with remaining weakness in the lower limbs had greater conditioning effects (increased rate of oxygen consumption and oxygen pulse) than those patients with relatively stronger limbs. These findings indicate that clinicians can expect significant improvements in functional ambulation performance in the first year following initial rehabilitation due to improved strength and conditioning. [JEE]

Comfort and Appearance. Oldenkamp I, reprinted from *Ergonomics* 33:413-420, 1990.

A project is being carried out with the aim to develop an individual, engine-driven, covered vehicle for handicapped people. The prime object is that this vehicle should meet the requirements of the handicapped. Nevertheless, choices had to be made by the parties concerned that could have violated this goal. In particular, this was experienced when designing the interior to accommodate large persons on the one hand and meeting the aesthetic requirements of the exterior, which called for a smaller height, on the other. Marketing ergonomics was used to deal with this problem. [JEE]

Control of Body Mass Transfer as a Function of Speed of Ascent in Sit-to-Stand. Pai Y, Rogers MW, reprinted from *Med Sci Sports Exerc* 22:378-384, 1990.

The purpose of this study was to test the hypothesis that a progressive variation in the speed of ascent would result in differences in the horizontal and vertical motions of the body center of mass (CM) and in the governing impulse-momentum relationship. A motion analysis system and two force platforms were used to examine the STS task among 10 healthy adults at each of three self-selected speeds. As the speed of ascent became faster, a progressively earlier time to the maximum vertical linear momentum and an increase in its magnitude occurred. In contrast, a relatively constant time to the maximum linear momentum, which was also the time when the propulsive impulse became the braking impulse, was found in the horizontal direction, and the propulsive impulse showed a disproportionately (1:3) smaller increase from slow to fast speeds than its vertical counterpart. The relative invariance in the horizontal motion suggested that different neuromuscular control strategies may have been employed in the horizontal and vertical directions to accomplish the different tasks of balance control in one direction and changing the gravitational potential energy in the other direction. [JEE]

Designing Special Switches and Control Systems for Multiply Handicapped Young People: A Problem-Led Approach. Thornett CEE, reprinted from *J Med Eng Tech* 14:87-91, 1990.

This paper discusses a design strategy for assistive equipment for disabled people, in particular for special switches and control systems to enable the severely physically handicapped to control powered wheelchairs, computers, communication aids and environmental control systems. Special switch systems in this application must provide a complex human-equipment interface. Experience over a number of years with over 80 severely handicapped young people has refined the design strategy for both special switch systems and interfacing. Some examples are given of a problem-led approach, and the materials used and the method of manufacture are discussed. [JEE]

Effect of Wheelchair Design on Posture and Comfort of Users. Harms M, reprinted from *Physiotherapy* 76:266-271, 1990.

The canvas sling seat and backrest incorporated into a conventional wheelchair provide a seating system which falls short of many basic ergonomic requirements, which may compromise the comfort, health and level of dependency of the user.

The high incidence of back pain among able-bodied people gives rise to much concern. Yet although there are indications that a similar proportion suffer, back pain in the disabled population receives less specific attention.

Two prospective studies were undertaken involving a total of 58 subjects. The first evaluated the effects of wheelchair design on posture and the second looked at the effects that this had on the comfort of the user. Posture was recorded using a technique for measuring spinal curves, and data on the comfort of each seat were collected by questionnaire.

The studies evaluated three different seating systems. The first was that of a conventional model 8BL wheelchair; the second and third were experimental rigs incorporated into an 8BL frame. One rig had cushions chamfered to fit the concavities of the canvas seat and backrest and the second had a rigid base on which was mounted cushioning material.

The unmodified 8BL was shown to encourage a kyphotic posture and caused discomfort in both able-bodied and disabled subjects especially in the neck and back. The two experimental rigs promoted an acceptable degree of lordosis and, although both proved more comfortable than the canvas seat, of the two the hard-based seat was preferred. [JEE]

The Effects of Simulated Knee-Flexion Contractures on Standing Balance. Potter PJ, Kirby RL, MacLeod DA, reprinted from *Am J Phys Med Rehabil* 69:144-147, 1990.

The effects of simulated unilateral and bilateral knee-flexion contractures on standing balance were studied by testing 15 normal subjects on a Kistler force platform. Postural sway (mediolateral and anteroposterior travel) and the mean position of the center of pressure (as a percentage of the distance between the midlines of the feet and from heels to toes) were determined from 20 s of data. Unilateral and bilateral knee-flexion contractures of 15 degrees and 30 degrees were simulated for each subject by means of an adjustable line from the subject's waist to the sole of each foot. Paired t tests were used to compare balance parameters while standing with the simulated contractures with those during relaxed standing. Mediolateral travel increased by a mean difference of 3.6 cm with a 30 degree unilateral contracture ($P < 0.01$) and by 5.0 cm with 30 degree bilateral contractures ($P < 0.01$). Anteroposterior travel increased by 4.7 cm ($P < 0.05$) and 8.8 cm ($P = 0.08$) with 15 degree and 30 degree bilateral contractures, respectively. With a unilateral contracture of 30 degrees, the center of pressure shifted 15.6% ($P < 0.0005$) toward the unflexed side, changes that were not eliminated by correction of the induced leg-length discrepancy. The center of pressure moved anteriorly by 8.3% with 30 degree bilateral contractures ($P < 0.001$). The results provide insight into how knee-flexion contractures alter standing balance, and underline the importance of preventing and treating this common disorder. [JEE]

The Efficacy of a Prophylactic Knee Brace to Reduce Knee Injuries in Football: A Prospective, Randomized Study at West Point. Sitler M, Ryan J, Hopkinson W, et al., reprinted from *Am J Sports Med* 18:310-315, 1990.

The purpose of this prospective, randomized study was to determine the efficacy of a prophylactic knee brace to reduce the frequency and severity of acute knee injuries in football in an athletic environment in which the athletic shoe, playing surface, athlete-exposure, knee injury history, and brace assignment were either statistically or experimentally controlled. The participants in the study were 1396 cadets at the United States Military Academy, West Point, New York, who experienced a total of 21,570 athlete-

exposures in the 1986 and 1987 fall intramural tackle football seasons. The use of prophylactic knee braces significantly reduced the frequency of knee injuries, both in the total number of subjects injured and in the total number of medial collateral ligament injuries incurred. However, the reduction in the frequency of knee injuries (total and medial collateral ligament) was dependent on player position. Defensive players who wore prophylactic knee braces had statistically fewer knee injuries than players who served as controls. This was not true of offensive players who served as controls; they had statistically no difference in the number of knee injuries from players who wore prophylactic knee braces. The severity of medial collateral ligament and anterior cruciate ligament knee injuries was not significantly reduced with the use of prophylactic knee braces. [JEE]

An Electric Wheelchair Mounted Robotic Arm: A Survey of Potential Users. Prior SD, reprinted from *J Med Eng Tech* 14:143-154, 1990.

This paper describes the results of a survey which investigated and evaluated the needs and abilities of electric wheelchair users. The results of this survey will be used to develop a low-cost electric wheelchair-mounted robotic arm for use by physically disabled people to facilitate rehabilitation. The survey was undertaken by the author together with staff and students from occupational therapist training colleges, using a four-page questionnaire containing over 110 questions. The questionnaire was developed by the author together with Dr Robin Platts (Director of Orthotics), Mr Ian Bayley (Director of the London Spinal Unit) and senior occupational therapists at the Royal National Orthopaedic Hospital, Stanmore, Middlesex. After a successful trial the questionnaire was used with 50 severely disabled people from various backgrounds and social circumstances. The results of this survey show that the average electric wheelchair user is 40 years old, single (68%), living at home (58%) with family support (69%) and without any paid employment (79%). The most prevalent disability is spinal cord injury (24%) followed by multiple sclerosis (16%). The survey has identified several tasks which electric wheelchair users find impossible to do, and some of these will form part of the design specification. Finally, 84% of the survey subjects would consider buying such a robotic aid. [JEE]

Energy Consumption in Paraplegic Ambulation Using the Reciprocating Gait Orthosis and Electric Stimulation of the Thigh Muscles. Hirokawa S, Grimm M, Le T, et al., *Arch Phys Med Rehabil* 71:687-694, 1990.

Six persons with paraplegia ranging from T1 to T10 were fitted with custom-made reciprocating gait orthoses. They received 6 weeks of daily training, and simultaneously, 6 weeks of functional electrical stimulation to the quadriceps and hamstring muscles 3 times a week. They then had 6 weeks of gait training with stimulation, after which energy consumption tests were administered by means of a nose clip and mouthpiece connected to a volume spirometer. Each subject walked at his preferred speed. Energy cost was reduced 16 percent with stimulation, with most reduction occurring at slower speeds. Stimulation also reduced heart rate an average of 12 beats per minute.

Energy expenditure with various walking aids was also compared. The lowest cost was with the reciprocating gait orthosis with stimulation. Second lowest was the reciprocating orthosis without stimulation. The knee-ankle-foot orthosis ranked third. The hip guidance orthosis allowed more efficient slow gait. The Marsolais stimulation required the highest energy at low-to-moderate speeds. With 0.2 ms as the preferred speed for most daily activities, the ranking of aids is: reciprocating orthosis with stimulation first, reciprocating orthosis and hip guidance orthosis tied for second, knee-ankle-foot orthoses third, and the Marsolais stimulation fourth, with the highest cost. [JEE]

Ergo Test 2000: A New Device for Muscle Testing and Rehabilitation. Brodie D, Callaghan M, Green A, reprinted from *Physiotherapy* 76:412-415, 1990.

Muscle function testing is either expensive or lacks scientific rigour in reliability, validity or objectivity. This article reports a new device to assess functional muscle force and work, enabling a wide range of movements to be undertaken using an accommodating resistance principle. In addition to being an evaluative device, the machine can be used for rehabilitation or training. The unit is safe, effective and requires minimal space. Its most important features are that it can be operated easily and provides accurate information for either the physiotherapist or the patient in a clear digital display. [JEE]

Field Test Estimation of Maximal Oxygen Consumption in Wheelchair Users. Franklin BA, Swantek KI, Grais SL, et al., *Arch Phys Med Rehabil* 71:574-578, 1990.

Thirty male wheelchair users had a preliminary cardiorespiratory assessment, then assumed a standard position

in front of an arm crank ergometer. After a 3-minute warm-up, the workload was increased gradually until volitional fatigue. Respiratory variables, heart rate, blood pressure, and perceived exertion were determined at each workload. Within a 2-week period, subjects engaged in field testing with a Quickie II wheelchair on an indoor level track, propelling themselves for 12 minutes, during which time distance was measured. Distance correlated highly with physiological variables measured in the laboratory. [JEE]

Functional Neuromuscular Stimulation in Four Patients with Complete Paraplegia. Hjeltnes N, Lannem A, reprinted from *Paraplegia* 28:235-243, 1990.

The effect of functional neuromuscular stimulation (FNS) on muscle strength and endurance was studied in 3 patients with long-standing complete injuries (T7–T12) and in 1 patient with a recent complete injury (T5). All 4 patients became strong enough to rise, stand and to walk a few steps within parallel bars. However, only 1 patient was able to walk without parallel bars (60 m). The energy demand of FNS-assisted walking was measured to be more than 60% of the maximal endurance capacity of this patient. This finding partly explains the low patient acceptance of FNS. [JEE]

Humans Were Not Created to Sit—And Why You Have to Refurnish Your Life. Grimsrud TM, *Ergonomics* 33:291-295, 1990.

The traditional straight static chair originated 5,000 years ago, probably as a sign of dignity, the symmetrical sitting position emphasizing the divine origins of chiefs and pharaohs. The current 90-degree hip, knee, and ankle posture is not appropriate for seated work. Standing at a high desk is preferable to sitting, because standing retains the natural curves of the back. Sitting has sociological meanings, as do standing and lying. Sitting is a means of being relieved of strain, relaxing, and being supported. The traditional environment should be refurnished to rid it of tables which are too low and static, stiff, and stressful sitting which may contribute to back pain. The 90-degree sitting angle at the hip exerts pressure on the diaphragm and restricts abdominal organ function, particularly in a low chair. Abdominal pressure reduces oxygen supply to the head, thus resulting in one's becoming tired. [JEE]

Injuries to Elite Wheelchair Athletes. Ferrara MS, Davis RW, reprinted from *Paraplegia* 28:335-341, 1990.

The purpose of this project was to describe the nature, type, and frequency of athletic injuries incurred by the elite wheelchair athlete. Nineteen athletes participated in a 1-year injury recall study at an elite wheelchair training camp. An injury was defined as anything the athlete expressed concern about and (a) caused a loss of participation due to an injury or illness or (b) an injury in which a fracture, dislocation, or subluxation occurred and the athlete was able to continue participation. There were 10 male and 9 female subjects who reported their injuries from 1 June 1987 to 31 May 1988. Fifty injuries were reported, strains and muscular injuries accounted for almost half of the injuries. Physicians were the primary care provider for 37% of the injuries, followed by physical therapists and athletic trainers at 26% and 15% respectively. Slightly over 57% of the injuries were classified as minor, missing 7 days or less of participation and 32% were classified as major, missing 22 days or more of participation. The upper extremity was the most frequently injured, followed by the lower extremity, head and spine, and illnesses. Conventional treatments of ice, heat, modalities, and medications, were the most common methods of treating these injuries. Flexibility and strength training programmes should be implemented throughout the competitive season. Careful consideration of the training programme and workout intensity should also be evaluated. [JEE]

KINEMAN: A Microcomputer-based Video Digitising System for Movement Analysis. Williams JG, Davis M, reprinted from *Physiotherapy* 76:353-356, 1990.

This paper describes and discusses a video-digitising system which uses a suite of microcomputer programs (KINEMAN) that has been developed and used to carry out kinematic analyses of human motor action. The equipment is relatively low cost and consists of a video camera, a high quality U-matic or Super VHS videotape recorder, a monitor and microcomputer (BBC Master or PC using MS.DOS). Mouse-driven software enables the acquisition of X-Y co-ordinates for reference points on the joints of the subject which are stored on the disk, then edited and converted to 'real' values.

Further programs from the suite are used to calculate and list angles, limb velocities, and limb accelerations. It also has facilities for data smoothing, graphing, and presenting sequences on stick figures.

The accuracy of the system as a means of generating two-dimensional kinematic data has been demonstrated and several studies have shown that reliable results can be obtained with minimal training and without technical assistance. [JEE]

Reciprocal Aided Gait in Paraplegia. Crosbie WJ, Nichol AC, reprinted from *Paraplegia* 28:353-363, 1990.

A group of 9 paraplegics, experienced in the use of walking aids for ambulation, were tested using an alternate four-point gait. Data were collected pertaining to the axial load transmitted through the crutches, the upper limb joint displacements and the moments about the elbow and shoulder joints during the period of contact of the walking aid with the ground. This gait was found to be slow with long periods of load transmission through the walking aids. Comparatively high values were calculated for the moments about the joints of the upper limb. [JEE]

Rehabilitation Technology or the Ergonomics of Ergonomics. Soede M, *Ergonomics* 33:367-373, 1990.

Rehabilitation technology should follow the rules of product design, even though the target user groups are small or have peculiar requirements. The commercial market for rehabilitation technology differs from the normal market. Target groups may be described by diagnosis, or by impairment, disability, and handicap. Impairment refers to the loss or abnormality in the body. Disability is the restriction to perform an activity, while handicap is a disadvantage that limits fulfillment of a normal role. Technology tries to reduce impairment, as with a hearing aid or prosthesis. Disability can be lessened, such as by Braille or a wheelchair. Handicaps are minimized by such devices as an alarm system which allows the disabled person to live independently. Often the user does not pay for the aid, which may result in different behavior and acceptance. Methodology which allows a minimum of labor costs is desirable because such costs are charged to the product. Often the most advanced technology, including information science, electronics, and new materials and design methods, is needed to provide sufficient durability, light weight, good appearance, and function. Robotic devices substitute for motor function by advanced manipulators. An industrial robot can perform a repetitive task, or the manipulator can function in a nonstructured environment. Electronics and computing can contribute to home comfort, savings, and safety with remote controls, alarm systems, bathroom safety provisions, and telematic services. A well-designed product may be technically complex, but should be functionally simple. [JEE]

Reliable In Vivo Estimation of the Instantaneous Helical Axis in Human Segmental Movements. Fioretti S, Jetto L, Leo T, reprinted from *IEEE Trans Biomed Eng* 37:398-409, 1990.

The assessment of the experimental setup and of the data processing methods for the *in vivo* kinematic investigation of the human joints is described here. The relative movement of contiguous body segments, supposed rigid, is described by means of the instantaneous helical axis (IHA). Great attention has been paid to the stereophotogrammetric aspects and to the filtering and numerical differentiation procedures, in order to obtain reliable estimation of IHA parameters. Their accuracy has been estimated in a simulation context. One experimental case relative to the metacarpophalangeal (MCP) joint is described in detail. The clinical application of the procedures and of the experimental protocol has been used in the entire work. [JEE]

Repeatability of the KT-1000 Arthrometer in a Normal Population. Wroble RR, Van Ginkel LA, Grood ES, et al., reprinted from *Am J Sports Med* 18:396-399, 1990.

Despite its popularity, the MEDmetric KT-1000 arthrometer's reliability remains inadequately documented. We conducted this study to determine the magnitude of trial-to-trial (within installation), installation-to-installation (within day), and day-to-day (between day) variability of anterior/posterior translation measurements in normal knees.

We selected six normal subjects, three males and three females, and tested each on 6 consecutive days with three separate installations per day. We recorded the total anterior/posterior translation at ± 89 and ± 134 N force at 25 degrees of flexion during three consecutive trials in a single installation.

Analysis of variance showed that no significant difference existed between trials (within installation) or between installations (within day) for all parameters. However, we did find a significant difference between days for individual right and left knee translation measurements at 89 and 134 N force. More importantly, no significant difference existed between days for right to left differences at both force levels.

The magnitude of the expected measurement variability was expressed by computing 90% of confidence limits for total anterior/posterior translation at ± 89 N force. These were ± 1.5 mm for the right knees, ± 1.4 mm for the left knees, and ± 1.6 mm for the right-left differences. Fischer's protected least significant difference post hoc test revealed that for all parameters, the 1st day measurements were significantly less than those on following days, suggesting that patient and examiner adjust to the testing procedure.

We conclude that the standard KT-1000 evaluation should report paired differences rather than individual knee measurements. Additionally, initial evaluation should be supplemented by follow-up examinations for verifying translation values. [JEE]

Reproducibility of Genucom Knee Analysis System Testing. Wroble RR, Grood ES, Noyes FR, Schmitt DJ, reprinted from *Am J Sports Med* 18:387-395, 1990.

The Genucom knee analysis system was studied to determine the reproducibility of test results. In the first phase of the study we investigated the reproducibility of anterior/posterior stress tests at 30 degrees and 90 degrees of flexion and varus/valgus stress tests at 20 degrees of flexion in 10 control subjects during three seatings on 3 separate days. In the second phase we studied the effect of errors in the digitization procedure (a part of the patient installation process) on anterior/posterior translation measurements. In the third phase we studied the reproducibility of a battery of tests in patients with chronic unilateral ACL deficient knees. The test battery was repeated 8 times on each knee on 6 separate days.

In Phase I, analysis of variance revealed no significant differences between tests within a single seating. The day-to-day variance of all subjects was not significant, but we found a significant interaction between day and subject which was due to significant day-to-day differences in individual subjects.

We found in Phase II that changing the location of the tibial joint line digitization points in the anterior/posterior or proximal/distal direction affected anterior/posterior translation measurements. Effects were larger at 30 degrees of flexion than at 90 degrees and when both the medial and lateral points were moved. Movement of the femoral condylar points resulted in a similar pattern of effects.

In Phase III, although we found significant differences between our two examiners, there were no significant intraexaminer test-to-test (within seating) effects. Additionally, while there was no significant day-to-day variance overall, we found a significant interaction between day and subject. This was due to significant day-to-day differences in individual subjects.

The results indicate that since measurements vary from day-to-day, care must be taken in interpreting the meaning of a single measurement or even of repeated measurements made within a single seating. We advise meticulous care in the digitization procedure, diligence in assuring patient relaxation, and attention to detail throughout. [JEE]

Research in Physical Medicine and Rehabilitation: VIII. Preliminary Data Analysis. Buchner DM, Findley TW, reprinted from *Am J Phys Med Rehabil* 69:154-169, 1990.

This paper describes important aspects of preliminary data analysis to be taken after data are checked for clerical entry errors and before the primary statistical analysis is performed. These include description and graphic display of each variable, recoding categorical data, transforming continuous data into another continuous variable and recoding continuous to categorical data. Missing values and outlying data points are identified and several techniques are recommended to minimize mistakes in variable recoding. Related variables measured with different units may be combined by using the z transformation and converted back to one of the original units for ease of interpretation. Finally, both categorical and continuous variables are checked for reliability by using kappa or the intraclass R. [JEE]

Response of Eight Knee Orthoses to Valgus, Varus and Axial Rotation Loads. Lunsford TR, Lunsford BR, Greenfield J, Ross SE, *J Prosthet Orthot* 2:274-288, 1990.

A testing apparatus was developed consisting of an above-knee prosthesis modified to allow valgus, varus, and axial rotation angles. The socket was filled with polyester foam and a mounting pipe. The knee joint was replaced with a soft crepe one. A rubber sleeve simulated skin friction. Eight orthoses were the Polyaction, Lerman, Lenox Hill, ECKO, DonJoy Analog, Pro Am, and CTi. Valgus and varus torques ranged from 0 to 650 inch-pounds to represent clinical conditions. For each torque value, the angle that the fixture deformed with or without an orthosis, was recorded. The Analog orthosis controlled valgus and varus best, while CTi and Lerman had most control of axial rotation. In general, rigid knee orthoses resisted deforming forces. Rigidity depends on design, metal sidebars, and overall length, as well as good fit. The most restrictive orthosis may not guard against high torques, and the least restrictive one may suffice for many low torque applications. [JEE]

Spinal Cord Injury Care System: Fifteen-year Experience at the Rehabilitation Institute of Chicago. Yarkony GM, Roth EJ, Meyer PR, et al., reprinted from *Paraplegia* 28:321-329, 1990.

A statistical study of 15 years of the spinal cord injury care system of the Rehabilitation Institute of Chicago is

reported. The Rehabilitation Institute of Chicago (RIC) is the rehabilitation component of the Midwest Regional Spinal Cord Injury Care System, a collaborative programme with Northwestern Memorial Hospital and Northwestern University. Data are reported on 1382 patients, a representative sample of the over 2000 patients treated since the inception of the centre. The sample was predominately male (83%, N=1147) and Caucasian (64%, N=888). The most common aetiology was motor vehicle accidents (36%, N=505). During the 15-year period there were significant decreases in both acute and rehabilitation lengths of stay. Ninety three percent of the patients were discharged home. Rehabilitation benefits were demonstrated by improvements in the Modified Barthel Index. The research, educational and clinical programmes are described. [JEE]

United States Government Regulation of Medical Device Software: A Review. Murfitt RR, reprinted from *J Med Eng Tech* 14:11-113, 1990.

A brief history of the regulation of medical device software within the United States is presented, along with a discussion of the reasoning that the US Food and Drug Administration (FDA) presents for modifying the requirements for software regulation from those previously used for hardware devices. The current regulatory status is discussed for the two categories of medical device software, software used within medical devices and software used to produce or test medical devices. The published FDA documents which determine the current environment for the regulation of software are summarized and discussed. The two types of medical device software are related to the two areas of FDA regulation, good manufacturing practices and permission to sell medical devices. The expected direction of future medical device software regulation, and its relationship to the European Economic Community (EEC) and international markets is discussed. [JEE]

Viscoelastic Properties of Muscle-Tendon Units: The Biomechanical Effects of Stretching. Taylor DC, Dalton JD, Seaber AV, Garrett WE, reprinted from *Am J Sports Med* 18:300-309, 1990.

Most muscle stretching studies have focused on defining the biomechanical properties of isolated elements of the muscle-tendon unit or on comparing different stretching techniques. We developed an experimental model that was designed to evaluate clinically relevant biomechanical stretching properties in an entire muscle-tendon unit. Our objectives were to characterize the viscoelastic behavior of the muscle-tendon unit and to consider the clinical applications of these viscoelastic properties.

Rabbit extensor digitorum longus and tibialis anterior muscle-tendon units were evaluated using methods designed to simulate widely used stretching techniques. Additionally, the effects of varying stretch rates and of reflex influences were evaluated. We found that muscle-tendon units respond viscoelastically to tensile loads. Reflex activity did not influence the biomechanical characteristics of the muscle-tendon unit in this model.

Experimental techniques simulating cyclic stretching and static stretching resulted in sustained muscle-tendon unit elongations, suggesting that greater flexibility can result if these techniques are used in the clinical setting. With repetitive stretching, we found that after four stretches there was little alteration of the muscle-tendon unit, implying that a minimum number of stretches will lead to most of the elongation in repetitive stretching. Also, greater peak tensions and greater energy absorptions occurred at faster stretch rates, suggesting that the risk of injury in a stretching regimen may be related to the stretch rate, and not to the actual technique. All of these clinically important considerations can be related to the viscoelastic characteristics of the muscle-tendon unit. [JEE]

SENSORY AIDS/REHABILITATION

Acoustic Reflex Thresholds in Normal and Cochlear-Impaired Ears: Effects of No-Response Rates on 90th Percentiles in a Large Sample. Gelfand SA, Schwander T, Silman S, *J Speech Hear Disord* 55:198-205, 1990.

Cutoffs for acoustic-reflex thresholds (ART) at the 90th percentile were determined for 1,374 persons. Results support the cutoffs for identification of retrocochlear pathology. The effectiveness of the procedure is not affected by including nonresponses, except when degree of loss is so great that reflexes are entirely absent. [JDS]

Adult Braille Instruction in Finland. Heikkila M, *J Visual Impairm Blindn* 84:274-275, 1990.

Using personal guidance and correspondence, along with traditional approaches, 15 full-time instructors and about 50 Braille tutors teach from 100 to 200 blind adults annually in Finland. Spaced instruction appears to be effective: students receive 3 days in class, followed by homework for a month or more, followed by another 3 days in class. No data on success/failure rates presented. [JDS]

Black English in a Mississippi Prison Population. Walton JH, McCardle P, Crowe TA, Wilson BE, *J Speech Hear Disord* 55:206-216, 1990.

Of nine linguistic features (e.g., use of present progressive and distributive "be"), only remote aspect "been" failed to distinguish prisoners' ethnicity (N=272). Implications for speech correction are drawn. [JDS]

Caregiver Strain: Need for Late Poststroke Intervention. MacNamara SE, Gummow LJ, Goka R, Gregg CH, *Rehabil Psychol* 35:71-78, 1990.

Interviews and examinations of 41 caregivers of stroke patients using the Barthel Index, Caregiver Strain Index, and Profile of Mood States showed a moderate level of stress across the group, with those longest engaged with a particular patient having higher levels. This finding contradicts earlier research, suggesting that the more time spent with a particular patient, the poorer the caregiver's adjustment. Authors urge more training for caregivers to assist them in overcoming anxiety and stress. Despite the number of interviews, the authors did not do a content analysis to amplify the psychometric data. The study has methodological implications. [JDS]

Crisis in Rehabilitation Staffing: Training, Recruiting, Retention, or What! Schein JD, Westwood R, Riediger EP, Thumlert ID, *Can J Rehabil* 3:195-200, 1990.

Discusses issues relating to staffing rehabilitation centers with direct-care personnel under Recruiting, Training, Management, and Structure. Offers suggestions for meeting the current crisis. [JDS]

Development of the Profile of Hearing Aid Performance (PHAP). Cox R, Gilmore C, *J Speech Hear Res* 33:343-357, 1990.

PHAP is a 66-item, self-administered inventory of hearing-aid use in everyday situations. The appendix contains the complete set of items. Using elderly wearers of hearing aids, authors calculated subscale internal consistencies ranging from 0.70 to 0.91 and test-retest reliabilities from 0.66 to 0.88. Clinical and research uses are discussed. [JDS]

Evaluation of an In-Situ Output Probe-Microphone Method for Hearing Aid Fitting Verification. Cox RM, Alexander GC, *Ear Hear* 11:31-39, 1990.

Using a probe microphone to measure amplified speech, in order to verify hearing aid fittings, the authors obtained data showing that most prescriptions can be matched within root mean square (RMS) error 5 dB through 500 to 2500 Hz. When sound-field stimuli presented to the aid are strictly controlled, the *in-situ* method yields valid results. Other findings relate to maximum-comfortable speech levels, prescriptions by MSUv3, and negative aspects of the procedure. [JDS]

Extended Communication Samples of Augmented Communicators I: A Comparison of Individualized versus Standard Single-Word Vocabularies. Yorkston KM, Smith K, Beukelman D, *J Speech Hear Disord* 55:217-224, 1990.

For linguistically intact augmented communicators, spelling letter by letter enables them to maintain substantial vocabularies, but at the cost of very slow speech transmission. Samples from 10 such cases yielded vocabularies ranging from 2,263 to 9,551 words. To determine the proportion of their vocabularies to include in individualized word lists, 5 lists, ranging from 5 to 30 per thousand, were analyzed. Authors conclude relatively short lists can represent a major portion of the communication sample and such lists can be more efficient than a standard vocabulary. [JDS]

Extended Communication Samples of Augmented Communicators II: Analysis of Multiword Sequences. Yorkston KM, Beukelman D, Smith K, Tice R, *J Speech Hear Disord* 55:225-230, 1990.

Long messages, defined as three or more words, should be chosen by linguistically intact augmentative communicators for their communication devices. The messages selected should be based upon message content and the speed with which they must be delivered rather than on frequency analyses, although the authors support the usefulness of such analyses. [JDS]

The Influence of Impairment on the Burden Experienced by Spouses of Partners with Dementia. Carlson KW, Robertson SE, *Can J Rehabil* 3:213-222, 1990.

Verbal administration of the Sickness Impact Profile (SIP), the Objective Burden Scale (OBS), and the Subjective Burden Scale (SBS) to 19 husbands and 19 wives of spouses with dementia who were living in the community yielded data showing SBS and OBS are not significantly

related, and that males and females experience similar OBS and SBS. However, female SBS was significantly related to spouse's psychosocial impairment, while neither SBS nor OBS was significantly related to that variable for males. Authors offer suggestions for health-care personnel. [JDS]

Interdisciplinary Approach to the Rehabilitation of Low Vision Patients in Japan. Yanashima K, Ishida M, Kikuiri A, Kanno K, Miwa M, *J Visual Impairm Blindn* 84:304-307, 1990.

Reports the results of a survey of visually impaired persons in Japan and describes its low-vision clinics. Service gaps, particularly for less severely involved patients, are noted. [JDS]

An Investigation into the Relationship Between Anxiety and Stuttering. Craig A, *J Speech Hear Disord* 55:290-294, 1990.

A case series of 102 stutterers who sought treatment from 1983 to 1986 was compared to a matched control group. Stutterers had significantly higher levels of state and trait anxiety, with the latter returning to normal after treatment. The research suffered from a number of methodological flaws. Applications of the findings to therapy are presented. [JDS]

Low-Vision Services in Australia. Lovie-Kitchin JE, *J Visual Impairm Blindn* 84:298-304, 1990.

Australian low-vision clinics have adopted multidisciplinary rehabilitation almost exclusively, with referral to other agencies when necessary for specific services. Article includes data on consulting time, distance traveled to regional clinics, and demographic descriptions of patients. [JDS]

New Model for Referral of Newly Blind and Visually Impaired Persons in Israel. Neustadt-Noy N, *J Visual Impairm Blindn* 84:253-254, 1990.

Describes the rehabilitation information station (RIS) in the ophthalmology clinic, which was introduced to reduce the delay in starting patients' instruction in orientation and mobility, activities of daily living, and communication. In its first year, RIS referred 160 patients to rehabilitation for the first time. [JDS]

Relationships Between Neuropsychological and Functional Assessment in Elderly Neuropsychiatric Patients. McCue M, Rogers JC, Goldstein G, *Rehabil Psychol* 35:91-99, 1990.

The Luria-Nebraska battery (LN) and the Performance Assessment of Self-Care Skills (PASS) were used to examine 58 elderly psychiatric patients. The LN correlated higher with PASS activities requiring substantial reasoning, memory, and other cognitive skills. Those that are more dependent upon physical activities, such as mobility and simple self-care, do not correlate highly with LN measures. [JDS]

The Reliability of Functional Gain. Humes LF, Kirn EU, *J Speech Hear Disord* 55:193-197, 1990.

Sound-field, warble-tone thresholds at 250 to 4000 Hz were established for 24 elderly adults, who averaged 65.3 years of age, with and without their hearing aids. Test-retest measures showed significantly greater standard deviations for functional gain than for unaided thresholds but not for aided thresholds. Findings are related to measures of insertion gain derived from probe-tube measurements. [JDS]

Resources and Information: An International Exchange. Byrne WC, Cylke FK, Hagle AD, Herndon JR, Perry H, *J Visual Impairm Blindn* 84:327-331, 1990.

The complexities of international sharing of materials are presented. Authors offer encouragement to those who desire to access materials across national boundaries. [JDS]

Speech Analysis Systems: A Survey. Read C, Buder EH, Kent RD, *J Speech Hear Res* 33:363-374, 1990.

Characteristics of five microcomputer programs and two dedicated devices for recording, editing, and analyzing speech, specifying the capabilities, requirements, and user interface of each. Recommendations and brief consideration of seven additional systems are included. [JDS]

Speech Perception with a Single-Channel Cochlear Implant: A Comparison with a Single-Channel Tactile Device. Carney AE, Kienle M, Miyamoto RT, *J Speech Hear Res* 33:229-237, 1990.

Based on the study of eight patients with single-channel cochlear implants compared to artificially deafened adults

using a single-channel vibrotactile device, authors conclude that regardless of the device, similar patterns of responses appear and that deciding which device is better is "unlikely to be useful in the management of hearing-impaired patients." [JDS]

The Structure of Attitudes Toward Persons With a Disability, When Specific Disability and Context Are Considered. Gordon ED, Minnes PM, Holden RR, *Rehabil Psychol* 35:79-90, 1990.

Based on the administration of the Disability Social Relationship scale to 259 college students in occupational therapy, physical therapy, nursing, medicine, and clinical psychology, the authors find support for the interaction of attitudes with specific disabilities and social context. Disabilities considered were amputation, blindness, cerebral palsy, and epilepsy. In view of this relationship, authors contend that further research should include disability and context for valid results. [JDS]

Training Mental Health Practitioners to Assist Families of Persons Who Have a Psychiatric Disability. Zipple A, Spaniol L, Rogers ES, *Rehabil Psychol* 35:121-129, 1990.

Following an 18-hour program to increase knowledge about families of psychiatric patients, improve attitudes, and encourage more practitioner-family contacts, 31 practitioners completed pretest data collection, as did 19 controls. The data suggest that the training did make significant changes in the desired directions. Severe methodological problems in the study limit its generalizability. [JDS]