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ERRATUM

Page 112, **Short Term Courses 1980–81** should read **Short Term Courses 1981–82.**

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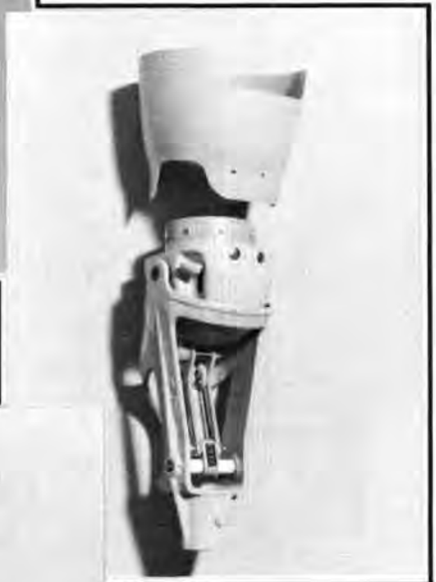

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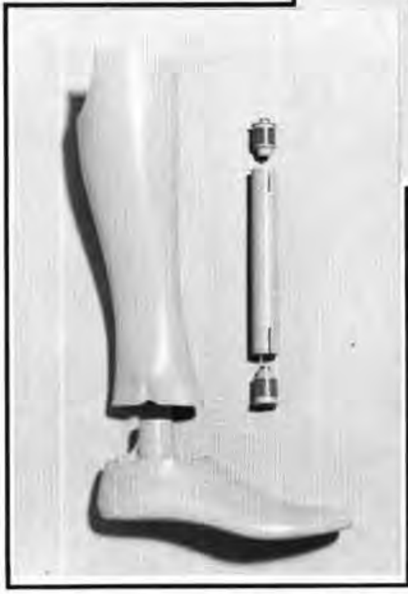

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The Journal of the International Society for Prosthetics and Orthotics

August 1981, Vol. 5, No. 2

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Editorial

We are proud to continue with the publication of the excellent articles from the 1980 World Congress held in Bologna, Italy. All of us who had a part in the scientific programme of that Congress were pleased with the technical products, and now we offer the full papers on some of these to our membership and to our other readers.

Although the array of articles appearing here testifies to the very broad span of interest within the International Society for Prosthetics and Orthotics, the problems of the developing world are still our major concern. The persistence of polio continues to frustrate, but the members of the rehabilitation team maintain their commitments demonstrably, to surgery, to therapy and to care through the use of technical aids. As members of our Society, we feel compelled to do more than simply display these problems; greater support appears to be needed for the kinds of efforts so ably performed by our Nigerian contributors. But what can the Society do to help? Can the professionals in the developing world define the support needed from their ISPO colleagues in terms which can guide action by ISPO?

Also noteworthy in this issue is that we can offer contributions from the major constituents of the ISPO team; surgeon, physician, prosthetist-orthotist, therapist, and engineer. The band of demands in patient care are clearly exhibited, from those of therapies and aids for polio patients to that used in gait measurement supporting the treatment of patients with spina bifida.

We present in the same issue a simple prosthetic modification as well as a prosthetic ankle with hydraulic controls. It is clear from this that ISPO operates within a wide spectrum. It is also clear that it is the international community's society for "rehabilitation engineering". Applications of modern technology to enhance the quality of life for the disabled really began with the advance in prosthetics and orthotics. The underlying practices, the necessary processes in the application of all the technical aids needed for "rehabilitation engineering" are based on the synergism and sharing in the team, the same team which matured in solving prosthetics and orthotics problems. From that same source should come the skills and competencies to oversee all rehabilitation engineering applications.

Although the engineer who specializes in rehabilitation has a role (in research, development, and special consulting efforts), it is our sincere belief that the surgeon and physician, the therapist (occupational, physical, speech) the prosthetist, the orthotist and most importantly, the skilled engineering technician will constitute the real-world rehabilitation engineering applications teams. Perhaps in some instances an existing team would necessarily be limited to prosthetics and orthotics and to simple technical aids but in many other instances, that same capability, in the environment which requires it, can expand to embrace all aspects of rehabilitation engineering, from the simplest walking aid to the most sophisticated communication systems for non-vocal handicapped. We look on this span of technology and its underlying surgical and medical treatments as ISPO's concern and charge in the future.

Anthony Staros,
President.

Register of Consultants

The Society is frequently called upon to form teams to take part in teaching activities, or to provide consultants to advise on or organize various aspects of prosthetic or orthotic services in different parts of the world. We are now establishing a register of those who are able and willing to take part in such activities. If you wish your name to be included, please provide the following details.

1. Name, age, sex, marital status, nationality.
2. Profession.
3. Present post.
4. Language capability—written and spoken—first and other (indicate fluency: excellent; good; fair).
5. Teaching experience—subject areas.
6. Special interests.
7. Previous experience abroad as consultant or teacher (indicate geographical areas, durations and sponsorships).
8. Length of overseas visits for which you are available.

Your details should be laid out under the above headings and forwarded to:—

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THE KNUD JANSEN LECTURE

The operative treatment of congenital limb malformation—part III

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In certain malformations of the lower limbs it is necessary to intervene surgically to make it possible for the child to walk, or to improve its walking ability. Surgical intervention is carried out at an appropriate stage in the child's development and in close co-operation with the prosthetist and orthotist.

Longitudinal deficiency tibia, total or partial

Orthopaedic-surgical treatment cannot be avoided if a child with this condition is to walk. If possible the operation is carried out at the suckling age, so that walking can start according to the child's development.

If, in the case of longitudinal deficiency tibia total, the femoral condyles and the knee capsule are normal, and if the child is to be operated on not later than in his second year of life, the Brown (1965) procedure—that is the construction of a knee joint between the femoral condyles and the head of the fibula—is indicated.

During a second operating session the distal end of the fibula is fused with the astragalus or calcaneus according to Blauth (1978) in preference to disarticulation of the ankle joint. From the third year of life, disarticulation of the knee joint is the method of choice if the tibia is totally lacking and a normal femur is present.

If the distal femur is hypoplastic, there may be a more or less serious disturbance of the growth and, after a knee disarticulation, a cone shaped, eventually mid-thigh and poor load carrying stump end. In such a case, especially if malformations of the upper limbs are present, fusion between the condyles of the femur and the head of the fibula is recommended; also between the distal end of the fibula and the astragalus or calcaneus, if necessary with ensuing partial amputation of the foot (Marquardt, 1981). Advantages in comparison with knee disarticulation are the better end bearing capacity and the self-supporting and rotation-stable fixation of the orthoprosthesis with Velcro closures which a child with a hand or arm disability may manage more easily than a knee disarticulation prosthesis (Fig. 1, left).

Fig. 1. Left, patient with longitudinal deficiency tibia, total bilateral, right coxa vara, PFFD type Aitken A left with sub-trochanteric pseudarthrosis; longitudinal deficiencies of metacarpal and phalanges total. The left hip was reconstructed and both knees and ankles fused. Patient is ambulatory (for case report see "Atlas of limb prosthetics", 634–637). Right, patient V.F. was non-ambulatory up to his 4th year because of bilateral tibial deficiencies.

In cases of longitudinal deficiency of the tibia partial there is a better chance of success if the patient is operated upon as a baby, but even for the young infant there is a good chance that a load carrying leg with a functioning knee joint can be provided by surgery. Correct interpretation of the radiological signs is

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essential as the proximal epiphys is of the tibia is often not visible on the X-ray (Jones et al, 1978). Meyer (1980) osteotomizes the fibula subperiosteally, preserves the periosteal tube and merges the distal fibular fragment with the chondric tibial rudiment. In Heidelberg, I transfer the proximal epiphysis of the fibula to a central position below the tibia rudimentum, stabilize with Kirschner wires and join the shaped proximal epiphysis of the fibula to a manchette of the periosteum of the tibia rudimentum and to the patellar ligament (Fig. 1, right and Figs. 2–6). For larger tibial rudiments which can be seen on the X-ray we osteotomize the fibula closely proximal to the level of the distal end of the tibia and fuse the distal fibular fragment to the tibial stump (Fig. 7).

Longitudinal deficiency fibula, total or partial

Accompanying malformations are shortening, bowing of the tibia, pes equino-valgus, fibular ray deficiencies of the foot and synostosis between the astragalus and calcaneus. Moreover, in some cases there may be disturbance of the lateral part of the proximal growing plate of the tibia. There is often a dimple-like skin retraction above the bowing of the tibia, a shortening of the triceps surae, often with fibrous tissue similar to the musculus sternocleido-mastoideus in torticollis, and connective tissue tending to contracture as a result of being a rudimentum of a non-ossified fibular-anlage.

In all severe cases with more than one ray deficiency of the foot, severe shortening and bowing of the tibia, the method of choice is ankle disarticulation or the formation of a modified Boyd amputation stump combined with a corrective osteotomy of the tibia (Kruger, 1971). Contraindication for the amputation or the disarticulation is the presence of severe malformations of the upper limbs, in which case the toes are required for grasping and particularly for self-care (Fig. 8). In cases where toes must be retained we carry out lateral arthrolysis of the ankle and, if present, of the talo-calcaneo joint, disconnection of the valgus contracture and posterior transposition of the peroneal tendon(s), if necessary, after three-dimensional correction osteotomy of the tibia (Fig. 9) (Marquardt, 1981). The good results of these correlated operations have caused us recently to be more cautious with the partial foot

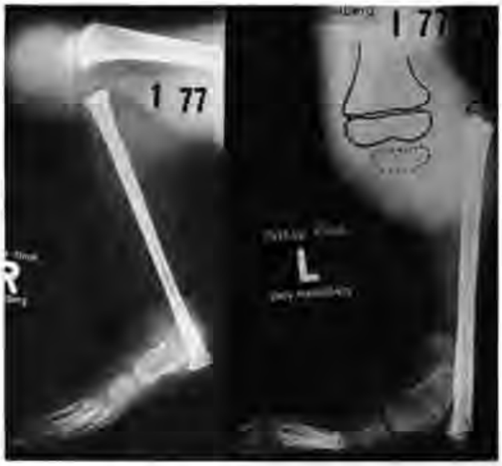

Fig. 2. Left, patient V.F. The X-ray of the right leg shows a longitudinal deficiency tibia, total. Type Ia (Jones et al, 1978). The Brown procedure is contraindicated because of the patient's age and the hypoplastic distal femur. Indication is for knee and ankle fusion or, as done, supracondylar osteotomy for correction of the severe flexion contracture and for fitting with orthoprosthesis. Right, X-ray of the left leg shows a longitudinal deficiency tibia total, but with almost normal femoral condyles. Intra operationem cartilage of the tibial condyles was present (Type Ib, Jones et al), as indicated by the dotted line. Operative indication is for transposition of the fibula below the tibial condyles.

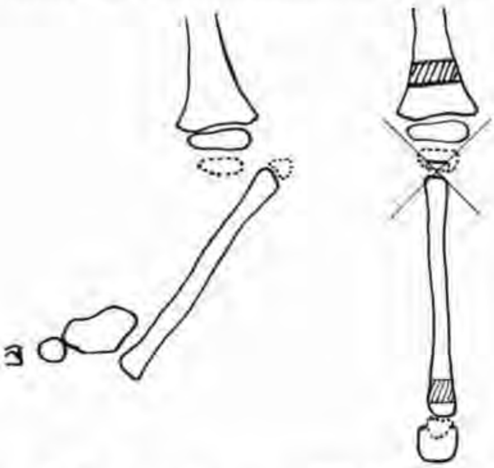

Fig. 3. The modified Brown procedure. Left, sketch of the X-ray shown in Figure 2, right. Right, the transposition of the head of the left fibula into the cartilaginous rudiment of the left tibia; fixation is by two Kirschner wires. Not shown is the Kirschner wire fixation after supracondylar shortening of the left femur and of the distal fibula before ankle fusion. Fixation of the patellar ligament to the transposed head of the fibula is done with resorbent sutures which resorb in about six weeks.

amputation or ankle disarticulation since it has been proved that children between three years and puberty should not be amputated for psychological reasons.

I am extremely sceptical about elongations of the tibia. Blauth (1978) has published favourable results, but in his publication nothing is said about the foot and the function of the ankle joint. Figure 10, left shows the frightening result of an elongation-osteotomy of the tibia that was carried out elsewhere when the patient was an infant; the foot is in extreme valgus contracture. Disarticulation of the upper talo-calcaneo joint accompanied by the formation of a modified Syme stump was the only acceptable solution (Fig. 10, centre and right).

Fig. 4. Patient V.F. Top, X-ray of the right knee one year after supracondylar hyperextension and shortening osteotomy for 90° flexion contracture. The knee has only passive mobility therefore an orthoprosthesis with a knee lock is necessary. Bottom, X-ray of the left knee three years after the modified Brown procedure showing maximum active flexion and extension. The point of fixation of the patellar ligament has developed rather like a tibial tuberosity.

Fig. 5. Patient V.F. Active extension and flexion of the left knee three years after the modified Brown procedure.

Fig. 6. Patient V.F. wears his orthoprostheses all day and is completely ambulatory. The orthoprostheses are fitted with a knee lock on the right and a free knee on the left. The thigh corset on the left side is necessary because of weak knee ligaments.

Fig. 7. Left, X-ray of the right knee, leg and foot of a four year old boy with longitudinal deficiency of tibia partial, and luxation of the knee joint caused by thalidomide. The left side is almost symmetrical. Right, two years after osteotomy of the fibula and fusion of the distal fibular fragment with the tibial rudiment, reconstruction of the knee joint and ankle fusion. There is good function in the knee. Note the adaptation of the distal fibula to tibial function. Proposed future management; partial foot amputation (modified Lisfranc) to improve the appearance and restoration to normal length by fitting an extension prosthesis.

Fig. 8. Top Left, in this case (patient G.F.) of total fibular and femoral deficiency on the left side, an ankle disarticulation (modified Syme) or a Boyd amputation is absolutely contraindicated because of the high level transverse deficiencies of both arms and the phocomelia of the rudimentary right foot. (In 1975 capping procedure was carried out on the right above-elbow stump and in 1975 and 1980 on the left stump. The procedure, which in this case made use of cartilage-bone transplants from the right phocomelic extremity, is described in part II, Vol. 5, No. 1.) Bottom, the increasing pes valgus makes function more difficult, this must be corrected but *not* amputated. Top right, the boy is ambulatory for short distances with a short Canadian hip prosthesis on the right and an orthopaedic "Innenschuh" on the left. The "Innenschuh" was unable to hold the left foot in the corrected position. The bilateral above-elbow prostheses improved the patient's balance.

Longitudinal deficiency femur, total or partial: PFFD

Children with a unilateral subtotal deficiency of the femur (PFFD type Aitken D) can walk without surgery by using an orthoprosthesis with a SACH foot (Fig. 11). Sooner or later, however, cosmetic problems occur due to the foot which, being at knee level, stands out in trousers or under a skirt. In addition, cosmetic and static-dynamic difficulties occur with the knee joint which, at the level of the ischial tuberosity, becomes increasingly prominent.

Surgical procedures are; the forming of a modified Syme or Boyd stump (Kruger, 1971, 1981), the tenomyoplastic Chopart stump (Marquardt, 1973) and the Borggreve (1930) and van Nes (1950) 180° rotation-osteotomy of the shank and foot with arthrodesis of the knee joint. The tenomyoplastic Chopart disarticulation and the Borggreve-van-Nes operations pre-suppose a normal ankle joint. Thus, both operations are contraindicated in the case of a combined fibular and femoral deficiency.

The pros and cons of these operations must be carefully discussed with the parents and the patient with the help of other patients who have undergone surgery and with the aid of photographs and films. Consultation with patients who have already had the operation is most valuable so that the patient and parents can understand the transformation of the ankle joint into a knee joint by the Borggreve-van Nes operation (Fig. 12). The radically altered phenotype of the foot, which points backward, is well compensated for by the fluid walking pattern achieved which is comparable with that of the below-knee amputee. The foot is concealed by an orthoprosthesis of good cosmesis and for the swimming pool or beach a bathing prosthesis is provided.

Fig. 9. Left, patient G.F. following corrective osteotomy of the tibia, lateral arthrolysis of the ankle joint and posterior transposition of the peroneal tendons to the tendon of m. tibialis posterior and to the medial ligaments; carried out in February, 1979, the function of the left foot is excellent. Right, fitting and alignment of the "Innenschuh" is now ideal. Both above-elbow stumps show considerable growth since the stump capping procedures; the stumps can be brought together which is useful for direct manipulation and for the positioning of prostheses.

Fig. 10. Left, right leg of a four year old child with longitudinal deficiency fibula and ray IV and V total showing extreme pes valgus after elongation of the tibia (see text). Centre, the right leg after distarticulation of the ankle joint (modified Syme). Right, the patient fitted with a modified PTS prosthesis.

We are still surprised that, about six months post-operatively, patients who have had this operation think in terms of knee movements while moving their ankle joint on the operated side—dorsiflexion causing knee flexion and plantarflexion causing knee extension.

Regarding bilateral PFFD type Aitken D, surgery is unnecessary for optimal fitting of orthoprostheses (Fig. 13, left). An absolute contraindication for amputation and the Borggreve-van Nes procedure is the case of

Fig. 11. Left, fourteen month old child with unilateral PFFD type Aitken D. Right, the child ambulatory with an orthoprosthesis without knee joint. SACH foot fitted.

Fig. 12. Transformation of the ankle joint into a knee joint by the Borggreve-van Nes procedure. Top, dorsiflexion of the ankle joints effects knee flexion. Bottom, plantarflexion effects knee extension.

bilateral PFFD combined with phocomelias or high level longitudinal and transverse deficiencies of the upper limbs (Fig. 13, right).

I do not wish, in this contribution, to go into detail regarding the operative treatment of PFFD type Aitken A, B and C; it is a matter of aligning the neck of the femur by resection of the sub-trochanteric pseudarthrosis and taking advantage of the knee joint in the best way possible.

Transverse lower limb deficiencies require surgical intervention only if there is a threatened perforation by the bone through the skin of the below-knee stump (American Academy of Orthopaedic Surgeons, 1981).

I shall report in our next Congress about surgical stump elongations, for example, the elongation of an ultra-short above-knee stump to provide a reasonable length for fitting an above-knee prosthesis. The majority of the examples discussed of operative interventions, particularly for the lower limb, can provide maximum benefit for the patient only when supported by appropriate prosthetic care.

Operation, prosthetic technique, physiotherapy and ergotherapy are bound into the

Fig. 13. Left, child with PFFD type Aitken D bilateral and normal upper limbs. No surgery is necessary for optimal fitting of orthoprostheses. The axis of the knee joints should be 3-4 cm higher than shown in the photograph. Right, twins with severe longitudinal deficiencies of both upper and lower limbs caused by thalidomide. In these cases of bilateral PFFD type Aitken D, amputations or Borggreve-van Nes procedures are absolutely contraindicated. Both children are ambulatory for short distances. For longer distances they use electrically driven wheelchairs.

same rehabilitative concept with the goal of reaching, or at least facilitating, mastery of the patient's everyday life, integration into school, occupation and participation in social life, including sports and leisure activities.

I have shown only some small elements; a lot of work still lies ahead. In preparing ourselves for this responsible task, Knud Jansen has pointed out that the way is by multidisciplinary co-operation.

Acknowledgements

I wish to thank my co-workers in the Orthopaedic Workshop, in the Occupational and Physiotherapy Departments, in Psychology and Education and finally, our patients and their parents for their wonderful co-operation. I also wish to express my gratitude to Mr. H. Brünler for the photographs used in this contribution.

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The team fights the scourge of poliomyelitis

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Abstract

Poliomyelitis is still a medical problem in Nigeria, the aftermath of which leaves patients with muscular paralysis, contractures and abnormalities which require elaborate treatment. One thousand one hundred and twenty patients affected with poliomyelitis and treated at the polio-clinic of Physiotherapy Department of the University College Hospital, Ibadan were studied. The multi-disciplinary approach of a professional health team was used to integrate the polio victims back into the community so that they do not constitute an economic liability. A case of a poliomyelitis victim who resorted to crawling is illustrated, effective treatment being given by the team approach resulting in his ability to maintain himself in the community. The importance of prophylactic immunization to prevent the wide spread of the disease in the community is also stressed.

Introduction

Many developing and African countries are endemic zones for poliomyelitis "One of the most perplexing facts in the history of infective diseases is that the incidence of paralytic poliomyelitis in contrast with almost all other infective disease is increasing" (Gear, et al 1955). Records of the Department of Medical Statistics, Federal Ministry of Health, Lagos (Table 1) show that poliomyelitis is still prevalent in all the nineteen States of Nigeria. The monthly distribution of the disease as it occurred in 1978 is shown in Table 2.

Table 1. Reported cases from notifiable diseases (polio) 1969–1978

Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
No. of cases	72	182	187	300	387	452	569	627	437	677

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Table 2. Monthly summary of reported cases from notifiable diseases (polio)—1978

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Acute polio-myelitis	37	30	55	33	55	47	40	30	54	128	39	36
Paralytic polio-myelitis	1	3	6	4	4	11	9	3	17	20	4	11
Totals	38	33	61	37	59	58	49	33	71	148	43	47

The few hospitals in Nigeria which have physiotherapy services are always overcrowded. Some 500 new cases of poliomyelitis are treated annually in Ibadan of which 400 are seen at the University College Hospital (UCH), Ibadan alone. Immunization against this disease as a public health priority has been widely recommended and the introduction of the effective poliovirus vaccine has been known to drastically reduce the incidence of poliomyelitis in developed countries (Drozdov and Cockburn, 1967; Cockburn and Drozdov, 1970; Lancet, 1970).

Most patients attended UCH between the onset of the disease and six months after. Therefore, they attended not only with paralysis but also with complications. Those who were unable to walk adopted a crawling position and eventually took to begging for alms in the streets in later years and they constitute an economic liability to the community (Collis et al, 1961). The paralysis and its consequential effect is the scourge left by an attack of the disease.

The purpose of this communication is to focus attention on the multidisciplinary approach and to emphasize the role of the team as an answer to the scourge left by poliomyelitis.

The multidisciplinary approach

Figure 1 illustrates the multidisciplinary team approach which has been successfully applied against poliomyelitis at UCH. The handling of the poliomyelitis patient is a typical example of team work and shows how various disciplines are responsible for the effective management of the patient where no single profession or discipline alone can successfully rehabilitate the patient. The team consists of different

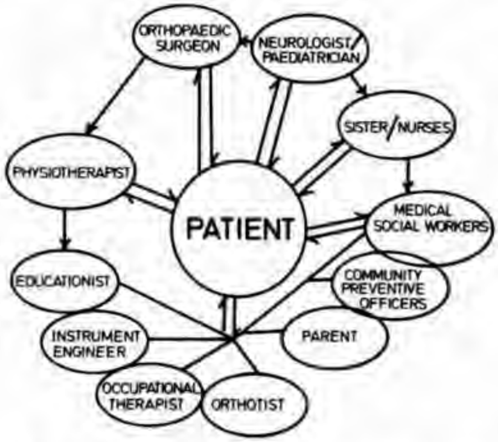

Fig. 1. The multidisciplinary approach to the treatment of the patient with poliomyelitis.

professionals who are co-ordinated by the most suitably placed member of the team depending on local circumstances. At UCH during the postparalytic stage, the physiotherapist fulfils this role and is the co-ordinator of the team.

The children with poliomyelitis are first referred by the community/preventive health officers. The first port of call at the hospital may be at the children's neurology clinic at which both the paediatrician and physiotherapist are present and where an average of ten new cases of poliomyelitis are seen weekly. Other patients, are seen at the orthopaedic clinic which is held weekly in the surgical out-patient department. The most important is the polio clinic held at the physiotherapy department jointly by the orthopaedic surgeon and the physiotherapist where an average of twelve patients are reviewed weekly. All clinics give an opportunity of discussing fully each patients needs, assessment, treatment and rehabilitation programme. Complete assessment including grading of paralyzed muscle, testing for contractures and examination of general health are carried out before the treatment is commenced. If there are contractures, these may have to be released and tendon transplants may also be necessary.

In general the consultant orthopaedic surgeons, paediatricians and neurologists examine the patients, diagnose the condition and map out a plan for treatment which is then given by the various specialities. The physiotherapist assesses the patient for muscle strength and contractures. They treat the patients to maintain erect posture and balance, re-educate for walking and build up muscle strength. The orthotists provide the splints to prevent and correct deformities and supply walking calipers and corsets as may be required. The occupational therapists make the knee cages, adjust walking aids and give the patient vocational training. The medical social workers help with sorting out financial and other social problems of the patient which includes the regular attendance for treatment. The medical record officers are responsible for registering and recording patients for statistical purposes.

The parents sometimes find their way to the respective clinics with their children and as they also help with the home programme they are instructed on how to look after their children. Instruction on diet, general hygiene, and good care of the calipers, shoes and walking aids is given. This helps to complement hospital treatment. Parents are advised to encourage the use of walking aids, night splints, to tie the children's legs together at nights, and to discourage crawling. They are discouraged from carrying their children on their backs in order to prevent contractures at the hips and knees.

Post-polio paralysis may leave many children crippled for life in a developing country where treatment is not available. This affects both mother and child socially, psychologically and economically. The family unit may be disrupted and the polio victim may eventually find himself begging for the rest of his life. It is the aim at UCH to ensure that this does not happen.

Preventive measures

It is presently estimated by the World Health Organization (WHO) that some five million children die yearly from six deadly diseases; diphtheria, pertussis, tetanus, measles, poliomyelitis and tuberculosis. The WHO goal by 1990 is to protect every child in the World from these diseases.

Today in Nigeria, the Sabin oral type of vaccine is used for the prevention of poliomyelitis. The disease could be eradicated or brought to a low incidence by immunization yet adequate preventive measures have not been generally taken. However, in Oyo State, an expanded immunization programme (EPI) is in operation and the result of this shows that even in a developing economy, polio can be eradicated. In Oyo State, progress had been made between 1974 (pre-EPI) and 1978 (post-EPI) and today over 80 percent of first contact are immunized as an important part of the team effort. (Tables 3 and 4).

Table 3. Oyo State Ministry of Health
Immunization Programme

	B.C.G.	D.P.T.	POLIO	MEASLES	SMALL POX
				376,716 (Total)	2,410,946 (Total)
1974 (Western State)	233,844	61,765	24,802 (represented only 6·2% of eligible population)	133,835 (To infants ½–1 year old, 18,052 cases of measles were notified)	1,897,649 (by M F U to all ages, 32,088 by MCHC units)
1975	167,685	68,051	37,203	259,257 (Total)	1,713,564 (Total)
(For Oyo State and most of former Western State 75% returns)	147,664 (88·1% to 0–1 yr. old)	82·6% (2nd dose) (69·4% had all 3 doses)	(represented only 8·3% of eligible population)	42,372 (to infants ½–1 yr. old 16,052 cases of measles were notified)	1,005,138 (by MFU given to all ages). 52,976 (by MCHC units)

Table. 4 Oyo State Ministry of Health
Expanded Immunization Programme (EPI)
Report of 2 years of operation

	1st Contact Antigens (BCG; 1st DPT; 1st Polio given at 3/12)	2nd Contact Antigens (Small Pox; Measles 2nd DPT; 2nd Polio given at 6/12)	Tetanus Toxiod immunization (for women in 15–45 age group)
June 1976–May 1977	277,721	197,872 (approx: 71% of 1st contact coverage)	327,721 (1st contact) 201,320 (2nd contact)
June 1977–May 1978	221,752	179,727 (approx: 81% of 1st contact coverage)	287,524 (1st contact) 188,205 (2nd contact)
June 1978–May 1979*	105,258	62,935 (approx: 60% of 1st) contact coverage)	53,935 (1st contact) 65,437 (2nd contact)

*The extremely low figures for June 1978—May 1979 reflect the near-total inactivity of the Mobile Immunization teams due to a shortage of vehicles.

Patients and results

One thousand, one hundred and twenty patients with diagnosis of paralytic poliomyelitis attending the polio clinic of the Physiotherapy Department at UCH between January 1968 and December 1977 were considered. The diagnosis was based on a clinical history of febrile illness followed by flaccid muscular paralysis and atrophy without any sensory loss. Complete muscle tests and records were made. The complication of contracture was noted and graded as mild, moderately severe and severe. Mild cases have fixed flexion deformity (FFD) of 25°, and are treated by stretching and manipulation. Moderately severe cases have FFD between 25° to 50° and are treated by manipulation and application of plaster of Paris. Severe cases have FFD above 50° and are treated by release operation followed by application of plaster of Paris.

Of the 1,120 patients, 723 were male and 397 female showing a male preponderance of ratio 2:1. The highest incidence was within the first to second year and the peak was in the second year of life. The youngest case was four months old.

Table 5. Distribution of Paralysis in Poliomyelitis

Both lower limbs	85
Right lower limb	79
Left lower limb	61
Both lower limbs and trunk muscles	10
Both lower limbs, both upper limbs and trunk muscles	5
Right upper limb	4
One lower limb and trunk muscles	3
Left upper limb	1
One upper limb and one lower limb	1
Both lower limbs, one upper limb and trunk muscles	1
One upper limb and trunk muscles	1

The gross anatomical distribution of the part of body affected is shown in Table 5. The highest incidence is recorded in paralysis affecting both lower limbs, the right lower limb being the next most affected. Table 6 illustrates the distribution of the lower limb muscle paralysis, the quadriceps muscle being the most affected (225 cases) and the gluteus maximus being the least affected (60 cases). Table 7 shows the distribution of the upper limb paralysis in poliomyelitis. The muscles of the shoulder girdle were the most affected and the muscles of the fingers were least affected.

Table 6. Lower limb paralysis—number of cases

Quadriceps	225
Hip abductors	158
Hamstrings	151
Hip flexors	149
Tibialis anterior	137
Hip adductors	137
Hip extensors	124
Toe extensors	115
Toe flexors	115
Flexor hallucis longus	110
Extensor hallucis longus	105
Peroneals	103
Gastrocnemius	102
Tibialis posterior	61
Gluteus maximus	60

The complications seen in the patients were in form of contractures. In the ten-year period, 513 patients were found to have appreciable contractures which needed treatment, 320 were male and 193 female. The age distribution of the onset of these contractures is shown in Table 8. The aetiology of contracture in poliomyelitis is not clearly understood, but it affects muscles where antagonists are severely paralyzed. It is the active muscle which undergoes contractures. When both antagonist and protagonist are paralyzed the contracture opens in the direction of gravity. Table 9 lists the distribution of contractures.

Seventy-six cases of tensor fascia lata contracture were mild and treated with stretching and passive movement, 122 showed moderate contracture and 50 with severe contracture showed good response to operative procedure.

Seventy patients had genu recurvatum with 15 very severe who were treated with plaster of

Table 7. Upper limb paralysis number of cases

Shoulder flexors	11
Shoulder abductors	11
Shoulder extensors	10
Shoulder internal rotators	10
Shoulder adductors	10
Shoulder external rotators	9
Elbow extensors	7
Elbow flexors	7
Wrist extensors	5
Wrist flexors	5
Finger extensors	3
Supinators	3
Pronators	3
Palmar interossei	3
Dorsal interossei	3
Shoulder girdle elevators	2
Finger flexors	2

Table 8. Age of onset of contracture in poliomyelitis

1st year	115
2nd year	215
3rd year	83
4th year	56
5th year	24
6th year	12
7th year	5
8th year	3

Paris cylinders, and later rehabilitated with knee cages and calipers. One hundred and fifty-seven cases had contracture of the Achilles tendon, most of these were treated with stretching manipulation and application of plaster of Paris and a few ended by having triple arthrodesis. Thirty-three patients had flexion deformity of the knee and about two-thirds were treated with manipulation and application of plaster of Paris and one third had hamstring tentomics. Five cases of paralytic scoliosis were treated with stretching, plaster of Paris and corset.

Table 9. Distribution of contractures

Tensor fascia lata—		
unilateral	186 (36·3%)	(48·4%)
bilateral	62 (12·1%)	
Tendo-Achilles	157 (30·6%)	
Genu recurvatum	70 (13·6%)	
Knee flexion	33 (6·4%)	
Scoliosis	5 (1·0%)	

Team effort

All members of the team came into contact and handled a substantial proportion of the 1,120 patients under review. Some 784 patients were seen at the neurological clinic while 336 patients were seen at the orthopaedic clinic. All these patients were referred for physiotherapy and 100 patients required surgical treatment. Nearly all the patients were seen at the occupational therapy department because of the lack of a regular orthotic service. The occupational therapy service therefore complements the orthotic service by providing toe raising devices, splints and knee cages. This is also complemented by the help from the hospital instrument engineer. The prosthetic and orthotic unit of Oyo State Ministry of Health saw 600 patients and provided them with calipers. The medical social worker was helpful in seeing 160 patients. A major drawback in our service is inadequate prosthetic and orthotic service and the same problem is encountered in other parts of Nigeria.

In parts of Oyo State the physiotherapists provide aids by joint effort with the local blacksmith and shoemaker. In Plateau State a shoemaker has become a regular supplier of calipers.

Illustrative case

T.A., a 20 year old Nigerian, contracted poliomyelitis when he was about two years old. He had traditional treatment which resulted in his being unable to walk on both feet and he crawled on his limbs (Fig. 2, left).

He managed however to take advantage of the free primary education and later got into the secondary school at Gbongan from where he appealed to the then military government for assistance to purchase a wheelchair. He was referred to the University College Hospital, Ibadan for clinical assessment by the Oyo State Government Ministry of Social Welfare, Youth and Sports. He was found to have contracture of the left tensor fascial muscle and also of the knee. The right lower limb was also affected but contractures in the limb were minimal. He was then referred to the Physiotherapy Department for thorough muscle assessment and also to plan his rehabilitation; he was admitted on 21/3/78.

He had an operation for release of contracture of the left tensor fascia and also of the iliotibia tract to correct the knee contracture. He was then put in the hip spica (plaster of Paris) for six weeks. After its removal he started physio-

Fig. 2. Left, a poliomyelitis victim moving about on his four limbs. Right, the same patient after rehabilitation. He is able to stand erect and walk with the aid of calipers.

therapy with back slabs to both knees, walking with a pair of crutches. He later graduated to bilateral calipers and walking stick (Fig. 2, right). He is still being seen at intervals at the follow-up polio clinic of UCH.

Discussion

The incidence of poliomyelitis has reduced greatly in the temperate countries with the use of poliovirus vaccine but the disease is increasing in the sub-tropical and tropical countries (WHO 1968; Lancet 1970). Nigeria is still an endemic zone for the disease. Over a million untreated victims of poliomyelitis could be found in Africa alone who had been reduced to crawling for lack of treatment (Huckstep, 1975; Cross, 1977).

The present study agrees with previous reports that at the age of two years poliomyelitis affection was at the peak, and infants under the age of six months were also affected (Collis et al, 1961; Richard, 1967; Familusi and Adesina, 1977). The study also shows that more lower limbs were affected than any other part of the body and there were more contractures in the lower limbs, most especially in the hip joints; which agrees with the findings of Sharrard (1955, 1956).

In the individual muscle study the survey shows that the quadriceps muscles were mostly affected but this finding differs from Sharrard (1955, 1971). It agrees with his conclusion that muscles innervated by the second and third lumbar segments were most likely to be affected in the lower limb.

It is essential for various disciplines to team up in order to help poliomyelitis victims maintain their own in the community. This does not mean that all disciplines constituting the team must be available at the same time.

As there is no regular orthotic service at UCH, Ibadan, alternative arrangements were made by using the occupational therapy workshop, instruments engineer and in other cases local craftsmen.

With dedication between the community health workers, who probably first see the patients and whose department is responsible for the preventive programme, and the hospital team that strives to rehabilitate already struck by the disease—the scourge of poliomyelitis can be controlled and the disease itself can be eradicated.

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Testing of manually-propelled wheelchairs

The need for international standards

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Abstract
The Veteran's Administration Rehabilitation Engineering Centre (VAREC), and others in the United States have been involved in work associated with improving the wheelchair since early in the 60's. United States Veteran's Administration standards for the "push" wheelchair have been promulgated based on a number of tests, some simple and some requiring complex equipment. A draft of a standard for electrically powered wheelchairs has also been developed by VAREC. Nevertheless, such efforts as those which have taken place in the United States on both the "push" wheelchair and electrically powered systems have so far not been related to the work in other nations; certainly the definitive action toward the development of international standards recently started should employ mechanisms to include the work of all.

International standards—when and how?

Although we in the United States and our colleagues in Canada, Germany, Scandinavia, Great Britain, Japan and perhaps elsewhere have for years worked on developing standards for wheelchairs and have designed and used test procedures associated with the standards, we have only recently seen some meetings to bring all this work together to develop international standards. But how encompassing have those meetings been? We have no way of knowing the details of what has been started except that starts occur and that only those who can get to a meeting are able to contribute or know what was contributed. Although such conferences are valuable, we appeal for the communications that are independent of the meetings, for the publication of the activities now underway nationally and internationally. We appeal for the involvement of the interested international professional bodies, the International Commission on Technical Aids and the International Society for Prosthetics and Orthotics.

This paper is aimed at all those who have developed and used test procedures for manually-propelled wheelchairs and who should now look to international standard setting through the International Standards Organization (ISO) and its technical committee ISO/TC173. We offer this to encourage work on the manually-propelled or "push" wheelchair as a priority for ISO using the facilities and capabilities made available by the national efforts. Since we are also urging that wheelchairs become freely sold in international markets, we now seek to reinforce the work started only recently by ISO.

Wheelchair deficiencies

For years the persons most concerned with the functional and durability characteristics of the wheelchair, the users, have been repeatedly reminding the manufacturers, the professionals in the clinic and in the marketing network, the counsellors, the designers, and representatives of large purchasers like Government agencies, to work to improve this essential mobility device. We interpreted the demand as being directed first to making improvements in the push "hand-propelled" wheelchair, then to do the same for the electric wheelchair.

Clearfield (1976) strongly recommended that technology be applied to improve wheelchairs. He urged the VA to take actions quite similar to those taken in rigorously employing standards for hand controls on personal licensed vehicles.

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In his opinion similar VA action was needed on wheelchairs. He also pointed out that "awareness of the . . . . . potential of . . . . . technology and its use and demand by the disabled can result in products that meet the requirements of durability and effectiveness". Although we would have chosen different words, we agree in principle.

As Clearfield pointed out repeatedly, breakdowns of wheelchairs and the required maintenance hinder the life-style of the user. We of the VA, before Clearfield, had demonstrated our concern about wheelchairs and had done a significant amount of work. It was obviously not enough; nevertheless we responded anew, particularly to enlist the disabled in promoting improvements.

A historical perspective

Let us review the recent past. In 1964 Peizer et al presented the first discussion of wheelchair studies in the VA Prosthetics Center (VAPC now VAREC). Evaluation methods were proposed; this was the real beginning of the work in the VAPC—then mainly aimed at quality improvements that were sought by a small number of "consumers" served in our own clinical programme. Performance factors such as propulsion characteristics, stability, and design quality were the major concerns of these first efforts. These early activities also responded to the opinions of users concerning the dimensions of wheelchairs and their durability. Mainly though, tests to show performance differences among several kinds of wheelchairs were presented; energy studies and measures of coronary response and pulmonary ventilation were cited.

In 1965 the American Rehabilitation Foundation and the Vocational Rehabilitation Administration sponsored a wheelchair conference at the Kenny Institute of Rehabilitation in Minneapolis. Organized to enhance contacts between the manufacturers of wheelchairs and those who were concerned about wheelchair use, particularly the clinicians, the conference keynote expressed the concern that there was no *regulatory* agency holding wheelchair manufacturers to particular standards.

But Peizer (1965) there and then offered a plan for the development of such standards and for the specifications to meet such standards. Although not proposed as regulatory in the strictest sense, the concept presented was that an agency such as the VA as a large consumer in screening for quality of materials and for function, safety, cost, and durability could indeed employ higher quality standards than those used at that time by the VA supply system. Function, energy demands, and key physical characteristics were mentioned particularly as part of the philosophy based on *performance* standards rather than the previously used dimensional standards. In fact some precise indices were given at this time about wheelchair stability, weights, and structural requirements for acceptable durability.

Then in 1969 Peizer and Wright published draft standards for push or hand-propelled wheelchairs with their report on 5 years of wheelchair evaluation in VAPC/VAREC. The standard presented tests to check wheelchairs for ease of operation, manoeuvreability, durability, weight and so forth. At that time the authors also gave preliminary criteria for powered wheelchairs. Subsequent evaluations reported in the Bulletin of Prosthetics Research displayed refinement and expansion of these criteria.

In 1977 VAPC published slightly modified draft standards for "push" wheelchairs in the U.S. Federal Register. These were then reviewed both at a workshop WHEELCHAIR I, and then by a Committee of the American Society for Testing Materials—(McFarland, 1978). Later Peizer (1979) in a paper presented to a second workshop, WHEELCHAIR II, reported the scope of much of Lipskin's work on wheelchair evaluations in VAPC. This report mainly showed the wide spectrum in powered wheelchair design which standards need to encompass. At WHEELCHAIR II, Stout (1979) offered a very detailed analysis of the requirements of high performance wheelchairs.

Most recently the VAREC has contracted with Wright State University of Dayton, Ohio to support the development of performance standards based on comparative evaluations of metabolic, muscular and cardiorespiratory demands (Glaser, 1980). A commonly used "push" wheelchair is used as a control for performance comparisons with subjects in other (test) wheelchairs being considered for purchase and use by the Veterans Administration. Findings of this type help guide prescription.

The Paralyzed Veterans Association have

always been concerned as consumer-users; its members have urged the VA to give priority to the improvement of structure and performance of wheelchairs. Much of the input came from our constant contact with members of the Eastern Paralyzed Veterans of America, particularly those members involved in wheelchair sports where performance and structural demands are the greatest.

The VA Rehabilitation Engineering Center working with colleagues of the Rehabilitation Services Administration (RSA)* organized two national wheelchair workshops to focus on the problems of wheelchairs as viewed by a larger number of interests including especially the users. Manufacturers, developers, clinicians, marketing firms, and representatives of purchasers such as Governments participated.

The first of these workshops termed WHEELCHAIR I, was held in 1977; the report gave a number of very specific recommendations which came out of its panel discussions of wheelchair design (Wheelchair I, 1977). WHEELCHAIR I also reviewed the VA draft standards. Recommendations made were:

I. Review of VA Draft Specification.

A. Specific recommendations for change in the draft, item by item, were made by two panels.

B. It was recognized by all that the draft standard prepared by the VA includes chairs for only a portion of the population of wheelchair users, and chairs for children, special models, etc. need to be covered. Also, standards for seat structure, brake locks, tyres, etc. are not included.

C. The draft standards should be forwarded to Committee F–19 of the American Society for Testing and Materials, along with the suggestions made at the workshop for changes.

D. The VA/RSA should conduct a continuing programme on validation of the laboratory tests by feedback of clinical performance and repair records.

*Currently (March 1981) U.S. Government rehabilitation engineering research, development, and evaluation efforts among the non-veteran population are overseen by the National Institute for Handicapped Research (NIHR) of the U.S. Department of Education.

II. Design Refinements.

A. Stronger mounts are needed for the handrim.

B Improved design to support the spokes properly is needed.

C. Tyres presently provided are not completely satisfactory with respect to durability and maintenance of proper inflation. The use of foam-filled tyres and puncture sealants should be studied for effectiveness in ameliorating inflation problems.

D. Critically damped casters for front wheels should be provided for all "active" wheelchair users.

E. Frames need to be strengthened at strategic points. An analysis of failures is needed for determination of the weak points in the present system.

F. Chairs narrower than those presently available should be made available.

G. More appropriate wheel bearings are available to wheelchair manufacturers and they should be used to improve useful life of the chair.

H. More attention needs to be given to the seat, seat fabrics, and accessory cushions to make seating more functional, comfortable, and durable.

Priority should be given to the development of the basic data needed to carry out the recommendations listed above.

III. Design Innovations.

Some of the more interesting ideas offered concerning manually propelled wheelchairs were:

A. With advent of smaller cars, storage en route requires even more attention than it has had in the past.

B. A study of the feasibility of use of automobiles with rear entry possibilities should be initiated.

C. The idea of Chair-E-Yacht or front-wheel "scooters" where the wheelchair can be driven onto the power package seems to have merit and should be explored.

D. Retractable arm rests would be helpful.

E. The efficiency of arm-propulsion should be investigated to determine optimal arm and body motion patterns for various disability groups.

F. The use of materials other than those presently used should be studied for all the parts of a wheelchair.
G. A lap tray that stays with the chair at all times, yet is not in the way, is needed.
H. Use of 3-speed hubs for gearing manually propelled chairs should be evaluated.
I. The use of "ski-boot" technology to provide custom seating should be studied.
J. The use of a "bendable" structure or "adjustable chair" for initial fitting is suggested.
K. A modular system that can be assembled and dismantled quickly might prove to be more efficient than the present-day collapsible system.
L. Pneumatic foam-filled tyres may be useful and should be evaluated.
M. Wheelchair systems that enable the user to stand up, squat, and assume other normal posture configurations should be investigated.
N. Stored energy to assist in standing, curb-climbing, ramp-climbing, and change in seat position should be investigated.

WHEELCHAIR II, a second workshop, was held in 1979 to look closely at the special problems of powered wheelchairs (Wheelchair II, 1979). In April 1981—in Dallas, Texas another wheelchair workshop (WHEELCHAIR III) will be held to respond to current needs and to review accomplishments since 1977. VAREC will there propose newly developed (Dec. 1980) draft standards for electrically powered wheelchairs as developed by Lipskin; these cover performance, electrical characteristics and requirements, the drive system, stability, controls, power supply and charging, as well as many of the structural requirements of the "push" wheelchair.

During recent years VAREC and the Rehabilitation Services Administration also sponsored two rehabilitation engineering conferences (The Interagency Conference on Rehabilitation Engineering 1978 in Washington, D.C. and the Interagency Conference on Rehabilitation Engineering 1979 in Atlanta, Georgia). At these conferences, all aspects of rehabilitation engineering were covered in courses, open-paper sessions, and symposia. All disciplines including the consumer participated. It is expected that such conferences will continue to be held in future years and wheelchair development and evaluation will be major concerns.

Persistent problems with wheelchairs

But we know without further input that manually propelled or "push" wheelchairs continue to demonstrate maintenance problems, due perhaps to very rough handling but nevertheless based on the reasonable needs of the user. Breakdowns are extremely inconvenient to the person who depends on the wheelchair for ranging, from and to his home or place of employment. This "inconvenience" can be a near disaster economically with the dependence on getting to and from a job.

In response to a charge in a recent VAREC contract, Joe Silverman of the Center for Independent Living in Berkeley, clearly pointed out the kinds of irksome problems of repairs and of the frequencies of various repairs, these based on studies in and around that Center. Silverman (1977) reported to WHEELCHAIR I:

"Front tyres, rear tyres, upholstery, and bearings were the most frequent classes of repairs. From the economic point of view, however, it is of greater importance to compute the frequency of each repair multiplied by the cost of that repair. *In these terms, the most serious repair problem was tyres. Thirty cents* of the dollar spent for repair of manual chairs was spent on fixing flats and replacing tyres or replacing tyres with wheels. *The second greatest expense was rear wheels. Fixing spokes, trueing wheels, and replacing rear wheels accounted for 22 cents of the pushchair repair dollar. Replacing worn upholstery was the next costliest category.* The total for seat, back, and armrest upholstery was 14 cents of the dollar. The fourth major item was replacing worn bearings, which cost 12 cents per wheelchair repair dollar."

The American Society for Testing and Materials in its 1978 review performed a paragraph-by-paragraph analysis of the VAREC testing procedures and other aspects of the standards; this analysis will assist in the development of useful international standards; such critiques after appropriate secondary review may be helpful in developing a second-stage national (U.S.) standard, but perhaps it is time for a direct thrust at the international level.

In its analysis ASTM endorsed the VAREC approach in stating that the purpose of a standard for wheelchairs is to assure "that the user is enabled to operate a wheelchair with safety and reliability by identifying *performance* characteristics of adaptive devices which have been shown to create safety and service problems".

The proposed standards of 1977

The standards proposed by the VA Rehabilitation Engineering Center in 1977 have been published (Peizer and Wright, 1969; VAPC, 1977). The entire standard will not be presented here. Some tests are described to show the nature of the measures employed. The several tests presented here show the coverage and thrust of the current "draft" and most importantly, project some positive attributes as well as the limitations in the test programme.

Wheelchair testing

The sample of tests shown in Figures 1 to 5 from the Veterans Administration draft represents attempts to control quality and durability during periodic reviews for initial approval and subsequent purchases on VA contracts. Some of these tests can be readily performed in the manufacturer's setting; others require special equipment.

Fig. 2. Left, "One year of normal use shall be simulated by driving a chair 360 hours with a 200 lb (91 kg) anthropomorphic dummy on a series of drums that provide a surface velocity of 5 mph (8 kph) and an alternating surface angulation of 9° both drum slope to the right, inward, to the left and outward." Right, "The chair shall be driven on 6 in (15 cm) curb drop simulator with the anthropomorphic dummy for 1,800 drops one way and 1,800 in a reverse direction" to subject the wheels and frame to equal impact loading over the 3,600 drops.

Fig. 1. Left, "The wheelchair must resist toppling on a surface with a 9° slope. The wheelchair shall be loaded with a 200 lb (91 kg) test load and positioned on the 9° slope with the front of the chair pointed upslope and locks on the drive wheels engaged. The standard 200 lb (91 kg) test load shall consist of a rigid 14 in (36 cm) cube with its centre of gravity (CG) at the intersection of the anterior-posterior and medial-lateral planes at a height of 4 in (10 cm) above the bottom surface. It shall be covered with a 0·5 in (1·25 cm) thick layer of 2 lb/ft (32 kg/cm) density, 30 durometer, foam rubber or (alternatively, the test can employ) an anthropomorphic 95th percentile dummy with movable joints such as the Sierra automotive test dummy in compliance with DOT, part 572." Right, "The gross weight of the chair, including all basic accessories such as footplates and armrests, shall not exceed 48 lb (22 kg)" (The seat, the backrest, and the legrests are also measured for certain dimensional requirements.)

Clinical evaluations of wheelchairs

Standards should not inhibit innovation; thus a standard must be clearly associated with a class of device, and the classification used must be realistic in embodying a clearly related family of devices. Only in this way will there be fair and equitable compliance testing without including

Fig. 3. Left, "Locks shall prevent wheel rotation when the wheelchair is loaded with a 200 lb (91 kg) test load and positioned on a 9° slope with the front of the chair pointed down-slope. Wheel movement with the locking device engaged shall be considered a failure". Right, "Measure force required to fold chair. The average of five readings shall not exceed 15 lb (66 N)."

Fig. 4. Top, "Trials of turning 180° in an area 48 in (122 cm) wide, and through a 28 in (71 cm) opening." Bottom, "The wheelchair is loaded with the 200 lb (91 kg) load. One end of a light cable which passes over a pulley is attached to the wheelchair at its centre of gravity and the other end is connected to a weight. The weight used to produce a continuous movement of 12 in (30 cm) is recorded. The average of five such tests shall not exceed 5 lb (22 N)."

Fig. 5. Left, "With the chair supported on its lower frame members, check the wobble of the drive wheels using a displacement indicator. Remove the supports and apply the 200 lb (91 kg) test load. While pushing the chair, check the wobble with the displacement indicator. The difference between the first and second reading is the wobble due to the payload; 0·0625 in (1·5 mm) is the maximum acceptable wobble." Right, "Tyres are marked with a soft crayon and the wheelchair loaded with a 200 lb (91 kg) test load is placed on a sheet of paper. Upon removal of the chair, the area of the tyre imprint on the paper is measured. A drive wheel tyre mark shall not be less than 0·75 sq in (4·84 sq cm); a caster wheel tyre mark shall not be less than 0·5 sq in (3·34 sq cm)."

those devices which because of special character deserve another family grouping and therefore another type of testing.

In rehabilitation engineering generally, and with wheelchairs specifically, there is also a need to "evaluate", to determine the utility of a device. Since there are differences even within a family of devices, the differing characteristics must be valued and associated with performance, function, or comfort and then linked with classes of disability to give prescription indices.

Compliance testing against a standard is part of the evaluation process; it presents the framework for assessing mechanical durability and other values easily measured in a laboratory. But rehabilitation engineering devices also require clinical assessments, on new designs or new versions of older design or with model changes or manufacturing process changes. Performance measures as with the Wright State University tests mentioned earlier need now to be part of an "evaluation standard". Moreover, user tests and subjective analyses arrived at thereby are absolutely essential; mechanical testing alone is insufficient.

To illustrate some features of the current VAREC programme and particularly the variability among devices seen we cite some wheelchairs now undergoing evaluations:

Lightweight wheelchair "A"

This lightweight wheelchair (Fig. 6, left) is a conventional folding manual wheelchair with fixed arm rests, hard rubber tyres and removable foot rests. The 22 in spoked wheel rims and hand rims are made of annodized aluminium. The 8 in front swivel casters have special aluminium caster stems and the upholstery is a lightweight nylon. Two units were submitted to VAREC for evaluation.

The samples underwent laboratory tests at VAREC, New York and failed the structural durability standard which states," . . . . shall be of materials and construction which does not deform permanently under the stress of normal usage." The failure occured while undergoing the simulated 6 in (15 cm) curb drop test with a

Fig. 6. Left, Lightweight wheelchair "A." Right, structural failure in "A" as a result of curb drop test.

load (Fig. 2, right). The force generated caused a break in the back support above where it was welded to the frame (Fig. 6, right). The testing was terminated at that point.

Lightweight wheelchair "B"

This lightweight wheelchair (Fig. 7, left) has conventional wheelchair features such as hammock seating, pneumatic tyres, chrome-plated steel hand rims, removable arm and foot rests. However, two main differences are the woollen upholstery and roller cam braker. The overall weight is 38·75 lb (17·57 kg). Attached to the wheelchair is a repair kit (tools) and a tyre pump. One unit was submitted to VAREC for evaluation.

Compliance tests in accordance with the VA Standards yielded the following; the chair when loaded with the 200 lb (91 kg) test load and mounted on-the-ground reaction cycle tester (cycled at three miles per hour) showed excessive tyre wear after 144 hours. Also the leg strap provided became disengaged while performing the curb drop.

Lightweight (Carbon Fibre) wheelchair "C"

The Lightweight Carbon Fibre wheelchair (Fig. 7, right) of Japanese origin is a manually propelled wheelchair constructed of carbon-fibre-reinforced epoxy with a resultant weight of 19·8 lb (8·9 kg). This weight is lighter than the lightest commercially available wheelchair, now approximately 30 lb (13·6 kg), on the market.

Fig. 7. Left, Lightweight wheelchair "B." Right, Lightweight (carbon fibre) wheelchair "C."

VAREC's testing so far has been based primarily on the curb drop carousel shown in Figure 2, right. The wheelchair passed the test; no deformation, cracks, or other failures occurred suggesting that this structure should hold up under normal wheelchair use.

The wheelchair incorporates pneumatic tyres on the rear wheels and solid rubber tyres in front. In contrast to the conventional wheelchair, it is without hand-brakes and employs a cloth-like material as a foot support. The arm rests are fixed to the frame as with some conventional wheelchairs; however, they are positioned somewhat higher. Without hand brakes, swing-away foot rests, and removable arm rest at proper height, there are apparent limitations which clinical evaluation projects are used to discern.

Push rod propulsion wheelchair

This wheelchair (Fig. 8, top) has a spring-loaded push rod apparatus that replaces the conventional handrim for propelling the wheelchair.

If a wheelchair occupant has restricted use of the hands, he may be able to use the conventional handrim for propulsion. The use of special purpose handrims as on this chair with its rod projections are alternate choices.

The occupant pushes on the tip of the uppermost push rod (this can be done without grasping the tip). As the wheelchair moves, that push rod moves away from the occupant while the following push rod moves into its upper position. Continuation of this process provides movement in the desired direction.

As the spring-loaded push rod reaches its lowermost position, by use of the eccentric cam shown, the push rod is retracted to clear the floor.

In order to ensure the safety of the occupant when the wheelchair is moving, particularly downhill, this development also provides a spring-loaded brake. This braking system can reduce the speed (and can control direction) without locking the wheels. Brake levers are positioned near the top of the armrest, one on each side, for easy access by the occupant.

Fig. 8. Top, Push-rod propulsion wheelchair. Bottom, lever drive wheelchair.

Tests for metabolic and cardiorespiratory responses of disabled persons using this chair are particularly important but other laboratory and clinical trials will also be used.

Lever-drive, manual wheelchair

A lever-drive wheelchair (Fig. 8, bottom) is available using either one or two levers for propulsion. This system utilizes a bell crank mechanism which turns one or both drive wheels when the operator alternately pushes and pulls on the lever(s). Steering is achieved by turning the handle on the end of one lever which, through appropriate linkages, steers the free-spinning front wheels.

Braking of the two lever-drive unit is achieved by offering resistance to the reciprocal action of the levers. Braking the one lever-drive unit is achieved by squeezing a caliper type handle located within the steering handle. Both units also contain parking brakes which are positive acting friction mechanisms acting on the rear drive wheel(s).

Again tests for metabolic and cardiorespiratory response will be highlighted in the evaluation of this wheelchair.

The Mobilpodium Mark III

The Mobilpodium is designed to allow a paraplegic person both horizontal and vertical mobility ranges similar to that of the able-bodied person. This device (Fig. 9, left) was developed by the Center for Orthotic Design under the sponsorship of the Veterans Administration Rehabilitation Engineering Center.

The Mobilpodium is a mobility system designed to perform as an indoor wheelchair with the addition of a standing feature allowing mobility in any position (Fig. 9, right). The joints of the lower torso and extremities are stabilized in the unit which also has a specially designed and contoured seat, backrest, knee and footrest to support the body. A person's balance over the base of support is maintained, freeing the hands for activities.

The horizontal mobility is short range such as within one or several (connected) rooms.

Fig. 9. Left, Mobilpodium in its full down mode. Right, Mobilpodium in its erect mode.

The occupant can squat, to pick up objects from the floor; adjust to a sitting height, or stand up to reach overhead to get items off shelves.

The device has a two-speed drive mechanism which the occupant can operate from any position from standing through squatting. It has two parking brakes on the rear wheels. Two positions for the feet are provided: for standing, the feet are placed on a footrest underneath the person and secured with an ankle strap. For seating, the feet rest on the front frame where there are heel loops on the front frame for support.

There is an upper torso strap which can be used either across the shoulder or around the waist. A pneumatic cylinder is the primary *energy source* used for standing.

The Mobilpodium has two speeds: the slow speed is engaged when the hand crank is in the upper-near propulsion socket, recommended for use when standing; the fast speed is engaged when the hand crank is in the lower-forward socket.

The VAREC evaluation procedure includes:

Laboratory tests for durability, safety and performance

Metabolic and cardiorespiratory responses

This testing and clinical trials conducted by VAREC at various VA centers throughout the United States demonstrated that the unit performed adequately mechanically; however, it did not provide the comfort demanded by the majority of paraplegic individuals who tried it. The primary problem was a slightly forward inclination of the standing occupant.

As a result of VAREC's laboratory tests and evaluation, which included very carefully controlled clinical use by one paraplegic, modifications in design had to be made.

The metabolic and cardiopulmonary data indicated that the unit was more stressful to operate than a control wheelchair under all test conditions; this was in part due to its additional weight. It appears that the biomechanical and physiological benefits which can be derived from use of an arm crank propulsion system may have been negated by the location of the cranks, the internal resistance or other design characteristics. The unit, however, does increase the wheelchair-dependent individual's vertical accessibility and may be best suited for short term use within the confines of the home or office.

Next steps for wheelchair standards

The "draft" specifications for manually-propelled wheelchairs require improvement. Publishing this information internationally can stimulate the mechanism needed to compare these methods with others in Western Europe and Japan. Since it is essential that an international standard be developed and that this should be based on testing and evaluation procedures agreed to by manufacturers and many national bodies, we propose that the process already begun in ISO include detailed review and comparison of current national standards and associated evaluation and testing processes. The ISPO programme is particularly important to the U.S. Veterans Administration which has been assessing wheelchairs not only from U.S. manufacturers but from Europe and Japan. Work really should start with the manually-propelled wheelchair; not far behind should be analyses of the efforts already begun on electrically-powered chairs.

These projects should engage the support of national governments; wheelchair manufacturers, and organizations of the disabled for all will benefit; however for this work to proceed most efficiently and effectively, funds will be needed from all parties involved.

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Technical note—tilting stubbies

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Abstract

Bilateral amputees who are fitted with standard full length prostheses find it difficult to walk fast or climb up and down stairs. Usually stubbies, or short prostheses with non-articulated rocker bottoms, are also provided, especially for geriatric amputees. An interchangeable system has been evolved which enables the same prosthesis to be used either as a full length prosthesis or as a stubby.

An above-knee prosthesis is converted into a stubby by removing the shin and foot piece from the socket/knee unit and replacing it with an articulated hollow rocker.

The tilting of the socket/knee unit which is made possible by the articulation at the junction of the rocker and socket enables the amputee to lower his body to use Indian type toilets with the help of a low level folding portable commode, in addition, tilting helps the amputee to work outdoors in gardens and fields.

The interchangeable system is particularly suitable for bilateral amputees in developing countries.

Bilateral above-knee amputees and those with asymmetrical amputations of above-knee on one side and below-knee on the other, who are fitted with standard length prostheses find it difficult to walk fast or climb up and down stairs. Usually stubbies or short prostheses with non-articulated rocker bottoms are also provided, especially for geriatric amputees. In advanced countries mobility for bilateral above-knee amputees fitted with long prostheses may not be a problem, as they can use wheelchairs inside the home and transfer to cars for mobility outside. However, cars and wheelchairs are beyond the reach of many of the bilateral amputees in developing countries. Even if free wheelchairs are provided, they may not be able to use them, as their small houses are not designed for wheelchair use. For mobility outside they have to make use of public transport systems.

A bilateral above-knee amputee will desire more stability say while walking through the corridors of a moving train or when he wants to walk fast or walk on uneven ground. In such circumstances, a reduction in height ensures better stability. Hence most bilateral above-knee amputees ask for stubbies even when they are fitted with full length prostheses.

Toileting is a major problem for a bilateral above-knee amputee using an Indian type toilet where the user has to squat. Bilateral amputees fitted with long prostheses or non-articulated stubbies find it difficult to lower their body to use Indian type toilets.

Fig 1. Left, bilateral above-knee amputee fitted with long prostheses. Right, tilting stubbies fitted.

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An attempt to solve the toileting problem and at the same time provide improved mobility was made by devising a system in which the shin and foot of a standard above-knee prosthesis (Fig. 1, left) could be replaced by an articulated rocker attached to the socket.

The knee bolt is removed from the prosthesis by the patient and the shin and foot detached. The hollow rocker, which is fitted with the same size knee joint sidestraps, is attached to the socket/knee unit by the same bolt. The tilting stubby is now ready for use. Careful alignment ensures the ability to walk safely with articulation at the socket/rocker junction (Fig. 1, right).

Fig. 2. Left, bilateral amputee using tilting stubbies. Right, extension bias to assist extension and control flexion.

An elastic extension bias controls flexion of the socket-knee unit with respect to the rocker when the amputee is lowering his body and assists in extension while raising the body from the floor (Fig. 2, left).

When the amputee wishes to restore the prosthesis to the standard length, the rocker is removed and the shin/foot assembly re-attached.

The tilting action which is provided by the articulation between the rocker and the socket/knee unit (Fig. 2, right) enables the amputee to use Indian toilets with the aid of a portable folding commode.

Advantages of the interchangeable system

a) The bilateral above-knee amputee can first be fitted with the socket-knee units attached to the hollow rockers for early walking training. This helps to strengthen the stump musculature, reduce flexion contractures, and gets him accustomed to ischial weight bearing. Once the amputee has gained confidence the shin and foot assembly is fitted to adjust the prosthesis to the standard length.
b) There is considerable reduction in cost and fabrication time as additional sockets are not necessary.
c) While travelling, there is no need to carry a pair of stubbies in addition to the standard prostheses. Only two extra rockers need be carried for attachment when necessary.
d) The amputee can use Indian type toilets and can also work in fields and gardens without difficulty.

Bilateral amputations are rare compared to unilateral amputations. Therefore some of the problems unique to bilateral above-knee amputees are likely to be overlooked. It is hoped that this contribution will stimulate interest in solving such special problems.

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A preliminary clinical evaluation of the Mauch hydraulic foot-ankle system

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Abstract

A preliminary clinical evaluation was conducted by the United States Veterans Administration on eight prototype Mauch hydraulic foot/ankle systems over a period of two years (June 1977–October 1979). One above-knee, three below-knee, and one bilateral above-knee/below-knee subjects were fitted. Both of the above-knee amputees were Mauch S-N-S hydraulic knee users. The purpose of this study was:

1. To determine if this system provides the functions of the natural anatomical ankle around all three main axes; mediolateral, anteroposterior, and vertical.

2. To determine its applicability as to level of amputation, its benefits to bilateral amputees, and its compatibility with crustacean and pylon prostheses/standard knee designs.

3. To determine ease of installation, alignment, and adjustment procedures by a prosthetist and any new gait training techniques by a therapist. The results of the study revealed that this system does simulate the anatomical ankle in activities such as walking on uneven terrain, descending stairs step over step, running, ascending and descending inclines step over step, and a variety of sports activities including skiing. Fifty units have been produced and are being clinically tested in a nation-wide clinical application study conducted by the VA Rehabilitation Engineering Center (formerly V.A.P.C.).

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Introduction

In 1956, shortly after the Veterans Administration had assumed the sponsorship of Mauch Laboratories work in the field of artificial limbs, Hans Mauch of Dayton, Ohio, invented an ankle control principle with an automatically adaptable dorsiflexion stop, enabling an amputee to walk uphill and downhill without loss of stability (Fig. 1).

Fig. 1. Mauch Hydraulic foot/ankle system, top exoskeletal, bottom endoskeletal.

Between 1956 and 1963, there followed a pause due to other higher priority work, mainly the swing and stance (S-N-S) hydraulic knee unit development.

In 1963 work on the hydraulic ankle was resumed and the design of an advanced prototype was initiated. This design included, in addition to the variable hydraulic dorsiflexion stop, a mechanical eversion/inversion control as an integral part of the ankle structure. In 1965 this prototype had been completed and was test worn by an amputee in Dayton. It was recognized that provisions for transverse rotation (around the vertical axis) should be added. In 1966, the hydraulic unit was completely redesigned, in addition to eversion/inversion and transverse rotation, hydraulic toe-slap damping and toe pick up were incorporated. In 1967, work on a production prototype was started but again there were delays, due to higher priority projects. The design was finally completed and a production prototype unit became available in 1970. The next year was spent in resolving many persistent difficulties such as wear and noise.

By 1974, all redesigning was completed resulting in a simpler, sturdier, more versatile system, compatible with wooden setups as well as pylon type legs. At this time, preparations for a preliminary clinical evaluation by the V.A. in New York of eight prototype ankles was initiated.

Function of the system

These prototypes now provided the functions of the natural ankle around all three axes, medio-lateral, anterior-posterior, and vertical. (Fig. 2.) These three controls are achieved from a mechanical point of view as follows:

1. *The medio-lateral axis* controls plantar and dorsiflexion. The hydraulic unit contains a gravity controlled element which closes a port in the vane piston and therefore prohibits oil flow from the rear chamber to the front chamber of the housing whenever the piston rod and the attached shank are in vertical position or inclined forward from the vertical. This dorsiflexion blocks whenever the shank, in its forward motion, reaches the vertical position no matter whether the foot is horizontal or pointing upwards or downwards. This means, compared with a standard ankle, that the dorsiflexion stop in walking uphill occurs later, thus avoiding the need for "pole-vaulting", and in walking downhill occurs sooner, thus maintaining knee alignment stability. It also means that in walking over doorsills or in stepping into a hole with the heel or the ball of the prosthetic foot, the ankle automatically compensates for these uneven portions of walking surface. The same happens when the amputee changes to shoes of a different heel height or to slippers.

A second port through the vane piston closes whenever the amputee steps on the leg (a 13·6 kg minimum load), and it opens when he takes his weight off. This means that in the unloaded condition, the foot of the ankle can assume any position from 10° dorsiflexion to 20° plantarflexion. This weight controlled port enables the amputee to walk downstairs step-over-step, without having to aim for the edge of the stairs with his prosthetic foot.

Also, due to this second weight controlled port, the amputee can sit on a chair having his prosthetic leg tucked under the chair, with the foot in a natural dorsiflexion position, or having the prosthetic shank in front of the chair, placed slightly forward, with the prosthetic foot plantarflexed and its sole touching the ground without the toe sticking up.

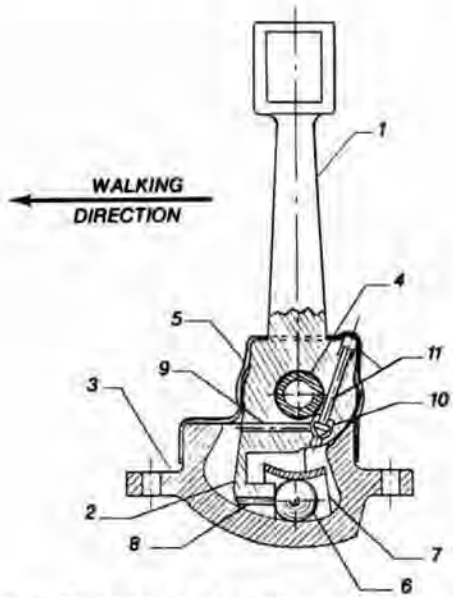

Fig. 2. The hydraulic unit. 1-piston rod. 2-vane type piston. 3-housing. 4-axle. 5-rubber boot. 6-control ball. 7-ball cage. 8-control port. 9-bypass port. 10-bypass valve. 11-valve stem.

A third port in the vane piston is spring loaded. It opens when the load on the ball of the foot exceeds 136 kg, to prevent overstress of the entire structure.

Finally, the hydraulic unit provides hydraulically controlled toe slap damping. The design of the hydraulic orifice is such that it produces turbulent flow, which means that the plantarflexion speed upon heel contact will only increase by 40 per cent if the amputee's weight is doubled.

2. *The anterior-posterior axis* controls eversion and inversion. The housing of the hydraulic unit is attached from below to the inside of a hollow keel of the foam foot by two screws. The housing pads and four rubber washers are so shaped that a 10° inversion of the foot encounters little restriction, but eversion is strongly resisted. This preserves lateral stability, but permits foot adjustment for a straddled stance, or for the downhill foot on laterally slanted surfaces.

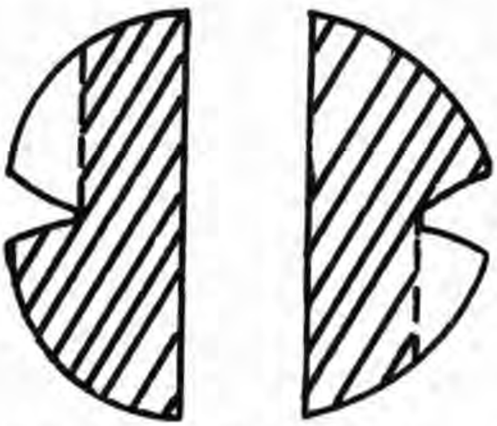

Fig. 3. Two profiled rubber bumpers which control transverse rotation around the vertical axis.

3. *The vertical axis* controls transverse rotation. Two profiled rubber bumpers (Fig. 3) are interposed between the two flat surfaces of the paddle and the inside of the shank where each bumper is kept from rotating with the piston rod. The bumpers are solid on one side of their groove and channelled on the other, providing different torque resistance for piston rotation in opposing directions. The arrangement is such that forward rotation of the pelvis is facilitated, but backward rotation is opposed. Thus the amputee, during the stance phase of the prosthetic leg, can accelerate the other leg at the beginning of its swing without his pelvis sliding backward and can stride out with his pelvis rotating forward while the other leg decelerates at the end of its swing.

Over a period of two years from June 1977–Oct. 1979, these eight prototype systems (Fig. 4), were evaluated by the V.A. Two units were held as spares.

Fig. 4. The complete foot/ankle system components (bottom to top), two holding screws, hydraulic unit, two rubber bumpers, moulded foot, wood block/shin tube set-up, 2 set screws and two locking nuts.

Purpose of the study

The purpose of this study was to determine if this system provides the functions of the natural anatomical ankle around all three main axes, to determine its applicability with crustacean and pylon prostheses, and to determine its ease of installation, alignment, and adjustment procedures by a prosthetist and any new gait training techniques by a therapist.

Table 1. Subject data
(5 subjects, 6 systems, 2 spares)

No.	Sex	Age	Weight (Kg)	Height (m)	Occupation	Etiology	Amputation Level/Side	Suspension Type	Foot Type	Time System Used
1 G.P.	M	55	72·7	1·78	Truck Driver	Traumatic	BK-Left	PTB	Sach	1/7/77– 9/8/77
2 M.D.	M	53	97·7	1·78	Prosthetist	Traumatic	BK-Left	PTS	Greisinger 3-Way	2/8/78– 2/2/79
3 J.S.	M	43	79·5	1·82	N.Y. Policeman	Traumatic	AK-Left	Suction (S-N-S Knee)	Sach	26/5/77– Present
4 C.K.	M	55	72·7	1·75	Public Utility Work	Traumatic	BK-Right	PTS	Sach and 4 Rotators	7/11/77– Present
5 J.M.	M	28	95·4	1·75	Orthotist	Traumatic	AK-Left	Suction (S-N-S Knee)	Sach	2/3/78– 10/4/78
5a							BK-Right	PTS	Sach	2/3/78–10/4/78

Subject data

The participating subjects were one unilateral above-knee, 3 unilateral below-knee, and one bilateral above-knee/below-knee amputees. The two above-knee amputees were Mauch S-N-S hydraulic knee users.

Table 1 describes the subjects characteristics; all were males, their ages ranged from 28 to 55 years; weight ranged from 72·7 kg to 95·4 kg pounds; height from 1·75 m to 1·82 m; and all amputations were traumatic. All of the subjects were active individuals both vocationally and avocationally.

The hobbies of subject number 4 were hiking and ballroom dancing; subject number 3 baseball, skiing, and tennis. Subjects number 2 and 4 had tried, used, and broken many of the commercially available rotators.

Results

The most common and frequent failures of the system were hydraulic leaks. The most common amputee complaint did not relate to the systems function but to a "squeaking noise".

Subject number 3 actually broke the piston rod while skiing (this activity was not recommended by the developer, however, this breakage led to the redesign and additional strengthening of the piston rod).

The bilateral amputee was a poor candidate to select, however he gave some indications as to prescription criteria. The stump on the BK side was extremely short and subject to skin breakdown. Two hydraulic systems totally unbalanced him. With the system only on the BK side, he felt more secure, however, he never quite adjusted to all the additional freedom of motion.

This subject was used to test the ease of attaching the system to a pylon (endoskeletal) AK set-up with a cosmetic cover (Fig. 5). No unusual problems were encountered.

Relating to ease of installation and adjustment of the system by the prosthetist, no unusual problems were encountered. Both AK and BK alignment procedures were standard—AK with an S-N-S knee unit followed the TKA line.

Fig. 5. Above-knee endoskeletal system bench alignment with multiplex.

Regarding training techniques, it was found advisable to take the subject through stair climbing, ramps, walking in a circle, and walking out of doors on uneven ground. This was done to ensure that the subject was made aware of the multi-functionality of the system.

As of this writing two of the subjects continue to use the system (almost three years): the unilateral AK policeman and the unilateral BK public utility worker.

All noise has been eliminated from the system, however, problems still exist with leakage.

Conclusion

The preliminary study has revealed that this prototype ankle system does simulate the anatomical ankle in activities such as walking on uneven terrain, descending stairs step over step, running, ascending and descending inclines, and a variety of sports activities including skiing.

Fifty production model units have been produced and as of July 1980 are being clinically evaluated in a nation-wide full scale clinical application study, conducted by the VA Rehabilitation Engineering Center in New York.

FURTHER READING

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Functional effectiveness of a myo-electric prosthesis compared with a functional split-hook prosthesis: A single subject experiment

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Abstract

The functional effectiveness of a myo-electric prosthesis with sensory feedback compared with that of a split-hook is described. Thirty independent observations were made on a single subject with a right below-elbow amputation wearing the myo-electric prosthesis and the split-hook prosthesis. Using a first order autoregressive model for making inferences about the two sets of data, the split-hook was found to be functionally better ($p<0{\cdot}001$) than the myo-electric prosthesis. Functional effectiveness was defined operationally as scores on the Minnesota Rate of Manipulation Placing Test and the Smith Test of Hand Function. No predictions are made regarding the use of either prosthesis for other amputees. However clinical evidence suggested suitability of the myo-electric prosthesis with sensory feedback for some other functional tasks.

Introduction

Traditionally in Australia, upper limb amputees have been fitted with a funcional split-hook operated by a shoulder harness and cable. In addition a passive cosmetic hand may be supplied.

Information regarding the long term follow-up of amputees is sparse and many of the claims regarding the successful use of prostheses have not been substantiated. Yet a recent survey on arm amputees (Department of Veterans' Affairs 1976) has raised questions about the rejection of prostheses as, of some 910 people issued with arm prostheses in Australia, only 240 appeared to be wearing their limbs.

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Some researchers (Day et al 1969; Jacobs & Brady 1975) have argued that acceptance of artificial limbs depends on the early fitting of temporary prostheses. Bailey (1970), on the other hand proposed that success depended on intensive training while Friedmann (1978) claimed that the greatest influence on prosthetic acceptance or rejection depended on the psychological effects of amputation.

In recent years work has continued in attempts to produce good functional upper limb devices with acceptable cosmetic appearance. A degree of success has been reported with the use of myo-electric prostheses though quantitative studies on the long-term use by amputees is yet to appear in the literature. Shannon (1975) has argued that the addition of sensory feedback will enhance the acceptability of the prosthesis to the wearer, and as a result of research by Shannon at the University of Queensland, Shannon and Agnew (1979) reported their experience after fitting two subjects with below-elbow myo-electric prostheses which conveyed a sense of touch. Altogether five subjects have been fitted with similar prostheses and Agnew (1979) has described the functional training in the use of the prostheses.

One of the five subjects was found to be a skilled user of the conventional Hosmer-Dorrance split-hook prosthesis. After two years of wearing the Shannon myo-electric prosthesis with sensory feedback, a study was done with the aim of comparing the functional effectiveness of the two prostheses for this subject.

Case report

In 1975, a 34 year old woman lost her hand following a motor car accident. Micro surgery was attempted, but the hand was not viable. A surgical below-elbow amputation was performed following the selection of an ideal stump site.

The patient was fitted with a below-elbow split-hook prosthesis and had a short uneventful rehabilitation period. She was taught to care for her stump and to use her prosthesis by an occupational therapist. The patient suffered a period of depression for some twelve months after being discharged and did not wear her prosthesis during this time. After twelve months, she became frustrated at her helplessness with one arm and began to use her hook. In 1978, she volunteered as a subject in the myo-electric prosthesis project and was accepted as she met the criteria for selection.

The subject was taught to use the myo-electric prosthesis and had no difficulty operating the myo-electric control system or the sensory feedback. Within a few weeks she had learned to do a variety of tasks with enthusiasm and confidence. She was given rechargeable batteries for continuous use and taught how to care for the apparatus. She was seen once a month for two years during which times new skills were taught, and occasional minor adjustments made to the apparatus. She was referred for a trial work period and now is employed in an office on a part-time basis.

Apparatus

A Hosmer-Dorrance below-elbow prosthesis, myo-electric prosthesis with sensory feedback (Shannon 1979), Minnesota Rate of Manipulation Tests (American Guidance Service 1969), Smith Hand Function Evaluation (Smith 1973) and one stop watch were used.

Design

A single subject experimental design with type of prosthesis as the independent variable, and scores on the Placing Test of the Minnesota Rate of Manipulation Tests and the Unilateral Grasp-Release tasks of Smith Hand Function Evaluation as the dependent variables were used. Thirty independent observations were made with the subject wearing the Hosmer-Dorrance split-hook prosthesis and thirty independent observations were made with the subject wearing the myo-electric prosthesis with sensory feedback (Shannon prosthesis). Scores were measured in seconds with a stop watch.

Possible potential error variables were loss of motivation by the subject and the order of testing both in terms of the two prosthesis and the two tests concerned. To control for loss of motivation as a potential variable, the subject was paid. To control the order of testing as a possible constant experimental error, randomisation of tests and prostheses was used. There was no need to control prosthesis rejection in a psychological sense as a possible error variable as this is considered a part of the inherent characteristic of all prosthesis.

Procedure

The grasp-release tasks of the Smith Hand Function Evaluation (1973) were administered in precisely the same manner as that originally described in the literature (Fig. 1).

For the Placing Test of the Minnesota Rate of Manipulation Test, the procedure followed was that as described in the Examiner's Manual (American Guidance Service 1969) except that only six rows of blocks were used (Fig. 2).

Two testing sessions were held per day for a period of thirty days. There was a fifteen minute interval between each session.

Results and discussion

To analyse the data, Higgins' (1978) autoregressive model for testing means in a single subject experiment was used, as this model guards against the type of gross misinterpretation of data that can occur when independence of observations is incorrectly assumed. The means, standard deviations and autocorrelation of lag 1 were calculated for each of the four sets of data summarized in Tables 1 and 2. If the rho lag 1 would be around 0·5 or less, (Higgins p. 719) the normal approximation to the autocorrelated Z could be regarded as reasonably good for $n=30$. Inferences for the two means in each case were based on the two sample autocorrelated Z-statistic defined by

$$Z = \frac{(\overline{X}-\overline{Y}-\{\mu_x-\mu_y\})}{(\hat{V}\{\overline{X}-\overline{Y}\})^{1/2}}$$

where the variance of the difference was estimated by using

$$V_2(\overline{X}-\overline{Y}) = V(\overline{X}) + V(\overline{Y}) - 2\operatorname{cov}(\overline{X}, \overline{Y})$$

and the covariance was given by

$$\operatorname{cov}(\overline{X}, \overline{Y}) = \frac{\sigma_x\sigma_y}{mn}\,\rho\,\frac{(1-\rho^m)}{(1-\rho)}\,\frac{(1-\rho^n)}{(1-\rho)}$$

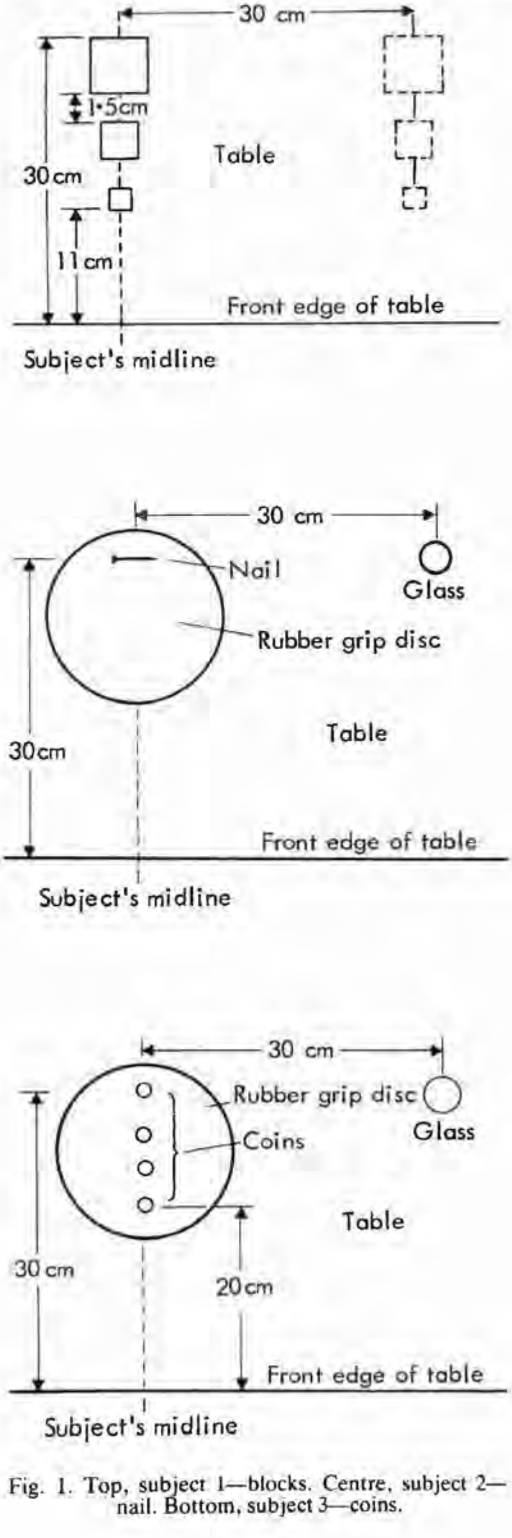

Fig. 1. Top, subject 1—blocks. Centre, subject 2—nail. Bottom, subject 3—coins.

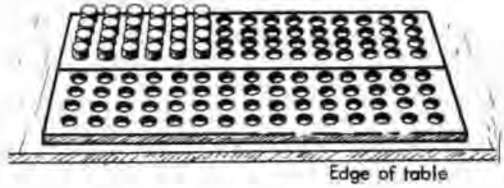

Fig. 2. Blocks set up for Placing Test.

As the sample mean has a normal distribution the approximation of variance was given by

$$V(\overline{X}) \simeq \frac{\sigma^2}{n} \frac{(1+\rho)}{(1-\rho)}$$

Tables 1 and 2 show the rho lag 1 ranging between $-0{\cdot}2$ and $0{\cdot}24$. As these values are much smaller than the critical values of 0·5 as stated previously, it would be safer to make inferences about the means from the autocorrelated Z values obtained.

The hypothesis tested was for equality of means of the myo-electric prosthesis and the split-hook prosthesis scores measured on the Placing Test of the Minnesota Rate of Manipulation Tests and the Smith Hand Evaluation as indicative of hand efficiency. The Z-statistics showed highly significant differences ($p<0{\cdot}001$) between the means of both test scores. As the means for the split-hook prosthesis were lower on both tests for hand function, this clearly indicated the split-hook as functionally better than the myo-electric prosthesis for this subject at that time in terms of two tests of hand function.

Inspection of the Figures 3 and 4 clearly shows no change in trend with time and practice, making an analysis of interaction unnecessary.

Clinical application

The experiment described was used to compare the functional effectiveness of two types of upper limb prostheses. While the results showed the efficiency of the split-hook to be better than that of the myo-electric prosthesis, it is interesting to note that the subject preferred to use the myo-electric prosthesis for certain activities such as handling a baby, folding laundry and when out on social occasions. This supports the views of Agnew and Shannon

Table 1. Means, standard deviation, autocorrelation and Z-statistic for scores on the Placing test of the M.R.M.

	$\overline{X}$	S	Autocorrelation Lag 1	Z-statistic
Myo-electric prosthesis	54·87	3·01	−0·20	21·861*
Split-hook prosthesis	45·03	2·73	0·04	

* $Z \geq 3{\cdot}290$, $p \leq 0{\cdot}001$

Table 2. Means, standard deviation, autocorrelation and Z-statistic for scores of the Smith Hand Function Evaluation

	$\overline{X}$	S	Autocorrelation Lag 1	Z-statistic
Myo-electric prosthesis	15·063	1·61	0·05	9·128*
Split-hook prosthesis	12·273	1·922	0·24	

* $Z \geq 3{\cdot}290$, $p \leq 0{\cdot}001$

(1980) that the myo-electric prosthesis with sensory feedback is of value despite its limitations in efficiency. While the good cosmetic appearance of the myo-electric prosthesis is an important consideration, it should be noted that the subject's choice of prosthesis for various activities could not have been made only on appearance. For example, the fact that the subject chose to wear the myo-electric prosthesis for laundry and kitchen work would indicate a preference for the myo-electric prosthesis for many functional tasks as well as for cosmetic appearance.

No predictions can be made regarding the two types of prostheses for other subjects. The importance in this particular experiment has demonstrated the need for objective study as, from clinical observation of the subject, it was difficult to decide whether there was any appreciable difference in the efficiency of the two types of prostheses. The experiment therefore, has eliminated the possibility of an incorrect and subjective evaluation being made in favour of one prosthesis over the other.

Further research is recommended in two major areas, viz. an objective evaluation of the sensory feedback component of the myo-electric

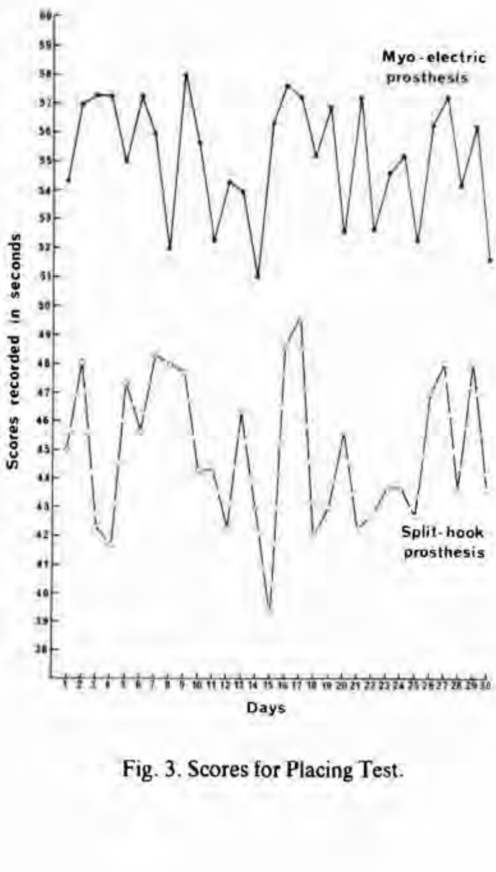

Fig. 3. Scores for Placing Test.

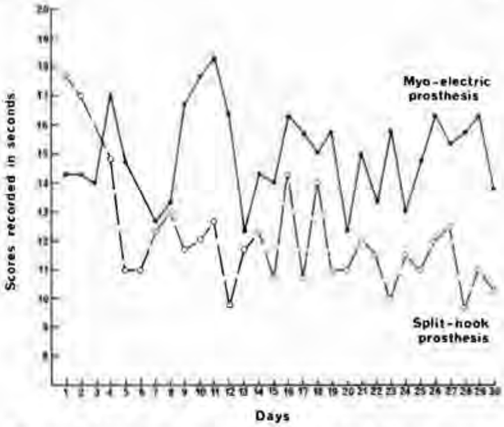

Fig. 4. Scores for Smith Hand Function Evaluation.

prosthesis; and secondly in the availability of multiple control sites for myo-electric prostheses to allow for the control of several degrees of freedom of movement, as it would appear from the literature (Herberts 1969) that there has been little development in myo-electric prostheses with more than one function.

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Prosthetics and Orthotics International, 1981, 5, 97–102

Comments on Orthopaedic research in amputation surgery, prosthetics and orthotics by N. C. McCollough

The above paper was published in Vol 5, No. 1 of the Journal. Comments were invited from a number of distinguished practitioners and have been received as follows:

JAMES FOORT

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I wish to comment on those facets of the presentation which I find provocative.

Direct skeletal attachment

So much could be done from a direct reconstruction using biologically acceptable processes that direct attachment across the skin barrier can wait. For example, something could be done again with bone bridging. We know a good deal more now than we did when Inman and Loon carried out their trials of that technique. Also, something should be done with respect to exploiting the body's capacity to develop callus. I would like to see displacements of selected segments from one site to another so that what is of value (say for weight bearing) could be salvaged from one level to be used at another. Furthermore, should implantation be of value, I would like to see such implants *within* the body (similar to Swanson plugs) which would improve interfacing the prosthesis with the residuum for end bearing. I visualize a surface of similar breadth to the femoral condyles (trimmed?) which would provide the area necessary, and skin conditioned by callusing to transmit the required forces.

Lower limb prosthetics

The emphasis of design and development should be directed toward establishing ever improving standardized prefabricated sockets using quite different techniques for their construction than we now use. Adjustability would be included and, as indicated by McCollough, responsiveness to residuum changes. Electrically driven alignment systems permitting alignment adjustments to be made as the person walks would be worthwhile, as was demonstrated in Winnipeg during the 1960's.

Refinement of the endoskeletal prostheses as proposed is correct. The systems presently used are all doing the same thing in different ways. Greater standardization of the bolts and nuts should be introduced so that parts become interchangeable betwen systems now classed as different. Joints could be moulded directly from plastic so that hingeing occured as a result of thinning the plastic in strategic locations; in this way any pattern of hingeing could be programmed in. The use of such internal hinges would suit the design of children's prostheses because of the size problem. This would lead to a similar approach to the hingeing of orthoses. I would like to see cosmetic restorations constructed out of elemental sections which could be interlinked; such cosmetic systems could be made adjustable and mobile.

A strong effort needs to be mounted to sense shape and replicate it by automatic means. The craftsmen will then have a most powerful tool with which to carry out their fittings so that as they learn, what they learn remains secure in computer memory. In this way the experience of each artisan can become common to all rather than a private preserve which perishes with him.

Lower limb orthotics

The emphasis should be placed on investigations and applications which link scant biological functions to reinforcing technological inputs as illustrated by functional electrical stimulation and comparable systems. At the same time there must be mechanical systems which will supplement or substitute for the functions we may reasonably expect to be derived eventually from procedures such as FES. The mechanical systems should be modular and that includes modularization of the support surfaces. There are numerous straight line regions on the body which should be exploited to make modularization of orthoses easier. Also, there should be a trend toward plastic tubular structures which in themselves are fragile until they are interlinked in ways that stiffen them in required directions so that a *system* develops instead of an *orthosis*. Thus, given spinal stabilization as the problem, tubular structures would be shaped around or along body parts to conform, and then be stiffened by other sections interlinked in truss form.

When McCollough speaks of research into materials it is likely he means the application of new materials. Such materials are used for what they will do. Thus, the graphite reinforced plastics are used where stiffness is required. Polyethylene tubing is used where the orthoses must form in against the body. Vacuum formed structures are used where the shapes are well defined. As suggested, there should be more aggressive attempts to apply modern computer technology such as microprocessors to problems of control. Repetitive patterns can be fed in by the patient and used until a changed pattern is required. With respect to fracture bracing, the need is for a modular approach to surfacing and containment which makes plaster obsolete. The system would be instantly appliable, continuously adjustable and impervious to water etc.

The development of emergency orthoses should be given a fairly high priority for the reason that such limited use systems will provide insights which will never be gained by refinement of existing systems. Such systems, because they can be designed without reference to cosmesis and will need to be adjustable to make them universally applicable, will lead us to the new generation of orthoses so badly needed. Because the spine is so accessible, can be treated as immobile and has such broad areas for force transmission, it is an attractive subject for which to develop "immediate application" orthoses.

One final point—many of the applications which are discussed with knowledge and confidence are areas in which I am ignorant. There was a time in our fair world when we (CPRD) knew what was going on everywhere and each contributed his knowledge to others. There is a dire need for some mechanism which will ensure an exchange of information. I suggest that ISPO be paid at advertising rates to publish in this journal brief progress reports from the various projects where innovations are being developed.

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It is difficult to add new ideas or to be critical concerning the projects proposed by McCollough in the April, 1981 issue of Prosthetics and Orthotics International, and therefore, for the most part, this presentation is restricted to amplification of the ideas set forth in that article.

Amputation surgery

1. The work currently being supported by Johnson and Johnson[1] in the use of coral calcium carbonate microstructures converted to hydroxyapatite (Holmes, 1979) as a substitute for bone in grafting procedures should be followed closely with the idea that stump length and function could be enhanced. If this technique is successful, the Marquardt

[1]New Brunswick, New Jersey, U.S.A.

osteochondral transplant procedure (Marquardt & Neff, 1974) probably could be simplified, and new reconstruction techniques might be possible especially when electrical current is used to stimulate bone growth.

2. While scientific evaluation of the merits of myoplasty and myodesis (Dederich, 1963) relative to more conventional procedures is probably not practical, a survey of patients who had such surgical procedures from, say, 1960–1970 would probably produce useful information. The bulk of the patients to be studied are probably in Germany, but patients from other countries should be included.

Lower limb prosthetics

1. The development of lightweight artificial legs should be accompanied by studies to determine the effects of weight reduction and weight distribution of the prosthesis on amputee performance. For the first time, we have available techniques and materials that permit practical fabrication of safe, functional artificial legs that are extremely light (Wilson & Stills, 1976), thus opening the way for experiments that will provide the information needed to determine optimum weight and weight distribution.

2. A simple method of measuring the change in energy requirements during level walking as weight and weight distribution are changed would be extremely helpful in this study, in alignment studies, and in lower-limb orthotics research.

3. The alignment studies proposed should include an extension of the work of Hobson (1972) where an adjustable leg that permits the patient to control alignment was used. I have been impressed that some patients would always select the same alignment, which was not always the case with the prosthetists, and the prosthetists and patients did not always agree on the optimum alignment. A variation of this study would be the development of a method for the determination of the optimum gait pattern for each amputee.

4. It certainly seems that the physical properties of polypropylene and other olefins (Stills & Wilson, 1980) lend themselves for the development of sockets that can be adjusted to accommodate changes in stump volume, while at the same time providing a socket that has a more flexible and thus more comfortable brim (Bennett, 1974).

Upper limb prosthetics

1. In a single case at the University of Virginia some years ago the use of a hydraulic system for power transmission (Goller & Lewis), in place of a Bowden cable appeared to be both satisfactory and quite superior to current practice. The obvious advantages are greater efficiency and the same efficiency at every position of arm and forearm. The patient involved in the study was a welder. This study should be reactivated.

Orthotics

1. Work in functional electrical stimulation (CPRD, 1972) should be given high priority. Extensive studies are needed to determine if functional regain in stroke cases is accelerated by use of FES as early as possible after onset. Many therapists feel that this is true but no evidence has been accumulated to prove it scientifically.

FES used in conjunction with all types of external orthoses should be studied. It might well be that some useful synergistic actions can be found.

General

1. Although considerable progress has been made in studies concerning the effects of mechanical stress on human tissues, especially the soft tissues, much more is needed for the advancement of rehabilitation and orthopaedic surgery.

Exact knowledge of the mechanism that results in pressure sores is yet to be determined.

The optimum pressure and pressure distribution between amputation stump and prosthesis are not known. Such knowledge, obviously, would permit better service. The same is true in the case of orthoses.

Almost nothing is known about the effects of shear stresses developed between prosthesis and patient, between patient and bed, and between patient and orthosis, including the shoe. Measurement techniques present the biggest problem here.

2. The use of the dilatency principle in casting stumps and other body parts has been studied

from time to time since 1945, usually with the idea of taking some of the art out of the process of modifying the positive model (Hägglund, 1975; Wijkmans & de Soeto, 1978). Another advantage of course is elimination of the mess and expense resulting in use of plaster-of-Paris bandages. With the advent of sheet plastics for fabrication of sockets and orthoses, a practical method of using dilatency would eliminate the need for wet processes altogether.

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JOSEPH H. ZETTL

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My compliments to Dr. McCullough for the fine analysis and summarization in his article. His keen knowledge and interest in current prosthetics and orthotics are the prerequisites of a successful surgeon, researcher and lecturer, and give authority to his recommendations and priorities.

Dr. McCollough has covered the subjects well, and there is little, if anything, one can disagree with. My personal opinions as practicing prosthetist therefore focus on my specialty, clinical observations and priorities from the prosthetist's viewpoint.

Amputation surgery

In spite of all the surgical improvements in amputation surgery, research should continue into refinements of techniques, specifically muscle stabilization techniques such as tension myodesis and myoplasty.

The value of the Ertl osteoplastic procedure and the Swanson method of silastic distal bone caps to achieve improved end bearing characteristics in below knee residual limbs should be further investigated and its desirability re-evaluated.

For vascular surgeons, a precise criteria for revascularization of the dysvascular ischaemic limb should be popularized. Bypasses and grafting techniques should be avoided if the chances for ultimate success and the saving of the limb are slim, since many of the failed vascular reconstruction attempts result in a pain syndrome that severely compromises residual limb comfort and diminishes prosthetic tolerance following below knee amputations. Additionally, the amputation level might be lowered if marginal revascularization procedures are avoided completely and a primary amputation is elected instead.

Postsurgical patient management

Immediate postsurgical prosthetic fitting has been standardized to a large extent and proves to be the patient management of choice. However, certain technical improvements are still indicated in the areas of rigid dressing suspension in the above-knee. Residual limb management in the interval between rigid dressing, discontinuation, and definitive limb fit is an area that requires improvement. The indication for a preparatory prosthesis or immediate definitive prosthesis, including the value of ambulation activities of geriatrics in the immediate postsurgical period, are possible areas for further research.

Prosthetic socket interface, design and suspension

The quadrilateral total contact above-knee socket design has brought about much improvement over the open end oval or plug fit socket it displaced. However, the above-knee geriatric amputee requires further improvements in socket design modifications, and materials that are less rigid and restrictive while the patient is seated and while being flexible, are still sufficiently supportive during ambulation.

The above-knee suspension systems for the geriatric amputee and the obese patient require prosthetic research and development. Hip joints and pelvic belts are cumbersome, bulky, restrictive and uncomfortable to many patients. Silesian belts are at best only partially effective. A modified Silesian belt or elastic suspension system that can be worn with comfort and handled confidently by a geriatric is a major requirement.

Similarly, socket interface design and suspension for the young, vigorously active and sports oriented amputee must be considered. The Prosthetic Research Study (PRS) in Seattle has been very active in recent years investigating high performance prostheses for such activities as snow and water skiing, running, tennis, cycling, basketball, baseball, and mountain climbing. Research should centre on the most suitable socket interface, soft vs. hard or combinations of both; the form of effective socket suspension, auxiliary, suprapatellar, supracondylar, hip, waist or combinations thereof. Also the dynamic alignment principles for these high performance prostheses differ greatly from conventional prosthetic principles and should be further studied and developed.

Important research is also being carried out by PRS on voluntary limb musculature control and the training of patients in conjunction with self suspending below-knee sockets. These developments could have significant impact on altering and possibly eliminating conventional socket design and suspension systems and enhance the voluntary control of the prosthesis by the patient. Below-knee residual limbs that allow increased distal end weight bearing (Ertl osteoplasty and Swanson's silastic plug) require research into modified socket designs that accommodate these advantages and probably allow much looser proximal socket fitting techniques. These studies should be encouraged and continued.

Additionally, the use of rotators or other torque absorbing devices or materials should be included in these studies and investigated.

Prosthetic feet and ankle joints

There are numerous prosthetic ankle and foot designs currently commercially available. While some are alike, others are distinctly unique in design and function. A complete review and a uniformly controlled testing and evaluation of these devices might help to establish some useful guidelines when selecting a particular type for a given patient. For years the SACH foot has enjoyed wide popularity and use; it should not be the final word in prosthetic feet. New materials and technology should allow for improvements in current designs. For one, more flexibility would be a desireable feature. The SAFE foot developed by Campbell and Childs is such a development and encompasses many features not found in previous designs. Another design currently being evaluated is the energy storing type of SACH foot that provides stored energy at the push off phase and improved function by providing a dynamic spring performance in active individuals. The multi-axial Greissinger foot, including the hydraulic design by Habermann and the new Mauch hydraulic foot place emphasis on increased function and are definite improvements in foot designs. This work should be encouraged and continued.

Casting techniques and measurements

Research into casting techniques to provide accurate residual limb replicas or positive moulds is required. Direct moulding of suitable plastics should also be continued. More accurate measuring techniques or systems should also be considered and investigated.

Hip disarticulation and hemipelvectomy prostheses

Engineering refinements and new sources of energy are needed specifically for the hip joint of hip disarticulation and hemipelvectomy prostheses. This applies for both endoskeletal and exoskeletal designs. A noteworthy development in this area is the Concept 80 Hip Flexion Bias System (HFB) by the Medical Centre Prosthetics Inc. which applies an energy storing system adapted for the Otto Bock endoskeletal system. Research and development in this area should continue.

Prosthetic components for children

There is still only a limited array of upper and lower extremity prosthetic components available for children. Simple scaling down of adult size components to child sizes is not always successful in view of the rugged demands placed upon the components by this particular group of patients. Knee-shin set-ups and swing phase control systems, including knee disarticulation systems are areas requiring attention. Softer, more flexible and waterproof foot designs that can be worn barefoot on the beach are also needed for children.

Upper extremity components for children show greater availability of suitable sizes, but these developments should be continued and further expanded.

Partial foot prostheses

There are numerous techniques and systems practiced in the fitting and fabrication of partial foot prostheses. While certain designs and fabrication techniques are used in some areas with great success, they are virtually unknown elsewhere. A collection of the various fitting and fabrication processes and publication of a manual on the subject would fill a void in the prosthetic education system and could even prove financially rewarding to the authors and publishers.

Education and dissemination of information

Education and dissemination of information are vital to our professions. New developments as well as basic procedures must be taught and understood in order to be practiced responsibly. The prosthetic schools in the USA and elsewhere fill this role effectively. Their continued existence must be assured for the benefit of the patients we serve.

For research, development and evaluation, we need a forum to organize and bring together the researchers, developers, evaluators, experts and educators to present the current state of the art and to discuss results and findings. This form of interchange of ideas avoids duplication of efforts and resources. The Committee of Prosthetic Research and Development filled this role effectively for many years in the USA before it was discontinued. A replacement is badly needed.

Professional publications and seminars are only partially effective due to the inherent time lag in comparison to specialized workshops that deal in depth with particular subjects and problem areas on a continuing basis.

If the successful developments of the past are an indication, I am positive the beforementioned problems can be resolved satisfactorily in the near future.

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Deutsch

Das Gleichgewicht bei beinamputierten Kindern
L. A. Clark and R. F. Zernicke
Pros. Orth. Int. **5:1,** *11–18*

Zusammenfassung
Die Standfestigkeit von fünf einseitig im Oberschenkel amputierten Kindern wurde untersucht mit zwei verschiedenen Prothesenfüssen, dem SACH-Fuss und dem neu entwickelten CAPP-Fuss. Mit der Druckmessplatte wurden die Abweichungen von der Kraftlinie gemessen und zwar beim Verlagern des Gewichtes nach vorne, rückwärts, links, rechts und in Mittelstellung. Die Rolle der Sehorgane auf das aufrechte Stehen wurde ebenfalls untersucht. Die gesamte Standfläche war ungefähr gleich bei den beiden Prothesenfüssen, die reelle Fläche jedoch beim SACH-Fuss eindeutig grösser als beim CAPP-Fuss. Verschiebungen der Kraftlinie in Mittelstellung bei normalem Stehen waren geringer mit dem CAPP-Fuss. Die Fixierung eines Gegenstandes durch die Augen war ohne Einfluss auf die Standfestigkeit in anterior-posteriorer oder seitlicher Richtung mit dem CAPP-Fuss, während das Ausschalten der Sehorgane das Gleichgewicht in seitlicher Richtung empfindlich störte, wenn der SACH-Fuss getragen wurde.

Beurteilung und Beschreibung der Leistungsfähigkeit Amputierter
H. J. B. Day
Pros. Orth. Int. **5:1,** *23–28*

Zusammenfassung
Die Leistungsfähigkeit eines Beinamputierten wird in der Regel klinisch geprüft oder durch Leistungsmessungen. Erstere ist selten exakt fassbar und beeinflusst durch Faktoren wie das Alter des Patienten. Obendrein ist die Beurteilung von einem Untersucher zum andern recht unter-schiedlich. Die Prüfung der Leistung hingegen gibt ein exaktes Mass, nicht jedoch der Leistungsfähigkeit des Patienten, die nicht nur vom körperlichen Allgemeinzustand abhängig ist, sondern von Umweltsbedingungen.

Der Beitrag versucht, ein Leistungsprofil des Patienten zu erhalten durch multiple choice-Antworten mit positiver und negativer Notengebung. Der Test dauert etwa 15 Minuten und stellt an den Untersucher keine hohen Anforderungen. Das Frageschema wurde während sechs Jahren entwickelt und an 2400 Patienten erprobt. Beschrieben werden Kontrollverfahren, insbesondere die Benützung von Schrittzählern. Diese zeigen eine auffallende Parallelität zwischen der jährlichen Anzahl Schritte und dem Leistungsprofil.

Das Gangbild mit Hüftorthesen und Krückstöcken
R. E. Major, J. Stallard and G. K. Rose
Pros. Orth. Int. **5:1,** *19–22*

Zusammenfassung
Mit Hilfe von Videorecordern und Druckmessplatte wurden die Aenderungen der Bodendruckkräfte pro Zeiteinheit über einen Gangzyklus untersucht. Dies führte zu einem besseren Verständnis der Fortbewegung mit Hüftorthesen. Unserem Patienten dienten die Krückstöcke zur Feinsteuerung der Fortbewegung. Zum Ausgleich von Energieverlusten können auch die Krücken geringe Kräfte zur Fortbewegung auf den Körper übertragen.

Die Behandlung angeborener Gliedmassenfehlbildungen—Teil II: Fallbeispiel
E. Marquardt
Pros. Orth. Int. **5:1,** *2–6*

Zusammenfassung
Der Bericht befasst sich mit einer 15-jährigen Patientin mit doppelseitiger Defektmissbildung zwischen mittlerem und distalem Drittel des Oberarms. An den unteren Extremitäten liegt ein doppelseitiger subtotaler Längsdefekt des Femurs vor. Beidseits fehlt die Fibula vollständig und die Füsse weisen einen vollständigen Strahldefekt IV and V auf. An beiden

Armstümpfen waren zwischen 1969 und 1973 sechs Kürzungen des Knochens notwendig wegen wachstumsbedingter Durchspiessung des Humerus. 1974 erfolgte die Deckung beider Stümpfe mit autogenen Knorpel-Knochentransplantaten.

Die Forschung in der Amputationschirurgie, Prothesen- und Orthesenversorgung
N. C. McCollough
Pros. Orth. Int. **5:1,** *7–10*

Zusammenfassung
Wir haben den Stand der Forschung auf dem Gebiet der Prothesen- und Orthesenversorgung untersucht. Geboten wird nicht nur ein Ueberblick über den heutigen Stand der Dinge, sondern auch über die zu setzenden Prioritäten. Unsere Untersuchung umfasste folgende Kapitel: Amputationschirurgie, Prothesen der unteren und der oberen Extremitäten, Orthesen der unteren und der oberen Extremitäten und Rumpforthesen.

Kostengünstige Sitzschalen nach Mass für behinderte Kinder
G. McQuilton and G. R. Johnson
Pros. Orth. Int. **5:1,** *37–41*

Zusammenfassung
Die Sitzschale nach Mass ist für schwerbehinderte Kinder in vielen Fällen die bestmögliche Rumpforthese. Sie verbessert die Sitzhaltung des Patienten, vermindert das Risiko von Druckstellen und erleichtert zahlreiche Tätigkeiten wie etwa die Nahrungsaufnahme. Wenn es jedoch gilt, eine grössere Anzahl solcher Patienten mit Sitzschalen zu versorgen, stellt sich das Problem, auf welche Weise diese Patienten sich Möglichst kostengünstig versorgen lassen.

Wir haben die Fragen der preiswerten Herstellung in allen Einzelheiten studiert und eine Vakuum-Giesstechnik entwickelt, mit der sich die Kosten für Geräte, Material und Arbeit erheblich senken liessen. Dabei wurde auf Aeusserlichkeiten grosser Wert gelegt durch die möglichst weitgehende Verwendung von Materialien, die im Handel erhältlich sind, etwa für die Stützschale und für die Verkleidung der Ränder.

Es stellt sich die Frage, ob diese Technik nicht auf für andere Orthesen angewendet werden könnte.

Orthopädische Massschuhe bei primär chronischer Polyarthritis-eine Erfolgskontrolle
C. Park and A. D. Craxford
Pros. Orth. Int. **5:1,** *33–36*

Zusammenfassung
100 Patienten mit primär chronischer Polyarthritis, denen orthopädische Massschuhe verschrieben wurden, haben wir gefragt, ob sie ihre Schuhe auch tragen. Die Adressen erhielten wir von einem Hersteller von orthopädischem Schuhwerk. 90% der Patienten berichteten über eine Besserung der Beschwerden, 50% übten Kritik an der Passform, Tragkomfort und modische Gestalung. Diskutiert werden die Auswirkungen von Aenderungen im Versorgungswesen und die Qualität der Fachleute. Der Beitrag schliesst mit Verbesserungsvorschlägen.

Myoelektrisch gesteuerter Ellbogen und Hand unter Verwendung von nur zwei Muskeln bei einem neunjahrigen Madchen
L. Philipson and R. Sorbye
Pros. Orth. Int. **5:1,** *29–32*

Zusammenfassung
Ein neun Jahre altes Mädchen mit einer angeborenen Oberarmamputation wurde in Mai 1978 mit einer myoelektrischen Oberarmprothese am Regionalspital Orebro, Schweden, versorgt. Hand und Ellbogen sind elektrisch angetrieben. Letzterer stammt von der New York University, die Schaltung von der Abteilung flur kilnische Neurophysiologie des Regionalspitals Orebro. Die Myosignale des Biceps und Triceps werden verwendet sowohl für die Steuerung des Oeffnens und Schliessens der Hand wie auch für die Flexion und Extension des Ellbogens. Zwei verschiedene Steuerprinzipien wurden versucht und klinisch erprobt. Das erste differenziert drei Signalstärken. Leichte Kontraktion des Biceps/Triceps steuert Oeffnen und Schliessen der Hand, starke Kontraktion steuert die Bewegungen des Ellbogens.

Das zweite Prinzip beruht auf der Differenzierung der Kontraktionsgeschwindigkeit. Langsame Kontraktion des Biceps/Triceps steuert die Hand, rasche Kontraktion den Ellbogen.

Beide Prinzipien wurden bei der Patientin zuerst unter Laboratoriumsbedingungen und anschliessend klinisch erprobt. Dieser Versuch ist noch nicht abgeschlossen. Winzige elektronische Steuerkreise sind direkt im Prothesenschaft untergebracht, welcher ohne weitere Aufhängung am Stumpf befestigt ist.

Für unseren Patienten hat sich das zweite Prinzip besser bewährt. Sie benützt ihre Prothese regelmässig und vermochte der Handhabung ständig zu verbessern.

Español

Balance de los niños amputados de miembro inferior

L. A. Clark and R. F. Zernicke

Pros. Orth Int. **5:1,** *11–18*

Resumen

La estabilidad postural de cinco niños amputados por encima de la rodilla se midió cuando utilizaban el pié SACH y el pié protésico experimental del CAPP. Se recogieron las excursiones del centro de presión de las fuerzas por medio de una plataforma de fuerza durante el cambio de peso, hacia delante, hacia detrás, derecha, izquierda y quieto. Tambien se demostraron los efectos visuales propioceptivos sobre la postura recta con estos niños amputados. La base total del soporte no difería de los dos tipos de pies protésicos, pero la base funcional de carga para el pié SACH era significativamente mayor que la CAPP. Las fluctuaciones del centro de presión en una mala posición estando de pié, eran menores en los niños que usaban pié CAPP. La concentración en un objetivo estático no tenía efecto en la estabilidad postural en dirección anterior, posterior o lateral para los pies CAPP, pero la falta de un objetivo visual tenía un efecto nocivo sobre la estabilidad lateral cuando se usaba un pié SACH.

Valoracion Y descripcion de la actividad del amputado

H. J. B. Day

Pros. Orth. Int. **5:1,** *23–28*

Resumen

La actividad lograda por un amputado de miembro inferior se evalua normalmente mediante juicios clínicos ó tests fisiológicos. El primero raramente es absoluto, estando afectados por factores tales como la edad del paciente y se expresa en categorias que pueden no ser equivalentes a las usadas por otros observadores. Los tests fisiológicos proporcionan una medida de las capacidades del paciente, pero no su actividad que puede depender más de necesidades sociales que del estado físico.

Este informe descibe un método para cuestionar al paciente utilizando múltiples respuestas con puntuaciones positivas y negativas, que sumadas proporcionan un complero "campo de actividades". La operación dura unos 15 minutos y requiere un mínimo juicio del observador. La técnica ha sido desarrollada durante un periodo de seis años y se han investigado a 2400 pacientes. Se describen procedimientos de validez, incluyendo el uso de contadoes de pasos que muestran una relación lineal sustancial entre el ritmo anual de paso y el "campo de actividad".

La dinamica de la marcha utilizando la ortosis de guia de cadera (HGO) con muletas

R. E. Major, J. Stallard and G. K. Rose

Pros. Orth. Int. **5:1,** *19–22*

Resumen

La variación de las reacciones de fuerza del suelo con el tiempo suficiente para un ciclo completo de marcha HGO utilizando muletas, se ha sintetizado de gravaciones video y de datos de la plataforma de fuerza. Esto ha hecho posible comprender la dinámica de la ambulación HGO. Los resultados demuestran que cuando un paciente utiliza la ortosis, las muletas proporcionan un sutil mecanismo decontrol, beneficiándose al máximo del momento hacia delante y produce pequeñas fuerzas propulsoras necesarias para sustituir la pérdida de energía.

Tratamiento operatorio de las malformaciones congenitas de los miembros—parte II, estudio de un caso

E. Marquardt

Pros. Orth. Int. **5:1,** *2–6*

Resumen
El paciente nació el 13 de Mayo de 1965 con una deficiencia bilateral transversa de ⅓ superior del brazo.

Las malformaciones de los miembros inferiores consistian en deficiencias longitudinales subtotales del fémur, deficiencias bilaterales de peroné y de la IV y V falanges metatarsianas. Entre 1969 y 1973 sufrió seis amputaciones por excesivo crecimiento de ambos húmeros. En 1974 se operaron los dos húmeros con transplantes de hueso y cartílago autógenos, con gran éxito.

Investigacion ortopedica en la cirugia de amputacion protesica y ortesica
N. C. McCollough
Pros. Orth. Int. **5:1,** *7–10*

Resumen
Este estudio muestra una valoración personal de la investigación en el campo de la protésica y ortésica. Subraya la situación de esta técnica y sugiere las prioridades por el trabajo futuro. Cubre los siguientes temas: cirugía de amputación, protésica de miembro inferior, protésica de miembro superior, ortésica de miembro inferior, ortésica de miembro superior y ortésica de la columna.

Asiento a medida de bajo coste para niños incapacitados
G. McQuilton and G. R. Johnson
Pros. Orth. Int. **5:1,** *37–41*

Resumen
No existe mejor solución para niños gravemente incapacitados necesitados de soporte corporal, que los asientos a medida. Estos asientos mejorarán la postura del paciente, re ducirán la formación de llagas y facilitaran actividades tales como la alimentación. Sin embargo, si hay que proporcionar este tipo de equipo a un grupo numeroso de pacientes, es importante que se fabriquen a un costo reducido sin merma de la calidad.

Estos problemas de fabricación han sido estudiados con todo detalle y se ha desarrolado un método de producción de consolidación por vacío junto con un proceso modificado de producción por vacío. Esto ha hecho posible la producción de asientos a medida con un mínimo de inversión de capital y se ha prestado mucha atención a su presentación final reforzada mediante el uso de artículos comercialmente disponibles en su estructura, bordes, etc.

Se sugiere que se diseñen otras ortesis para su fabricación, utilizando los mismos métodos anteriormente indicados.

Calzado quirurgico en artritis reumatica, estudio sobre la aceptacion de un paciente
C. Park and A. D. Craxford
Pros. Orth. Int. **5:1,** *33–36*

Resumen
Se preguntó a 100 pacientes con artritis reumática sobre su aceptación de los zapatos quirúrgicos prescritos para sus problemas del pié. La encuesta se hizo según los records de un fabricante de suministros médicos. Mientras el 90% experimentó alivio a sus síntomas, un 50% se quejó de problemas de ajuste, comodidad y estilo. Se discuten las implicaciones de los cambios en el suministro de zapatos y requisitos ortésicos y se hacen sugerencias para la investigación futura.

Protesis mioelectrica de codo y mano controlada por las señales de solo 2 musculos, en una niña de 9 años
L. Philipson and R. Sörbye
Pros. Orth. Int. **5:1,** *29–32*

Resumen
Una niña de 9 años, con una amputación congénita por encima del codo fué equipada con una prótesis de brazo controlada mioléctricamente en el Hospital Orebro, Suecia, en Mayo de 1978. La prótesis estaba dotada de una mano artificial, así como de un codo. Este codo fué diseñado en la Universidad de Nueva York y controlada en el Departamento de Neurofisiología Clínica en el Hospital Regional de Orebro. Las señales eléctricas de los músculos biceps y triceps se utilizaron para el control de la apertura y cierre de la mano, así como para la flexión y extensión del codo. Se han utilizado y comprobado dos métodos diferentes de control.

El primero es un método de tres niveles en el que una ligera contracción de los biceps/triceps proporciona movimientos de apertura y cierre de la mano y un ligero nivel de contracción más alto de estos músculos facilita la extensión y flexión del codo.

El segundo es un método para la detección de la velocidad de la contracción mediante la cual una lenta contracción del biceps/triceps proporciona la apertura/cierre de la mano y una más rápida contracción de ostos músculos proporciona asi mismo una flexión/extensión del codo.

Ambos métodos han sido experimentados en el laboratorio con los pacientes mediante un ensayo clinico todavio en marcha. Se han diseñado unos pequeños circuitos electrónicos y colocados en el encaje de la prótesis.

Según los diferentes ensayos, el segundo método parece ser el más conveniente para el paciente. Utiliza su prótesis todos los dias, mejorando continuamente su habilidad de control.

Français

Equilibre chez des enfants amputés d'un membre inférieur
L. A. Clark and R. F. Zernicke
Pros. Orth. Int. **5:1,** *11–18*

Résumé
Nous avons examiné la stabilité de cinq enfants amputés à la cuisse et appareillés de prothèses à deux pieds différents, le pied SACH et le nouveau pied CAPP. Avec une plaque de mesure des forces, nous avons mesuré les déviations de la résultante des forces pendant le déplacement de la charge en avant, en arrière, à gauche, à droite et en position moyenne. L'importance des yeux sur l'équilibre en station debout a également été examinée. La surface d'appui était à peu près égale pour les deux types de pied. La surface fonctionnelle cependant était plus grande pour le pied SACH que pour le pied CAPP. Le déplacement de la ligne résultante des forces en position moyenne et station debout était plus petit avec le pied CAPP. La fixation d'un objet par les yeux n'a pas eu d'influence sur la stabilité dans la direction antério-postérieure ou latérale avec le pied CAPP tandis que l'élimination de la vue a sévèrement perturbé l'équilibre latéral avec un pied SACH.

L'évaluation de l'activité physique des amputés
H. J. B. Day
Pros. Orth. Int. **5:1,** *23–28*

Résumé
L'activité physique des amputés des membres inférieurs est examinée cliniquement ou par la mesure de performances. La première méthode n'est que rarement exacte et est influencée par différents facteurs tel que l'âge du malade. L'appréciation varie d'un spécialiste à l'autre. L'examen de quelques critères exacts ne permet pas d'obtenir une idée des activités globales du patient qui ne dépendent non seulement de son état physique, mais aussi des circonstances extérieures.

Notre contribution essaie d'obtenir une réponse sur les performances du malade par un système de réponses à choix multiple avec appréciation positive et négative. Ce test dure environ 15 minutes et n'exige pas de connaissances particulières de la part de l'examinateur. Notre schéma a été développé pendant six ans et 2400 patients ont été testés. Des compteurs de pas installés dans les prothèses ont donné des résultats assez parallèles à notre test à réponses à choix multiple.

La marche avec une orthèse de hanche et avec des béquilles
R. E. Major, J. Stallard and G. K. Rose
Pros. Orth. Int. **5:1,** *19–22*

Résumé
Nous avons examiné les variations de force de pression au sol chez des malades munis d'orthèses de hanche et béquilles à l'aide d'appareils vidéo et de plaque de mesure des forces. Ceci nous a permis d'avoir une meilleure compréhension de la dynamique de la déambulation. Nous avons trouvé que les béquilles jouent un rôle important dans le contrôle du mouvement, spécialement de propulsion. En outre, les béquilles transmettent des forces mineures de propulsion (du sol au corps).

Le traitement des malformations congénitales des membres—deuxième partie: Exemple d'un cas
E. Marquart
Pros. Orth. Int. **5:1,** *2–6*

Résumé

Le rapport s'occupe d'une jeune fille de 15 ans, née en 1965, qui présente une amputation congénitale bilatérale entre le tiers moyen et inférieur des bras. Aux extrémités inférieures, on note des deux côtés une hypopeasie subtotale longitudinale sévère du fémur, une aplasie du péroné ainsi que des IV^e et V^e rayons (métatarses et phalanges).

Aux deux moignons des bras, six opérations ont été nécessaires entre 1969 et 1973 pour raccourcir l'humerus qui, à la suite de la croissance, avait perforé la peau. En 1974, nous avons recouvert les pointes des moignons de greffes cartilagino-osseuses autogènes.

Recherche dans la chirurgie de l'amputation, dans l'appareillage prothétique et orthétique

N. C. McCollough

Pros. Orth. Int. **5:1,** *7–10*

Résumé

Nous avons étudié l'état actuel de la recherche dans le domaine de l'appareillage prothétique et orthétique. Le point de la situation permet de proposer des travaux en priorité. Notre investigation est divisée en chapîtres suivants: chirurgie de l'amputation, prothèses des membres inférieurs et supérieurs, orthèses des membres inférieurs et supérieurs et orthèses du tronc.

Des sièges sur mesure à prix avantageux pour enfants handicapés

G. McQuilton and G. R. Johnson

Pros. Orth. Int. **5:1,** *37–41*

Résumé

Dans bien des cas, un siège sur mesure représente une des meilleures orthèses pour le tronc des enfants sévèrement handicapés. Le si ege améliore la posture du patient, diminue le risque des escarres et facilite de nombreuses activités, telle que la prise des repas. Si l'on se trouve devant le problème d'appareiller de nombreux patients avec ces sièges sur mesure, il est important d'obtenir un rapport qualité-prix le plus favorable possible.

Nous avons étudié dans le détail une méthode de fabrication qui permet, en développant une technique de coulage à vide, de diminuer considérablement le coût des outils, du matériel et du travail; ceci tout en utilisant des matériaux que l'on trouve dans le commerce, par exemple pour la coquille et le revêtement des bords, etc.

L'auteur suggère qu: cette technique pourrait être appliquée à d'autres orthèses.

Acceptation de chaussures orthopédiques par les malades souffrant de polyarthrite chronique évolutive

C. Park and A. D. Craxford

Pros. Orth. Int. **5:1,** *33–36*

Résumé

100 malades polyarthritiques à qui on avait prescrit des chaussures orthopédiques ont été interrogés sur leurs expériences avec leurs chaussures. Nous avions obtenu leurs adresses d'un fabriquant de chaussures orthopédiques. 90% des patients ont signalé une diminution des douleurs, 50% critiquaient la forme, le confort et l'aspect extérieur de la chaussure. Nous discutons les conséquences des modifications dans la distribution des chaussures et les aspects de la qualité des spécialistes. Quelques réflexions sur les améliorations possibles terminent le rapport.

Prothèse myoélectrique du membre supérieur avec coude et main dirigée par deux muscles seulement chez une jeune fille de 9 ans

L. Philipson and R. Sorbye

Pros. Orth. Int. **5:1,** *29–32*

Résumé

En mai 1978, une jeune fille âgée de neuf ans, avec une aplasie congénital du bras, a été appareillée avec une prothèse myoélectrique à l'hôpital régional d'Orebro en Suède. La prothèse était munie d'une main et d'un coude électriques. Ce dernier était fourni par la New York University tandis que le système électronique était développé par le département de neurophysiologie clinique de l'hôpital régional d'Orebro. Pour l'ouverture et la fermeture de la main ainsi que pour la flexion et l'extension active du coude, on a utilisé les signaux myoélectriques du biceps et du triceps. Nous avons étudié deux différents principes de contrôle, d'abord en laboratoire et ensuite à l'examen clinique. Le premier principe est basé sur l'intensité des signaux. Une légère contraction des muscles dirige le mouvement de la main, tandis qu'une contraction plus importante dirige le mouvement du coude.

Le deuxième principe est basé sur la différenciation de la vitesse de contraction. Des contractions lentes du biceps et du triceps dirigent la main, des contractions rapides le coude. Nous avons étudié les deux principes sur la malade d'abord dans des conditions de laboratoire et ensuite en pratique. Ces derniers essais ne sont pas encore terminés. Le système électronique miniaturisé se trouve dans le fût-même de la prothèse qui est fixé au moignon sans aucune sangle.

Notre malade préféra le deuxième principe de contrôle. Elle se sert régulièrement de cette prothèse et continue à améliorer ses performances.

Italiano

Resoconto su Amputati Infantili Agli Arti Inferiori
L. A. Clark e R. F. Zernicke
Pros. Orth. Int. **5:1,** *11–18*

Riassunto
E' stata misurata la stabilità posturale di cinque bambini amputati monolaterali di coscia che unsavano il piede SACH e il piede protesico sperimentale per bambino progetto CAPP. Le escursioni del centro di pressione delle forze di sostegno sono state registrate mediante piattaforma per le misurazioni delle forze in fase di sollevamento del peso in avanti, all'indietro, a sinistra, a destra e in posizione normale. Gli effetti visivi propriocettivi in posizione eretta sono stati anch'essi dimostrati su tali amputati infantili. Per i due tipi di piede protesico la base totale di sostegno non differisce, ma la base funzionale di sostegno per il piede SACH era significativamente maggiore di quello del piede CAPP. Le fluttuazioni del centro di pressione in posizione normale erano mediamente ridotte quando i bambini usavano il piede CAPP. La concentrazione su un obiettivo statico non aveva alcun effetto sulla stabilità posturale sia in direzione anteriore-posteriore che in direzione laterale con riferimento alle condizioni del piede CAPP, ma l'assenza di un obiettivo visivo dava luogo ad un effetto deleterio sulla stabilità laterale quando veniva usato il piede SACH.

La Valutazione e la Descrizione dell 'Attivita' di Amputati
H. J. B. Day
Pros. Orth. Int. **5:1,** *23–28*

Riassunto
L'attività svolta da un amputato agli arti inferiori viene in genere valutata in sede di giudizio clinico o mediante test psicologici. Il primo è difficilmente assoluto essendo esso condizionato da fattori quali possono essere l'età del paziente, e si esprime in categorie che non sempre possono essere equivalenti a quelle di altri osservatori. Il test fisiologico dà una misura delle capacità del paziente, ma non della sua attività che può dipendere più ancora da bisogni sociali che non dallo stato fisico.

Con questo scritto si descrive un metodo di interrogazione del paziente con possibilità di risposta a "scelta multipla" che danno luogo a punteggi positivi e negativi dalla cui somma si ricava un "punteggio dell'attività" complessivo. Questa procedura richiede sui 15 minuti e un minimo di giudizio da parte dell'osservatore. Questa tecnica è stata messa a punto in 6 anni e sono stati interrogati 2400 pazienti. Si descrivono procedure di convalidazioni, ivi compreso l'impiego di contatori di passi che indicano un sostanziale rapporto lineare tra percentuale tasso annua di passi e il "punteggio d'attività".

La Dinamica della Deambulazione con l'impiego della Ortesi Correttiva dell'anca (HGO) con L4USO di Stampelle
R. E. Major, J. Stallard e G. K. Rose
Pros. Orth. Int. **5:1,** *19–22*

Riassunto
Il variare nel tempo di forze di reazione di base per un intero ciclo di deambulazione (HGO) con l'uso di stampelle è stato sintetizzato da videoregistrazioni nonchè da dati della piattaforma per la misurazione delle forze. Ciò ha consentito una comprensione della dinamica dell'ambulazione HGO. Dai risultati si rileva che quando un paziente usa la ortesi, le stampelle producono un sottile meccanismo di comando che trae il massimo vantaggio dal momento di avanzamento dando luogo a piccole forze propulsive quando queste siano richieste per recuperare perdite di energia.

Il Trattamento Chururgico delle Malformazioni Congenite Agli Arti
Parte II, Studio di un Caso
E. Marquardt
Pros. Orth. Int. **5:1,** *2–6*

Riassunto

La paziente è nata il 13.5.1965 con difetto bilaterale trasversale al 3° superiore di braccio.

La malformazione agli arti inferiori consistevano di difetti bilaterali, subtotali, longitudinali al femore, difetti totali bilaterali alla fibula nonchè difetti radiali bilaterali (metatarso e falange) IV e V.

Essa ha sofferto di frequenti incidenti di ipercrescita ossea dell'omero sui due lati, e fra il 1969 e il 1973 vennero eseguite 6 amputazioni per tale motivo. I procedimenti di ricopertura dei monconi mediante trapianti autogeni di ossa cartilaginose sono state effettuati con esito positivo su ogni moncone omerale nell'anno 1974.

La Ricerca Ortopedica Nella Chirurgia Amputativa, Protetica e Ortotica
N. C. McCollough
Pros. Orth. Int. **5:1,** *7–10*

Riassunto

Col presente scritto si descrive un rilevamento personale di una ricerca effettuata nel campo della protetica e dell'ortotica. Esso si propone di delineare lo stato dell'arto e suggerisce delle priorità per il lavoro futuro. Gli argomenti trattati si riferisco no alla tecnica di amputazione, alla protetica degli arti inferiori e qualla degli arti superiori, all'ortotica degli arti inferiori, quella degli arti superiori e all'ortotica spinale.

Il Sedile Eseguito su Misura a Basso Costo per il Bambino Handicappato
G. McQuilton e G. R. Johnson
Pos. Orth. Int. **5:1,** *37–41*

Riassunto

Per molti bambini gravemente handicappati, che necessitino di sostegno esterno per il proprio tronco, non esiste probabilmente miglior soluzione del sedile esequito su misura. Ciò comporterà un miglioramento della posizione del paziente, ridurrà l'emergere di piaghe da compressione agevolando al tempo stesso le attività quali possono essere la nutrizione. Tuttavia, se un tale tipo di attrezzatura dovrà essere fornito a un numero esteso di pazienti, sarà importante poterlo produrre ad un costo possibilmente basso compatibilmente con una qualità accettabile.

Su tali problemi di produzione sono stati sviluppati studi approfonditi, e si è venuto elaborando un metodo di produzione che applica il sistema della colata con consolidamento a vuoto congiuntamente ad un procedimento di formazione del vuoto modificato. Ciò ha reso possibile la produzione in modo efficiente di sedili su misura con un minimo di investimenti. Si è prestata particolare attenzione all'estetica finale del prodotto; a tale fine si è voluto valorizzare articoli disponibili sul mercato per le strutture d'appoggio, per la rifinitura dei bordi ecc.

Si suggerisce di ridisegnare ai fini produttivi anche altri dispositivi correttivi facendo uso del tipo di approccio che nella presente relazione viene descritto.

Calzature Ortopediche per Artriti Reumatoidi— Studio Sulla Accettabilita' di un Paziente
C. Park e A. D. Craxford
Pros. Orth. Int. **5:1,** *33–36*

Riassunto

Un centinaio di pazienti è stato interpellato con riferimento all'accettabilità di calzature ortopediche prescritte agli stessi per i loro problemi ai piedi. Il rilevamento è stato operato ricorrendo alle registrazioni di un produttore di articoli chirurgici. Mentre dal 90% è stata riscontrata una buona riduzione dei sintomi, il 50% lamenta carenze relativamente all'adattamento, al comfort e allo styling. Sono state discusse le implicazioni di una modifica nella fornitura di calzature e nella preparazione del personale e sono stati messi a punto dei suggerimenti per la ricerca futura.

Gomito Mioelettrico e Protesi per Mano Comandata da Segnali di Soli Due Muscoli, in Bambina di 9 Anni
L. Phillipson e R. Sorbye
Pros. Orth. Int. **5:1,** *29–32*

Riassunto

Ad una bambina di anni 9 con amputazione congenita del gomito superiore è stata applicata una protesi di braccio controllata mioelettricamente. Applicazione eseguita presso il Regional Hospital di Orebro (Svezia) nel maggio del 1978. La protesi è stata munita di mano artificiale nonchè di articolazione del gomito. Quest'ultimo è stato disegnato presso l'Università di New York, il comando a interruttore presso il Reparto della Clinica Neurofisiologica dell'Ospedale Regionale di Orebro. I segnali elettrici in partenza dai muscoli del bicipite e del tricipite vennero usati per il comando della chiusura e apertura della mano nonchè per la flessione ed estensione del gomito. I differenti metodi di comando (controllo) sono stati applicati e collaudati in clinica.

Nel primo caso trattasi di metodo a tre livelli ove una leggera contrazione di bicipite/tricipite dà luogo ai movimenti di chiusura/apertura della mano, ed un maggior livello di contrazione in questi muscoli produce la flessione/estensione del gomito.

Nel secondo caso trattasi di un metodo di rivelamento del tasso di contrazione ove una leggera contrazione dei bicipiti/tricipiti produce la chiusura/apertura della mano, e la contrazione più rapida di tali muscoli dà luogo alla flessione/estensione del gomito. Entrambi i metodi sono stati collaudati sulla paziente in laboratorio appositamente allestito nonchè mediante un prova clinico tuttora in corso. Sono stati elaborati minicircuiti di controllo elettronici che sono stati collocati all'esterno della protesi la quale è completamente autonoma.

Dai diversi collaudi eseguiti il secondo metodo di comando sembra essere quello più indicato alla paziente in questione. Essa usa la propria protesi ogni giorno con continuo miglioramento della propria capacità di controllo.

Prosthetics and Orthotics International, 1981, 5, 112–115

Calendar of events

National Centre for Training and Education in Prosthetics and Orthotics

Short Term Courses 1980–81
Courses for Physicians and Surgeons

NC103 Introductory Biomechanics, Prosthetics and Orthotics; 26–30 October, 1981.
NC101 Lower Limb Prosthetics; 30 November–4 December, 1981.
NC102 Lower Limb Orthotics; 8–12 February, 1982.

Courses for Physicians, Surgeons and Therapists

NC501 Functional Electronic Peroneal Brace; 7–10 December, 1981.
NC502 Upper Limb Prosthetics; 1–5 March, 1982.

Courses for Prosthetists

NC211 Patellar-Tendon-Bearing Prosthetics; 12–23 October, 1981.
NC205 Above-Knee Prosthetics; 9–20 November, 1981.
NC210 Above-Knee Modular Prosthetics; 11–15 January, 1982.
NC208 Patellar-Tendon-Bearing Prosthetics—supracondylar suspension; 14–18 December, 1981.
NC212 Hip-Disarticulation Prosthetics; 15–26 February, 1982.

Courses for Orthotists

NC213 Ankle-Foot-Orthotics—Conventional and Plastic; 29 September–9 October, 1981.
NC203 Knee-Ankle-Foot and Hip-Knee-Ankle Foot Orthotics; 18–29 January, 1982.
NC206 Upper Limb Orthotics; 2–5 November, 1981.
NC207 Spinal Orthotics; 8–19 March, 1982.

Courses for Occupational and Physiotherapists

NC301 Lower Limb Orthotics; 23–27 November, 1981.
NC302 Lower Limb Prosthetics; 1–5 February, 1982.

Courses for Prosthetic and Orthotic Technicians

NC603 Modular Above-Knee and Hip-Disarticulation Prosthetic Construction; 22 March–2 April.

Further information may be obtained by contacting Professor J. Hughes, Director, National Centre for Training and Education in Prosthetics and Orthotics, University of Strathclyde, 73 Rottenrow East, Glasgow G4 0NG, Scotland. Telephone 041–552 4400, extension 3298.

Nuffield Orthopaedic Centre
Short Term Courses 1981–82

The Principals and Practice of Making Simple Orthoses (for physiotherapists only), 28–30 September, 1981.
Wheelchairs, 28–29 October, 1981.
Sexual Problems of the Physically Disabled, 8–9 March, 1982.

Information: The Secretary, Demonstration Centre, Mary Marlborough Lodge, Nuffield Orthopaedic Centre, Headington, Oxford OX3 7LD.

30 August–3 September, 1981
Rehabilitation Engineering Society of North America (RESNA), Annual Conference on Rehabilitation Engineering. Theme "Technology That Enables". To be held in Sheraton Washington Hotel, Washington D.C.
Information: Convention Management Consultants (CMC), 5401 Kirkman Road, Suite 550, Orlando, Florida 32805, U.S.A.

31 August–4 September, 1981
15th Congress of the International Society of Orthopaedic & Surgery & Traumatology (SICOT), Rio de Janeiro.
Information: Sec. Gen.: Dr. R. De Marneffe, SICOT, 4 rue des Champs Elysées, B-1050, Bruxelles, Belgique.

7–12 September, 1981
The Seventh International Symposium on External Control of Human Extremities.
Information: Yugoslav Committee for Electronics and Automation, P.O. Box 356 11001, Beograd, Yugoslavia.

9–11 September, 1981
1st Annual Advanced Course in Lower Limb Prosthetics, New York.
Information: Dr. L. W. Friedmann, Chairman, Department of Physical Medicine and Rehabilitation, Nassau County Medical Centre, 2201 Hempstead Turnpike, East Meadow, New York 11554, U.S.A.

9–11 September, 1981
Medizin-Technik 81. Congress on Medical Technology, University of Stuttgart, Germany.
Information: Tagungsgeschäftsstelle, Medizin-Technik 81, Universität Stuttgart, Postfach 560, D7000 Stuttgart 1, Germany.

11–15 September, 1981
Aids Exhibition: International Handicapfair and Conference on Technical Aids, Copenhagen, Denmark.
Information: Handicaparssek-re-tariat, Borgervanget 5, 2100 Copenhagen, Denmark.

14–19 September, 1981
Radar Exhibition of Aids at Wood St. Library, Walthamstow, London E17. Waltham Forest Association for the Disabled.

16–20 September, 1981
Mediterranean Conference on Medical and Biological Engineering Marseilles.
Information: Prof. G. Kapham, Faculté de Médecine (Nord) Boulevard P. Drummard, 13326, Marseilles, Cedex III, France.

19–23 September, 1981
American Society of Mechanical Engineers, Engineering in Medicine and Biology, Shamrock Hilton, Houston, Texas.
Information: ASME, 345 East 47th Street, New York, N.Y. 10017.

21–24 September, 1981
International Workshop on "Practical Aids for the Disabled and their Families," Norway.
Information: Norwegian Red Cross Fund, Raising Campaign 81, P.O. Box 5855, Hegdehaugen, Oslo 3, Norway.

21–25 September, 1981
Growing old—disaster or challenge? (geriatric care of disabled people). Castle Priory College, Thames Street, Wallingford, Oxon.

23–26 September, 1981
IV Mediterranean Symposium on Orthopaedic Techniques and Appliances, Monte Carlo.
Information: Mr. J. F. Desoeuvres, EXPAND-77, rue de Château, 92103 Boulogne Billancourt, France.

5–9 October, 1981
Technology for the handicapped child.
Information: Castle Priory College, Thames Street, Wallingford, Oxon.

10 October, 1981
Microcomputers for the handicapped child.
Information: Castle Priory College, Thames Street, Wallingford, Oxon.

Autumn, 1981
Amputation Surgery and Prosthetic Rehabilitation. American Academy of Orthopaedic Surgeons. Seattle, Washington.

5–10 October, 1981
Exhibition and conference covering topics relating to employment, health, mobility and education facilities both in schools and in further education.
Information: Accrington Town Hall, Blackburn, Lancs. Social Services Divisional Committee for I.Y.D.P.

15–17 October, 1981
International Seminar on Rehabilitation, co-sponsored by Japanese Ministries of Health, Welfare and Labor and Japanese Society for Rehabilitation of the Disabled, Tokyo, Japan.
Information: Japanese Society for Rehabilitation of the Disabled 13-15, 3-chome, Higashi, Ikebukuro, Toshima-ku, Tokyo, Japan.

16–18 October, 1981
"Fundamentals of Gait and Orthotics" at the Robert Jones and Agnes Hunt Orthopaedic Hospital, Oswestry.
Information: Mr. J. H. Patrick F.R.C.S., Orthotic Research & Locomotor Assessment Unit (O.R.L.A.U), The Robert Jones and Agnes Hunt Orthopaedic Hospital, Oswestry, Salop.

21–23 October, 1981
Naidex '81 "Apart or a part—the removal of barriers for disabled people." Nine different seminars held over 3 days by RADAR at the National Agricultural Centre, Kenilworth, Warwicks.
Information: Conference Officer, RADAR, 25 Mortimer Street, London W1N 8AB.

27 October–1 November, 1981
American Orthotic and Prosthetic (AOPA) Annual Assembly, at Sahara Hotel, Las Vegas, Nevada.
Information: The American Orthotic and Prosthetic Association, 717 Pendleton Street, Alexandria, VA 22314.

10 November, 1981
"Rights for disabled people and families." Conference at Friends House, Euston Road, London. Friendship Group of Charities.

10–13 November, 1981
"Amputee Rehabilitation for therapists" at Limb Fitting Centre, Manchester.
Information: Mrs. Hindley, Rehabilitation Unit, Withington Hospital, Manchester M20 8LB

13 November, 1981
"The Disabled—Who are they? Ceritas at work." Symposium on the Disabled. Imperial College, Exhibition Road, London SW7 (to be confirmed). The Royal College of General Practitioners.

15–20 November, 1981
International Symposium on Design for the Disabled, in co-operation with Israel Design Centre and International Council for Industrial Design. Tel Aviv, Israel.
Information: Israel Society for Rehabilitation of the Disabled, 10 Ibn Gvirol St., Tel Aviv, Israel.

1982
Eighth International Congress of the World Federation of Occupational Therapists.
Information: World Federation of Occupational Therapists. P.O. Box 26445, Arcadia, Pretoria, S.A.

21–23 January, 1982
Third Meeting European Society of Biomechanics, Nijmegen, Netherlands.
Information: Ton de Hange, Conference Secretary, c/o Miss Cora Rooker, Dept. of Orthopaedics, 6500 HB Nijmegen, The Netherlands.

18–24 April, 1982
Fourth World Congress of the International Rehabilitation Medicine Association, San Juan, Puerto Rico.
Information: Herman J. Flax, M.D., Chairman IRMA IV, P.O. Box 11696, Caparra Station, Puerto Rico 00922, U.S.A.

23–28 May, 1982
Ninth International Congress of the World Confederation for Physical Therapy on the theme "Man in Action" Stockholm, Sweden.
Information: L.S.R. Birgerjarlsgatan 13, III, 45 Stockholm, Sweden or the WCPT, 16/19 Eastcastle Street, London W1, England.

13–18 June, 1982
Eighth International Congress of the World Federation of Occupational Therapists on theme "Occupational Therapy and Rehabilitation: Help for the Handicapped", Hamburg, Federal Republic of Germany.

September, 1983
I.S.P.O. Fourth World Congress, London.
Information: Conference Services Ltd., 3 Bute Street, London.

ISPO Publications

The Deformed Foot and Orthopaedic Footwear
Edited by Bo Klasson. Co-editors, Alfred Forchheimer, John Hughes, George Murdoch.

This ISPO book is the report on an ISPO-workshop held at the Hässelby Castle, Stockholm, Sweden, in spring 1977. Orthopaedic surgeons, orthopaedic shoemakers, engineers, educators, administrators, etc. from different countries met and discussed specific and general problems.

The book contains reports from these discussions and the following papers (lead-papers or short reports):

Debrunner: Classification of foot deformities.
Krantz et al.: The need for orthopaedic footwear as related to sex and age.
Toft: Some facts about the rheumatoid foot.
Condie: Biomechanics of the normal and the pathological foot.
Kraus: Biomechanics of the normal and deformed foot.
Veres: Graphic analysis of forces acting upon a simplified model of the foot.
Debrunner: The surgical management of foot deformities.
Kraus: Classification and nomenclature of footwear.
Stoll: Aspects of classification of orthopaedic shoes.
Tjernström: Short statements from an evaluation of orthopaedic footwear supply in Norrköping.
Stoll: Footwear considerations in certain pathological conditions.
Berkemann: About shoes for arch supports.
Stoll: Construction of orthopaedic laced shoes.
Toornend: Wider possibilities of providing orthopaedic footwear.
Johansson: A short statement about the central manufacture of orthopaedic shoes at LIC.
Hägglund: Manufacturing of orthopaedic shoes at a larger orthopaedic shoemakers shop.
Friemel: Modern orthopaedic shoe techniques.
Lyquist: Orthopaedic footwear in Denmark.
Constantine: United Kingdom organization, service, distribution and legislation for orthopaedic footwear.
Mazoyer: Orthopaedic footwear in France.
Meyer: Orthopaedic shoemaker trade.
Veres: The training of prosthetics specializing in orthopaedic footwear in Norway.
Klasson: On the education of orthopaedic shoemakers in Sweden.

Finally there is a list of terms used in this profession. The book is written in English and German throughout.

The price is U.S.$18 ($15 for members of ISPO and IVO) including surface mailing.

Orders, which must be accompanied by the appropriate remittance (cheque or international bank draft), should be sent to:

ISPO,
Borgervaeget 5
Copenhagen 2000,
Denmark.

Directory of Films in Prosthetics and Orthotics
Compiled and Edited by Joan E. Edelstein and Ronald G. Donovan.

The Directory is published on behalf of ISPO by the National Centre for Training and Education in Prosthetics and Orthotics, University of Strathclyde, Glasgow.

It contains information on over two hundred 16mm films in prosthetics and orthotics, from a variety of sources, which are available for rent or purchase. The films are grouped under the following headings:

Gait	Prosthetics:
Orthotics:	Lower limb
Lower limb	Upper limb
Spinal	Psychology
Upper limb	Rehabilitation
Paediatrics	Surgery

All films are indexed alphabetically by title.

The entry for each film includes running time, year of production, description of content with, where appropriate reference to other relevant subject areas, and the source(s) from which the film may be obtained.

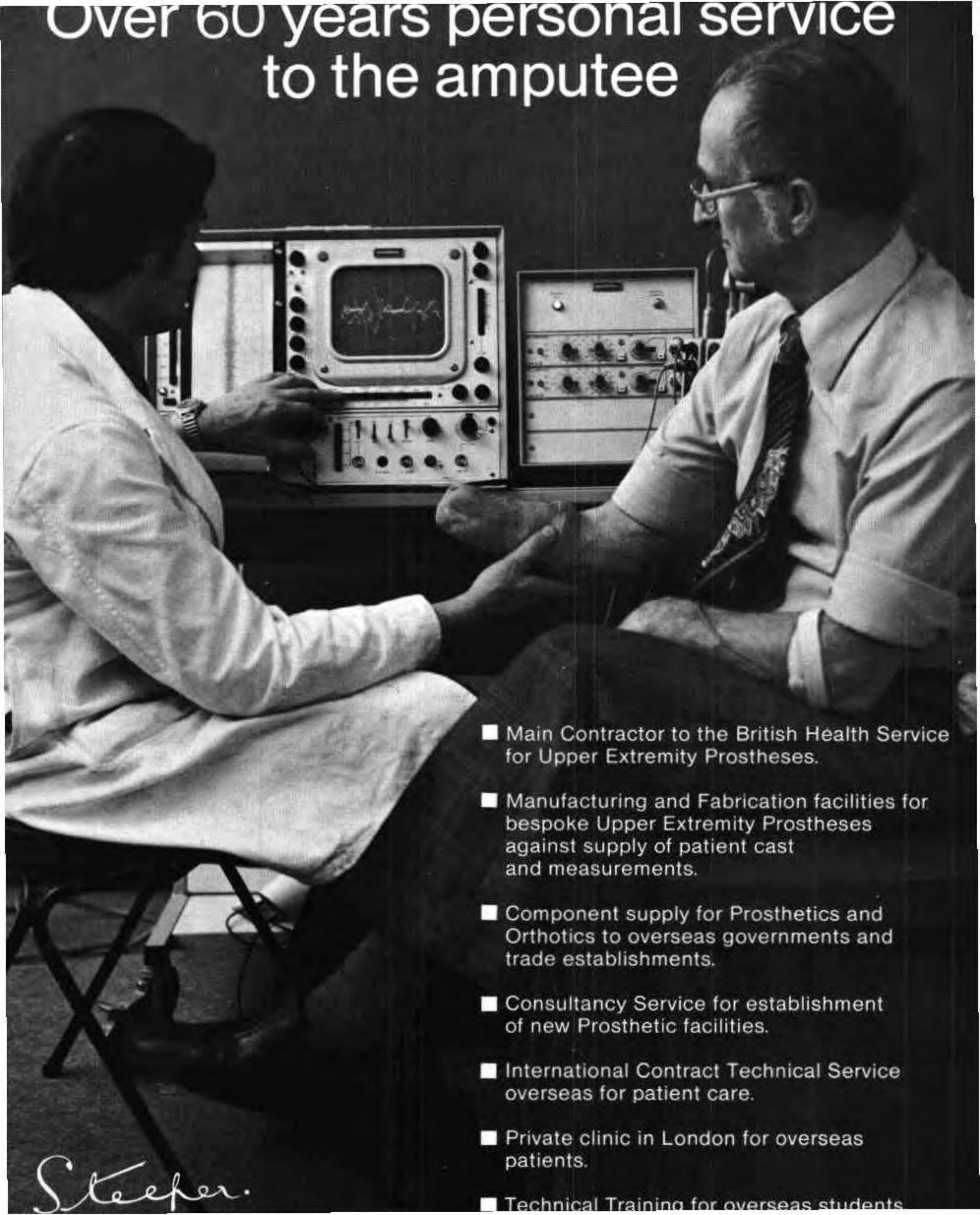
The cost of the Directory is U.S.$4 including surface mailing. Orders which must be accompanied by the appropriate remittance (cheque or international bank draft made out to ISPO) should be sent to:

Film Directory,
National Centre for Training and Education in Prosthetics and Orthotics,
University of Strathclyde,
73 Rottenrow East,
Glasgow G4 0NG,
Scotland.

ADVANCED COURSE ON BELOW-KNEE AND THROUGH-KNEE AMPUTATION AND PROSTHETICS

10th–13th May 1982
Copenhagen

Details in next issue



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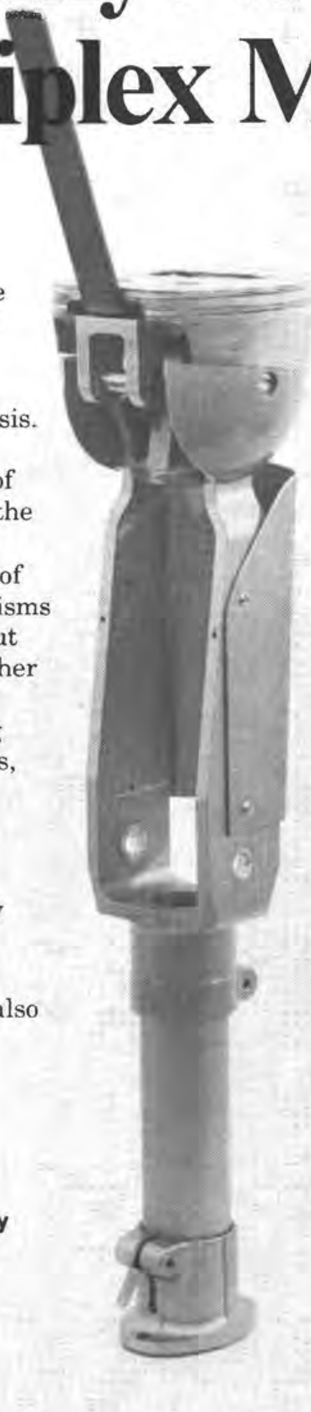

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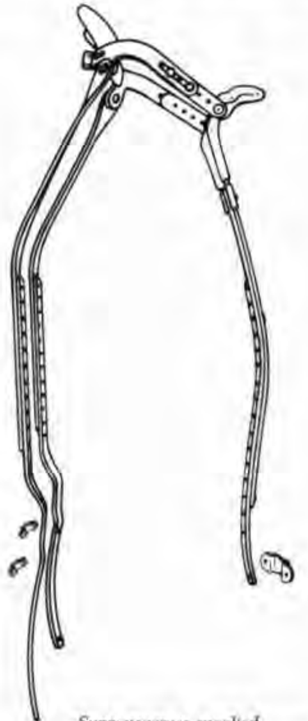

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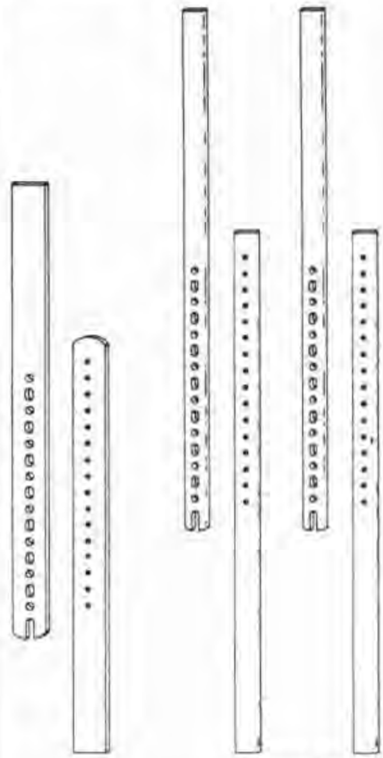

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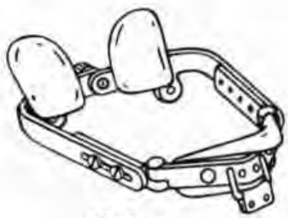

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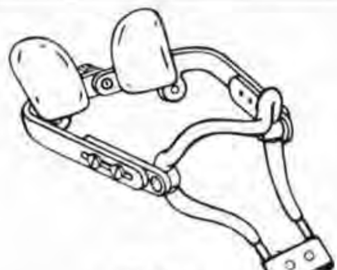

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(1) Title and short title. The short title should appear at the head of each page and should not exceed forty-five characters including spaces.
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Illustrations

All illustrative material should be lightly marked on the back in pencil with the figure number in arabic numerals, title of paper, authors' name and a clear indication of the top of the figure. The approximate location in the text should be marked. Figure captions should be typed on a separate sheet. Tables should be used only when necessary to clarify important points. Each table should be typed on a separate sheet and numbered consecutively in arabic numerals.

References

References in the text should follow the author/date system for example: Peizer (1971). If there are more than two authors—Solomonidis *et al.* (1974). References at the end of articles should be listed on a separate sheet in alphabetical order of (first) authors' name, as follows: Marx, H.W. (1974). Lower limb orthotic designs for the spastic hemiplegic patient. Orthotics and Prosthetics, 28(2), 14–20. Journal titles must be given in full.

References to articles in books should include author, year of publication, article title, book title edition, editor (if different from author) first and last pages, publisher and place of publication. For example, Hughes, J. (1975). Recent developments in prosthetics and orthotics. Recent Advances in Orthopaedics (2) Ed. McKibbin, B., 196–216, Churchill Livingstone, Edinburgh.

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Ten reprints will be supplied free of charge to the first named author. Additional reprints will be available at cost if they are ordered when the proofs are returned.