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Beginning with the first issue of the Bulletin of Prosthetics Research in the Spring of 1964, the VA Prosthetics Center (VAPC), now the VA Rehabilitation Engineering Center (VAREC)*, has presented descriptions of its programs and projects, for the purpose of disseminating information on new devices and technology available to the handicapped veteran. Although funded in part by VA Research and Development funds until very recently, the VAPC programs were always oriented toward the most crying needs of the disabled veteran for treatment service. The Center was in large part engaged in finding the immediate solution to these needs.

The Center’s long-time role in evaluation of rehabilitation devices aimed at improving the quality of patient care and the efficiency of service delivery is well-known. We will continue all of these missions as the VA Rehabilitation Engineering Center. But it should be apparent from past and current efforts that although the major programs are service delivery and evaluation of devices for the handicapped in support of treatment programs, the Center also has certain unique capabilities in research.

Most of the Center’s work throughout those years when it was in part funded with VA Research and Development dollars was focused on development. In later years, to help fill a real world-wide need, the Center undertook an increasing role in evaluation and in testing. The broadening of the Center’s scope recently mandated by VA Central Office calls for an even wider service-delivery capability with a more direct impact on the rehabilitation efforts of the VA Department of Medicine and Surgery, nationwide.

VAREC will report its work in a new publication on a quarterly basis. The audience of this new publication will be mainly those who are on the “front line” of patient care, service delivery, and counseling. Indeed it is expected to become one of the VA’s major channels for information about new products and processes being developed by manufacturers, other rehabilitation centers, research laboratories, private inventors, and others. The new VAREC publication will periodically present descriptions of the Center’s development, evaluation, and testing programs, as well as its service-delivery programs.

Within the broad spectrum of rehabilitation, the center’s work will remain concentrated in the band most closely associated with treatment programs. Its commitment to high quality service delivery means that the center must always be on the forefront of technology, thus underlining the importance of its major role in the evaluation of the products of technology. During the process of evaluation, criteria for prescription, training, and use become apparent. Gaps in the technology are also noted, new needs in design and development become known. Moreover, with VAREC engineers directly involved in the care of the severely handicapped to solve or alleviate their individual problems, general needs become more precisely defined. Indicated development projects can then be undertaken with vigor.

In contrast, the research activities of the Center are related to studies or development of devices or systems which will have not an immediate impact but, rather, a long-term potential. The Center staff will continue to publish progress reports on these, periodically, in the Bulletin of Prosthetics Research.

As part of the Center’s broadened scope and new status, it will become more closely identified with the medical capabilities within the VA Medical Center in New York City, with New York University College of Medicine, and the Polytechnic Institute of New York. From these relationships, other research projects are expected to be generated.

Beginning with this issue of the Bulletin, the VAREC (formerly VAPC) report will be presented in a new format. Presented here is a brief report on research currently being conducted in the center, and selected final reports on evaluation projects previously the subject of Progress Reports in the Bulletin of Prosthetics Research.

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Research

In recent years, reports on the operations of the Center have not presented material specifically designated as “research.” The results of both in-house and contractual work dealing with design and new technology were reported as “developments,” ranging from relatively simple items to highly complex electromechanical innovations. Many of those projects involved scientific efforts of sufficient rigor and novelty to be considered research. For that reason, and in response to changes in our mission and to the higher technological level of our work, we now wish to identify certain projects as research efforts even though they remain goal-oriented.

To conduct research studies in several areas of great need, we have established the Tissue Stress Laboratory and the Motion Control Laboratory. The mission of the former is very broad, encompassing studies on the response of all kinds of tissue to all kinds of stress. The Motion Control Laboratory is charged with re-establishing, or substituting for, lost control of motion of the limbs. The following are descriptions of some current research in those laboratories.

A. Pressure Sores

Work in this area consists of clarifying the etiology of pressure sores as the essential first step in developing effective preventive, amelio-

*The VAPC became VAREC on July 1, 1980.
1. Etiology—The sitting characteristics of geriatric hospital patients have been examined in terms of pressure, shear, and skin arteriolar blood-flow in the area of the ischium (Fig. 1). The blood vessels of geriatric patients occlude at lower sitting pressures (in two cases, as low as 20 mmHg) and may develop three times the average shear value seen in young healthy males. The design goals of conventional passive seat-cushions appear insufficiently stringent in the light of our results. For example, we question the desirability of 40-mmHg contact pressure, or even 32-mmHg, for long-term sitting of geriatric patients.

A paper dealing in detail with the subject is being prepared.

2. Prevention—The concept of a seat that is arranged to supply an oscillating or alternating pressure to prevent pressure sores is roughly 26 years old. While a number of mechanically practical versions of this idea have been produced, to date no significant clinical successes seem to have been achieved. To some extent, this lack of success may reflect inadequate design information, and reliance on intuitive choices of seat-oscillation amplitude and frequency.

We are designing a dynamic seat containing motorized cammed shafts arranged to produce a traveling wave under the ischial area. Amplitude and frequency are the input parameters; output will consist of skin arteriolar blood volume and flow-rate, and shear values.

Instrumentation capable of functioning while placed between a moving cushion and a portion of soft tissue is currently in development. Testing will seek to determine appropriate seat motion, amplitude, and frequency required to ensure adequate skin blood-flow near the ischium.

B. Microcirculation

A second related area deals with more general phenomena related to the microcirculation of the skin and deeper tissue of the lower limbs. Changes in blood-flow in the limbs resulting from electrostimulation have been infrequently reported over the last century. In the past few years, the ready availability of stimulating devices (transcutaneous electrical nerve stimulators) has accelerated efforts in this area. Recent reports indicate that roughly two-thirds of those patients with occlusive vascular disease of the lower limbs experience a 25 percent or more increase in blood-flow after extended electrostimulation treatment. Relief of symptoms is reported as most effective for those patients with vasospastic disorders,

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FIGURE 1.
Instrumented wheelchair seat simultaneously measures local skin arteriolar blood flow as well as pressure and shear. Remote reading device is located to gather data in the vicinity of the ischial tuberosity. (Some information on the sensor, the disk-shaped device shown taped to the hard transparent-plastic seat of the wheelchair, appeared in: Bull Prosth Res BPR 10-29, Spring 1978, pp. 160-161).
varicose ulcers and intermittent claudication.

The reasons for increased blood-flow in an electrical field are unclear. The limitations of the procedures are unknown. The threshold value of blood-flow, i.e., the level below which augmentation will not succeed, is unknown although the literature suggests that such a threshold exists.

In a major effort to clarify these matters, VAREC has joined forces with the Rehabilitation Medicine department at the Bronx, N.Y. VA Medical Center. We are currently assembling instrumentation and preparing protocols for these studies.

C. Prosthetic Myoelectric Hook

This work is intended to improve the functional performance of upper-limb amputees by means of a myoelectric hook which is interchangeable with the VA myoelectric hand. The system is attached at the wrist by means of a quick-connect device, permitting the amputee to use one socket for both units.

The hook makes use of a high-performance permanent-magnet motor, a unidirectional force lock, two stages of "Eveloid" gearing, and modified removable (interchangeable) hook fingers. The batteries consist of six 450-mAh Nicad cells, located in the wrist housing with the myocontrol electronics. The hook features proportional control and the same feature of energy savings during motor stall that was originally developed for the VA switch-hand. Protection from feedback stimulation is also provided.

The engineering performance-goals are: fast response of less than 50 ms tau (τ); fast speed of 25 cm/s; large opening range of 15 cm maximum; high pinch-force of 5 to 7 kg maximum (49 to 68.6N); 800 cycles per battery charge; large proportional control range of at least one decade; and provision for position and force feedback. The prototype hook provides many of the desired characteristics, but our goals related to proportional control, weight, and efficiency have not been fully achieved.

D. Paraplegic Ambulation

This seven-step research program is intended to explore a number of available physiological and technological means to enable paraplegics to walk. The first step will be to develop a self-contained, externally powered orthotic support system that can provide enough energy to enable a paraplegic to ambulate at an acceptable fatigue level. The user will control this servosystem with slide potentiometers in the handgrips of a pair of Canadian crutches. The angular position of the hip relative to the torso will be controlled by the user's thumb on the slide. Putting the user in the system as the control "intelligence" will simplify the logical interface, at this research stage.

VAREC Evaluation Program

The purpose of this program is to evaluate rehabilitation engineering devices, procedures, and systems. Activities may range from the most basic mechanical bench-testing, through engineering and bioengineering evaluation of a concept and its implementation, to broad-scale, multicenter clinical studies in appropriate environments and populations, with attention to subjective factors, training requirements, etc.

An Evaluation Committee to guide the program is composed of a physiologist (who also serves as its coordinator), a health science specialist, a rehabilitation engineer, a prosthetist-orthotist, and a secretary. The Committee screens and channels all incoming projects earmarked for evaluation, sets priorities, reviews protocols and reported results, maintains data, and monitors project status.

Evaluation projects may be conducted within the center, or at other VA or contract facilities, or both. They are multidisciplinary, requiring the services of engineers, prosthetists-orthotists, therapists, and physicians. Medical support for the program is provided by VAREC’s Chief of the Special Clinic Team, and staff of participating VA Medical Centers; paramedical support is provided by the physiologist and health science specialist and their staffs; engineering support is provided by a VAREC rehabilitation engineer and his staff stationed at VA Medical Center, Castle Point, New York. Prosthetic-orthotic support is provided by the Chief of VA-REC’s Prosthetics-Orthotics Service. The functional relationship between the Evaluation Program and each of the other VAREC services is mutually supportive. Other services conduct tests, specialized analyses, and small-scale in-house evaluations of devices or techniques, as requested by the Evaluation Committee.

Following are final reports of VAREC evaluation projects between 1 July 1979 and 1 July 1980. Where appropriate, historical reviews are also presented.

Stand Aid

The Stand Aid (Fig. 2) designed by Ken Haibeck of South Falls, South Dakota, and manufactured and distributed by Main-Trainer Corp., Shelton, Iowa, is a portable standing frame designed to support a handicapped individual in the standing position. The adult Stand Aid 900 consists of a 30-in by 50-in by 27-in metal frame that weighs

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approximately 85 lb. The metal side grab bars are hinged to the front support bar, to permit folding when the device is transported or stored. The contoured knee support, which is padded, can be removed or adjusted easily for various leg lengths. The trunk support is also padded and attaches at various heights. Five-inch rubber casters allow safe and controlled mobility while an attendant is moving the Stand Aid with occupant.

The foot platform has properly spaced foot locations, with adjustable heel stabilizers.

The brakes are located on the front frame; when forced down, they lift the front casters slightly off the floor.

There are three other models available: 1. Little Tots 30-in Model 903 (35 in through 45 in child's height); 2. Mini Jr. 40-in Model 902 (45 through 55 in child's height); 3. Adults Jr. 48-in Model 901 (5 ft through 5 ft 10 in—small adult's height).

Optional equipment includes a clear plastic worktable, 25 in by 22 in, enclosed in a metal frame and padded on the area that supports the occupant. A very important option is the power lift to operate the lift bar. Two 12-V d.c. motors and gear assemblies and a 12-V rechargeable battery are provided. A standard canvas sling is attached to the hooks located on the lift bar: the lift bar slowly raises and lowers the occupant when he engages the power lift's rocker switch which is attached to the frame.

Utilization—The Stand Aid can be used either independently or with assistance, when using the power lift. The canvas sling should be placed in the wheelchair before sitting, particularly for those who need assistance. The user approaches the frame from the open end, positioning the wheelchair within the frame so that the knees are against the padded knee-support and positioning the feet on the foot platform. Next, the rocker switch is depressed to lower the lifting bar so that the canvas sling can be attached to the hooks on each side of lift bar. By depressing the upper part of the rocker switch, the user is then able to attain a full standing position. When the lower part of the rocker switch is depressed, the user is lowered into the wheelchair.

A paraplegic needs the power lift to stand alone since he cannot independently attach the buttock support even if he can achieve the standing position alone. (At least two strong attendants are needed to stand a quadriplegic in the Stand Aid without the power lift.) Therefore, the power lift is highly recommended.

Initial Evaluation—On August 16, 1978, Mr. E. Kleinwolterink demonstrated the Stand Aid to VAPC staff. The demonstration was videotaped. The device then underwent laboratory tests. The unit was then placed in the Corrective Therapy Clinic at the VA Medical Center, Castle Point, N.Y., for clinical trials for a period of 4 weeks; next, it was tested in the homes of several disabled veterans for a period of 6 weeks.

Initial recommendations for improving utility of the Stand Aid were:

1. A power lift for raising the user;
enough to stall the motors: more than 18 repetitions were obtained before the battery ran down if an interval of a few minutes was allowed between cycles.

User Trials—Evaluations by veterans in VAREC Laboratory and veteran homes.

a. A 48-year-old male (with an unconfirmed diagnosis of multiple sclerosis) with normal function of the upper limbs used one unit. He had sensation and movement in the lower limbs but was unable to stand and remain standing without knee support. He also experienced spasticity at times. He weighed 140 lb and was 6 ft tall.

His initial use of the original Stand Aid produced no problems in getting from wheelchair to standing position, due to a thin body structure and good upper limbs. However, he was unable to strap himself in across the trunk with the padded support. At that point it was obvious that some type of lift assist was needed; without it he could not use the Stand Aid independently.

b. A 50-year-old paraplegic who weighed 181 lb and was 5 ft, 8 in tall tried the Stand Aid before and after the power lift kit and nylon harness strap were added. He had been unable to pull himself up to a standing position without help from an attendant, but was able to stand independently with the power lift. (Once he was up and strapped in, the nylon trunk harness dug into the soft tissue in the gluteal area. It was again recommended that the manufacturer replace the nylon harness with a full canvas sling.)

After the full canvas sling was added, the same veteran tested the unit at home for 6 weeks. He was able to stand approximately 2 hours per day, 4 to 6 days a week. In comparing the device to other standing devices he had tried previously, he found it to be more useful because he could read, eat, or talk on the telephone while getting his standing exercise. The only disadvantage was an inability to move independently from one place to another while standing. He stated that it was an excellent device and he would like to purchase one.

2. A full canvas sling (Fig. 3) instead of the nylon harness;
3. An improved method for connecting the charger to the battery.

The above recommendations were adopted by the manufacturer and the device was again laboratory and clinically evaluated. The results were:

Laboratory Tests—The power cell was a 12-volt, 5.0 Ah, sealed lead-acid battery produced by Gates Energy Products. The battery charger produced a 12 V d.c., 500-mA output; it uses a standard 120-V 60-Hz a.c. power source and consumes 8 watts. The system drew 12 amperes when lowering the buttock pad with no occupant; the system drew 25 amperes when raising and 12 amperes when lowering a 220-lb occupant. The system was cycled continuously until the voltage dropped
c. Another veteran tried the Stand Aid in the laboratory for 40 min, with intervals of standing for 10 min and sitting for 5 min. (He had previously been using a Stand Alone at home.) The Stand Aid’s motorized lift and its table top were the features he most preferred. After several uses, the nylon trunk harness showed signs of cutting into the gluteal area. He said that the control switch could be made more accessible to the user if hooked on the frame with an extension cord instead of being screwed to the frame. Another suggestion was to include an adjustable back-plate for the heels, and a set of straps to hold the foot across the top, for spastic individuals. The final suggestion was to provide a completely padded lift bar. He liked the device very much and stated he would like to have one—with these modifications.

d. Another veteran, age 40, with multiple sclerosis, reported after 10 weeks with the Stand Aid that he used the device 2 hours per day, 7 days a week. He had previously used other standing devices (parallel bars, a Castor Standing Frame, a LEVO Standup Wheelchair, etc.). He liked the power lift on the Stand Aid because he was unable to stand up safely on his own without knee and trunk supports. He said that while the Stand Aid was very useful to him, he would like to see a propulsion motor added to give the user mobility while standing.

When the Stand Aid was retrieved from that veteran after the evaluation period, it was operating improperly due to low energy in the battery. A checkout revealed that the charger was malfunctioning. This was reported to the manufacturer, who later sent a replacement.

e. Another veteran, age 22, with traumatic encephalopathy and right hemiparesis due to head injury, had been using one of the original Stand Aids without the power lift. He was functionally strong enough to stand, but due to ataxia he needed an attendant to attach the trunk support. When he was not using the Stand Aid for standing, the veteran’s father allowed him to walk behind it while pushing it under the father’s supervision. The father felt that this was an excellent device for standing exercises and hoped it would aid in improving his son’s walking ability. The father liked the folding feature especially because when folded, the device fit into the car trunk.

Recommendations—The Stand Aid with canvas sling trunk-support and power lift was recommended for approval for veteran beneficiaries (clinical trials had proved the Stand Aid could not be used independently without power). It was also recommended that an instruction manual be supplied with each unit. Other (optional) recommendations were for a motorized base for mobility in a work area, and a manual override or release to allow the occupant to lower himself if the lift mechanism failed.

Apor Safety Shower and Tub Guards.

These devices (Fig. 4), manufactured by Apor Industries, Inc., Aurora, Ohio, replace standard built-in shower or tub filler-spouts. Temperature controls regulate water flow by reacting to increases in water temperature. This can be a critical requirement for persons with absent or decreased sensation.

Description—Both devices use sealed thermostatic valves that sense changes in temperature. The valves are encapsulated in chrome-plated, molded acrylonitrile-buta-diene-styrene plastic filler spouts. Operating temperature is 110 deg F (43 deg C); normal bathing temperature is 102 deg F (39 deg C) to 104 deg F (40 deg C). When water temperature exceeds 110 deg F, water flow automatically reduces to less than one half gallon (1.80 liters) per minute. Hot water must then be turned off and cold water left on until full flow (cold) is reestablished, in approximately 15 to 20 seconds. The water temperature is then readjusted for normal bathing. The units come in two models: Model CP-1 and CP-2 are the standard models, and Model V-CP-1 and V-CP-2 are the “theft-proof” models which employ a recessed Allen screw that is used to apply pressure on the water pipe to prevent easy removal.

Clinical Evaluation—Shower Guards were installed and tested in the

FIGURE 4.
Apor Safety Shower and Tub Guards replace standard built-in tub-filler spouts (left) or shower fixtures.
shower room of the Activities of Daily Living (ADL) Training Room and in the shower room on Ward D-1 at the VA Medical Center, Castle Point, New York. Three weeks following these supervised clinical trials, a Shower Guard unit was installed in the home of a disabled veteran in the Castle Point area, and several Shower and Tub Guards were sent to the Acting Coordinator of the Home Based Home Care (HBHC) program at the Albany, New York, VA Medical Center, and to the Aids Technician at the Center for Independent Living, Berkeley, California.

The Spinal Cord Injury Service staff at the Castle Point VAMC reported the Shower Guard to be beneficial to patients who bathe independently, and suggested that all showers in the hospital be equipped with the device, for safety. The head nurse stated: “Our water temperature does fluctuate and burns are a real probability in patients with lost or diminished temperature-sensation. This device eliminates that probability. Patients would also benefit from such a device in their showers at home.”

The therapist in the ADL Training Room at Castle Point felt it would be an advantage to have both a Tub Guard and Shower Guard if they could be fitted without modifications. The Shower Guard was installed in the ADL Training Room, with a hand-held shower attached for the convenience of some of the disabled veterans training in that area.

The installer said that it was easy to install the Shower Guards, but he overtightened the Allen screw on the first unit and thus caused a crack in the plastic housing. The cracked unit was replaced and the units are now functioning well.

A Shower Guard was installed in the house of a disabled veteran by a staff technician of the VAREC laboratory at Castle Point. On his initial visit to the veteran’s home, the technician noted that an extension pipe would be necessary before the Shower Guard would fit. He was able to obtain a 0.5-in by 2.5-in (1.27-cm by 6.35-cm) nipple from the plumbing shop to complete the installation of the Shower Guard. Also, a hand-held shower was attached to the Shower Guard for the convenience of the veteran.

The hand-held shower unit came with a “water-saver” washer that limits water flow. When the hot and cold water valves were fully opened, only a moderate amount of water came out, causing back pressure on the Shower Guard and initiating a leak around the seam. The water-saver washer was removed and the leak was eliminated. This occurrence was reported to the manufacturer who later sent us a Dole Flow Control, Model PCG 3.0 GPM (which was never used), manufactured by Eaton Controls Products, Carol Stream, Illinois. Apor Industries recommends that this water saver be used with its Shower Guard if a problem occurs with the flow of the water.

The Apor Shower and Tub Guards were evaluated at the Center for Independent Living, Berkeley, California, by subjects with spinal-cord-injury disabilities, arthritis, multiple sclerosis, and post-polio quadriplegia.

**Results**—Five Shower Guards and two Tub Guards were installed, with a total of 59 user-months. All devices functioned properly after installation and during followup testing. Although the devices operated frequently only during original temperature adjustment, there were two occasions of flow reduction when the user was actually in the shower: those two users reported that serious scalds might otherwise have resulted. All users claimed a greater feeling of security in their bathing, and one arthritic user who had been taking baths rather than showers for 15 years because of fear of scalding, now took showers confidently.

Consultations with two plumbing companies pointed up a problem, however. Both expressed concern that flow reduction would cause hot water back-pressure to the extent that, if the flow were not readjusted quickly, hot water might enter the toilet system through the cold water inlet and crack the fixture. Although this seemed unlikely, both companies stated it was a possibility.

The Shower and Tub Guards are relatively easy to install; they have standard half-inch threads and require only a simple hand tool. They are chrome-plated and so do not clash visually with other bath fixtures. All in all, these devices seem to be extremely cost-effective and in some cases might mean a great difference in bathing comfort, independence, and sometimes safety.

**Conclusion**—The Apor Shower and Tub Guards have proven to be effective devices in controlling the flow of water to a bathing area by reacting to increases in temperature of the water-supply system. They have eliminated any dangers of a bather with lost or diminished temperature sensation being scalded.

Clinical evaluation of the devices showed that they provide safety against scalding during bathing, and that they are useful in both hospital and home. The evaluation of the Tub Guard was limited because it lacked a diverter for tub/shower combination fixtures, but most bathrooms have modern tubs with combination tub and shower. The Tub Guard functions identically to the Shower Guard and should be used when it can be properly installed.

**Recommendation**—The Apor Safety Shower and Tub Guards can be prescribed when medically indicated as part of a treatment program for a veteran beneficiary. It was further recommended that the manufacturer include a statement about use of the Dole Flow Control, Model PCG 3.0 GPM, and how and where to purchase it. The manufacturer was also asked to add a warning against over-tightening the Allen screw on the vandal-proof model, in the installation instructions.

**Porta Care Sink.**

The Porta Care Sink, a product of the Sinkette Corporation, Gardenville, Pennsylvania is a portable sink used to shampoo and wash the hair.

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of individuals confined to bed or wheelchair and unable to use bathroom facilities (Fig. 5).

The Porta Sink is made of lightweight molded plastic (polystyrene) in the shape of a small sink, with the following attachments (Fig. 6): a plastic yoke that goes around the neck to prevent water from flowing on the user, a reservoir with four pegs to hold a plastic disposable bag for collecting the soiled water (about 2 gal), a shoulder-board attachment for use when sitting in a wheelchair, a hose with a spray head, a Power-Pak (12-V dry-cell battery), a 12-V d.c. submersible pump, and a water chamber that holds about 2 gal of water. Overall the device is 10 in wide by 16.5 in deep by 12 in high, and it weighs 20 lb.

Utilization—In use, the Porta Care Sink is brought to the disabled person's bed or wheelchair, and a disposable sanitary bag is attached to the four pegs in the reservoir. To shampoo the head of a person in a wheelchair, the shoulder board is attached to the sinkette at the proper height of the sinkette relative to the fold in the back of the neck. To shampoo a person in bed, a pillow is placed beneath the shoulder so that the neck is free from obstruction and is approximately 5 inches off the bed. The sinkette is positioned behind and beneath the head, and the yoke is attached by gently bending and engaging it in the grooves of the shoulder board. The water chamber is filled with 6 to 8 quarts of water and the Power-Pak is placed directly into the near chamber of the unit. The Power-Pak is turned on and the spray head is used to wet the user's head. While shampooing the user's hair, the Power-Pak is turned off to save battery energy and aid motor life.

Upon completion of the shampoo, the yoke and Power-Pak are removed and the hair is towel-dried and wrapped in a towel. The disposable pouch is removed and discarded and the sinkette is removed. The user's hair is now ready for blow drying or styling.

The manufacturer contends that the Porta Care unit is easily adaptable to use for neurosurgery preparations, decubitus care, perineum care, as an ADL device, and for emergency room use.

In May, 1977, the Sinkette Corp. loaned one Porta Care unit to VAREC for evaluation. The unit underwent laboratory tests to determine its safety and operation. The project monitor demonstrated the unit to the nursing staff on Spinal Cord Injury Wards at the VA Medical Center, Castle Point, New York. The unit was left on the wards to be tested on as many different patients as possible in the wheelchair and in bed. A second unit was purchased by VAREC for evaluation in the homes of severely physically disabled veterans.

Laboratory Tests—

Inventory and specification checks: all attachments were supplied and were operational on receipt of the unit. The manufacturer's brochures were supplied with diagrams, operating instructions and suggested usage.

Power requirements: the 12-V dry-cell battery was adequate for operating the unit.

Clinical and Home Evaluation—

In the hospital: the Porta Care Sink was used on a 44-year-old veteran with a partial myelopathy, traumatic left-leg amputation, and osteomyelitis. He was functionally able to wash his own hair in a standard bathroom; however, while he was confined to bed, the nursing staff tried the Porta Care Sink. He said he was very pleased and comfortable with the unit's operation and wanted to try it again. The nurse said it was an excellent device. Its portability and simplicity was of great value in grooming bedridden or wheelchair-confined patients.

A 45-year-old veteran with Guillian-Barré Syndrome was at one time functioning on the level of a complete quadriplegic. During the time he was tested with the Porta Care Sink he had begun to show functional use of all four limbs. He asked to try this device because he speculated that he would need it if he had a relapse. After having the unit used on him once, he observed
that the head-and-neck slot was inadequate because it produced undue discomfort in both the neck and upper back. Overall, he thought the concept was good but something should be done to better support the head and neck. It was suggested that he use a pillow for support in the future.

In the home: the family of a veteran who had severe joint contractures, limited use of upper limbs, and paralysis of the lower limbs from neuromyelopathy and Parkinsonism, also used the Porta Care Sink. He reported that the sink had worked well but he had experienced discomfort in the neck area due to a lack of proper support and padding. Folded wash towels placed beneath the neck and shoulder provided the necessary support and comfort. Prior to using the Porta Care Sink, the family had used a face pan and pitcher of water, which proved inconvenient and untidy. The Porta Care Sink represented a timesaver for the family and an easier means of hygienic care for the patient.

Two malfunctions occurred during the evaluations. After the first, the VAREC technician first checked the battery and wiring but could not isolate any problem. The battery holder, which was glued on with a special waterproof glue, was then removed to gain access to the motor. One strand of hair was found wrapped tightly around the motor shaft, preventing it from rotating. Once it was removed, the unit was operational again. That piece of hair was probably sucked in from the clean water chamber. The second time the unit malfunctioned, it had to be sent back to the manufacturer. It was repaired, waterproofed and returned to VAREC.

A C4-5 quadriplegic had his hair washed three times a week using the Porta Care Sink. Prior to using it, his hair had been washed once a month. He reported that approximately 10 minutes is required to completely wash his hair. Most im-

FIGURE 6. Porta Care Sink and associated accessories. Reservoir at right in photo shows freshwater chamber (filled) in rear and empty wastewater sink lined with disposable plastic bag.
portant, the unit could be used almost anywhere because of its size and portability. Also, once water is added, it is completely self-contained.

This same veteran also reported that the hose was too short to adequately spray the entire head, the water spray was not forceful enough, and the battery needed to be replaced “too often” (once every 2 months). He suggested a rechargeable battery instead of the 12-V dry cell. (The first time the 12-V battery was replaced, two 6-V batteries had to be wired together because the required 12-V dry-cell battery was not readily available at local stores.)

Conclusions and Recommendations—The Porta Care Sink is useful in the care of veteran beneficiaries who cannot wash their own hair. There are, however, several modifications which would improve the overall quality of the unit: conversion to a rechargeable battery system to eliminate the periodic need to purchase the hard-to-find and expensive 12-V dry-cell battery; addition of an adapter to connect two readily available 6-V dry-cell batteries, and provision of slightly longer hose to allow the user to rinse all parts of the patient’s head without moving him.

Winsford Feeder

The Winsford Feeder, originally called the Morewood Spoon Lifter (Fig. 7) was developed by Mr. William H. Morewood and is distributed by Winsford Products, Inc., Pennington, New Jersey. It is a semiautomatic feeding device that allows quadriplegics to feed themselves independently, using only head motion, when food is already on the plate and they are properly positioned. The original Morewood Spoon Lifter was submitted to this Center for evaluation in March 1974. Following clinical evaluation of the original device at Castle Point, New York, a list of recommended modifications was sent to the manufacturer to be incorporated in the Spoon Lifter.

In 1975, VAPC purchased 12 modified Spoon Lifters; 11 of them were distributed to Veterans Administration Spinal Cord Injury Centers for clinical evaluation; one was retained by VAPC.

Description—The Spoon Lifter consisted of a square polypropylene base approximately 12 in by 12 in with four 1-in steel legs attached at the corners beneath the base. The switch control was connected to the base on the upper-left corner, and the switch rod, which required a downward touch, had to be installed by the attendant before each meal. The motor, which operated from standard 110-V a.c. house current, was connected to the base at the lower-right corner. A metal extension arm from the motor, with an adjustable steel clamp attached to a steel disc at the end, held almost any size of eating utensil. The arm moved between the two positions in one continuous motion once the switch control had activated the motor. At the lower left corner, there was a stainless steel glass-holder with a stainless steel receptacle for a straw—it could hold a standard 10-in plastic straw at the same height as the spoon when the spoon was lifted to its highest level.

The other component of the Morewood Spoon Lifter was an adjustable plastic headband with a stainless steel piece connected to it that went around the front of the user’s head. The stainless steel band had a steel receptacle attached to it in the front, which was used to hold a 14-in non-adjustable vinyl-covered metal rod with a “pusher” or shovel at its end.

The modified Morewood Spoon Lifter, designated the Winsford Feeder, utilizes an 18-in by 14.5-in polypropylene base with a 3-inch-deep curve cut out across the end nearest the user so that he can be positioned nearer the plate. Beneath the base, at each corner, the stationary legs were replaced with a receptacle designed to hold each of the four sets of legs of different lengths that range in size from 1 in to 5 in. The switch control, connected to the base at the upper left corner, was enclosed, and the switch rod no longer requires installation each time the device is operated. No changes were made in the headband, but the rod receptacle attached to the front of the stainless steel piece was changed from steel to plastic, to reduce the chance of electrical conductance that could shock the user. The pushing rod was designed for continuously adjustable length, to prevent pushing the head-piece off and to enable it to be set to any position on the plate by merely a tilting or turning of the user’s head without moving the shoulders. The glass-holder and straw receptacle were not altered in any way for the Winsford Feeder model.

In June 1976, the feeder was further modified by removing the stainless steel disc at the end of the lifting arm and replacing it with a Delrin disc. In July 1976, the stainless steel spoon clamp was replaced by a plastic spoon clamp. Both changes were initiated to improve the device’s insulation to avoid creating an electrical pathway between the user and the mechanism. The motor on the Winsford Feeder uses a 110-V a.c. energy source activated by a single-pole, single-throw Microswitch, via a switch rod that moves to the side and is held in position for a brief moment to activate the cam in the spoon drive.

Clinical Evaluation—Evaluation was conducted at the following Veterans Administration Medical Centers: Castle Point, New York; Cleveland, Ohio; East Orange, New Jersey; Hines, Illinois; Long Beach, California; Miami, Florida; Palo Alto, California; Richmond, Virginia; Tampa, Florida; West Roxbury, Massachusetts; and Wood, Wisconsin.

The purpose of the evaluation project was to determine the safety, utility, and efficacy of the device and to ascertain the accuracy of the manufacturer’s claim that only head motion was needed for a quadriplegic to independently feed himself.

The user of the Winsford Feeder requires assistance before he can independently feed himself. The helper must cut such foods as meat or spaghetti into pieces that can be...
FIGURE 7.
The Winsford Feeder is a semiautomatic feeding device for quadriplegics, based upon the Morewood Spoon Lifter shown here.

picked up with a spoon, must set the plate of food on the base of the feeder, must place the spoon in the clamp and place the headband with its attached "shovel" on the user. The attendant should then run the spoon to the upper end of its travel and position the user so that, with the user sitting comfortably, his mouth and the spoon will be at the same height. The subject should then use the pusher to hold the switch rod in position for a brief moment to activate the extension arm, which moves the spoon to the lower position. Once the spoon is in the lower position, the attendant should adjust the spoon so that the bowl of the spoon just clears the plate and the tip of the spoon touches the plate. Once this process is completed and the attendant has made all adjustments necessary, the user shovels or pushes the food into the spoon with head motions. Another touch on the switch rod with the pusher (holding it in position briefly) causes the spoon to lift in one continuous motion to its highest level, where it stops and allows the subject to eat. This process is followed until the subject has completed his meal. The attendant removes the headband when the subject has finished eating.

Most users have been able to operate the Winsford Feeder independently, once the plate of food was placed on the base of the device and the headband was attached to their heads. However, very few subjects were interested in use of the device because they would rather be fed by someone else than expend the time and energy needed to do it themselves.

Evaluation reports on the Winsford Feeder received from six VA SCI Centers: (Castle Point, Long Beach, Miami, Palo Alto, Richmond, and Wood) reported on 16 quadriplegics, of level C-5 and above, who tested the device at those centers. The test trials ranged all the way from only one attempt to repeated daily use in the home environment. Highlights of the reports follow.

a. (Castle Point): The staff reported that the attitude of most individuals who saw the original spoon-lifter was negative toward "gadgets"—they preferred to have someone else feed them. However, one quadriplegic (C-4) was able to feed himself a complete meal by using the device. This subject requested permission to take the device home and arrangements were made for him to do so. He continued to use it at home for almost 3 years. He found it necessary to put Reston foam under the front of the headband to relieve pressure against his forehead and help keep the band from slipping.

The initial suggestions of the staff at that center were incorporated in the modified feeder, and that subject's spoon-lifter was modified.

The staff also reported that a subject required good trunk balance to use the feeder, and that the motor would stall if food stuck to the spoon bottom.

b. (Long Beach): The Winsford Feeder was evaluated in a clinical setting with five quadriplegics, C-5 level and above. One subject took the device home for a week trial after learning how to use it; he could use it only if he was up and in a wheelchair. A second subject interested in using the device could only assume a sitting position up to 90 deg and had a tracheotomy tube that interfered with the cervical neck motion necessary to activate the device. The fourth subject was able to use the Winsford Feeder in the clinical setting; and the fifth individual, who also used the device several times in the clinic, was able to use it well and with consistency; he also wanted to use it at home.

Staff members at this facility observed the following: (i) the device failed to operate properly with sticky foods such as baked beans and mashed potatoes, (ii) the subject needed good range of motion of the cervical neck to use the device properly, and (iii) newly injured subjects were more receptive to trying the device than those with old injuries.

Staff and subjects at the Long Beach facility recommended the following:

1. Lengthen the switch lever and spoon.

2. Adapt the legs with a spring-loading mechanism to facilitate po-
sitioning the device.

3. Reduce the speed of the lifting arm.

4. Try a "scoop-shaped" spoon which might be more advantageous.

5. Adapt the device for battery power for use away from the home, and even outdoors.

c. (Miami): Staff members reported that the Winsford Feeder worked well, and that subjects were able to use it, but that its use proved to be too strenuous for certain subjects and required too much training. They further noted that subjects should have good trunk balance, should not be too spastic, and should have good neck strength, control and coordination. Finally, they reported that the subjects rejected the headband because of "appearance."

d. (Palo Alto): The staff at this SCI Center evaluated the Winsford Feeder with four quadriplegic subjects (C-5); they requested three more feeders because all subjects were able to use the device.

e. (Richmond): The Winsford Feeder was evaluated with four quadriplegic subjects (C-5) in the clinic; the subjects were able to use the device. However, the staff was unable to find a subject who would accept the device and use it more than once, because most of their subjects had developed a dislike for "gadgets." Staff suggestions included:

1. The pusher rod should be telescopic rather than coming in variable lengths.

2. The grip of the spoon clamp should hold more securely.

3. The switch rod should consist of adjustable lengths.

4. The headpiece should be padded.

f. (Wood): The Winsford Feeder was used successfully by a subject who could operate the control switch and load the spoon with his hands but could not lift his hands to his mouth. Other subjects at this center rejected the head device.

Conclusions and Recommendations—Recommendations for improvement in the design of the "modified spoon lifter" reported from the various field stations include:

1. A more comfortable headband, which can maintain its position during "shovelling" and chewing, is suggested;

2. The holding grip of the spoon-clamp should be more secure;

3. The legs should be made adjustable (instead of supplying legs of various size) for greater convenience when one unit is used by several persons;

4. A longer and/or adjustable switch rod is needed;

5. A slower and/or an adjustable spoon speed is needed;

6. Adaptation for battery power, for use away from home and outdoors, would be useful.

The Winsford Feeder in its present form was found to be useful by

FIGURE 8.
Recent version of the Winsford Feeder reflects comments and evaluations from patients and clinicians: the headband and its antenna-like pusher have been eliminated. Ball-tipped switch arm now conveys minimal patient head motion to switch, and both the "pushing" and the spoon motion are powered. Smooth, seamless housing conceals working parts, replacing the former box-like metal housings which gave a strong visual suggestion of machinery, the laboratory, and industrial gaudgery to some patients.
a small number of the veterans who evaluated it. In its present configuration, it was most useful to the newly injured and those with relatively mobile cervical spines. For these reasons, we can recommend that the device be made available to veteran beneficiaries on prescriptions that recognize its limitations. It is further recommended that the manufacturer be urged to improve the utility of the device in accordance with the six recommendations cited above, to make it useful to an even larger number of people.

For a recent view of the Winsford Feeder see Figure 8.