SUMMARY OF SCIENTIFIC/TECHNICAL PAPERS IN THIS ISSUE

Beth A. Todd, PhD and John G. Thacker, PhD (p. 111)

Purpose of the Work. To reduce pressure sore (decubitus ulcer) incidence among wheelchair users (particularly those with muscle paralysis and loss of sensation due to spinal cord injury), cushion development concentrates on minimizing pressure at the surface between the buttocks and the cushion. Stress (force per area) levels throughout the tissue of the buttocks have been calculated to provide designers with a better indication of the mechanical effects of a cushion on the skin. Subjects/Procedures. To demonstrate the procedure, computer models of the buttocks tissues were created for a male and a female subject. Both subjects were young able-bodied adults. Results. For the male subject, stress was 3.5 to 4.5 times greater in internal tissues than at the buttock-cushion surface. For the female subject, stress in internal tissues was 11 to 13.5 times greater. Relevance to Veteran Population. Research studies suggest that pressure sores form deep within internal tissues of the buttocks and progress toward the surface of the skin. Knowledge of where the stress sites are throughout the soft tissue will be useful to cushion designers, thereby reducing the incidence of pressure sores.

Anaerobic Power Output and Propulsion Technique in Spinal Cord Injured Subjects during Wheelchair Ergometry.
Annet J. Dallmeijer, MSc; Yvonne J. Kappe, MSc; Dirkjan H.E.J. Veeger, PhD; Thomas W.J. Janssen, PhD; Luc H.V. van der Woude, PhD (p. 120)

Purpose of the Work. A large number of day-to-day activities of the spinal cord injured population seem to rely on the anaerobic or short-term power production. Differences in lesion level are expected to influence overall functionality, and as such the anaerobic power production and the characteristics of propulsion technique. The purpose of this study was to investigate the influence of the level of the spinal cord injury on anaerobic or short-term power production and propulsion technique in the spinal cord injured and wheelchair-dependent population. Subjects/Procedures. Twenty-three male spinal cord injured subjects with a level of injury ranging from cervical to lumbar performed a 30-second sprint test on a stationary wheelchair ergometer. Power production and characteristics of propulsion technique were determined. Results. Anaerobic power production was found to be significantly lower for subjects with a cervical lesion, whereas no differences were found between subjects with a thoracic or lumbar injury. Unexpectedly, no differences were found for the effectiveness of the force applied on the rim between subjects with a cervical injury and subjects with a lower level injury. It is possible that the high hand-rim velocity reached by subjects with a lower injury cause coordinative problems. Relevance to Veteran Population. The large diversity in functional capabilities of the spinal cord injured population, as found in this study, should be taken into account when guidelines for a spinal cord injured person are developed.

Modelling the Propulsion Characteristics of a Standard Wheelchair.
Michael Hosftad and Patrick Patterson, PhD (p. 129)

Purpose of the Work. This study investigated the propulsive characteristics of a standard wheelchair building upon prior work with racing chairs. The study consisted of two stages: (I) use of a number of existing models and their variations to predict force characteristics, and (II) development of additional models from analysis of those models which performed best during the first stage of the study. Subjects/Procedures. In Stage I, seven nondisabled
subjects propelled a standard wheelchair that was connected to a load cell. The trials were all videotaped as an aid in determining velocities and accelerations. Both a statistical and a graphical analysis were done to determine the models that best represented the actual force and motion profiles. The models used in Stage II were developed from the Stage I results. **Results.** The Stage I results indicated the need for utilizing a linear proportionality constant to account for subject weight and the negative swing of the models' force predictions, and to match the changes occurring in force values from stroke to stroke. It was also found that model applicability in part depended upon the phase of the motion (starting, stopping, constant) being modelled. A second group of four subjects was then used to evaluate the developed model, using the same procedure as in Stage I. The resulting model was found to better represent the forces and motions occurring throughout the stroking motion than those previously developed. **Relevance to Veteran Population.** This information could be of use in determining the most appropriate set of wheelchair characteristics for a given disabled individual during the prescription and ordering process.

Michael Hofstad

**Drag and Sprint Performance of Wheelchair Basketball Players.**

Kenneth D. Coutts, PhD *(p.138)*

**Purpose of the Work.** The purpose was to measure the wheelchair drag and maximal sprinting abilities of wheelchair basketball players. **Subjects/Procedures.** Nine male and eight female players with disabilities were subjects. Each subject, using his or her own wheelchair, completed six coast-down trials, and four maximal sprint trials on a gymnasium floor. A portable computer recorded the information needed to calculate the speeds, accelerations, forces, and power outputs during the trials. Differences between the genders were statistically evaluated. **Results.** There were no significant differences between the males and females in age (27 vs. 28 yrs), wheelchair mass (12.0 vs. 11.61 kg), or drag forces at speeds of 2 m/s (5.3 vs. 5.5 N) and 5 m/s (16.7 vs. 13.5 N). Male subjects were heavier (78.3 vs. 59.1 kg), used a higher tire pressure (123 vs. 94 psi), and had a higher maximal speed (4.75 vs. 4.08 m/s), peak acceleration (1.32 vs. 1.03 m/s/s), and peak power output (530 vs. 264 w). Wheeling at a given submaximal speed thus required a similar muscular demand for the male and female subjects, which represented a lower percentage of the males' maximal ability. **Relevance to Veteran Population.** The relevance of this paper is to make a further contribution to this body of knowledge by reporting the overall drag and power requirements of propelling a sport model wheelchair in a group of basketball players and noting their maximal power output during a sprint effort under actual wheelchair use conditions. These additional insights into the demands of wheelchair propulsion and the capacities of wheelchair users should aid our understanding of some of the limits to wheelchair locomotion.

Kenneth D. Coutts, PhD


Rory A. Cooper, PhD; Ken J. Stewart, BS; David P. Van Sickle, BS *(p.144)*

**Purpose of the Work.** Wheelchair standards have been in development for several years. A set of tests has been approved by the American National Standards Institute (ANSI) and by the International Standards Organization (ISO). The tests continue to be refined. Static stability is one of the indicators used to evaluate manual wheelchairs. Static stability is measured by placing a loaded wheelchair on a platform and tilting the platform until the wheelchair's front wheels lift off the platform. When measuring rearward stability, if the wheelchair's parking brakes slip, a block is placed behind the rear wheels and the tip angle is measured. **Subjects/Procedure.** The rearward static tip angle for eight manual wheelchairs using three load cases (a 55-kg person with paraplegia, a 100-kg ambulatory person, and a 100-kg ISO test dummy) were measured. Measurements were made with three different restraints: 1) the wheelchair's wheel locks, 2) a block behind the rear wheels; and, 3) a belt fixed to the rising edge of the platform whose other end, after being wrapped around the rear wheels, was attached to the backrest of the wheelchair. In all cases the wheel locks were activated. The wheel locks were adjusted or the braking force was supplemented to prevent wheel rotation. Only back-
ward tip angle was measured. **Results.** There were no significant differences in rearward tip angle found between the types of wheelchairs: the depot (hospital issue, stock manual chair) versus the active (prescription manual chair). There were significant differences found between the type of load device. The data for the 55-kg person and the 100-kg person were significantly different from that of the ISO dummy, with the dummy being the more conservative measurement. There were no significant differences found between the data for the two people. There were significant differences found between test conditions. Both the tests using the wheelchair’s wheel locks and the belts differed significantly from the blocks. However, no significant difference was found between the results using the wheelchair’s wheel locks or the strap method. The results indicate that there is no difference between the rearward static tip angle when measured using the wheelchair’s wheel locks or when using a flexible belt around the rear wheels. The current test procedure using the block behind the rear wheels, when the wheel locks slip, biases the results in favor of wheelchairs that require the block. The block nearly doubles the rear static tip angle. The standard for rear static tip angle should be changed to use the strap or flexible membrane method instead of the block. The difference in the rearward static tip angle can be explained by the change in the pivot point between “for the belt/brake-alone” and the block methods. The wheelchair/rider will pivot about the point of contact of the rear wheel with the tilt-table when using the belt or brake-alone methods. The wheelchair/rider will pivot about the point of contact between the rear wheel and the block when using the block method. The block, when the wheel is restrained from rotating about its hub, has the effect of moving the pivot point rearward and of slightly lowering the height of the wheelchair/rider center of gravity with respect to the pivot point. **Relevance to Veteran Population.** The depot and active wheelchairs with the rear axle in the furthest-back position yielded similar results for rearward static tip angle. This suggests that manufacturers of active duty wheelchairs design their wheelchairs to incorporate the more conservative rear axle position of depot wheelchairs and then allow greater forward adjustment as the user becomes more skilled.

*Rory A. Cooper, PhD*