Journal of Rehabilitation Research and Development

Rehabilitation R & D Progress Reports 1983

International Spinal Cord Injury

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Spinal Cord Injury R & D

ELECTRICAL STIMULATION AND GAIT ANALYSIS

RORRC (CANADA)

AN EMG PROBE ELECTRODE

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The process of regeneration following nerve injury can result in very isolated regions of EMG activity occurring in limb muscles. These small regions of activity can often be missed in conventional electromyography using needle electrodes, and in standard biofeedback using surface electrodes with normal placement. A probe electrode (Fig. 1) has been designed that can be moved over the surface of the muscle area to find regions of activity which might otherwise be missed. When activity is found, the locations are marked and normal adhesive surface electrodes are applied.

The probe electrode's contact points are tipped with saline pads, to make good contact. The spacing of the pads can be varied, along with their orientation with respect to the handle. A long handle is used to minimize interference pick-up from the person holding it. Even with all possible precautions taken, a considerable amount of interference (power-line interference, movement artifact, etc.) is usually picked up by the electrode. Thus, an oscilloscope display is essential so that EMG signal can be distinguished from artifact.

This probe electrode has successfully found EMG activity that was missed in standard electromyography. Later clinical electromyographic examinations confirmed the findings of the probe electrode ■

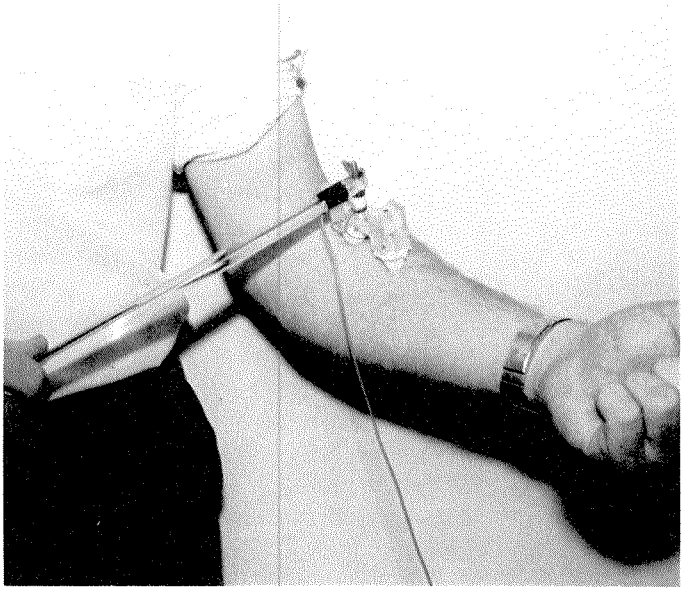

FIGURE 1
EMG probe electrode.

MOBILITY AIDS WHEELCHAIRS

NZDRC (NEW ZEALAND)

INDEPENDENT MOBILITY FOR CHILDREN

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The SEDO wheelchair, a children's wheelchair embodying three chairs in one, has been extensively redesigned as a result of the field-testing described in last year's review. Strong interest has been shown by several wheelchair companies in this wheelchair.

The first prototype of the "Go Cart", a mobility aid for very young disabled children, has currently been tested with one child. Testing on a wider scale is planned.

The SEDO wheelchair has been specially adapted for amilic children. The modular nature of the wheelchair lends itself to this sort of adaptation. The seat height can be adjusted by the child to suit various work/play surfaces. It can be lowered to ground level to promote independent transfer.

The Department of Industrial Management and Engineering at Massey University have used their advanced technical knowledge in cooperation with the Centre to develop a microprocessor-based wheelchair controller. Such a device will provide greater flexibility in adapting the controlling mechanism of an electric wheelchair to suit the specific needs of the client. It should also assist measurably with the safety of such devices because of the device's ability to shut down under fault conditions ■

MOBILITY AIDS
WHEELCHAIR ACCESSORIES

RORRC (CANADA)

MODIFICATIONS TO WHEELCHAIR FOR A HIGH-LEVEL QUADRIPLEGIC

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A quadriplegic with a C1-C2 lesion required special adaptations to his electric wheelchair. The original wheelchair was a fully-reclining model built by Everest and Jennings. It came with a sip and puff control manufactured by Medical Equipment Distributors Inc. of Maywood, Illinois, The following modifications were performed by Rehabilitation Engineering in association with Occupational Therapy:

1. An electrically operated horn was placed in series with the emergency stop control. This enabled the patient either to activate the horn alone with a small push, or both horn and emergency stop with a longer push.
2. A bumper was attached to the footrests to protect the subject in the event of an accidental collision. Such collisions occurred quite frequently in the beginning, due to the difficulty in operating the wheelchair with a single sip and puff control.
3. Circuitry was installed so that the reclining mechanism could be operated by the user using a second sip and puff switch.
4. A gravity-operated goniometer was installed on the wheelchair to give a continuous indication of the reclining angle.
5. Modifications were made to the back of the wheelchair to prevent dangerous levels of vibration occurring while traveling on rough ground.

This wheelchair, with its adaptations, is operating very successfully and the modifications are important contributing factors to this person's rehabilitation ■

RORRC (CANADA)

A WHEELCHAIR BUMPER

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Conventional wheelchairs, whether manually or electrically propelled, leave the feet of the users exposed and quite vulnerable. Thus, severe injury could occur to the feet in a collision. This danger is especially severe with quadriplegic persons since, with no movement of either hands or feet, they may be unable to protect themselves in the event of a collision.

A bumper was designed which can be fitted on almost any wheelchair and which will protect the user's feet in a collision. Furthermore, because of its design, the bumper is very useful in some wheelchair sports by providing a means for pushing a ball. Since the danger of injury is greatest during competitive sports, the bumper is especially valuable in those circumstances.

The shape of the bumper is such that it will envelop the feet as much as possible without restricting transfers to and from the wheelchair. To attach the bumper to a wheelchair, it is simply necessary to remove the small rubber tips from the footrests. The bumper then slides on, and is fixed to the wheelchair by the same metal screws that are used to hold the rubber tips. The special attachment system enables the bumper to be adjusted for different wheelchair widths and different angles of the footrests. Since the bumper is 6 inches high, a 4-inch height difference between two bumpers will still allow protection in the event of a head-on collision. (For very high footrests, small blocks can be made to lower the bumper to an acceptable height.)

The bumper is used regularly by high-level quadriplegic persons who, because of difficulty in control-

ling their wheelchairs, experience frequent accidental collisions. In addition, the bumper is used regularly by persons playing a game called "pushball." The game was originated by Leisure and Recreation, for whom the bumper was first designed. In this game the bumper is used to control the ball; at the same time, it provides protection to the feet.

The bumper is made of vacuum formed high-density polyethylene, with ancillary metal supporting parts. The construction is relatively simple, and with the exception of the vacuum-formed part, can be manufactured in any mechanical shop ■

RORRC (CANADA)

ADJUSTABLE WEIGHTS TO PREVENT WHEELCHAIR TIPPING

Royal Ottawa Regional Rehabilitation Centre
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Lower-extremity amputees with high-level bilateral amputations frequently use wheelchairs for mobility. For these people, the centre of gravity is high and quite far back on the wheelchair. Thus, there is a constant danger of the wheelchair tipping backwards. Special adapters for amputee wheelchairs solve the problem in most of the cases; but for many high-level amputees the danger remains, particularly when climbing ramps.

Adjustable sliding weights have been designed which enable the centre of gravity of the wheelchair, with its user, to be adjusted for optimum safety. Each weight is 7 lb and can slide on a 14-inch rod. The wheelchair can be collapsed and stored without the removal of the weights. Thus, it is suitable for wheelchairs that must be transported by car ■

DERBY O&DRC (GT. BRITAIN)

THE EXAMINATION AND COMPARISON OF SEATING AND POSTURAL SUPPORT SYSTEM AVAILABLE IN 1980, TO DEFINE CRITERIA FOR THEIR PRESCRIPTION

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In 1979 the Orthotics and Disability Research Centre, Derbyshire Royal Infirmary, reported on the results of assessment of three different types of moulded body support. During that study, techniques have been developed to record and analyse clinical and functional data on the patients involved, and these have made it possible to assess the benefits of the three systems being considered, which are custom moulded thermoplastic shell, moulded external corset-type support, and sunflower custom cushion.

By the time that report was submitted, a range of postural supports had become available and a number of centres were producing their own form of special trunk-supporting devices. It was therefore proposed that the study should be carried out to define prescription criteria for the available range of commercial and other types of trunk support. The need for the provision of postural support to patients unable to support themselves in wheelchairs and geriatric chairs is well known. As the awareness of the need to solve seating problems has increased, so there has been a corresponding increase in the number of commercially available devices. These include evacuated beanbag-type supports, wheelchair bolt-on supports, and a number of specially designed rigid supports. Despite the number of systems that were and are available, there is little firm data on which to base prescription decisions. In view of this, the Orthotics and Disability Research Centre at Derbyshire Royal Infirmary obtained a grant from the Department of Health and Social Security to carry out this 3-year project.

The aims of this project were:

1. To produce a catalogue of the available seating systems and postural supports available at the time and to examine these, grouping each item into principal types according to their design, construction, and function.
2. To obtain samples of 25 adults and 25 children with severe seating, postural, and trunk-support problems having as wide a range of diagnosis and age as possible.
3. To identify the prescription criteria for each

type of seat or group of seats through each patient trying each type of seat and taking into account as many physical and functional aspects of each seat as possible.

The final report for this particular project has only recently been submitted to the DHSS and we are unable to provide full details of the results of this particular project yet. However, full details of this should be released ready for the next progress report and will certainly appear in various publications ■

NZDRC (NEW ZEALAND)

WHEELCHAIR ADAPTATIONS

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A new project under development is a Caster-Wheel Lock. This device is currently being developed with the Otara Spinal Unit. It is used to help stabilize a wheelchair by preventing the front casters from swiveling during lateral transfers from the wheelchair to another seat.

Special Seating and Support

A number of specialized supportive devices have developed this year, including (i) prone stander, (ii) standing frame, (iii) canvas slung seat, (iv) mountain chair, (v) child's car seat, and (vi) a special feeding chair aimed at institutional use.

A solid seating project is designed to replace the plywood, foam, and vinyl custom-made seats habitually used for people with cerebral palsy and muscular dystrophy. Using a modular approach, the solid seating system will be flexible enough to accommodate for the needs of such individuals. Because of its flexibility it will permit changes in posture on a daily short-term basis and accommodate for physical growth in children in the longer term. Such a system should prove more comfortable, functional, and practical from the user's point of view than the relatively fixed form of custom upholstered seating. The system will also be designed to interchange with the SEDO wheelchair and the "Go Cart" ■

MOBILITY AIDS
DECUBITUS ULCERS
CUSHIONS

STRATHCLYDE

PROVISION OF WHEELCHAIR CUSHIONS FOR PATIENTS AT RISK OF DEVELOPING PRESSURE SORES

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Wheelchair cushions consisting of flexible polyurethane foam supported on a more rigid polyethelyne foam are provided for paraplegic patients and others who are at special risk of developing pressure sores. Interface pressure measurements are made; and where the pressures at the ischial tuberosities are considered excessively high, a simple cut-out is provided and modified until acceptable measures are obtained.

A key element of the program is the regular follow-up of the patients, and it is becoming clearer that flexible foam cushions have a limited useful life of 9 to 15 months for the majority of patients ■

RORRC (CANADA)

INFRARED THERMOGRAPHY

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An Agatronix 780 infrared thermography system is operated for the Centre by Rehabilitation Engineering. This equipment is used for the following purposes:

1. For spinal cord injured patients as part of a program to prevent decubitus ulcers. Reactive hyperemia, often an indicator of the future onset of a decubitus ulcer, can be monitored quite easily with thermography.
2. The monitoring of temperature changes associated with pain.
3. The monitoring of temperature changes associated with nerve injury.
4. The monitoring of global temperature changes during standard temperature biofeedback. Standard temperature biofeedback uses very small thermistors on appropriate limb segments. The patients are asked to increase or decrease the temperature, as indicated by the thermistor, depending on the type of feedback being performed. It is of interest to us to determine what temperature changes are occurring in the areas surrounding the thermistor ■

ADL AND RECREATION

RORRC (CANADA)

OPERATION OF VIDEO GAMES BY HIGH-LEVEL QUADRIPLEGICS

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High-level quadriplegics are often unable to operate the joystick used in video games. We performed modifications to enable a sip-and-puff switch to be used instead of a single joystick. A second sip-and-puff switch is used to reset the game. Since many video games involve the activation of a "firing" command, a pressure switch is placed at a suitable site on the body (such as behind the head) enabling the user to perform that function.

A single-stage sip-and-puff switch can be used for games involving only left-right or up-down control. For games involving both control directions, a two-stage sip-and-puff switch is necessary. (The two stages are achieved by two levels of sip and two levels of puff).

Quadriplegics, even at the C1-C2 level, have achieved quite a high degree of expertise in the playing of video games using this system ■

RORRC (CANADA)

A KNIFE HOLDER

Royal Ottawa Regional Rehabilitation Centre
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A knife holder was designed and built for a quadriplegic person who lacked adequate grip strength to hold eating utensils. This holder, which is made of phenolic, is fixed by leather and velcro bands at the hand and wrist. The device can be applied easily with the other hand.

This knife holder is very useful as an eating aid. Other utensils, such as forks or spoons, can be fitted to a similar harness ■

RORRC (CANADA)

LEATHER-WORK TOOL HOLDER

Royal Ottawa Regional Rehabilitation Centre
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This device was designed for persons who have only one usable arm and who wish to do leather work involving the use of metal punches. The tool holder can hold the punch against the leather, freeing the hand to operate the hammer. To use the holder, the punch is slid into the metal block. The knob is tightened, to hold the punch firmly. The punch is placed against the leather and then hammered.

The leather tool holder was built for Leisure and Recreation for a leathercraft course. Users include unilateral amputees, hemiplegics, etc. ■

STRATHCLYDE

LOWER LIMB LOADINGS DURING SELECTED SOMERSAULT ACTIVITIES

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The purpose of the present investigation was to describe the function of muscle groups about the hip, knee, and ankle joints during performance of a standing back-somersault. International gymnasts acted as subjects, and each subject performed two trials which were recorded on 16-mm film. Ground reaction force records were also obtained during each trial, and the film and force records were synchronized for the purpose of analysis. Moments of force about the hip, knee, and ankle joint during take-off were calculated for all trials.

The results show that hip moment is dominant throughout the whole of the take-off period (dip and propulsion phases) and contributes between 44 percent and 76 percent to the total support moment (Ms). The moment about the ankle contributes between 20 percent and 40 percent to the Ms; whereas, the moment about the knee (3 percent to 30 percent of Ms) shows a single peak that occurs close to the point of zero vertical velocity at the end of the dip phase. It would appear that the hip and knee extensors are largely responsible for breaking the fall of the whole-body c. of g. during the dip phase (eccentric contractions), while the hip extensors in combination with the plantar flexors of the ankle are largely responsible for generating upward velocity of the whole body c. of g. during the propulsion phase (concentric contractions).

Other activities will be tested, and it is envisaged that the information will provide coaches with a greater understanding of control of the lower limb, giving reduction in injury frequency ■

RORRC (CANADA)

GOLF AID

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We were asked by Leisure and Recreation to produce a golf club attachment for indoor putting from the sitting position. The golf aid which we constructed is shown in Figure 1. The attachment grips the golf club firmly and holds it away from the user's knees. Users of this attachment have achieved a good level of skill in putting ■

FIGURE 1
Golf club attachment allows indoor putting from a sitting position.

TREATMENT AND TRAINING

RORRC (CANADA)

TILT-SENSITIVE BUZZER

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A buzzer was designed to train patients to correct postural deficits. It contains a mercury switch with a buzzer circuit, which is activated when a specific angle is exceeded. The angle at which the buzzer sounds is fully adjustable and is determined by its placement on the patient. The package is in the shape of a disc, 3.5 cm in diameter by 1 cm deep. The small size enables it to be placed under the clothing, making it almost invisible.

The buzzer is used to correct postural deficits in a wide variety of patients, including those with Parkinson's disease and those with torticollis. It is easy to use and quite inexpensive to construct ■

RORRC (CANADA)

A MOUTH SWITCH TO TRAIN FOR NOSE BREATHING

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A mouth switch was designed to train a patient to breathe through the nose. This patient had cerebral palsy, accompanied by mild mental retardation. He had a dental malocclusion which required a jaw resection. A complicating factor was that he was a mouth breather. It was feared that he would suffocate in his sleep while his jaw was wired shut as part of the post-operative procedure.

The mouth switch was used to give biofeedback to the patient prior to the operation. During the biofeedback sessions, a loud tone sounded if the mouth was opened, even slightly. During 2 months of biofeedback performed by Communication Disorders (who originally requested this device), the patient achieved nose breathing to a degree that the surgery could be undertaken.

The mouth switch can be made in different sizes. It has a vinyl cover, making it watertight. Thus it is safe and washable. A variety of controlled outputs can be used with the switch, including lights, radio, etc ■

DIAGNOSTICS AND INFORMATION

STRATHCLYDE

PRESSURE SORE PREVALENCE

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Pressure sore prevalence was assessed in large groups of patients within Greater Glasgow and (Scottish) Boarders Health Board Areas. The prevalence of lesions that could be unequivocally identified as pressure sores was in excess of 8 percent in both areas. Elderly patients formed the majority of those with sores, although they represented a minority of the patient survey population. Patients with neurologic damage also had a high sore prevalence.

The deleterious influence of immobility and incontinence was demonstrated by data ■

STRATHCLYDE

THE MEASUREMENT OF THE MOBILITY OF SUBJECTS IN BED

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The movements made by normal subjects in hospital beds have been measured by supporting the bed legs on load cells. Initial studies, made using an entirely analog system, show that normal subjects were highly mobile, and the durations for which pressures acted were considerably shorter than the pressure histories produced by two-hourly turning of immobile patients.

More recent studies on elderly patients (Dr. R. Kennedy, Stobhill Hospital, Glasgow) have employed a digital system to detect and measure body movements. The results indicate that the majority of patients assessed as being at risk of developing pressure sores could be detected using mobility parameters obtained after 2 nights of monitoring subsequent to admission to the hospital ■

STRATHCLYDE

EVALUATION OF INTERFACE CONDITIONS ON HOSPITAL MATTRESSES

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Measurements have been made of the interface pressures and temperatures produced by normal subjects and paraplegic patients lying on a variety of foam and interior sprung mattresses. It was shown that significantly different pressures could be produced by lying on different mattresses and that the fitting of an inextensible mattress cover elevated the interface pressures.

Long-term temperature measurements showed that abnormally elevated temperatures were present at skin-support surface-contact areas ■

NZDRC (NEW ZEALAND)

COMMUNICATION ASSESSMENT AID FOR CEREBRAL PALSIED CHILDREN

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The Centre is developing a relatively simple scanning communication aid to help therapists and other professionals make a preliminary assessment of the abilities of such children. This work is being carried out by an electrical engineer sponsored through a fellowship provided by the Auckland Industrial Development Division of the DSIR ■

RORRC (CANADA)

HEAD-ROTATION GONIOMETER

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Physiotherapy training, following injuries such as whiplash, often requires the measurement of range of head rotation. This measurement is commonly done using a magnetic compass attached to the head. However, patients who cannot hold the head fully upright often cause the compass to get stuck, thereby giving a false reading. A standard car compass was modified by adding gimbals which compensate for non-rotational movements of the head. The goniometer is mounted on a hockey helmet to facilitate placement on the head. A locking thumbscrew enables the therapist to zero the compass for easy reading.

This device is used routinely by physiatrists and physiotherapists as part of an Acute Neck Sprain Study which is in progress at this centre ■