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Autumn 1966

Artificial Limbs

A Review of Current Developments

COMMITTEE ON PROSTHETICS RESEARCH AND DEVELOPMENT

COMMITTEE ON PROSTHETIC-ORTHOTIC EDUCATION

National Academy of Sciences
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CONTENTS

COMMITTEE ON PROSTHETICS RESEARCH AND DEVELOPMENT
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2101 Constitution Ave. Washington, D. C. 20418

Aging and Amputation

HAROLD W. GLATTLY, M.D.[1]

The loss of a part of a lower extremity due to peripheral vascular disease (PVD) incident to the effects of arteriosclerosis with or without the presence of diabetes is today the predominant type of amputation that is being performed in peacetime in the Western World; *i.e.*, the United States and Europe. These ischemic amputations begin to make their appearance in the late forties of life and their incidence increases rapidly in succeeding decades. Lower-extremity PVD cases constituted 85 per cent of all amputations performed at the Massachusetts General Hospital during the period 1962-1964 and the average age of these patients was 70 years.

This predominance of PVD lower-extremity cases in the field of amputation surgery is a development of quite recent origin. A survey of lower-extremity amputations by Doctor Jan Hansson in Sweden for the period 1947-1962 documents this fact. During this period, the incidence of lower-extremity amputations in individuals under 60 years of age remained constant at an annual rate of 4 to 5 per 100,000 population. In males over 60, the rate rose from 34 per 100,000 in 1947 to 129 in 1962. In females over 60 years of age, the amputation rate increased from 24 to 62 per 100,000 during this period. Doctor Hansson expressed the opinion that these rates would continue to rise over the coming years.

One cannot but surmise that these rapidly increasing rates of lower-extremity amputations in individuals over 60 years of age are but a reflection of the change in the character of our older aged population that has occurred over the past four decades as a result of the dramatic advances that have been made in the prevention, care, and management of disease. Before the advent of insulin, it is doubtful that many diabetics lived long enough to develop gangrene of a lower extremity. Countless numbers of people are now reaching the age of 65 or older with medical conditions which, forty years ago, would have been fatal at a much earlier age.

Ischemic amputations of the lower extremity formed an insignificant part of the workload of prosthetic facilities forty years ago. This is borne out by

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Doctor Hansson's Swedish study. In 1926, only 2 per cent of fitted lower-extremity cases were due to PVD amputations, whereas by 1955, they had increased to 57 per cent. Older prosthetists in the United States, whose professional experience dates back to the 1920's, have unanimously stated that this Swedish study accurately reflects their own experience in that forty years ago they rarely fitted a PVD amputee, whereas today these cases form the major part of their workload. The incidence of ischemic amputations was relatively low in 1926 and at that time the mortality rate for these operations was extremely high in view of the fact that no means were available to control infection. Furthermore, it appears that forty years ago very few of these cases were considered as candidates for prosthetic rehabilitation.

Potentially, the Medicare Act for the Aged which became effective in July 1966 can relieve a serious national inequity that in the past has involved the older aged amputees in this country. Over the years federal and state programs have been available to provide financial assistance for needy amputees from birth until they reached the 60 to 65 year age period. The Children's Bureau and the Vocational Rehabilitation Administration of the Department of Health, Education, and Welfare have conducted these assistance programs through their support of corresponding state agencies. Until the Medicare Act, amputees and other handicapped individuals over 65 years of age who needed assistance, except for beneficiaries of the Veterans Administration, have been dependent upon local welfare programs that varied widely in their character throughout the country. The 1964 annual VRA report revealed that only 1.7 per cent of their rehabilitated cases for that year were over 65 years of age. Yet this older aged segment of our population is characterized by multiple disabilities and, as a group, does not have the financial resources to take advantage of the rehabilitation opportunities that are available in most sections of this country. A bulletin of the National Health Survey of the Public Health Service, Series 10, Number 32, reports that 50 per cent of citizens 65 years or older have incomes of less than $3,000 per year and that 50 per cent have disabilities that limit materially their daily activities.

Table 1 compares, in terms of their ages, a study of 12,000 new, fitted amputees that were collected during the two-year period 1961-1963 in the United States with all new cases that were furnished prostheses in Great Britain in 1962. No unfitted or old amputee cases provided with a new replacement device are included in these two groups of amputees.

TABLE 1

Percentage of Total Cases by Age	Great Britain 1962, 3,216 Cases	United States 1961–1963, 12,000 Cases
Over 60 years	57.6 per cent	37.0 per cent
Over 65 years	—	27.0 per cent
Over 70 years	32.5 per cent	13.0 per cent

The basis for this wide disparity between Great Britain and the United States with respect to the fitting of older aged amputees is economic. Any amputee in Great Britain, regardless of his age, can receive a prosthesis at government expense if he demonstrates that he has some useful prosthetic rehabilitation potential.

Table 2 presents the sources of payment for prostheses of the 12,000 new, fitted cases cited in Table 1 above. Cases assisted by welfare agencies are almost exclusively geriatric since the state programs subsidized by the Children's Bureau and VRA are available to younger amputees.

TABLE 2. SOURCE OF PAYMENT FOR PROSTHESES
(12,000 New Cases—1961–1963)

Source of Payment	Percentage
Amputee or His Family	34.5
State Bureau of Vocational Rehabilitation	26.5
Welfare Agency	12.7
Veterans Administration	12.7
Insurance Companies	9.0
State Crippled Children's Services	4.6

The data presented in Table 2 apply to the United States as a whole and vary widely between individual states. This is illustrated by Table 3 that compares the percentage of new, fitted cases over 65 years of age in two states

TABLE 3

State	Percentage of New Fitted Cases Over 65 Years	Percentage of Prostheses Paid for by Amputee	Percentage of Prostheses Paid for by Welfare
A	43.7	30	27
B	6.0	14	2
(National Average, Table 1, above)	27.0	34	12.7

that have, roughly, the same numerical population. The relatively higher economic status of state A and its well-developed welfare programs, as compared with state B, form the basis for the very wide disparity in the fitting of older aged amputees in these two states. The Medicare Act is now available to provide the geriatric amputees in state B with the prosthetic rehabilitation services that have been denied them in the past.

Individuals with peripheral vascular disease of their lower extremities of a severity requiring amputation have, as a group, multiple disabilities that can abridge and even reduce to zero their prosthetic rehabilitation potential. The prosthetic evaluation of these cases, therefore, is critical. They have widely varying rehabilitation goals. Recent studies of these geriatric amputees indicate that, under present management concepts, only about 30 per cent will ever be able to obtain any use of their prostheses. This percentage could be significantly increased if the surgical community would adopt a conservative philosophy in its management of PVD amputations with respect to the original level of amputation and the indications for reamputation in cases of delayed wound healing.

The study of PVD amputations at the Massachusetts General Hospital, referred to above, documents the fact that the preservation of the knee joint is all important in determining the rehabilitation potentials of these cases. Percentage-wise, twice as many below-knee cases will be able to use effectively a replacement device as those with above-knee amputations. That there are today widely divergent views concerning the level of amputation in PVD cases is indicated by the fact that, in one large metropolitan area, two-thirds of these cases were amputated above the knee and, in another large city, two-thirds were amputated below the knee. A study of all ischemic amputations performed in 1964 at 14 Veterans Administration hospitals reveals this same disparity in surgical philosophy as regards the level of amputation. The two extremes among these hospitals is shown in Table 4.

TABLE 4

Level of Amputation	Hospital A	Hospital B
Transmetatarsal	0	4
Below Knee	0	11
Above Knee	48	3

The study of 12,000 new, fitted cases cited earlier reveals that the reamputation rate in successfully fitted, below-knee cases is almost zero. The reamputation of a BK is nearly always due to wound complications at the time of amputation. Pedersen and others have shown that a high percentage of these cases of delayed wound healing following amputation below the knee will successfully respond to conservative management and, because of the preservation of the knee joint, will become effective users of prostheses.

The percentage of geriatric amputees that can achieve some useful degree of prosthetic rehabilitation would be increased by early fitting and ambulation. There is today an undue time lag between amputation and the fitting of these cases. A recent spot check revealed that this interval averages seven and one-half months. During this period, many of these older amputees will have developed contractures that may preclude prosthetic restoration, or they may become wedded to a wheelchair existence.

It is hoped that orthopedic surgeons who are knowledgeable in the field of amputee rehabilitation will endeavor to inform the general surgeons in their respective communities with regard to modern concepts in the care and management of this form of disability.

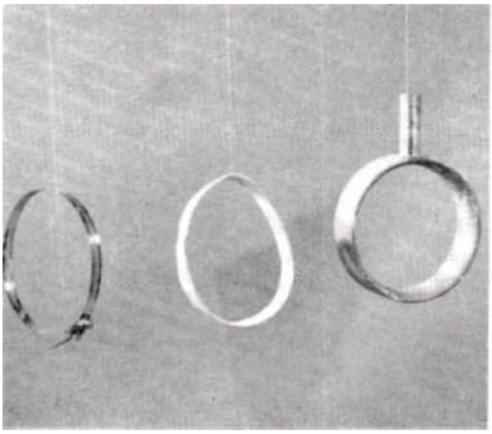
Suspension Casting for Below-Knee, Above-Knee, and Syme's Amputations

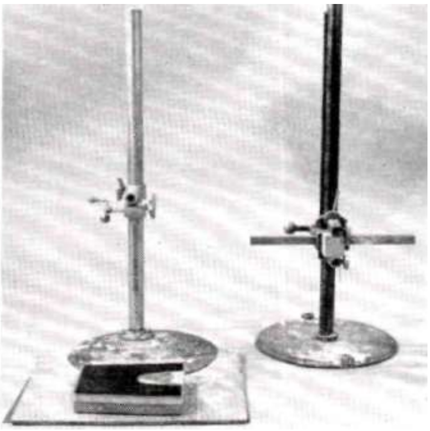
Fred Hampton, C.P.[1]

The suspension casting technique permits the casting of an amputee's lower-extremity stump while it is being held in an attitude simulating stance-phase weight-bearing in a prosthesis. This is accomplished through application of the principle of the Chinese finger trap; namely, when a cloth cylinder of suitable weave is stretched longitudinally, the circumference of the cylinder is decreased.

SUSPENSION CASTING OF THE BELOW-KNEE STUMP

In casting below-knee stumps, a cast sock clamped in a ring is the cloth cylinder. As the amputee bears weight on the suspended sock, the sock stretches longitudinally and constricts circumferentially, thereby firming the tissues of the stump during the application of the plaster wrap. The amputee is properly oriented in an upright position for casting and for producing accurate alignment lines on the cast. The tissues are firmly contained, edema is restricted, and bony prominences are emphasized. Distal redundancy is held firmly in the correct position by the suspension sock. While the stump is suspended, areas requiring relief can be definitively outlined and, if necessary, build-ups of appropriate thickness can be applied to the suspension sock prior to wrapping.





Equipment required includes:

1. A ring, approximately 6 1/2-in. inside diameter.
2. A rubber gasket.
3. A hose clamp.
4. A VA or a Berkeley casting stand with vertical adjustment.
5. Bathroom scale and platform.

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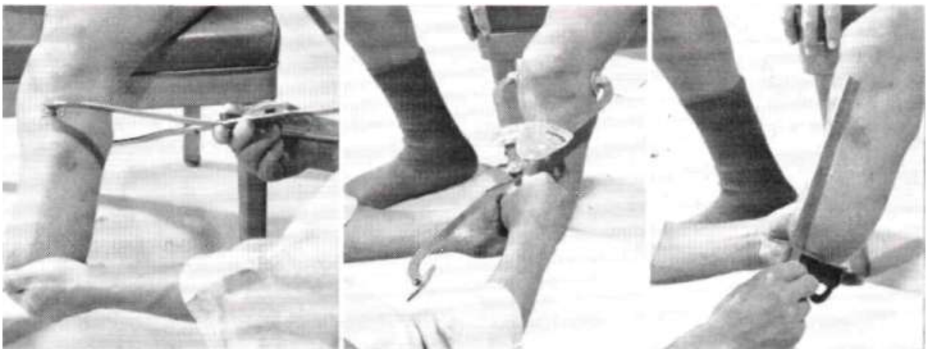
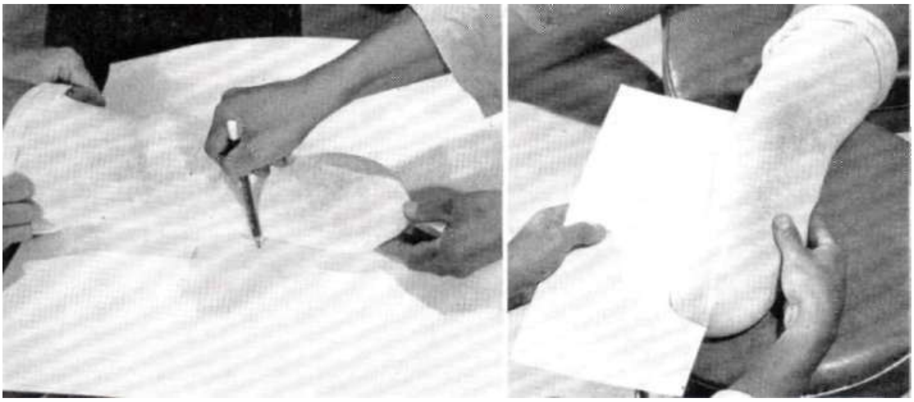
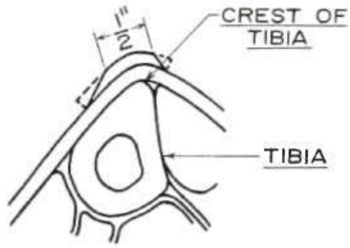


Data to be obtained and recorded are:

1. The length of the normal leg from the medial tibial plateau to the floor, with the shoe off.
2. The shoe size.
3. The anteroposterior dimension of the stump, measured with a VA caliper while the stump is fully relaxed and supported by the prosthetist.
4. The mediolateral dimension of the stump just proximal to the tibial plateau, measured with a VA caliper.
5. The length of the stump, measured from the end of the stump to the level of the midpatellar tendon. A small square is used to obtain this measurement; the blade of the square should contact the crest of the tibia.



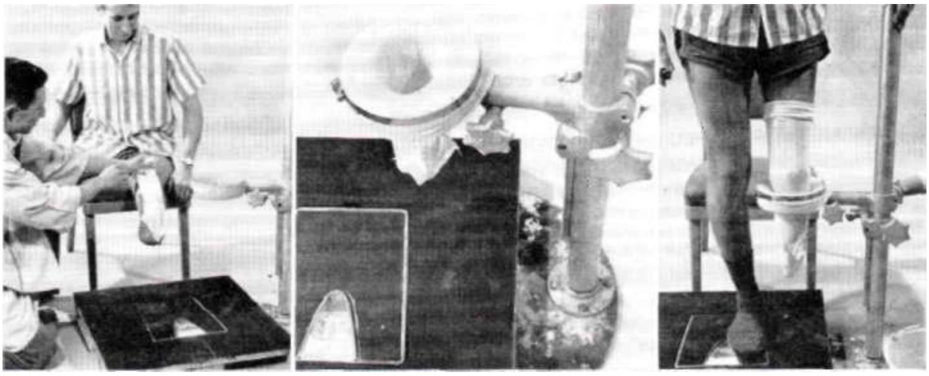
PREPARATION OF MEDIAL TEMPLATE. Because the medial flare of the tibial condyle is a particularly good weight-bearing area, it is desirable to construct a medium-weight cardboard template of the medial aspect of the stump for use as a guide in checking and maintaining the contours of the positive model in this important area. A cast sock is pulled over the stump and held with moderate tension by the amputee. To prevent bulging of the gastrocnemius during the tracing, the weight of the stump is supported by the prosthetist. The pencil is held vertically and slight pressure is exerted against the stump as the outline is drawn. The outline should extend from the proximal border of the femoral condyle to the midline of the distal aspect of the stump. After the medial tibial plateau is marked on the outline as an important landmark, the template is cut out and checked against the stump.



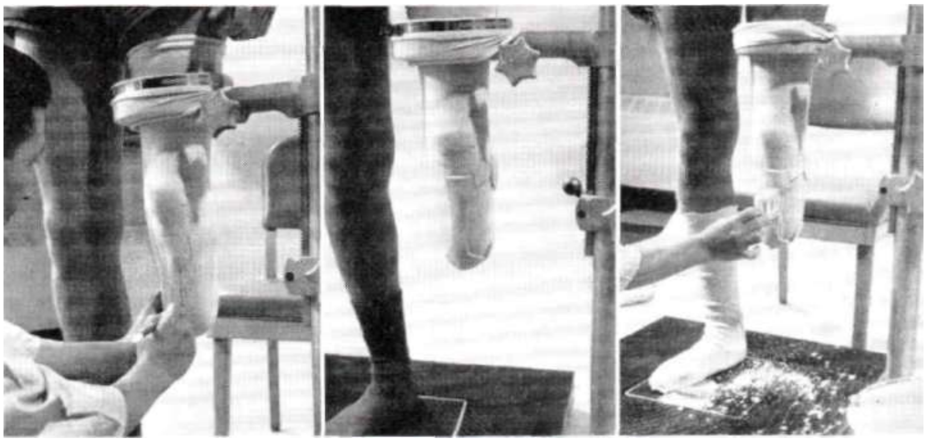
PREPARATION or RELIEF PATCHES. Relief patches should be prepared prior to suspension of the amputee in the ring. Various materials may be used for the patches, such as 1/8-in. Kemblo rubber, 1/8-in. adhesive-backed felt, or any foam material 1/8-in. thick and of sufficient density for dimensional stability. Areas usually requiring relief are the tibial tubercle, the tibial crest, the distal end of the tibia, the leading edge of the lateral tibial condyle, and the head and distal end of the fibula.

The patch for the head of the fibula should extend at least 1/4 in. beyond the bone area. If the head of the fibula is prominent, a double patch is sometimes indicated.

The patch for the tibial crest should be 1-in. wide. This will allow 1/4 in. of plaster on each side for blending the edges of the positive stump model. The actual relief remaining is 1/2-in. wide, sufficient to cover the lateral edge of the tibial crest and blend into the medial tibial surface.



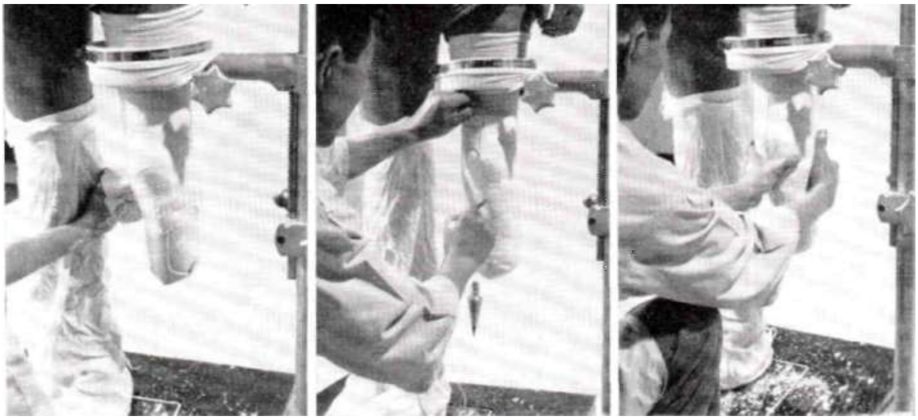
SIZING THE CAST. The dimensions of the negative cast produced are dependent upon the stump, the number and weight of the socks used, and the tension with which the plaster bandages are applied. One heavy cast sock is used to accommodate the fit of a stump wearing a three-ply wool sock in a hard socket. For a mature stump, two heavy cotton cast socks are used to accommodate a five-ply wool-sock fit in a hard socket. For a socket incorporating an insert, one light-weight cotton cast sock is used. Both socks and relief patches are removed from the negative cast before the plaster is poured to form the positive stump model.



ASSEMBLY OF EQUIPMENT AND SUSPENSION OF AMPUTEE. Preparatory to taking the negative cast of the stump, the distance from the end of the stump to a point 4 in. above the proximal edge of the patella is marked on a heavy cast sock, the ring is mounted horizontally on the vertical stand, and the cast sock is centered in the ring with the mark showing. The gasket is then applied over the sock and secured with the hose clamp.

Next, the ring is lowered on the easting stand to facilitate entry of the stump into the sock. Then the ring is raised until one-half of the body weight is borne by the stump sock, as indicated by the scale. Under these conditions, the suspension sock should contain the thigh to a point 3 in. above the superior border of the patella. The height of the ring should be adjusted until the amputated side is slightly high, so that further stretching of the suspension sock will be accommodated during the wrapping process.

The amputee should be positioned so as to obtain a correct base of support and so that his thigh is vertically centered in the ring. The knee should be flexed so that the stump is approximately 12 deg. from the vertical, measured along the crest of the tibia. Excessive flexion will result in loss of support or cause bridging of the sock along the posterior aspect of the stump. The stump is palpated, and areas requiring relief are outlined. The relief patches are glued to the appropriate areas. and the flexion angle of the knee is checked.



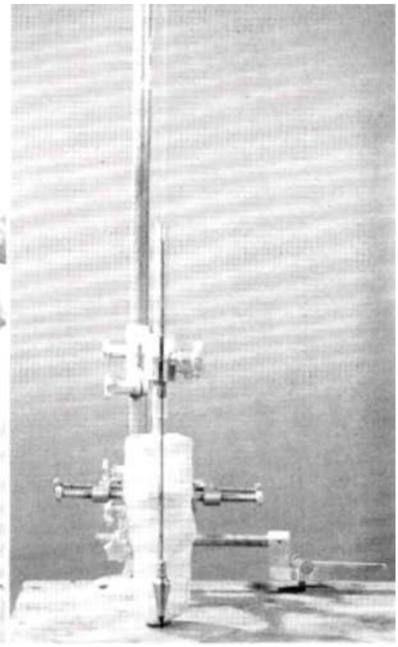
WRAPPING THE STUMP. Starting from a level just proximal to the top edge of the patella, four wraps of 4-in. plaster bandage are firmly applied. As noted previously, the medial flare of the tibial condyle is a good weight-bearing area. For emphasis, the plaster bandage is applied with firm tension diagonally upward in this area. The plaster bandage is then spiraled downward until the remainder of the stump is completely covered.

Before the plaster begins to set, it is worked by hand to ensure an intimate contact between the wrap and the stump, to emphasize bony areas including the patella, to enhance the texture of the plaster, and to assist in obtaining a smooth inner surface in the cast.

Several techniques and devices may be used when casting a below-knee stump to locate and define the patellar tendon and the support area posteriorly. Later in this article some of the variations will be presented.

When the suspension casting technique was used initially, no attempt was made to deform the cast permanently at the patellar tendon or in the popliteal area. The patellar tendon was defined by a light massaging action on the cast, using the web of the hand between the thumb and index finger, and by applying a light counter-pressure posteriorly with the other hand. The hands were removed after the contouring, and the plaster was allowed to set. This method kept distortion of the tissues to a minimum and preserved the contours of the medial flare of the tibia.

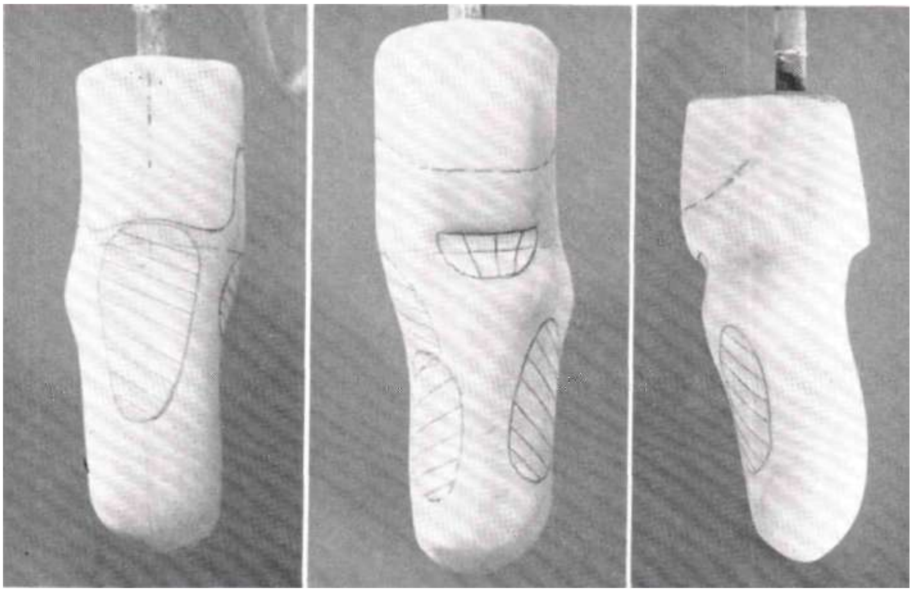
This technique has been modified to the extent that the hands are held in such a manner as to deform the cast permanently, producing a patellar-tendon bar anteriorly and a flattening of the popliteal area posteriorly. Any distortion of the contours of the medial flare of the tibia is corrected later by use of the template (previously discussed) when modifying the positive model of the stump.

ALIGNMENT LINES. After the plaster has set, two vertical alignment lines are scribed on the cast with the use of a plumb bob while the amputee is standing in a position simulating stance phase in a prosthesis. Half of his weight should be borne on the amputated side. The pelvis should be level and at right angles to the line of progression. One line, scribed on the anterior aspect of the cast, will be used as a reference for the correct adduction or abduction angle of the socket during bench alignment. The other line, scribed on the lateral aspect of the cast, will serve as a reference for the flexion angle of the socket.

In order to remove the cast, the hose clamp is released to allow rotation of the ring in the stand. After the ring has been lowered sufficiently to permit the amputee to sit down, the hose clamp, gasket, and ring are removed. Care must be taken to avoid distortion of the cast during its removal.

Before plaster is poured to form the positive model of the stump, the cast socks and relief patches are removed from the negative cast, and the cast is oriented with the reference lines vertical. Orientation can be accomplished by setting the distal end of the cast in plaster and using a square to obtain the correct alignment. A Milmo vertical transfer jig is a useful device for this procedure and also provides a means for holding the pipe vertically in the cast until the plaster hardens.



MODIFICATION OF THE POSITIVE MODEL. Modifications of the plaster model of the stump are made in accordance with the principles developed at the University of California Biomechanics Laboratory, Berkeley and San Francisco *(5)*.

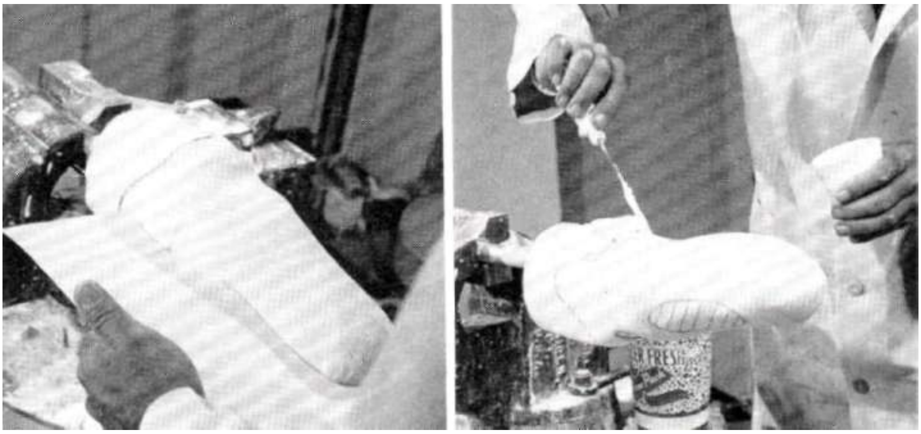
An essential prerequisite to the modification of the plaster model is a complete examination and evaluation of the stump by the prosthetist. Variations in modification will necessarily be based upon this evaluation.

An outline of the socket is drawn on the plaster model of the stump. This outline extends from the midpatellar level anteriorly to 2 1/2 in. to 3 in. above the midpatellar tendon level on the medial and lateral aspects of the model, down to a point 1/2 in. above the midpatellar-tendon level on the posterior aspect of the model.

The anteroposterior dimension of the positive model will be determined by the type of socket to be fabricated. For a socket with a soft insert, the anteroposterior dimension of the model should be modified to that of the stump. For a hard socket, the anteroposterior dimension of the model should be 1/4 in. greater than the measured anteroposterior dimension of the stump; for example, if the anteroposterior dimension of the stump is 3 in., the anteroposterior dimension of the model should be 3 1/4 in.

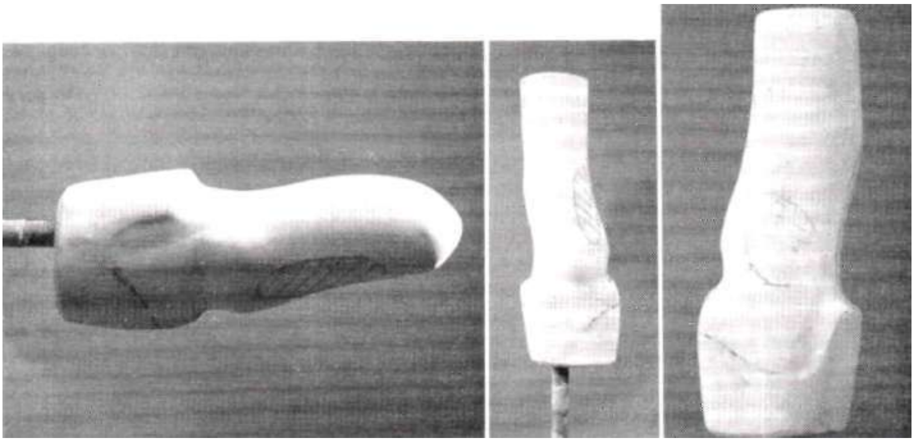
The following example is offered for guidance in determining the amount of plaster to be removed from the patellar-tendon area of the stump model as opposed to the amount to be removed from the popliteal area. Assuming that the anteroposterior dimension of the stump is 3 in. (to which 1/4 in. must be added for a hard socket) and that the anteroposterior dimension of the slump model is 4 in., it follows that 3/4 in. of plaster should be removed (that is, 4 in. less 3 1/4 in. equals 3/4 in.). Two-thirds of this amount, or 1/2 in., is removed from the patellar-tendon area (that is, 2/3 of 3/4 in. equals 1/2 in.). The remainder, or 1/4 in., is removed from the popliteal area (that is, 3/4 in. less 1/2 in. equals 1/4 in.).

To prevent restriction of circulation in the stump, the plaster is removed posteriorly to produce a flattened surface rather than a bulge. The deepest removal of plaster is opposite from and just distal to the midpatellar-tendon level—thus creating the start of a radius proximally—and is continued downward to blend in toward the distal aspect of the stump model.



MODIFICATION or THE POSITIVE MODEL. Starting approximately 1/4 in. from the edge, plaster is removed from the reliefs to blend the edges into the contours of the stump model. Plaster is removed from the area of the medial shaft of the tibia to within 1 in. of the end. The angulation of the shaft must be maintained. The amount of plaster removed is dependent upon the amount of tissue covering the shaft. Approximately 1/8 in. to 1/4 in. of plaster is removed from the anterolateral aspect of the model, starting at the distal border of the relief for the leading edge of the flare of the lateral tibial condyle and continuing to within 1 in. of the end of the tibia. The template made from the stump is used as a guide in modifying the flare of the tibial condyle. The mediolateral dimension of the model should be reduced to within 1/8 in. to 3/16 in. of the measured mediolateral dimension of the stump. Usually, smoothing this area of the model with wire screening is all that is necessary.

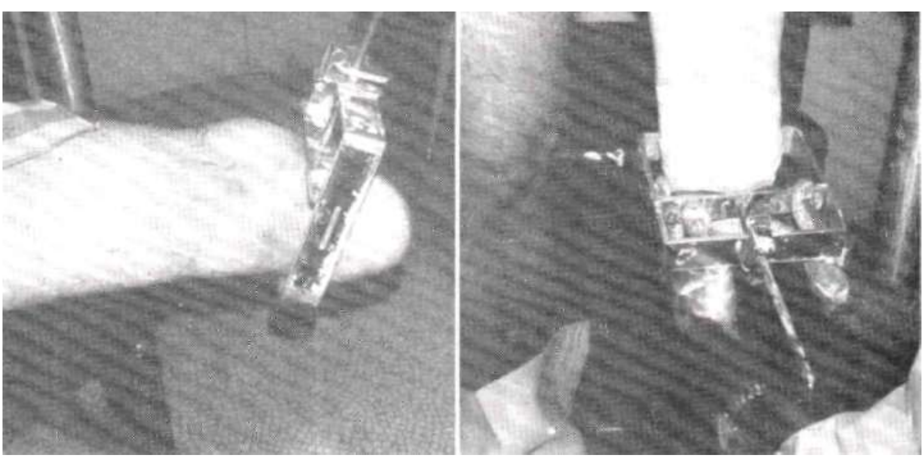
If warranted, 1/8 in. of plaster may be added to the relief of the anterodistal aspect of the tibia. The patella is smoothed by a wash of plaster rather than removal of plaster. Along the previously drawn posterior trim line of the socket, a build-up of plaster is applied to a height, of about 3/4 in. The build-up should be given a generous flare, and the distal border of the liare should be blended into the contours of the model, especially in the area of the hamstrings. Plaster should be added to eliminate any groove between the junction of the posterior plaster build-up and the medial or lateral side of the model. A piece of plastic screen or line sandpaper should be used to smooth the entire surface of the model.



BUILD-UP FOR RTV PAD. When a Silastic RTV pad is to be used in the socket of the finished prosthesis, an additional plaster build-up about 3/4 in. high is formed on the distal aspect of the model. A piece of cardboard is applied to the cast to serve as a form for the plaster to be added. The form is sloped away from the distal anterior aspect of the tibia to provide any additional relief required. If the pipe is held vertically when the plaster is poured, a flat distal surface incorporating the correct angular alignment will result. All edges should be feathered into the contours of the model, especially in the tibial area.

VARIATIONS IN SUSPENSION CASTING OF THE BELOW-KNEE STUMP

Since the introduction of the suspension casting concept, many variations have evolved in its use. These variations are mainly in the wrapping, the forming of the patellar-tendon bar, the modification of the wrap cast, and the modification of the positive model of the stump.

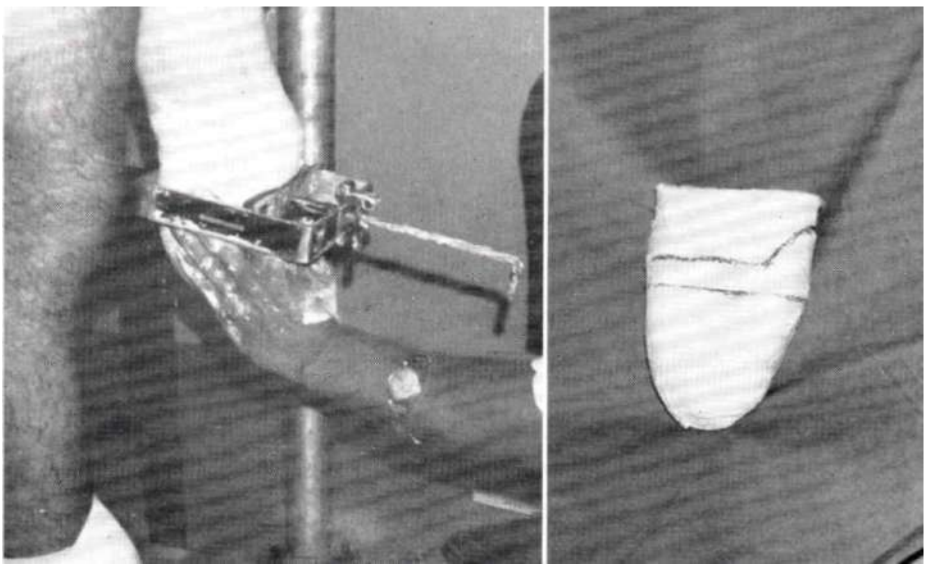


CALDWELL PROCEDURE. In the procedure followed by Mr. Jack L. Caldwell,[2] gypsona plaster bandage is used in place of standard plaster bandage, a clamp (the Caldwell

[2] Manager, J. E. Hanger, Inc., of Florida, 938 South Orange Ave., Orlando, Fla. 32806.

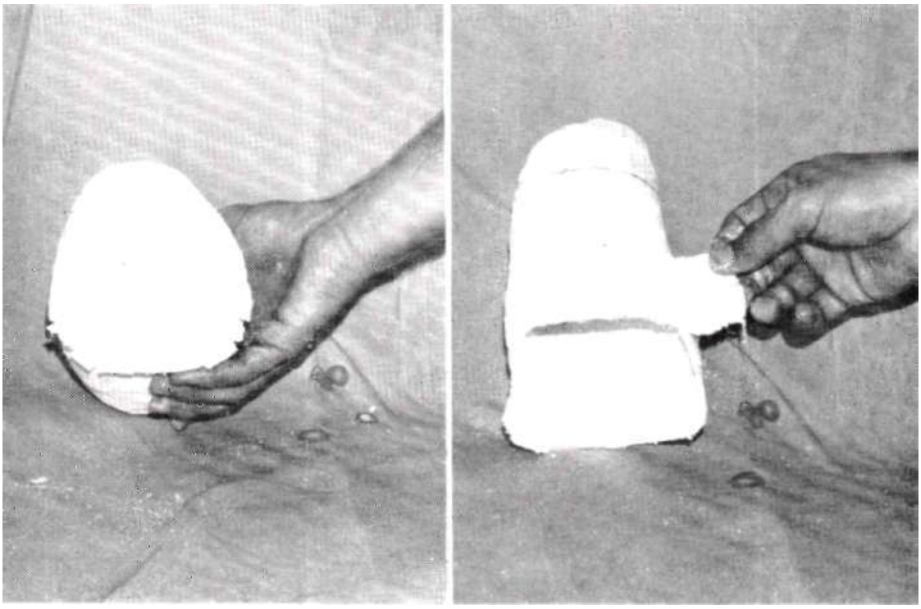
clamp) is used to measure the anteroposterior dimension of the stump and to contour the patellar-tendon bar and the popliteal area into the wrap cast, one heavy-cast sock is used during the wrapping procedure, the flare for the posterior proximal edge of the socket is formed in the wrap cast prior to pouring the plaster to form the positive model of the stump, and the distal portion of the stump is wrapped first for contouring purposes.

In the Caldwell procedure, measurements are taken and recorded on a measurement chart before casting is begun. The patellar-tendon bar of the Caldwell clamp is pressed gently against the amputee's patellar tendon, and the reading made on the clamp scale is recorded. After the stump has been wrapped, the dimension should be approximately 1/8 in. greater than the measurement made on bare skin. Before the contouring clamp is applied to the gypsona-wrapped stump, the popliteal pad and the patellar-tendon bar should be greased with vaseline, since gypsona has an adhesive property not present in the ordinary plaster of Paris or elastic plaster.

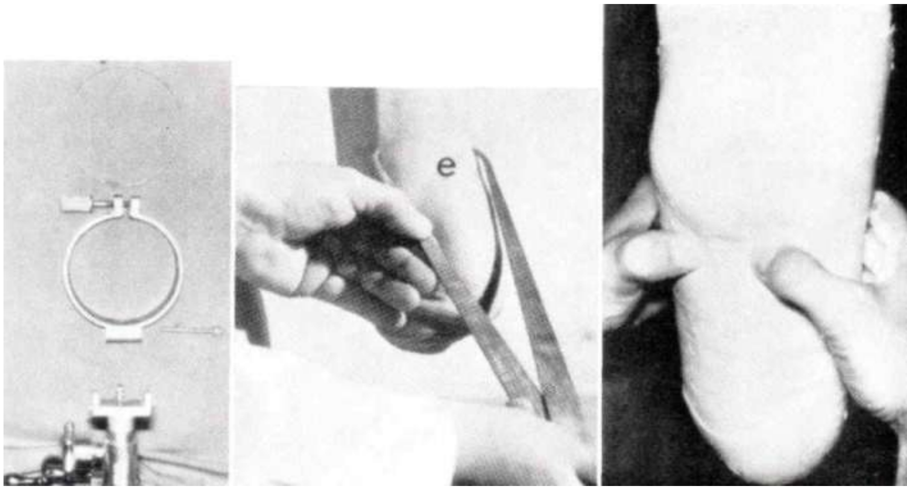


CALDWELL PROCEDURE. As soon as the wrap is completed, the clamp should be slipped onto the amputee's stump and the popliteal pad pressed into the proper area gently and correctly. With the contouring clamp in place, the wet plaster is worked into the medial tibial condylar shelf.

A line is drawn circumscribing the wrap cast at the midpatellar-tendon level, also the socket trim line.



CALDWELL PROCEDURE. After the cast has been trimmed along the proximal trim line, several longitudinal cuts about 1/2 in. in length are made downward from the trim line in the area above the popliteal fossa. The cut area is reinforced with small strips of wet gypsona plaster. The use of warm water will reduce the time required to handle the plaster. The inside of the cast where the cuts were made is smoothed with a paste of warm water and plaster-of-Paris powder.



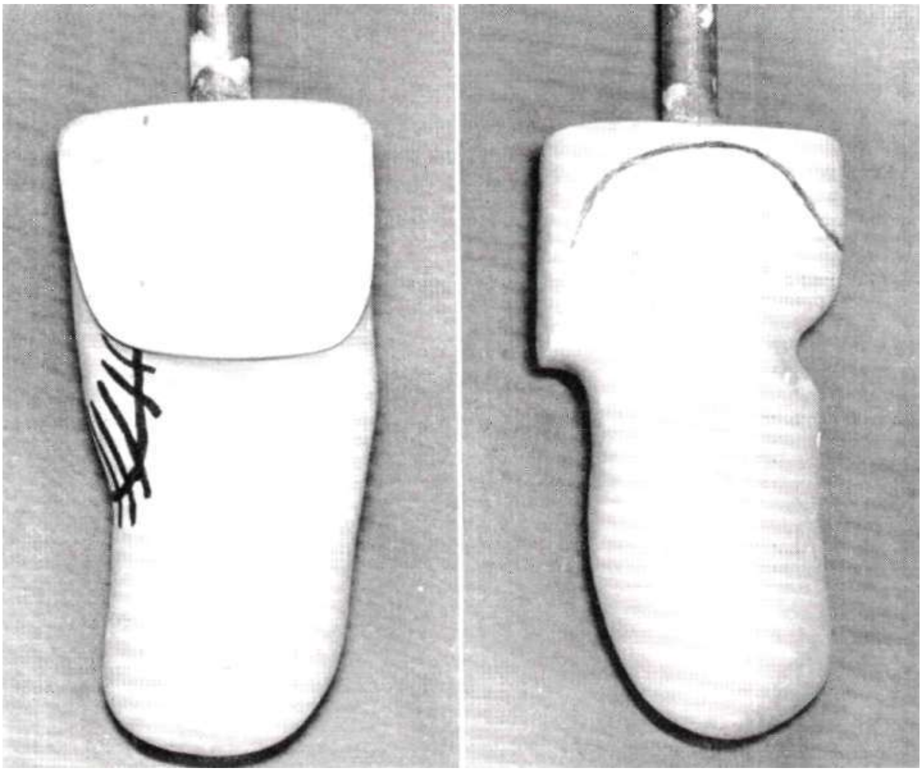
FOORT PROCEDURE. In a procedure developed by Mr. James Foort,[3] one heavy cast sock is used routinely, no relief patches are applied to the suspension sock prior to wrapping, plaster is used to provide reliefs during modification of the positive model of the stump, the distance between the hamstrings is measured and used as a control for the posterior outline of the socket, the modification of the positive model under the flare of the medial tibial condyle is extended posteriorly to include the hamstring tendons, and the position of the posterior flare on the plaster model of the stump is located at the midpatellar-tendon level.

A fixed ring holds the casting sock at the top, a clamp ring binds the sock against the fixed ring, a clamping screw is used to force the clamp ring out against the fixed ring, and a pin connects the ring assembly to the UCB stand.

The distance between the outer edges of the tensed hamstring tendons is measured and recorded.

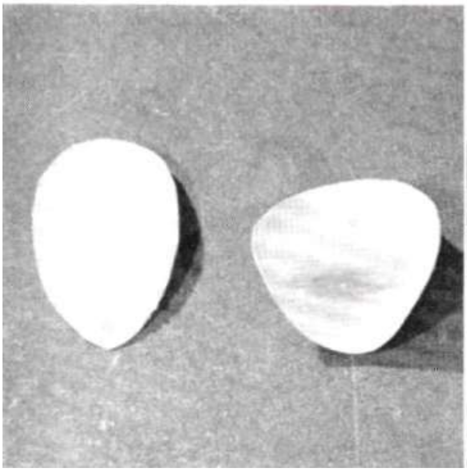
After the plaster wrap has been applied to the stump, the patellar tendon is defined by pressing the thumb tips on either side of it. At the same time, light counterpressure is exerted with the fingers across the back of the stump. This procedure is similar to the technique described in *The Patellar-Tendon-Bearing Prosthesis* (5) and subsequently modified as reported in *Air-Cushion Socket for Patellar-Tendon-Bearing Below-Knee Prosthesis (4).*

[3] Technical Director, Prosthetics-Orthotics Research and Development Unit, Manitoba Rehabilitation Hospital, 800 Sherbrook St., Winnipeg 2, Man.

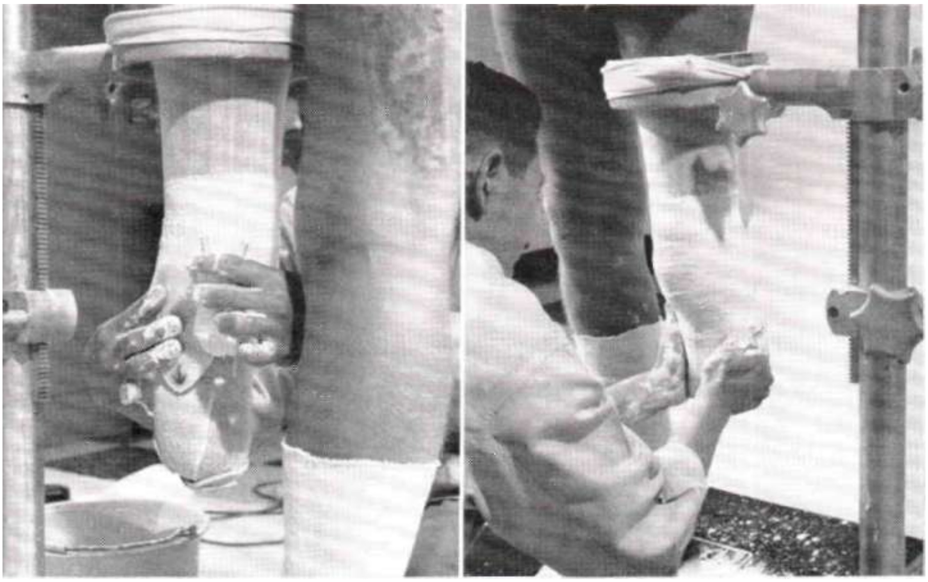


FOORT PROCEDURE. When the plaster stump model has been cast, plaster is removed from the sloping surface of the medial flare with a curved 1 1/2-in. rasp. The purpose here is to prepare the surfaces for supporting weight. Coupled with pressures from lateral surfaces, the medial flare helps to stabilize the stump mediolaterally in the socket. But very little adjustment of this surface is required. A 1/4-in. adjustment at the deepest part of the shelf, tapering off to nothing along the vertical portions, would be the greatest amount removed. If the model is of a seasoned stump, it is sufficient merely to work this area smooth with wire screening. The screening should be swept around the natural contours of the flare, into the posterior area, and over the hamstring tendons.

Plaster is added to the stump model in bony areas to provide relief. In addition, a posterior flare is constructed on the model by means of a plaster build-up. This is done by pouring plaster over the posterior surface above the circumscribed mid-patellar-level line until the addition is 1-in. thick. The plaster is spread with a wet spatula, and the flare is formed with wet fingers and thumb. The back flare is not grooved for the hamstring tendons. Instead, a broad surface is provided against which the tendons can rest when the amputee is seated. The build-up for the posterior flare should be trimmed to about 3/4 in. with a flat rasp *(2)*.

VARIATION USED AT NUPRC. Another slightly different procedure sometimes used at the Northwestern University Prosthetics Research Center incorporates a patellar-tendon pad and a popliteal pad into the wrap during suspension casting. The pads used were developed at the Veterans Administration Prosthetics Center in conjunction with a pneumatic casting svstem. These pads define the patellar-tendon bar and the popliteal depression, and their use results in a positive stump model with an anteroposterior dimension that is within 1/16 in. of the measured anteroposterior dimension of the stump.



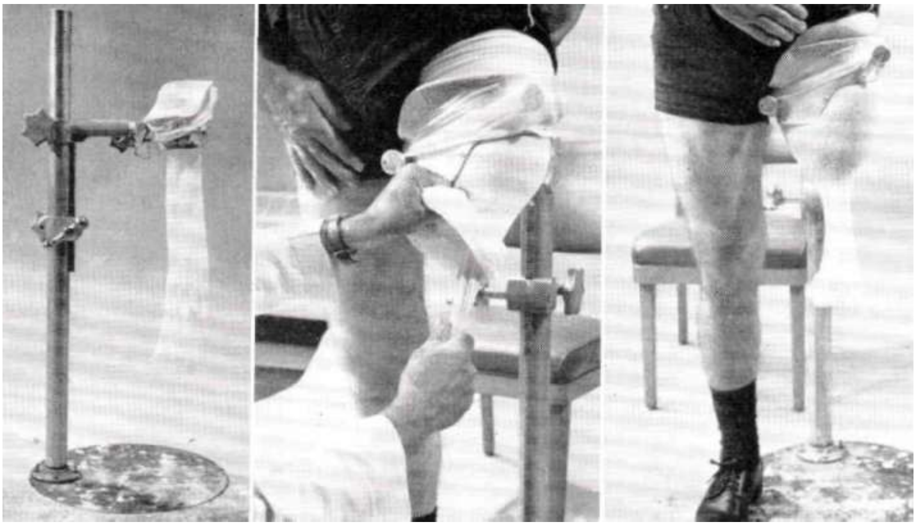
VARIATION USED AT NUPRC. Two wraps of standard plaster bandage are applied to the proximal aspect of the stump, covering the patellar-tendon area. The protuberance of the pad is positioned over the patellar tendon and covered with two additional wraps of bandage applied with firm tension to hold the pad in place.

The popliteal area is then covered with two wraps of plaster bandage, and the pad is placed so that its top edge is approximately 1/2 in. above the top of the proximal border of the head of the fibula. The lateral edge of the pad should be placed 1/2 in. medial to the medial border of the head of the fibula. The pad is covered with two additional wraps of plaster bandage, and firm tension is applied during the wrapping. The wrap is then spiraled down to include the rest of the stump, and the plaster is worked by hand to emphasize bony areas.

If the resulting stump model has a depression in the popliteal area, some plaster is removed from the medial and lateral border of the depression so as to prese nt a flatter posterior surface. A slight screening is usually all that is necessary to finish the patellar-tendon bar. The medial template should be used when modifying the cast to arrive at a true contour of the medial flare of the tibial condyle.

SUSPENSION CASTING OF THE ABOVE-KNEE STUMP

Suspension casting of above-knee stumps may be used in conjunction with a UCB casting stand and brims. The technique permits the firming of stump tissues that are not in contact with the brim. It is also a means of controlling bulges at the distal end of the brim and the adduction angle of the femur. The technique results in a smooth interior to the negative cast of the stump.

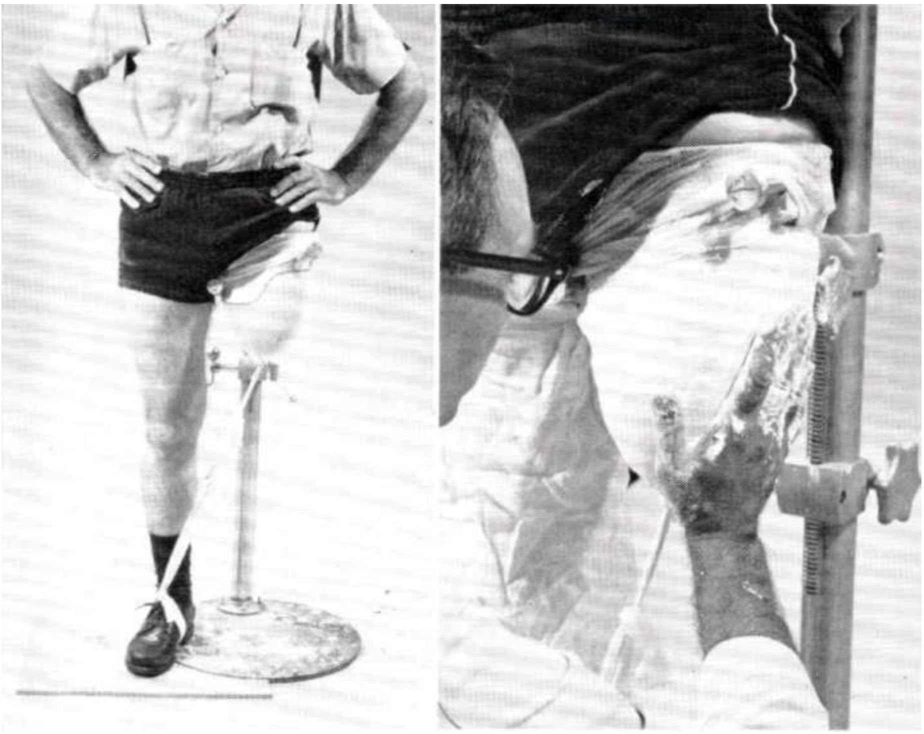


CASTING THE ABOVE-KNEE STUMP. The major equipment required is a UCB stand, a set of brims, and a roll of 4-in. tubular gauze.

Initially, the stump is correctly fitted into the brim, in accordance with the instructions contained in *Adjustable-Brim Fitting of the Total-Contact Socket (1).* The brim is set in the stand horizontally. When all the necessary conditions—such as, the correct anteroposterior and mediolateral dimensions and the circumference of the brim—are satisfied, a piece of tubular gauze approximately 1-yd. long is applied to the brim. The tubular gauze is held to the outside of the brim with adhesive tape and is then draped down through the brim. A stump sock is then applied to the amputee's stump. The distal end of the stump sock is pulled down through the tubular gauze, and the stump sock is removed entirely while pulling the stump into the brim.

Pulling the stump into the brim in this manner results in a bulging of the stump around the distal edge of the brim. To alleviate this situation, the amputee is instructed to flex his trunk over the brim as far as possible, thereby easing the gluteal muscles proximally. As the amputee straightens up in the brim, the tissues should be gently eased proximally in the anterior area of the brim. When the amputee bears weight on the brim, some of the bulging will have been eliminated.

CASTING THE ABOVE-KNEE STUMP. The tubular gauze distal to the brim is grasped and pulled downward, causing the tubular gauze to stretch longitudinally and reduce circumferentially, thereby compressing the stump tissues. With one hand, the prosthetist maintains tension on the distal end of the gauze as he grasps the gauze at the distal end of the stump with his other hand. The amputee is instructed to remove some weight-bearing from the brim, and the gauze is tied with string at the distal end of the stump. Weight-bearing should be reapplied to equal approximately one-half of the amputee's weight. A piece of 1-in. elastic webbing is tied to the distal end of the gauze and passed under the arch of the amputee's foot, usually from the lateral to the medial side. Sufficient force is applied to the elastic to maintain the correct adduction attitude of the femur.

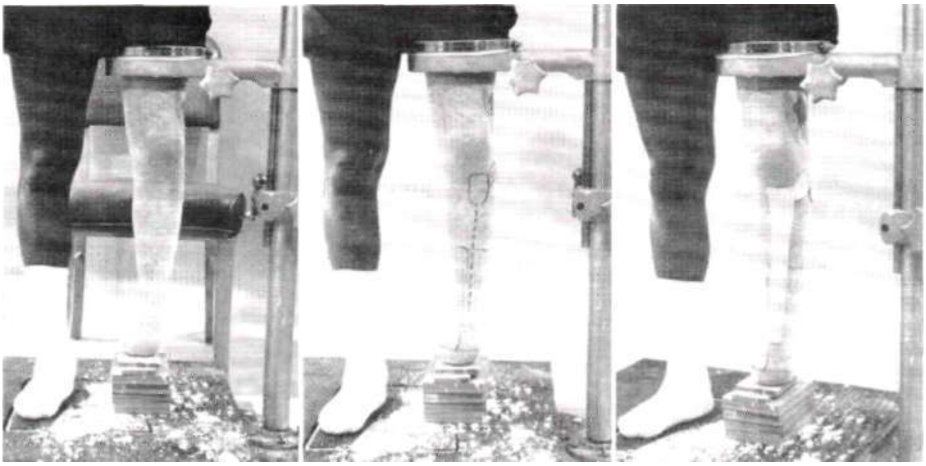


CASTING THE ABOVE-KNEE STUMP. A firm, even wrap of standard plaster bandage is applied, enclosing the stump completely. While the plaster is still wet, the prosthetist palpates the stump to locate the distal end of the femur. He then applies gentle pressure approximately 1 in. above the end of the femur until the plaster sets.

Before the plaster is poured to form the positive model of the stump, the tubular gauze is removed from the brim area down to its contact with the plaster wrap.

SUSPENSION CASTING FOR THE SYME'S AMPUTATION

The suspension casting technique provides a means of wrapping a Syme's stump with plaster bandages under weight-bearing conditions. It is an excellent means of holding an unstable heel flap or supporting redundant tissue in the correct position during the casting procedure. It firms tissues, resulting in a smooth interior to the wrap cast, and it provides a means for checking the size of the medial opening prior to laminating the socket.

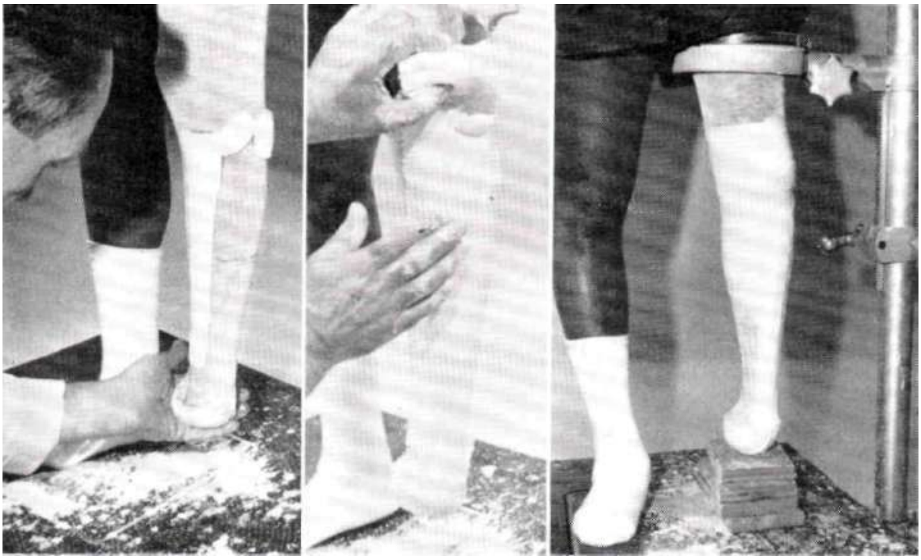


CASTING THE SYME'S STUMP. The equipment used is the same as that used for casting below-knee stumps; namely, an adjustable vertical stand, a ring, a gasket, a hose clamp, a cast sock, and a scale.

A light-weight cast sock is used because it has more stretch than a heavy cast sock and can conform intimately to the contours of the stump. The sock should contact the thigh approximately 3 in. above the patella, with one-half of the amputee's weight borne by the sock.

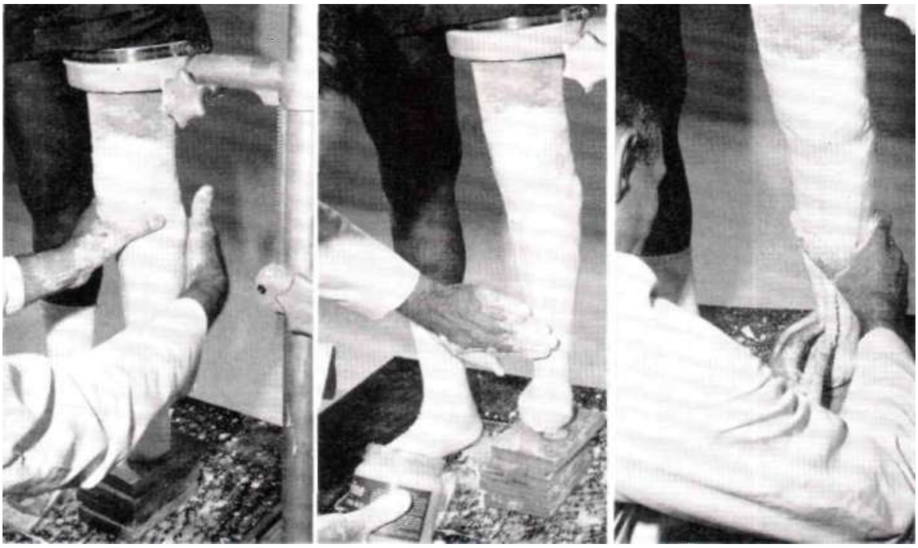
With the amputee supported in a level position, blocks are placed under the stump to contact its distal surface. Areas requiring relief are located by palpation and outlined. An outline of the medial opening is planned and drawn on the suspension sock, as described in *VAPC Technique for Fabricating a Plastic Syme Prosthesis with Medial Opening (3).*

The largest circumference at the bulbous end of the stump is measured, and a horizontal line is drawn just proximal to this. The stump is then measured proximally until the same circumference is obtained, and another horizontal line is drawn at this level. A line is drawn along the crest of the tibia. Just 3/4 in. medially from the tibial line another line is drawn parallel so as to intersect the two horizontal lines. The width of the cut-out is usually equal to 1/4 of the circumference measured. This remaining vertical line is drawn following the posterior contour of the stump to complete the medial opening. Relief patches 1/8-in. thick are prepared and applied to the areas previously outlined on the suspension sock.



CASTING THE SYME'S STUMP. The blocks are slid from under the stump, and the amputee retains weight-bearing on the sock. Plaster bandages are contoured to the distal end of the stump, and the bulbous end is wrapped up to the distal horizontal line of the medial panel. The plaster bandage is applied vertically to cover the stump to the anteromedial and posteromedial vertical outlines of the panel, and horizontally to include the top edge of the patella down to the top line for the medial opening. After wetting his hands, the prosthetist works the plaster to ensure an intimate contact of the wrap, especially in the area just proximal to the bulbous end. If necessary, one wrap of plaster bandage can be applied in this area to prevent possible bridging.

The wooden blocks are then slid back under the plaster wrap of the distal stump. Slight contact pressure is all that is required to provide a flattened surface to the distal end of the cast. If too much weight is borne on the blocks, the amputee should be raised slightly by vertical adjustment of the casting stand.



CASTING THE SYME'S STUMP. The plaster is worked along the stump and around the proximal aspect of the wrap. The prosthetist locates and defines the patellar tendon and flattens the wrap cast posteriorly just below the midpatellar-tendon level.

After the plaster has set, the remaining area to be covered is evident. Vaseline is applied to the uncovered portion of the sock and 1 in. to 1 1/2 in. along the plaster cast bordering the area. A splint of plaster bandages is made, large enough to cover the opening but not so large as to extend beyond the lubricated areas of the wrap cast. The splint is applied to cover the medial opening and worked well by hand to obtain an intimate mating along all the edges.

CASTING THE SYME'S STUMP. After the panel covering the opening has set, alignment lines are drawn on the cast to be used later for bench alignment. The amputee is oriented so that his pelvis is level, with half of his weight borne on the amputated side. Using a plumb bob, the prosthetist draws a vertical line on the anterior aspect of the wrap cast to determine the adduction angle of the socket and another vertical line on the lateral aspect of the cast to determine the flexion angle of the socket. Before removing the panel, the prosthetist draws two horizontal lines on the panel extending onto the body of the cast for positioning purposes.

The clamp on the casting stand is loosened to permit the amputee to be seated. The clamp and ring holding the cast sock are removed. The prosthetist slides a knife under the edges of the medial panel and exercises care to avoid distortion during removal. The exposed cast sock is cut, and the stump is withdrawn from the cast.

The cast sock and relief patches are removed from the interior of the wrap cast, and the medial panel is replaced and held in position with additional strips of plaster bandage.

The positive stump model is then poured into the wrap cast, with the wrap cast held so that the alignment lines are vertical. The holding pipe is inserted vertically and should be invested into the plaster to within 1/2 in. of the end of the cast.

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Fitting and Training Children with Swivel Walkers

W. M. Motloch[2] AND
Jane Elliott[3]

Mobility can be provided fairly successfully for the bilateral hip-disarticulation patient when his arms can be used in connection with crutches and canes, but when the patient cannot use crutches a most difficult problem is presented to the clinic team. The most effective means of treating patients who have complete or essentially complete absence of all four limbs has been to provide them with a socket encasing the pelvic region mounted on a three- or four-wheeled platform (Fig. i), or to provide them with motorized carts with special controls. The unpowered vehicles permit the patient to be upright but generally they must be moved from place to place by an attendant, and the motorized carts are expensive.

Experiments at the Child Amputee Prosthetics Project, University of California, Los Angeles, with pylons mounted on rockers, and hinged at a point anterior to the anatomical hip joint, proved to be very disappointing mainly because the effort required in their use exceeded the functional gain (Fig. ii) (1).

To overcome some of the deficiencies presented by previous approaches, Richard E. Spielrein (3), Senior Engineer, Repatriation Department, Commonwealth of Australia, suggested a pylon arrangement to capitalize on side-to-side oscillations of the man-machine combination (Fig. iii) and built a prototype, based on mathematical computations, which was used successfully by a 16-year-old girl.

The Ontario Crippled Children's Centre, Toronto, Canada, has successfully utilized the principles set forth by Spielrein and presents herewith instructions for fabrication and use of the so-called swivel walker (Fig. iv).

Experience has been limited to young children, but the walker should prove successful with older persons. It has been suggested that the principle of the swivel walker might also be applied in the case of paraplegia.

A. Bennett Wilson, Jr.[4]

Fig. i. Three-wheeled cart built by Child Amputee Prosthetics Project, University of California, Los Angeles, for patient with congenital bilateral above-elbow amputations and bilateral lower-extremity amelias. From Blakeslee, Berton, *The Limb-Deficient Child (1).*

[1] The device described in this article was developed by the Prosthetic Research and Training Unit, Ontario Crippled Children's Centre, under a grant from the Department of National Health and Welfare, Project No. 605-7-304.

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Fig. ii. Same child who appears in Figure i shown on pylons mounted on rockers and hinged at a point anterior to the anatomical hip joint. Although the child learned to ambulate with this device, her progress was slow and the energy expenditure extremely high. From Blakeslee, Berton, *The Limb-Deficient Child (1).*

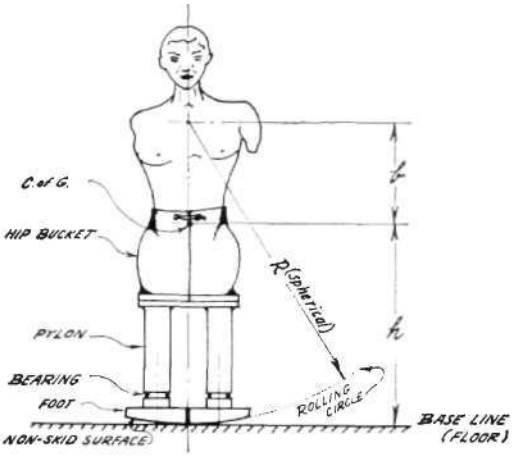

Fig. iii. Swivel walker developed by Richard E. Spielrein, Senior Engineer, Repatriation Department, Commonwealth of Australia. From Spielrein, R. E., *A Simple Walking Aid for Legless People (3).*

The swivel walker in its simplest form (Fig. 1) consists of two pylons attached in a vertical position to a pelvic socket, and two foot pieces which are attached to the pylons so that each may rotate about the vertical axis of the appropriate pylon. Stops are provided to limit rotation of the feet in each direction, and a spring returns the feet to a neutral position when no force is applied.

The soles of the feet are canted in relation to the floor, and the pylons are positioned with their center lines falling posterior to the center of gravity of the patient and prosthesis so that tilting of the body on one side will cause rotation of the socket about the long axis of the pylon on the tilting side. The contralateral pylon is raised initially and swings forward due to gravity until it strikes the floor ahead. Backward motion can be obtained by tilting sideways and leaning backward so that the center of gravity falls posterior to the center lines of the pylons. Of course, to manipulate the swivel walker, the patient must have a mobile trunk.

The type of walker suggested for initial use is shown in Figure 2. Later, a more cosmetic device can be used.

The socket is essentially the same as that for a conventional bilateral hip-disarticulation prosthesis *(2)* and is mounted on a platform which, in turn, is mounted on two aluminum tubes. In the bottom end of each pylon is mounted an ankle joint, or rotation unit, which in turn is attached to a foot piece mounted so that the inner edge rests on the floor when the appliance is at rest (Fig. 2). The foot pieces should have rubber soles to prevent slipping.

MEASUREMENTS

Measurements that need to be recorded (Fig. 3) are:

Crown-rump length
Waist width

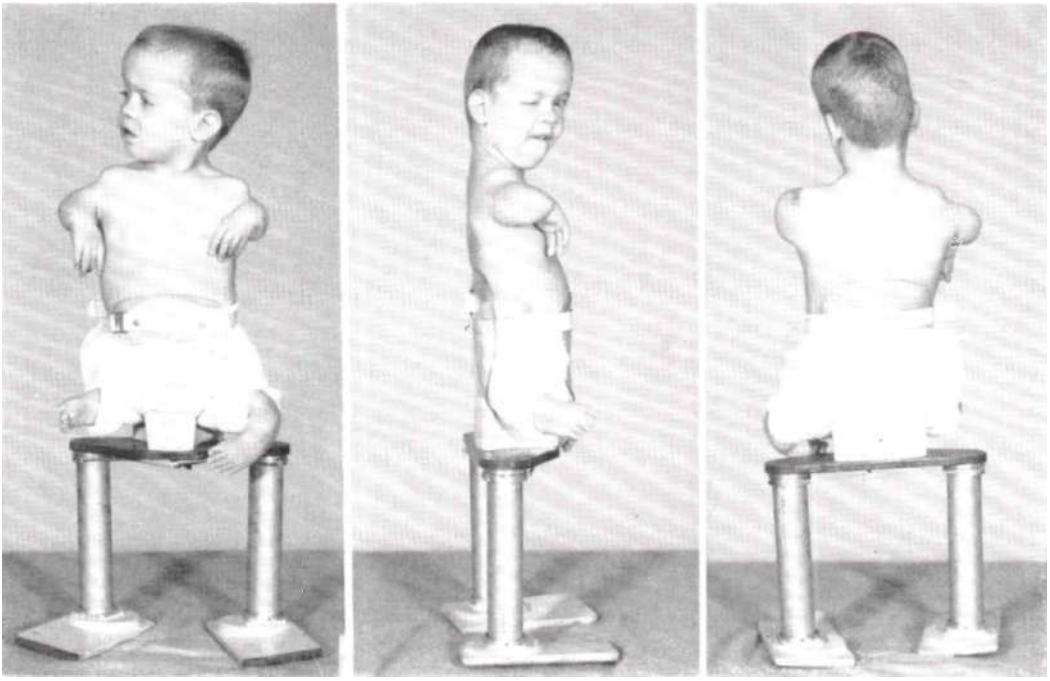

Fig. iv. Swivel walker developed by the Ontario Crippled Children's Centre, Toronto, Canada.

Crest of ilium to ischial tuberosities
Distance between ischial tuberosities
Maximum distance across pelvis

The "normal" height of the child with pylons on can be estimated by multiplying the crown-rump length by two or a little less.

TAKING THE CAST

Taking the cast usually requires the services of two people. A length of large-diameter stockinette is sewn closed at one end, with openings for existing limbs if present. Straps or webbing are used to suspend the stockinette from an overhead hook. This arrangement ensures firm contours and supports the child. The lower trunk, excluding the limbs, is then wrapped with plaster bandages up to the rib cage.

If the child is not toilet trained, the cast is made over the diapers. If diapers are not worn, the ischial tuberosity, pubic tubercle, crests and anterior spine of the ilium, and the rib cage are marked as shown in Figure 4. For use in alignment, vertical lines indicating the lateral and sagittal planes are drawn on the cast before it is removed from the patient.

FABRICATION

SOCKET

The original socket is usually made so that it extends a little higher than the waist, both front and back, for early training. As ability to balance improves and proficiency increases, the height can be reduced to approximately waist level. It is important that forward, backward, and side-to-side motions of the torso are not restricted.

The original socket fabricated for testing the first model of the swivel walker was heat-formed out of acrylic sheet, but all later models have been of polyester laminate. Two complete layers of Dacron felt, two partial layers of Dacron felt, and two partial layers of glass cloth are used, as shown in Figure 5. The lay-up is completed with four layers of nylon stockinette before impregnation with a mixture of 70 per cent rigid and 30 per cent flexible polyester resin. The laminate should be formed under a vacuum in order to prevent unnecessary bulk.

After curing and removal from the plaster cast, the socket is trimmed approximately

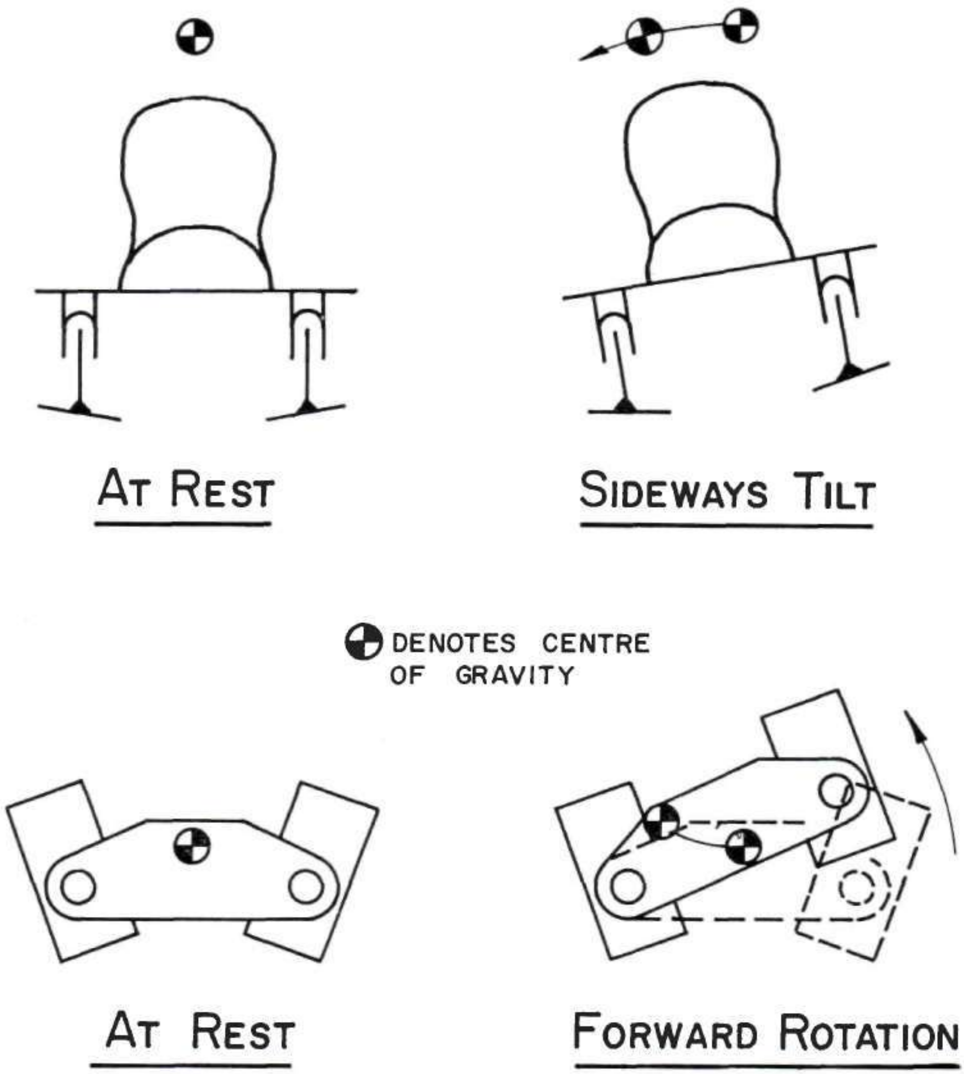

Fig. 1. Principle of the swivel walker. The child can transfer his weight to one foot by leaning sideways and then swivel forward about this foot, using only the force of gravity. Stops are provided to limit forward or backward swing, with springs returning the foot to the neutral position when it has been returned to the floor.

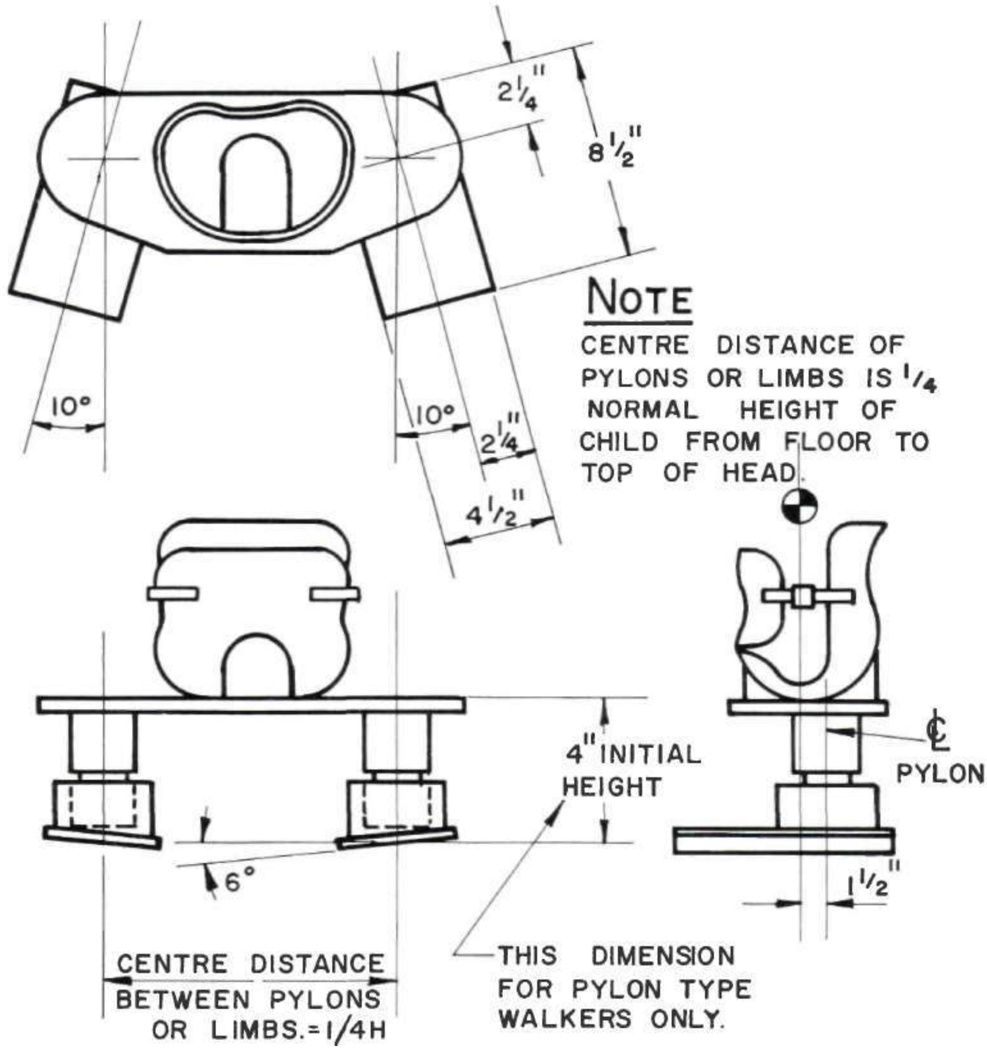

Fig. 2. Basic dimensions of the swivel walker.

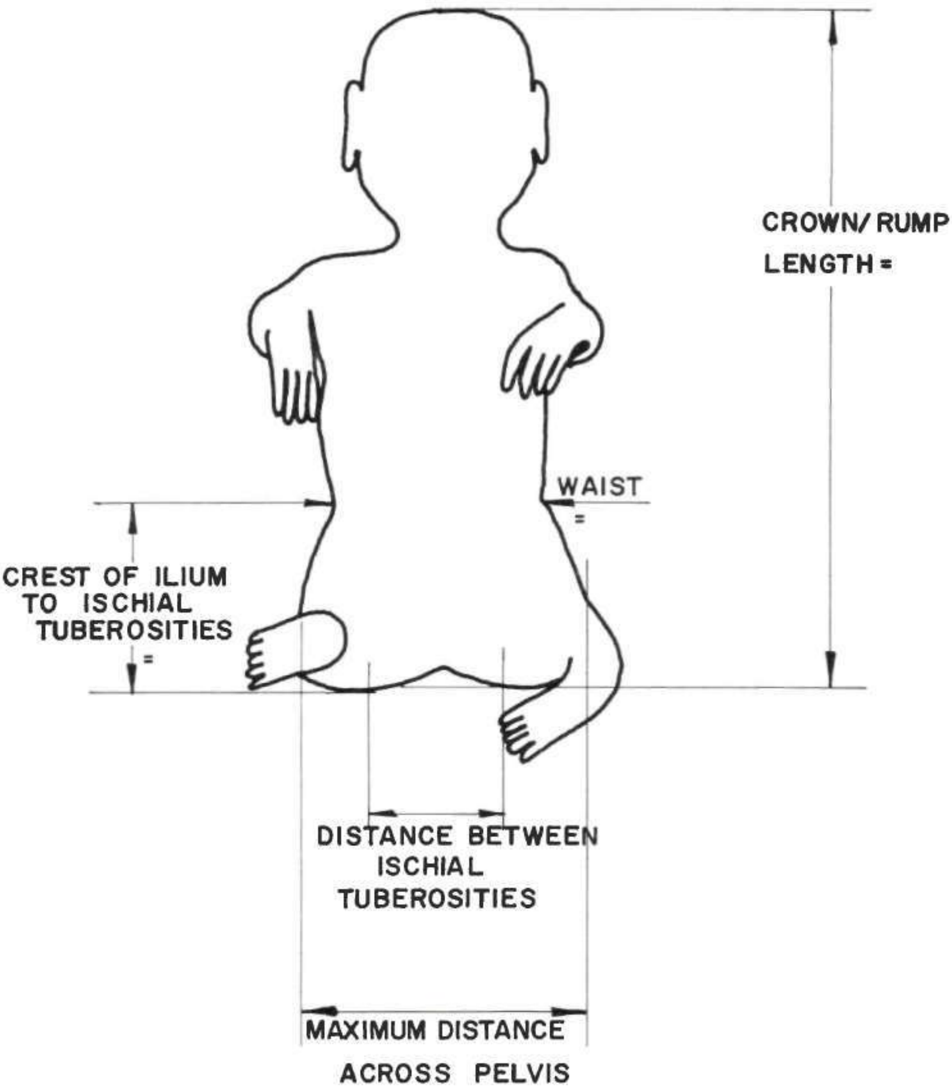

Fig. 3. Measurements required for fabrication of the swivel walker.

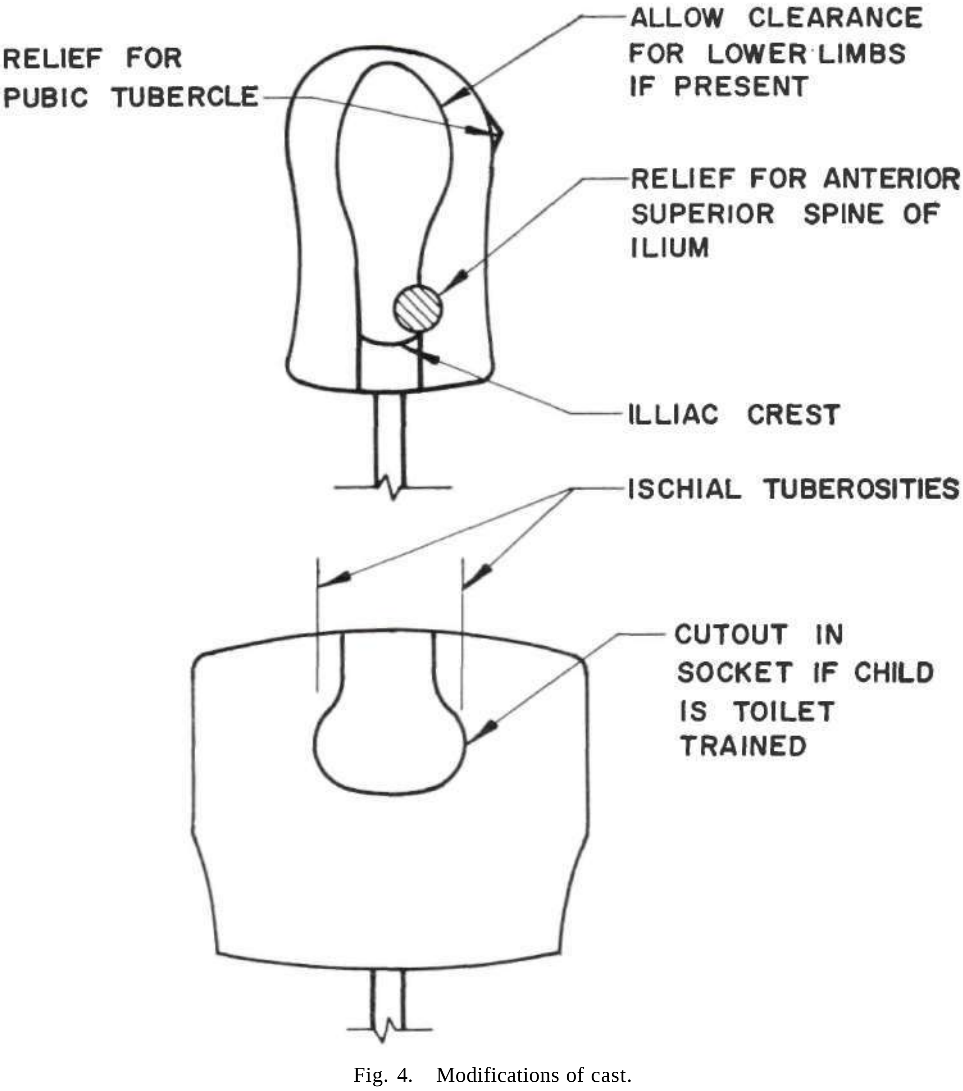

Fig. 4. Modifications of cast.

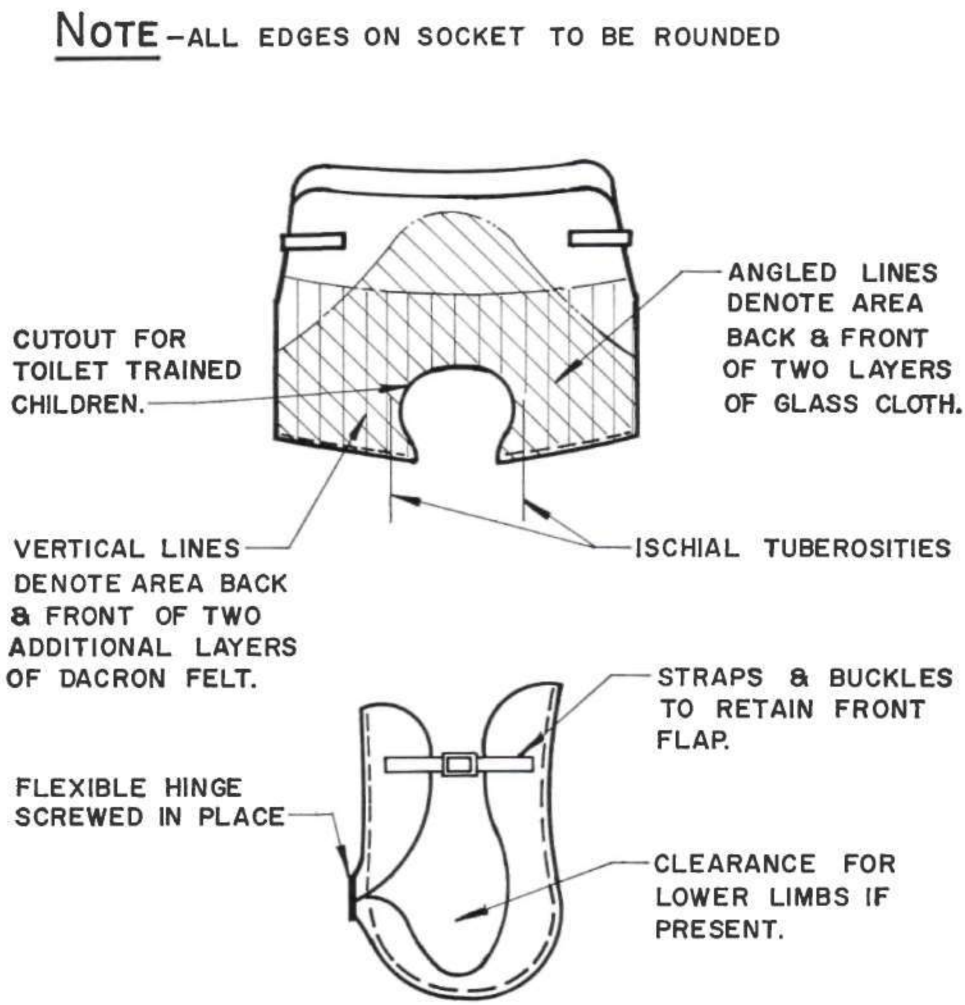

Fig. 5. Recommended socket configuration.

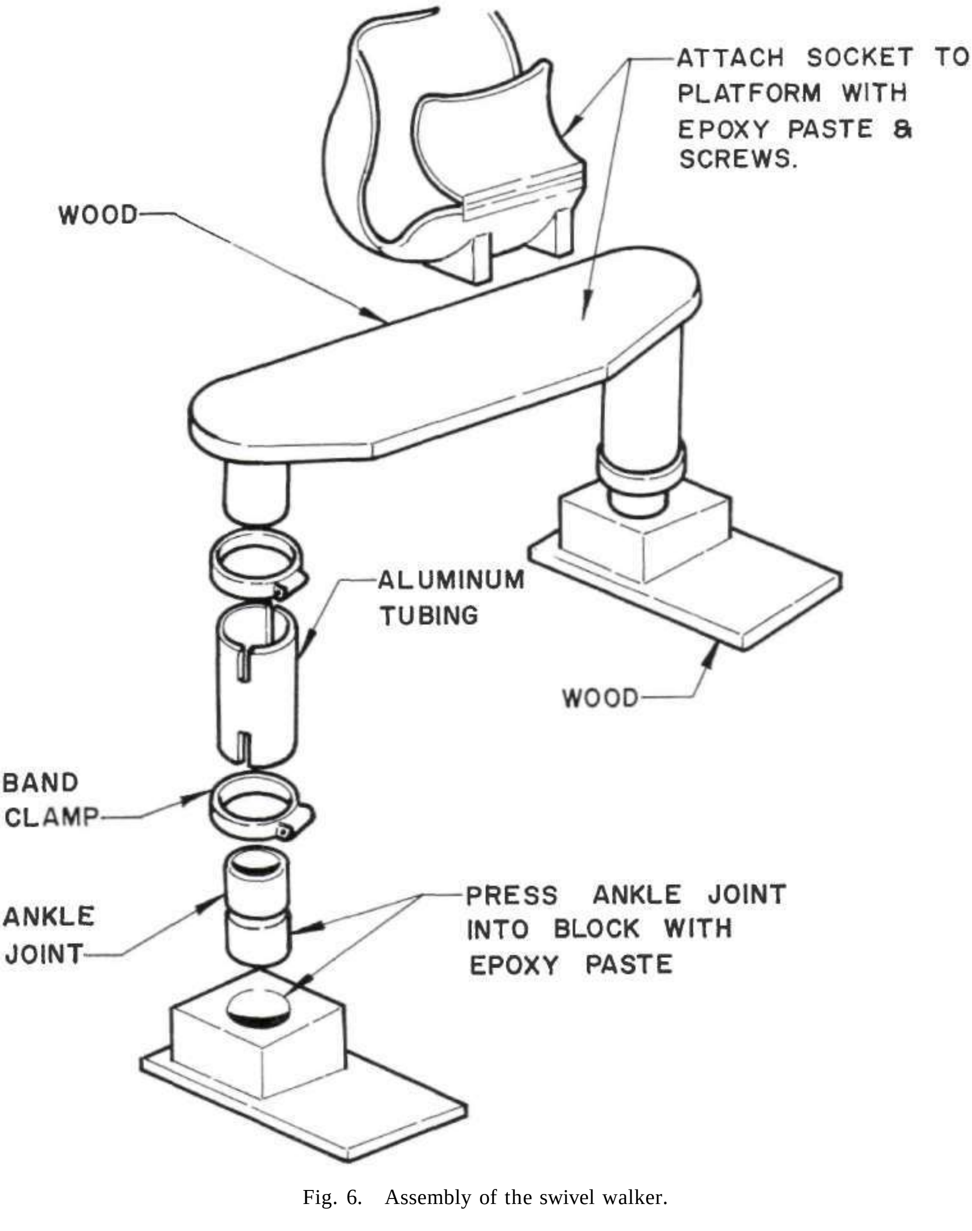

Fig. 6. Assembly of the swivel walker.

as shown in Figure 5 and all edges are rounded and smoothed. Ease of entry and exit is facilitated by an anterior hinge.

A plastic hinge with the trade name of Polyhinge is satisfactory and may be fastened with flat-head wood screws. Either polyester or epoxy paste can be applied to the screw heads to prevent corrosion if necessary.

Wooden blocks are screwed to the base of the socket to provide a level surface for mounting the socket on top of the pylon walker.

The pylons are aluminum tubing, 2-in. outside diameter, 1/16-in. wall thickness. The top ends are fitted with wooden plugs; the bottom ends are fitted over the ankle joints.

The dimensions of the pylon and its placement are based on the "normal" height of the child and are indicated in Figure 3.

An adequate method for fastening the pylons is to slit the ends and use hose clamps (Fig. 6).

ANKLE JOINT

The ankle joint (Fig. 7), mounted between the pylon and the foot piece, permits rotation of the foot piece about a vertical axis to allow forward and backward swing. As can be seen in Figure 7, the foot piece is returned to a neutral position by a spring-loaded roller. Built-in stops restrict rotation to approximately 39 deg. forward and 11 deg. backward. (It is planned that a simpler, less expensive version of the ankle joint will be available commercially in the near future.)

FOOT PIECES

The foot piece (Figs. 2 and 6) consists of a block of wood, a platform sole, and a rubber undersole. The rubber is glued to the wooden platform, which is fastened to the block of wood with glue and screws. The block is bored to receive the lower part of the ankle unit, which is held in place with epoxy resin or paste.

ALIGNMENT

The main considerations in alignment are (Fig. 2):

- The center lines of the ankle joints should fall approximately 1 1/2 in. behind the center of gravity of the child's body.

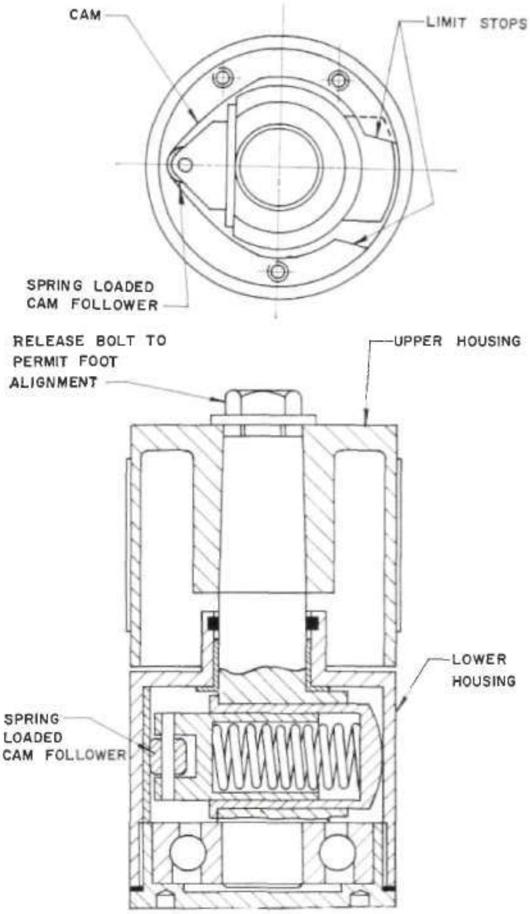

Fig. 7. The ankle unit.

- When the walker is at rest, the pylons should be vertical.
- The foot platform should tilt about 6 deg. and rest on the medial edge.
- When viewed from above, the foot pieces are rotated out about 10 deg. (This adjustment is made by reaching down inside the pylon with an extension wrench and slackening off the bolt. This releases a tapered shaft, enabling the foot piece and lower ankle housing to be rotated to the desired position.)

THE COSMETIC SWIVEL WALKER

To improve appearance and to permit the patient to assume a sitting position, the pylons can be replaced with articulated limbs (Fig. 8).

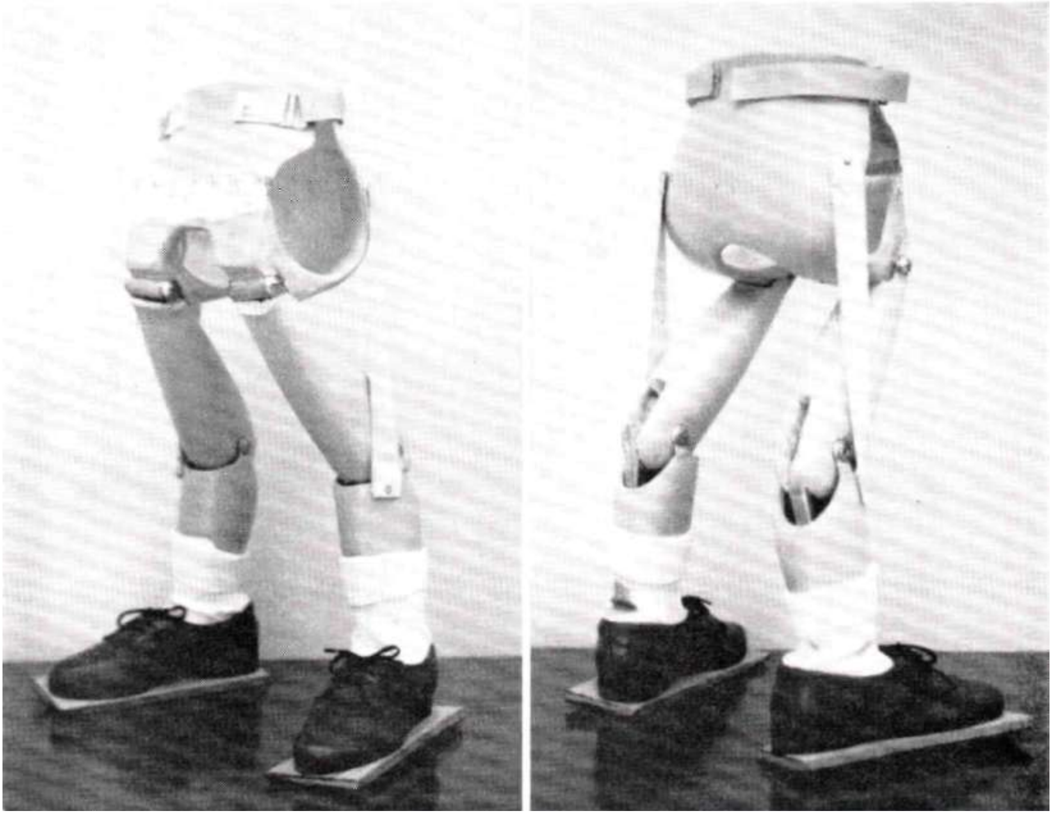

Fig. 8. Swivel walker equipped with articulated limbs to permit sitting, and fabricated to improve cosmesis.

The knee joints and hip joints are those used in a Canadian-type hip-disarticulation prosthesis, and they are aligned in a similar manner. For purposes of stability, the hip joints are placed well forward and the knee joints well back. It is imperative that the alignment between the socket and the foot pieces be identical to that used with the pylon type.

The lateral straps are 1-in. elastic webbing installed with sufficient tension to prevent hip or knee flexion when the limb is lifted clear of the floor. Each strap is attached to the socket and to the lower limb in such a manner that in the standing position the direction of pull is behind the hip joint and in front of the knee joint. In the sitting position, the straps pass in front of the hip joint and behind the knee joint.

The foot is carved from solid wood, bored out to receive the lower housing of the ankle joint. Foot pieces, used for training, are attached by screws through the soles of the shoes into the wooden feet. When the child has progressed to a point where foot pieces can be removed, screws are used to secure the soles of the shoes to the wooden feet. The shoe soles should be flat, with the same 6 deg. tilt from the medial edge.

The shank sections must be hollow so that a wrench may be inserted from the top to adjust the vertical shank bolt.

TRAINING

It is recommended that training for young children be commenced by using a lateral rocker as shown in Figure 9 to enable the child to establish balance, to learn and practice the sideways rocking motion, and to establish a rhythm. When the child feels secure in this arrangement, he is transferred to the swivel walker with short pylons and encouraged to go through the same rocking motion. At this point it is necessary to demonstrate to

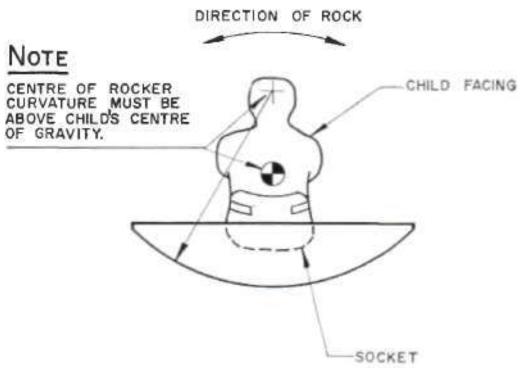

Fig. 9. Device for training patient to use the swivel walker. The lateral rocker enables the child to establish balance, to learn and practice the sideways rocking motion, and to establish a rhythm.

the child the forward swing by placing the hands on the trunk and guiding the child through the side-to-side motion coupled with a forward tilt. This support is gradually decreased until the child can manage unaided.

As proficiency in the use of the swivel walker increases, the height of the pylons is raised in 1-in. increments until a "normal" height is attained. The rate of increase will vary according to the child's capability. Experience at the Ontario Crippled Children's Centre has been that the height can be increased one inch about every two days.

At low heights body sway above the waist is required to operate the walker. As the height is increased, the child's movement alters to a lateral displacement of the hips such that the body moves sideways while remaining vertical.

When patients become proficient in the use of the walker, they do not swing the walker to the limits of the stops.

The ability to walk backward is attained with little more difficulty than walking forward, but smaller steps are generally used. One child was able to walk very well in either direction within a period of two weeks. Walking backward is important because it permits the child to back out of corners or similar situations.

Great care must be taken with the child during training, since it is possible that a few falls will occur until his sense of balance is perfected. Falls from being pushed by other children are likely to be far greater in number than those resulting from overbalancing. It is recommended that some form of protective head covering (such as an ice hockey head guard) be worn during this stage of training.

One child was fitted with the swivel walker shown in Figure 8 after she became proficient with the pylon type. Initially, the foot pieces were larger than the shoes. As proficiency developed, they were gradually trimmed in size and finally removed, leaving the shoes tilted at the same angle.

With both types of walker it was found that the children averaged approximately 120 steps per minute, each step being approximately three inches when walking forward.

Each child had to be treated individually according to his own temperament. One child was extremely nervous and frightened, and so training had to be carried on more slowly than with another child who accepted alterations readily.

From experience gained so far, it is suggested that a child who is nervous and cautious be given a period of at least one week to become used to major adjustments and alignment changes.

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Review of Visual Aids for Prosthetics and Orthotics, Continued[1]

PROSTHETICS (GENERAL)

"Good-Bye to Captain Hook" University of Michigan, 1966, 20 min., color, sound, 16 mm.

Summary: Presents an overview of the medical management of the upper-extremity amputee, including selection of amputation level, principles of surgery (illustrated diagrammatically), occupational and physical therapy, selected basic steps in fabrication, prescription of prosthesis, types of terminal devices, training activities and prevocational testing. Some of the newer prosthetic fittings (for example, Munster) are not included.

Evaluation: Technically and professionally, this is an excellent film, accurate and informative in its presentation. Coverage of a large amount of material precludes the detailed exposition necessary for a teaching film. It serves well, however, as an over-all orientation, particularly for the general medical practitioner to whom it is directed. For allied groups, it would be useful as background material. Since it presupposes some knowledge of the subject, it would not be suitable for nonprofessional groups.

Distributor: University of Michigan, Audio-Visual Education Center, Ann Arbor, Mich. 48104.

Rental Fee: $7.00.

Purchase Cost: $175.00.

"Immediate Postoperative Fitting of the Below-Knee Amputee," University of Miami, 1965,15 min., color, sound, 16 mm.

Summary: A large portion of the film is devoted to a graphic description of surgical techniques used in below-knee amputation. Principles important in achieving a satisfactory stump and prosthesis for immediate postoperative fitting are stressed. Level of amputation, proper alignment of the prosthesis, and criteria for weight-bearing are briefly discussed. Advantages of immediate fitting are pointed out and several below-knee amputees are shown walking with temporary patellar-tendon-bearing or Syme prostheses.

Evaluation: The primary purpose of the film appears to be to stress the important principles underlying amputation surgery and the immediate application of the cast. This purpose is achieved through excellent photography and lucid explanation. The film lacks continuity and the narration is uneven. The case presentations are too brief to be very meaningful. Since rehabilitation procedures are not included, the use of the

[1] This review, a continuation of the review appearing in the Autumn 1965 issue of *Artificial Limbs,* was compiled by an *ad hoc* committee appointed by the Subcommittee on Prosthetics in Paramedical Education of the Committee on Prosthetic-Orthotic Education. Chairman of the *ad hoc* committee is Miss Mary Poole, Director, Department of Social Work, University of Pennsylvania Hospital, Philadelphia, Pa. Members are Mrs. Joan E. Edelstein, Associate Research Scientist, School of Medicine and Post-Graduate Medical School, New York University, New York, N. Y.; Miss Nancy Ellis, Associate Director, Occupational Therapy Courses, College of Physicians and Surgeons, Columbia University, New York, N. Y.; Miss Jamie Lisle, Director of Physical Therapy, Medical College of Virginia, Richmond, Va.; Miss Lena M. Plaisted, Professor of Rehabilitation Nursing, Boston University School of Nursing, Boston, Mass.; and Miss Muriel E. Zimmerman, Associate Chief, Occupational Therapy Service, New York University, New York, N. Y. Colonel Ruth A. Robinson, Army Medical Specialist Corps, U. S. Army (Ret.), Chairman of the Subcommittee on Prosthetics in Paramedical Education, serves as an *ex-officio* member of the *ad hoc* committee. Mrs. Barbara R. Friz, Staff Officer of the Committee on Prosthetic-Orthotic Education, serves as secretary of the *ad hoc* committee.

The Committee on Prosthetic-Orthotic Education is supported by the Training Division of the Vocational Rehabilitation Administration and by the Prosthetic and Sensory Aids Service of the Veterans Administration.

film for paramedical personnel would be chiefly to provide worthwhile background material. It would serve surgeons and prosthetists more advantageously.

Distributor: American Academy of Orthopaedic Surgeons, 29 East Madison St., Chicago, Ill. 60602.

Rental Fee: $3.00

Purchase Cost: $65.00.

"*Immediate Postsurgical Filling,"" U. S. Naval Hospital, Oakland, Calif., 1965, 25 min., color, sound, 16 mm.*

Summary: A concisely written synopsis of the history, definition, and advantages of immediate postsurgical fitting is projected on the screen by way of introduction. The film discusses indications for the use of this method of amputee management, presents preamputation work-up procedures, mentions briefly some principles of surgical techniques, and devotes considerable time to the application of a plaster-of-Paris socket which incorporates an unusual method of suspension. Demonstrates adjustment of the temporary prosthesis and shows several patients walking at varying intervals following amputation and immediate prosthetic fitting.

Evaluation: A technically excellent film that presents the subject matter in a well-organized and professional manner. The film might have been more convincing had the cast not been applied to a two-week-old stump. Application of the socket did not include an explanation of weight-bearing areas, thereby somewhat limiting its instructional value. The film would be of particular interest to physicians and prosthetists and would serve to acquaint therapists, nurses, and others in selected procedures of immediate postsurgical fitting.

Distributor: Navy Prosthetic Research Laboratory, U. S. Naval Hospital, Oakland, Calif. 94627.

Purchase Cost: Approximately $250.00.

"*Immediate Postsurgical Prosthesis," Veterans Administration Hospital, Seattle, Wash., 1966, 35 min., color, sound, 16 mm.*

Summary: Dr. Ernest M. Burgess, principal investigator, Seattle Prosthetics Research Study, presents the historical background leading to the present research program and explains the concept, rationale, and advantages of immediate postsurgical fitting. A patient with a nonhealing defect is followed from the preamputation period to 31 days postamputation, at which time he demonstrates his dancing ability while wearing a permanent prosthesis. The film presents details of the surgical techniques, including tension myodesis, and shows application of the plaster-of-Paris socket and temporary prosthesis immediately following surgery. The film outlines the rehabilitation program and introduces other types of amputees who have had immediate prosthetic fitting.

Evaluation: The surgical procedure from the initial incision to the closing of the wound is clearly and graphically portrayed. Inclusion of the anatomical structures involved adds to the value. Details of prosthetic fitting and postsurgical care are sketchy, but adequate to illustrate principles. The photography is excellent. The narration tends to be wordy and is sometimes confusing in terms of understandability and identification of the speaker. The film is directed primarily toward introducing and encouraging the use of immediate postsurgical fitting. It is a completely optimistic report. Criteria are not discussed. Of special interest to the physician, prosthetist, nurse, and physical therapist, and certainly of value in graduate prosthetics programs.

This film and the Navy film on the same subject complement each other and it is recommended that they be seen together, if time permits.

Distributor: Central Office Film Library, Veterans Administration, Vermont Avenue and H St., N. W., Washington, D. C. 20420.

Purchase Source: DuArt Film Laboratories, Inc., 245 West 55th St., New York, N. Y. 10019.

Purchase Cost: $113.88.

"Phantom Pain," Public Health Service, 32 min., black and white, sound, 16 mm.

Summary: The psychiatrist comments briefly before and after an interview with a 39-year-old below-knee amputee suffering from severe phantom pain. The patient is on screen most of the time, vividly relating his experiences, feelings, and symptoms. He is interrupted only by an occasional question from the physician. No attempt is made to probe the reasons for the phantom pain or to suggest any definitive treatment plan.

Evaluation: The patient's remarks and behavior in describing the history and character of his pain provide a good stimulus for discussion among professional persons interested in the emotional aspects of this condition. The picture is not consistently clear and the fact that the sound is not synchronized with the visual part is somewhat distracting. Psychiatrists, residents, and medical students might find the film useful, especially for seminar-type discussions. Allied groups concerned with this and other problems of pain would be interested in seeing the film.

Distributor: Communicable Disease Center, Public Health Service. Attn: Audiovisual Facility, Atlanta, Ga. 30333.

Rental Fee: None.

Purchase Source: DuArt Film Laboratories, Inc., 245 West 55th St., New York, N. Y. 10019.

Purchase Cost: $44.40.

"Problems of Amputee Joint Alignment," Charles Bechtol, M.D., 1951, 12 min., black and white, silent, 16 mm.

Summary: Shows a limited number of gait deviations related to faulty knee-joint alignment in above-knee amputees.

Evaluation: Although the year of production precludes use of the adjustable leg to establish alignment, the film may still be useful to prosthetists and student prosthetists in understanding faults in old-type prostheses. It should be used in a classroom environment because it lacks the narration needed for clarification. Freeze frames help in analyzing the deviations.

Distributor: American Academy of Orthopaedic Surgeons, 29 East Madison St., Chicago, Ill. 60602.

Rental Fee: $3.00.

"Rehabilitation Approach to the Hemicorporectomized Patient," New York University Medical Center, 1965, 20 min., color, sound, 16 mm.

Summary: Presents a 49-year-old man amputated between L_4 and L_5 for pelvic cancer. Traces the chronological progress of the amputee, emphasizing preprosthetic management, fitting, and transfer, and ambulation activities. Makes reference to social, psychological, and vocational adjustment and to continuous medical and prosthetic follow-up.

Evaluation: This is an excellent film, professionally and technically. Although such a patient is rare, his rehabilitation illustrates principles of fitting and training applicable to amputees with relatively high levels of amputation and to severely involved paraplegics. The results of cooperative team effort are well presented. Physicians, nurses, prosthetists, and physical therapists will find the film of interest as will hemicorporectomized patients, should there be others.

Distributor: Communicable Disease Center, Public Health Service. Attn: Audiovisual Facility, Atlanta, Ga. 30333.

Purchase Source: Color Service Company, Inc., 115 West 45th St., New York, N. Y. 10036.

Purchase Cost: Approximately $56.00.

"Upper-Extremity Prosthetics—Harnessing and Control Systems," Northwestern University, 1966, 23 min., color, sound, 16 mm.

Summary: Presents the mechanics of the single-control system for a below-elbow amputee and the dual-control system for an above-elbow amputee. Body control motions and sequence of operation for each are demonstrated. Clarification of concepts is achieved by use of patients, the actual prostheses, and two-dimensional models of the prostheses. Does not include shoulder disarticulation or triple-control system as title might imply.

Evaluation: The sequential, properly paced presentation of well-selected items and procedures and the judicious repetition of pertinent points result in an extremely well-organized film and an effective teaching device. The technical quality is excellent and the narration is clear and specific. The film presupposes a fair amount of knowledge of prosthetics. It would be extremely valuable for use in a graduate program or for review by physical therapists, occupational therapists, nurses, and any other groups concerned with the prescription or fabrication of upper-extremity prostheses, and for those who instruct amputees in use of upper-extremity prostheses.

Distributor: American Academy of Orthopaedic Surgeons, 29 East Madison St., Chicago, Ill. 60602.

Rental Fee: $3.00.

CHILD PROSTHETICS

"Upper-Extremity Prosthetic Checkout Procedures—Below Elbow" Michigan Crippled Children Commission, 1961, 23 min., color, sound, 16 mm.

Summary: Defines and states the purpose of checkout and identifies the equipment needed. Demonstrates checkout procedure on a 4-year-old boy with short below-elbow amputation by showing how each item on the checkout form is tested or measured.

Evaluation: The film is technically good, except for cutting procedures. Although modern fitting makes the prosthesis shown outdated, the film is well planned and would be of value to anyone learning the checkout procedures, presumably the occupational therapist in most instances. For maximum benefit the viewer should have some knowledge of amputee training and standards of performance. Film viewing will be much more meaningful if checkout forms are on hand and can be followed item by item.

Distributor: Michigan Crippled Children Commission, Area Child Amputee Program, 920 Cherry St., Grand Rapids, Mich. 49506.

Rental Fee: None.

Purchase Cost: Negotiable upon request.

"Kevin is Four," Ohio Slate University, 1965, 26 min., color, sound, 16 mm.

Summary: Presents a congenital amputee with left below-elbow and right below-knee limb deficiencies. Demonstrates fabrication and enumerates advantages of new upper- and lower-extremity prostheses which eliminate the undesirable features of the old out-grown prostheses. Prosthetist is shown with child in a series of close-up shots. Also describes a waterproof leg used for swimming, and worn to bed by this child. Shows Kevin engaged in a wide variety of play and work activities.

Evaluation: This film effectively demonstrates the active life which may be led by the child amputee and shows clearly the value of a suitable well-fitting prosthetic device. The photography is good and includes some very appealing shots of Kevin. Narration is not always distinct and it is sometimes difficult to distinguish between speakers. The film would be excellent for showing to parents, teachers, and organizations such as the PTA, as well as other groups interested in the habilitation potential of the child amputee. It is not a teaching film for professional people.

Distributor: Ohio State University Motion Picture Division, 1885 Neil Ave.. Columbus, Ohio 43210.

Rental Fee: $8.50.

Purchase Cost: $220.00.

"Proximal Femoral Focal Deficiency," Michigan Department of Public Health {Authors: G. T. Aitken and C. H. Frantz), 1966, 30 min., color, sound, 16 mm.

Summary: Differentiates between congenital coxa vara and proximal femoral focal deficiency by identifying characteristic X-ray and clinical features of each. Presents four radiographic types of proximal femoral focal deficiencies and illustrates each with a specific patient for whom surgical indications, prosthetic fitting, and gait pattern are shown. One bilateral case is included. Stresses needed to retain feet in patients with bilateral proximal femoral focal deficiencies are shown. Serial X-rays are shown and the patients are followed for several years.

Evaluation: This is a skillfully produced, effective teaching film. The material is well organized, narration is realistically paced, and the main points are conclusively summarized. X-ray plates, diagrams, and cineradiography contribute to the clarity of the presentation. The film is of value primarily to the orthopaedic surgeon, the resident, and the medical student for purposes of differential diagnosis and to provide orientation to some aspects of medical management. No mention is made of the need for prolonged gait training. For other professional groups the film provides a background of information for better understanding in working with this type of patient.

Distributor: Michigan Crippled Children Commission, Area Child Amputee Program, 920 Cherry St., Grand Rapids, Mich. 49506.

Rental Fee: None.

Purchase Cost: Negotiable upon request.

ORTHOTICS

"An Application of Research in Orthotics" Texas Institute for Rehabilitation and Research, 1965, 22 min., color, sound, 16 mm.

Summary: Presents a wide variety of upper-extremity orthoses developed during a three-year research program. Important among these is a wrist-extension device designed to provide the hand with the function of pinch. Discusses and demonstrates the device in terms of an artificial muscle powered by compressed carbon dioxide, the actuation of valves by voluntary control movements, and the orthosis itself. Also illustrates equipment that enables the patient to perform shoulder and arm movements. Stresses the value of the team concept, the importance of fitting the device to the patient, and the necessity of training to achieve the most effective use of the device.

Evaluation: This is an excellent orientation film because it presents effectively the basis of orthotic design and development as well as the importance of fitting and training in the use of orthoses. It demonstrates well how design application, engineering technology, and technical innovation can combine to produce an efficient device and how the team concept enhances the prospect of satisfactory patient rehabilitation. The technical quality of the film is excellent except for the rapidity of the narration. The film would be of interest to anyone concerned with orthotic fitting and training of the patient with severe upper-extremity disability. It might be considered as a recruitment film for orthotists and would be informative for rehabilitation counselors.

Distributor: Orthotics Department, Texas Institute for Rehabilitation and Research, 1333 Moursund Ave., Houston, Tex. 77025.

Rental Fee: $10.00.

"Nonoperaiive Treatment of Scoliosis with Milwaukee Brace," Marquette University and Pope Foundation, 1963, 38 min., color, sound, 16 mm.

Summary: Shows briefly the physical examination for scoliosis in an adolescent girl; discusses principles and techniques in construction of the brace, fitting, application of pressure pads, and general treatment management of the young scoliotic patient. Most of the film is devoted to demonstration of the progressive steps in fabrication of the Milwaukee brace.

Evaluation: This is a technically superior film. The material is well organized and the step-by-step fabrication of the brace is exceptionally well demonstrated. Although the psychological problem is recognized, it is treated rather lightly in consideration of its seriousness. Results achieved by wearing the brace might appear to be overly optimistic. The orthotist has most to gain from this picture, but for anyone working with the adolescent scoliotic patient who wears the Milwaukee brace, it would be of value. One worthwhile feature is the explanation of how to determine whether the brace is too short or only appears to be so. The film could be shown to selected patients and family.

Distributor: American Academy of Orthopaedic Surgeons, 29 East Madison St., Chicago, Ill. 60602.

Rental Fee: $3.00.

Purchase Cost: Approximately $135.00.

"Self-Help Devices for Patients with Arthritis," Institute for Physical Medicine and Rehabilitation, I960. 16 min., color, sound, 16 mm.

Summary: In a foreword, Dr. Howard Rusk describes the need and place for self-help devices for persons with arthritis. A physician then demonstrates and explains a variety of self-help devices as used by several severely involved patients in performance of activities of daily living. Kitchen design for handicapped persons is discussed. Sources of devices and information are given.

Evaluation: This is a technically excellent film which could serve to orient health professions and organizations to the potential value of devices in helping the handicapped achieve independence. The explanations would have been more meaningful if the film had portrayed other members of the health team involved in rehabilitation of these patients. Of special interest to the general practitioner, nursing personnel, public health nurses, and vocational counselors.

Distributor: Campus Films Distributor Co., 20 East 46th St., New York, N. Y. 10017.

Rental Fee: $10.00. (Schedule at least two weeks in advance.)

Purchase Cost: $152.00.

"Use of the Flexorhinge Hand," Rancho Los Amigos Hospital, 1963, 25 min., color, sound, 16 mm.

Summary: Describes wrist-driven and externally powered nexorhinge hands, orthotic devices for patients with inadequate prehension. Also presented are surgical interventions to obtain prehension. Shows several patients who demonstrate inadequate pinch in severely involved hands. The loss of hand function in each is evaluated, the appropriate nexorhinge hand for each is described, and the patients are shown performing a variety of activities using the device. Supplementary bracing and adaptive equipment are also described.

Evaluation: A well-organized, clearly presented film that could be used advantageously as an effective teaching aid in basic educational programs for physical and occupational therapists and nurses. Especially valuable for anyone working with patients having upper-extremity disability. Because it is not overly technical, it might be considered for showing to parents and to selected patients.

Distributor: Medical Education Service, Rancho Los Amigos Hospital, 7601 East Imperial Highway, Downey, Calif. 90242.

Purchase Cost: $250.00.

Amputations, a Bibliography[1]

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17. Klopsteg, Paul E., Philip D. Wilson, *et al., Human limbs and their substitutes,* McGraw-Hill, New York, 1954. Out of print.
18. Larson, Carroll B., and Marjorie Gould, *Calderwood's orthopedic nursing,* pp. 339-361, C. V. Mosby Co., St. Louis, 1965. $7.75.
19. Lawton, Edith B., *Activities of daily living for physical rehabilitation,* p. 234, 245-250, McGraw-Hill, New York, 1963. $17.50.
20. Mosely, H. F., *The forequarter amputation,* J. B. Lippincott, Philadelphia, 1958. $10.00.
21. Radcliffe, C. W., and J. Foort, *The patellar-tendon-bearing below-knee prosthesis,* Biomechanics Laboratory, University of California (Berkeley and San Francisco), 1961. $3.00.
22. Rusk, H. A., *Rehabilitation medicine,* pp. 378-387, C. V. Mosby Co., St. Louis, 1964. $15.50.
23. Santschi, William R., *Manual of upper extremity prosthetics,* 2nd ed., University of California (Los Angeles), 1958. $4.00.
24. Slocum, D. B., *An atlas of amputations,* C. V. Mosby Co., St. Louis, 1949. Out of print.
25. Stoner, E. K., *Evaluation of gait,* in Krusen, F. H., F. J- Kottke, and P. M. Ellwood, Jr., *Handbook of physical medicine and rehabilitation,* W. B. Saunders Co., Philadelphia, 1965.
26. Smith, D. W., and C. D. Gips, *Care of the adult patient,* in *Medical surgical nursing,* 2nd ed., pp. 318-329, J. B. Lippincott Co., Philadelphia, 1966. $10.60.
27. Tosberg, William A., *Upper and lower extremity prostheses,* Charles C Thomas, Springfield, Illinois, 1962. $5.75.
28. Wellerson, Thelma, *A manual for occupational therapists on the rehabilitation of upper extremity amputees,* American Occupational Therapy Association, New York, 1958. $2.50.

JOURNALS AND PERIODICALS

Artificial Limbs: a Review of Current Developments. Committee on Prosthetics Research and Development and Committee on Prosthetic-Orthotic Education, National Academy of Sciences-National Research Council, 2101 Constitution Ave., Washington, D. C. 20418. Published twice a year. No charge.

Bulletin of Prosthetics Research. Prosthetic and Sensory Aids Service, Department of Medicine and Surgery, Veterans Administration. Subscriptions are not possible and the cost varies with each issue. The Veterans Administration does not sell the *Bulletin.* The following issues may be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

Spring 1965: $0.70.
Fall 1965: $0.75.
Spring 1966: $0.65.
Fall 1966: $1.00.

Inter-Clinic Information Bulletin. Subcommittee on Child Prosthetics Problems of the Committee on Prosthetics Research and Development, National Academy of Sciences-National Research Council. Prepared by Child Prosthetic Studies, Research Division, College of Engineering, New York University, 317 East 34th St., New York, N. Y., 10016. Published monthly. No charge. Recently published was an index of articles, abstracts, and reprints appearing in the *Bulletin* between October 1961 and September 1966, compiled by Maurice Schweizer, New York University.

Orthopedic and Prosthetic Appliance Journal. Official organ of the American Orthotics and Prosthetics Association. Issued in March, June, September, and December. Subscription rate: $5.00 per year. Address Editor, Orthopedic and Prosthetic Appliance Journal, 919 18th St., N.W., Washington, D. C. 20006.

Prosthetics International. International Committee on Prosthetics and Orthotics of the International Society for Rehabilitation of the Disabled. Published at irregular intervals. International Society for Re-

habilitation of the Disabled, 219 East 44th St., New York, N. Y. 10017. No charge.

Birth Defects. Abstracts of Selected Articles. S5.00 per 12 issues per calendar year. *Original Articles Series.* No charge. *Reprint Series.* No charge. Publication lists may be obtained from the Medical Department, The National Foundation-March of Dimes, 800 2nd Ave., New York, N. Y., 10017.

Rehabilitation Literature. Original articles and abstracts of current literature. Published by the National Society for Crippled Children and Adults, Inc., 2023 West Ogden Ave., Chicago, Illinois 60612. S4.50 a year, United States; $5.00 a year, other countries.

BROCHURES AND MANUALS

Dieterich, Margrit, *Information on measures for habilitation of children with dysmelia,* Deutsche Vereinigung fur die Rehabilitation Behinderter, c/o Dr. Marlis Miiller, 6900 Heidelberg-Schlierbach, Zechnerweg 1 a, Germany.

Hall, C. B., *Prosthetic socket shape as related to anatomy in lower extremity amputees,* Reprinted from *Clinical orthopaedics and related research,* J. B. Lippincott, Philadelphia, 1964. No charge. May be requested from Committee on Prosthetic-Orthotic Education, National Academy of Sciences-National Research Council, 2101 Constitution Ave., N.W., Washington, D. C. 20418.

Hanger, H. B., *Above-knee socket shape and clinical considerations: a guide for physicians,* August 1964. No charge. May be requested from Committee on Prosthetic-Orthotic Education, National Academy of Sciences-National Research Council, 2101 Constitution Ave., N.W., Washington, D. C. 20418.

Hanger, H. B., *The Syme and Chopart prostheses: a manual for prosthetists,* Prosthetic-Orthotic Education, Northwestern University Medical School, Chicago, 1961. $3.00.

Hennessy, C. A., *Maintenance of the prosthesis. $0.05.* May be purchased from American Orthotics and Prosthetics Association, 919 18th St., N.W., Washington, D. C 20006.

Levy, S. W., and G. H. Barnes, *Hygienic problems of the amputee,* University of California (Berkeley), 1962. $0.15. May be purchased from American Orthotics and Prosthetics Association, 919 18th St., N.W., Washington, D. C. 20006.

Levy, S. W., and G. H. Barnes, *Stump edema,* University of California (Berkeley), 1961. $0.25. May be purchased from American Orthotics and Prosthetics Association, 919 18th St., N.W., Washington, D. C. 20006.

Linck, Lawrence J., *Help for your crippled child—you are not alone,* National Society for Crippled Children and Adults, Inc., 2023 West Ogden Ave., Chicago, Illinois. $0.25.

Lund, Aida, *Upper extremity prosthetic dictionary,* Accounting Department, Mary Free Bed Guild Children's Hospital, 920 Cherry St., S.E., Grand Rapids, Michigan 49506. 1960. $1.25.

Purka, Steven L., *A selected bibliography on artificial limbs and the amputee,* Veterans Administration, Research and Development Division, Prosthetic and Sensory Aids Service, 252 7th Ave., New York, N. Y. 10001. No charge.

Amputation—ask the man who has one, The War Amputations of Canada, Dominion Headquarters, 140 Merton St., Toronto 7, Ontario, Canada. Printed in English and French. No charge.

Limb prosthetics—in the interest of rehabilitation of the amputee, J. E. Hanger, Inc., 947 Juniper St., N.E., Atlanta, Ga. 30309. No charge.

Review of prosthetic-orthotic visual aids, Committee on Prosthetic-Orthotic Education. No charge. May be requested from the Committee on Prosthetic-Orthotic Education, National Academy of Sciences-National Research Council, 2101 Constitution Ave., N.W., Washington, D. C. 20418.

The child with the missing arm or leg, Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. $0.10.

Amputations Caused by Malignancy, an Annotated Bibliography[1]

The following annotated bibliography covers articles on amputations caused by malignancy published during the period 1956 through 1966. The purpose of the bibliography is to assist clinicians and educators in the location and selection of published materials without the necessity for extensive library research.

This material has been organized as follows:

[1] This bibliography was compiled by an *ad hoc* committee appointed by the Subcommittee on Prosthetics in Paramedical Education of the Committee on Prosthetic Orthotic Education. Chairman of the *ad hoc* committee is Miss Mary Poole, Director, Department of Social Work, University of Pennsylvania Hospital, Philadelphia, Pa. Members are Lieutenant Colonel Mildred Anderson, Army Medical Specialist Corps, U. S. Army (Ret.), Mrs. Joan E. Edelstein, Associate Research Scientist, School of Medicine and Post-Graduate Medical School, New York University, New York, N. Y.; Miss Nancy Ellis, Associate Director, Occupational Therapy Courses, College of Physicians and Surgeons, Columbia University, New York, N. Y.; Miss Jamie Lisle, Director of Physical Therapy, Medical College of Virginia, Richmond, Va.; Miss Lena M. Plaisted, Professor of Rehabilitation Nursing, Boston University School of Nursing, Boston, Mass.; and Miss Muriel E. Zimmerman, Associate Chief, Occupational Therapy Service, New York University, New York, N. Y. Colonel Ruth A. Robinson, Army Medical Specialist Corps, U. S. Army (Ret.), Chairman of the Subcommittee on Prosthetics in Paramedical Education, serves as an *ex-officio* member of the *ad hoc* committee. Mrs. Barbara R. Friz, Staff Officer of the Committee on Prosthetic-Orthotic Education, serves as secretary of the *ad hoc* committee.

The Committee on Prosthetic-Orthotic Education is supported by the Training Division of the Vocational Rehabilitation Administration and by the Prosthetic and Sensory Aids Service of the Veterans Administration.

MEDICAL MANAGEMENT

UPPER- AND LOWER-EXTREMITY AMPUTATIONS

1. Bowers, R. F., *Eleven years' experience with quarterectomy for malignant melanoma,* Arch. Surg., 81:752-756, November 1960.

No operative deaths occurred in this series of 17 adult men, 9 of whom underwent lower quarterectomy and 8 upper. Survival time and degrees of palliation are discussed. Tables.

2. Bowers, R. F., *Observations from the use of quarterectomy,* Arch. Surg., 79:483-486, September 1959.

Malignancy was reason for 29 quarterectomies, 16 upper and 13 lower extremities. Mortality rate was 3.4 per cent. Two patients survived more than 5 years; 6 more than three years. Results indicate that palliation can be expected in a small selected group of malignancies. Tables.

3. Byron, R., Jr., *et al., Interscapulothoracic amputation and sacroiliac disarticulation with adjunctive arterial chemotherapy,* Surg. Gynec. Obstet., 111:457-463, October 1960.

Series reported consists of 11 forequarter amputations and 9 hemipelvectomies, all performed for malignant disease. Technique described for both procedures and end results discussed in terms of morbidity, mortality, and rehabilitation. It is technically possible to combine local chemotherapy with surgery, but long-range results are unknown. Tables, x-ray plates.

4. Jacobson, S. A., *Early juxtacortical osteosarcoma {parosteal osteoma),* J. Bone

Joint Surg. (Amer.), 40A:1310-1328, December 1958.

Discussion of an osteochondroma-like lesion which represents the beginning of juxtacortical osteosarcoma. Presents 8 cases, 3 with subsequent amputations. Photographs, photomicrographs, tables.

5. McKenna, R. J., C. P. Schwinn, and N. L. Higinbotham, *Osteogenic sarcoma in children,* Calif. Med., 103:165-170, September 1965.

Report on 130 children seen during 30-year period with at least 10-year follow-up. Survival rate at 5 years was 23 per cent; at 10 years 20 per cent. Amputation is much more effective than radiation in terms of survival. Charts.

6. Nilsonne, U., *Radical amputation for malignant tumours of the extremities,* Acta Chir. Scand., 129:150-155, February 1965.

Of 34 patients treated with radical amputation, 15 died of the tumor disease within 12 months of operation. Five years after surgery, 15 per cent were free from metastasis. Indications for amputation discussed. Procedure is effective in prolonging life and in some instances in affording freedom from metastasis. Photographs, x-ray plates, tables.

7. Salerno, D. J., *Forequarter and hindquarter amputation,* J. Amer. Osteopath. Ass., 61:15-21, September 1961.

Indications, pre- and postoperative care, and operative procedures for forequarter and hindquarter amputations are briefly discussed. Presents illustrative case for each type.

8. Taswell, H., E. Soule, and M. Coventry, *Lymphangiosarcoma arising in chronic lymphedematous extremities,* J. Bone Joint Surg. (Amer.), 44A:277-294, March 1962.

Reports 13 cases and presents summary of 64 accepted and 7 probable examples found in literature. Forequarter found to be the most common definitive treatment but prognosis poor regardless of method of treatment. Photographs and tables showing detailed information on each case reported in literature.

9. Troup, J. B., and W. H. Bickel, *Malignant disease of the extremities treated by exarticulation: analysis of two hundred and sixty-four consecutive cases with survival rates,* J. Bone Joint Surg. (Amer.), 42:1041-1050, September 1960.

Five-year survival rates were 40.6 per cent for forequarter amputations; 41.5 per cent for hindquarter; 39.6 per cent for hip-joint disarticulation and 19.2 per cent for shoulder-joint disarticulation. Survival rate for all was 36.8 per cent. Analysis of series indicates that survival rates were adversely affected by patients who received surgical treatment as a palliative measure. Nine tables presenting statistical data.

10. Weinfeld, M. S., and H. R. Dudley, Jr., *Osteogenic sarcoma,* J. Bone Joint Surg. (Amer.), 44A:269-276, March 1962.

Variability in histological definition has frequently diluted reported series with tumor. Criterion for histological sarcoma in this study was presence of sarcomatous cells producing osteoid in some part of tumor. Of 164 cases diagnosed and treated over 40-year period, 94 fulfilled criterion. (Slides not available on 32.) Majority of tumors located in metaphysis of long bones. Thirteen cases survived more than 5 years after surgery.

UPPER-EXTREMITY AMPUTATIONS

11. Hardin, C. A., *Intrascapulothoracic amputation for sarcoma of the upper extremity,* Surgery, 49:355-358, March 1961.

Two case reports. A 63-year-old woman was free of disease 7 years after resection and a 33-year-old male four years later. Photographs, x-ray plates.

12. Holleb, A. I., and J. C. Lucas, Jr., *Palliative interscapulothoracic amputation in the management of the breast cancer patient,* Cancer, 12:643-647, July-August 1959.

Of 6 patients, 5 had satisfactory palliation lasting from 8 months to 12 years following amputation. Indications and contraindications are discussed. Photographs.

13. Lansche, W. E., and H. J. Spjut, *Chondrosarcoma of the small bones of the hand,* J. Bone Joint Surg. (Amer.), 40A: 1139-1145, October 1958.

Summary of 9 reported cases of chondrosarcoma in the small bones of the hand. One case is studied extensively. In 5 of the 9 cases, chondrosarcomas were located in the long finger. Charts, photographs.

14. Nadler, S. L., and J. T. Phelan, *A technique of interscapulothoracic amputation,* Surg. Gynec. Obstet., 122:359-364, February 1966.

Detailed description of the operation is given. Drawings.

15. Pack, G. T., and T. A. McGraw, *Interscapulomammothoracic amputation for malignant melanoma,* Arch. Surg., 83: 694-699, November 1961.

Describes operation designed by Prudente who reported that operative mortality rate on 28 patients was only 2. Indications and contraindications. Two case histories. End results of conventional interscapulothoracic amputation performed on 102 patients also recorded. Photographs.

LOWER-EXTREMITY AMPUTATIONS

16. Ariel, I. M., and R. Margolis, *The sacroiliac twist: inoperable chondrosarcoma rendered resectable by hemipehectomy,* New York J. Med., 62:3297-3301, October 1962.

This procedure is an alternative to sacroiliac dissection. Surgical procedure described. Drawings, photographs, x-ray plates.

17. Aust, J. E., and K. B. Absolon *A successful-lumbosacral amputation, hemicorporectomy,* Surgery, 52:756-759, November 1962.

Surgical procedure performed on a 29-year-old male. Technique of procedure is described and indications are discussed. Drawings, photographs.

18. Ben-Aderet, N., *Pregnancy following hindquarter amputation,* J. Obstet. Gynaec. Brit. Comm, 72:306-307, April 1965.

Patient was delivered of twins by Caesarean section. Amputation performed 1 1/2 years previously for echinococcal cyst. Photographs, x-ray plates.

19. Brunschwig, A., *Hemipehectomy in combination with partial pelvic exenteration for uncontrolled recurrent and metastatic cancer of the cervix, five-year survival,* Surgery, 52:299-304, August 1962.

Describes surgery performed on the 35-year-old mother of four who 5 years later is fully active and well adjusted to colostomy and ambulation. Drawings, photographs.

20. Churchill, C. J., *et al., Postoperative "restoration" of the hemipelvectomized patient,* J. Kentucky Med. Ass., 55: 904-906, October 1957.

Reports four cases, all of whom survived surgery. With proper prostheses and training, they were "restored" to carry on a relatively normal life. Photographs.

21. Clutts, G. R., and W. R. Deaton, Jr., *Hemipehectomy: a palliative procedure,* Amer. Surg., 24:511-514, July 1958.

Two cases reported were ambulatory and feeling better, one 11 months and one 12 months after surgery. Operation has a definite place in the palliative treatment of malignancies of the upper thigh and pelvis. Photographs.

22. Fredell, C. H., *Hemipehectomy for soft tissue tumor in a child,* Amer. J. Orthop., 6:39-41, February 1964.

Hemipelvectomy performed on a 13-year-old boy yielded an excellent result. Tumor was originally thought to be a fibromyxoma. After 3 years of follow-up, reappraisal revealed it to be an unusual myositis ossificans. Stresses need for definite pathological consultation. Children tolerate radical operative procedures remarkably well and should never be deprived of curative surgery when indicated. Photographs and x-ray plate.

23. Freed, M. M., and E. E. Charettee. *Rehabilitation after amputation of the lower extremity for malignancy,* Arch. Phys. Med., 45:564-570, November 1964.

Seven-year follow-up study of 12 individuals who underwent above-knee amputations as a result of malignancy. Each patient fitted and trained prosthetically. Selected case studies and discussion. Table.

24. Gilmer, W. S., and G. MacEwen, *Central (medullary) fibrosarcoma of bone,* J. Bone Joint Surg. (Amer.), 40A:121-141, January 1958.

Presents 22 case reports of 15 males and 7 females with medullary fibrosarcomas. Age range from 12 to 73 years. Seventy-seven per cent of lesions were located in distal femur and proximal tibia. Survival rates after amputation are discussed. Charts, photographs.

25. Higinbotham, N. L., R. C. Marcove, and P. Casson, *Hemipelvectomy: clinical study of 100 cases with five-year follow-up on 60 patients,* Surgery, 59:706-708, May 1966.

Mortality rate (death within 30 days of surgery) was 7 per cent in 100 cases. Of 35 patients included in a 10-year follow-up, 12 (34 per cent) are alive and well; of 60 patients in a 5-year follow-up, 21 (35 per cent) are alive and well. Twenty-four patients have used a prosthesis for an extended period of time. Chondrosarcoma and osteogenic sarcoma were the most frequent indications for surgery. Operation considered worthwhile, its use justified by an acceptable mortality rate and an adequate long-term survival rate. Tables.

26. Johnson, L. L., and R. L. Kempson, *Epidermoid carcinoma in chronic osteomyelitis: diagnostic problems and management,* J. Bone Joint Surg. (Amer.), 47A:133-145, January 1965.

Signs, symptoms, and course of disease studied. Presence of all gradients of epithelial proliferation in any given case makes diagnosis difficult. Appears to be found most frequently in sinus tract of tibia. Histological diagnosis of disease indicates amputation at adequate level. Ten cases reviewed. Photographs, photomicrographs, tables, x-ray plates.

27. Kennedy, C. S., *el al., Lumbar amputation or hemicorporectomy for advanced malignancy of the lower half of the body,* Surgery, 48:357-365, August 1960.

Surgical procedure is described in this detailed case history of a 74-year-old man. Patient survived to the eleventh postoperative day, death presumably due to unduly increased blood volume. Authors would attempt procedure again when circumstances arise. Graphs, photographs, x-ray plates.

28. Lane, D., *Hind-quarter amputation for advanced malignant melanoma of the lower limb,* Med. J. Aust, 49:709-710, November 1962.

Case report of successful surgery on a 28-year-old woman with advanced secondary malignant melanoma. Electromyographic tracings, photographs.

29. Loon, H. E,, *The past and present medical significance of hip disarticulation,* Artificial Limbs, 4:4-21, Autumn 1957.

Discusses change in military and civilian indications for disarticulation since the eighteenth century, methods of reducing mortality and surgical fashioning of large, short soft-tissue, thigh stumps. Possible systemic effects of disarticulation. Extensive bibliography, illustrations.

30. McLeod, M., *Osteogenic carcinoma: a teenager's reaction to radical surgery,* Canad. Nurse, 60:49-52, January 1964.

Related subjectively in form of diary entries.

31. McPeak, C. J., *et al., Amputation for melanoma of the extremity,* Surgery, 54:426-431, September 1963.

Patients in this series considered incurable by any means other than amputation. The total cure ratio is 18 of 54 patients (33.3 per cent) treated by major amputation for recurrent and local or regional metastatic melanoma. Tables.

32. Miller, T. R., *et al., Hemicorporectomy,* Surgery, 59:988-993, June 1966.

Translumbar amputation on two patients affected with uncontrollable cancer seems to indicate the technical feasibility of this operation to be well established. Socioeconomic problems are enormous. Prolongation of a useful life remains to be seen. Detailed history on two patients. Photographs.

33. Miller, T. R., *Hemipelvectomy in the treatment of advanced cancer,* Amer. J. Roentgen., 87:531-535, March 1962.

In a series of 37 cases the 5-year survival rate was 18.9 per cent, or 20.8 per cent (if the 13 cases of advanced melanoma are not included in series). Suggests that palliation, comfort, and sometimes cure in advanced cancer justifies this radical but safe procedure. Photographs.

34. Miller, T. R., *Interilio-abdominal amputation: a report of 32 cases,* Acta Radiol. (Suppl.), 188:173-189, 1959.

Detailed description of surgical procedure. Personal experience with 32 cases in terms of preoperative preparation, postoperative management, rehabilitation, and end results.

35. Monahan, D. T., *Hemipelvectomy for fibrosarcoma,* Ann. Surg., 148:189-191, August 1958.

Documents a case of fibrosarcoma that survived over seven years after hemipelvectomy.

Patient died of myocardial infarction and autopsy revealed no evidence of fibrosarcoma. Photographs.

36. Pack, G. T., and T. R. Miller, *Exarticulation of the innominate bone and corresponding lower extremity {hemipelvectomy) for primary and metastatic cancer: a report of one hundred and one cases with analysis of the end results,* J. Bone Joint Surg. (Amer.), **46A:91-95,** January 1964.

Indications are listed. Tables showing types of tumors and end results are given. Brief discussion of experiences.

37. Pack, G. T., and T. R. Miller, *Exarticulation of the innominate bone for primary and metastatic cancer. An experience with 201 cases,* Progr. Clin. Cancer, 2:98-106, 1966.

Indications for surgery in 201 consecutive cases were: malignant skin tumors, 14.9 per cent; soft-part sarcomas, 34.8 per cent; malignant bone tumors, 50.3 per cent. Brief discussion of technique and postoperative course and rehabilitation. Mortality and survival rates. Chondrosarcomas involving the proximal femur have a better prognosis than those involving the distal end of the femur because hemipelvectomy is more often practiced with the former. Latest in a series of articles reporting work at Memorial Cancer Center, New York. Drawings, photographs, table, x-ray plates.

38. Phelan, J. T., and S. H. Nadler, *A technique of hemipelvectomy,* Surg. Gynec. & Obstet., 119:311-318, August 1964.

Criteria for surgery and graphic details of standard surgical procedure are presented. Drawings.

39. Phelan, J. T., J. T. Grace, and G. E. Moore, *Hemipelvectomy for the management of soft tissue tumors of the lower extremity,* Amer. J. Surg., 107:604-608, April 1964.

Twelve cases reported. In selection of patients for hemipelvectomy, emphasis is directed to utilization of the tumors' histologic and biologic behavior. Survival rates are cited. Photographs, table.

40. Ravitch, M. M., and T. C. Wilson, *Long-term results of hemipelvectomy,* Ann. Surg., 159:667-682, May 1964.

Series of 37 hemipelvectomies performed for a variety of indications is reported. Two operative deaths occurred, neither early. A number of patients in each tumor category had long periods of survival free from tumor. Operative technique is described. Brief review of literature. The operation affords the best chance of cure for malignant bone and soft tissue tumors of the upper thigh. Diagrams.

41. Smith, B. C, *A 54-year follow-up report of disarticulation of the left hip for recurrent Ewing's tumor of the femur,* Surg. Gynec. Obstet., **118:120-122,** January 1964.

Original bone tumor section casts some doubt on diagnosis of Ewing's tumor and suggests it may have been reticulum cell sarcoma. In 1962 patient reported partial inactivity because of cardiac status but no symptoms referable to any other portion of the body.

42. Stevens, J., and B. Lennox, *Long survival after amputation for Paget's sarcoma of bone.* J. Bone Joint Surg. (Brit.), **40B:** 735-739, November 1958.

Three cases are reported, one of whom is alive and well seven years following amputation. Two previously reported cases surviving seven years or more are mentioned and presumed cured. Photographs, radiographs.

43. Wesseling, E., *The adolescent facing amputation,* Amer. J. Nurs., 65:90-94, January 1965.

Case history of patient with osteogenic sarcoma. Presents nurse's role in pre- and postsurgical period. Nurse provides milieu for patient and family to express emotional reactions. Adolescent nursing unit in orthopaedic department of University of Illinois Hospital emphasizes interdepartmental approach to patient care.

44. Wilhite, J. L., *Carcinoma developing in a pre-existing scar: a case report of carcinoma of amputation stump,* Virginia Med. Monthly, 91:292-294, July 1964.

Patient underwent high thigh amputation following cancerous scar on mid-thigh amputation. Malignant tumors arising in scar tissue extend and invade surrounding tissue more slowly than those not arising in scar tissue.

45. Wyndham, N., *Hindquarter amputation for sarcoma of the femur,* Med. J. Aust., 44: 466-467, September 1957.
Exact type of sarcoma not determined. Patient employed and well eight years after surgery.
46. Yancey, A. A., H. F. Ryan, and J. J. Blasingame, *An experience with hemicorporectomy,* J. Nat. Med. Ass., 66:323-325, July 1964.
The patient whose case is reported died the fourth postoperative day after developing pulmonary edema, bronchopneumonia, and atelectasis. X-ray plates.
47. Young, E. L., and W. A. Barnes, *Hemipelvectomy,* Amer. J. Nurs., 58:361-364, March 1958.
Brief description of operation and indications for use. Stresses importance of considering patient's total needs and discusses doctor's and nurse's role. Preoperative and immediate postoperative care are discussed. Drawings, photographs.

PROSTHETIC MANAGEMENT

UPPER-EXTREMITY AMPUTATIONS

48. Wee, G. C, *et al., Rehabilitation following interscapular amputation, a case report,* Arch. Phys. Med., 44:284-287, May 1963.
Excellent results achieved through a well-organized program and high degree of motivation of 66-year-old patient. Photographs, table.

LOWER-EXTREMITY AMPUTATIONS

49. Bogrette, A., *Case report: a hemipelvectomy patient,* J. Amer. Phys. Ther. Ass., 42:776-777, December 1962.
Hemipelvectomy performed because of malignant mesenchymal neoplasm. Patient fitted and trained with a Canadian hip-disarticulation prosthesis.
50. Childs, T. F., and M. Holtzman, *Postoperative management and rehabilitation of the hemipelvectomized patient,* Arch. Phys. Med., 40:227-230, June 1959.
Treatment program described includes bandaging and exercise programs. Photographs.
51. Easton, J. K., W. J. Dawson, and F. J. Kottke, *Fitting of a prosthesis on a patient after hemicorporectomy,* Arch. Phys. Med., 44:335-337, June 1963.
Radical surgery was performed on 29-year-old paraplegic in whom a squamous cell carcinoma had developed in an extensive decubital ulcer. Prosthesis allowed him to be mobile in a wheelchair in the upright position. Photographs.
52. Foort, J., *Some experience with the Canadian-type hip disarticulation prosthesis,* Artificial Limbs, 4:52-70, Autumn 1957.
Experience with eight cases summarized, the hip-disarticulation prosthesis proving to be highly satisfactory. Numerous photographs.
53. Hampton, F., *A hemipelvectomy prosthesis,* Artificial Limbs, 8:3-27, Spring 1964.
Biomechanical considerations and detailed instruction for the fabrication of the prosthesis. Numerous sequential photographs.
54. Hampton, F., *Northwestern University suspension casting technique for hemipelvectomy and hip disarticulation,* Artificial Limbs, 10:56-61, Spring 1966.
Technique differs from that described in Spring 1964 issue (see 53) in that weight is borne over the entire area of the "stump" and lower rib cage rather than just at the distal area. Drawing, photographs.
55. Holscher, E. C, R. J. Curtis, and H. G. Farris, *Hip-level amputation—a report of a survey of the United States military veterans,* Bull. Prosth. Res., 10-4:52-64, Fall 1965.
In this series of 87 amputees, 55 per cent reported continual use of a prosthesis in their routine pursuits. Suggests that the individual falls into a pattern of either regular dependence on the limb or of complete abandonment. Pattern seemingly related to vocational and avocational skills. Patients' comments on socioeconomic effects of the amputation and advantages and disadvantages of the Canadian hip prosthesis are presented. Tumors were cause of 15 amputations, 14 of which occurred in post-World War II period. Graphs, questionnaire form, tables.
56. McLaurin, C. A., *The evolution of the Canadian-type hip-disarticulation prosthesis,* Artificial Limbs, 4:22-28, Autumn 1957.

Functional characteristics of saucer-type and tilting-table prostheses are presented. Development of Canadian design. Numerous illustrations.

57. Radcliffe, C. W., *The biomechanics of the Canadian-type hip-disarticulation prosthesis,* Artificial Limbs, 4:29-38, Autumn 1957.

Principles of mechanics, functional sequence in use of the prosthesis, action of the socket in lateral support, surgical fitting, and training implications. Numerous illustrations.

58. Randle, A. P., J. N. Wilson, and W. H. Tuck, *Rehabilitation after hindquarter amputation,* Brit. Med. J. 5336:1001-1002, April 1963.

Molded felt artificial buttock is incorporated into a corset to provide satisfactory support in sitting for long periods. Photographs, x-ray plate.

59. Vagias, G. J., *Plaster pylon for a patient with a hemipelvectomy,* J. Amer. Phys. Ther. Ass., 45:700-702, July 1965.

Detailed description of method used to make device. Photographs.

60. Watkins, A. L., *Prosthetic rehabilitation after hemipelvectomy,* Orthop. Prosth. Appliance J., 17:173-174, June 1963.

Successful fitting of Canadian-type prosthesis for hemipelvectomies reported for patients with various occupations and physical problems.

61. Watkins, A. L., *Rehabilitation after hemipelvectomy,* J.A.M.A., 181:793-794, September 1962.

Ten patients with hemipelvectomy were supplied with prostheses, including six Canadian-type. Results reported. Suggests that expenditure of time and money are vindicated. Photographs.

62. Yue, S. J., and C. K. Goldstine, *An improved prosthesis for hemipelvectomy,* Arch. Phys. Med., 38:781-784, December 1957.

Report of a study of bucket-type prosthetic design used by 10 patients. Photographs.

Amputations Caused by Vascular Disease, an Annotated Bibliography[1]

The following annotated bibliography covers articles on amputations caused by vascular disease published during the period 1956 through 1966. The purpose of the bibliography is to assist clinicians and educators in the location and selection of published materials without the necessity for extensive library research.

This material has been organized as follows:

[1] This bibliography was compiled by an *ad hoc* committee appointed by the Subcommittee on Prosthetics in Paramedical Education of the Committee on Prosthetic-Orthotic Education. Chairman of the *ad hoc* committee is Miss Mary Poole, Director, Department of Social Work, University of Pennsylvania Hospital, Philadelphia, Pa. Members are Lieutenant Colonel Mildred Anderson, Army Medical Specialist Corps, U. S. Army (Ret.); Mrs. Joan E. Edelstein, Associate Research Scientist, School of Medicine and Post-Graduate Medical School, New York University, New York, N. Y.; Miss Nancy Ellis, Associate Director, Occupational Therapy Courses, College of Physicians and Surgeons, Columbia University, New York, N. Y.; Miss Jamie Lisle, Director of Physical Therapy, Medical College of Virginia, Richmond, Va.; Miss Lena M. Plaisted, Professor of Rehabilitation Nursing, Boston University School of Nursing, Boston, Mass.; and Miss Muriel E. Zimmerman, Associate Chief, Occupational Therapy Service, New York University, New York, N. Y. Colonel Ruth A. Robinson, Army Medical Specialist Corps, U. S. Army (Ret.), Chairman of the Subcommittee on Prosthetics in Paramedical Education, serves as an *ex-officio* member of the *ad hoc* committee. Mrs. Barbara R. Friz, Staff Officer of the Committee on Prosthetic-Orthotic Education, serves as secretary of the *ad hoc* committee.

The Committee on Prosthetic-Orthotic Education is supported by the Training Division of the Vocational Rehabilitation Administration and by the Prosthetic and Sensory Aids Service of the Veterans Administration.

MEDICAL MANAGEMENT

COMPREHENSIVE ARTICLES

Gerber, A., *Amputations as life-saving measures,* J. Amer. Osteopath. Ass., 62:1082-1085, August 1963.

Philosophical approach, indications, and general technique of amputations are briefly presented. Describes surgical procedures of above-knee amputation for patients with gangrene from vascular occlusive disease.

Gibbel, M. I., *Special considerations in amputations of the lower extremity for gangrene vascular disorders,* Surg. Clin. N. Amer., 40:165-176, February 1960.

Dry and moist gangrene are explained. Preoperative, operative, and rehabilitation considerations, including care of the remaining foot, dry-ice refrigeration, exercises for the stump, and early provisions of temporary prosthesis. Drawings.

McKittrick, J. B., *Lower extremities,* G P 13: 104-113, May 1956.

Lower-extremity amputations in the patient with poor arterial blood supply are discussed in terms of indications for amputation, preoperative program, timing of amputations, level of amputations, and surgical techniques. Drawing, tables.

Neuman, L. A., and R. A. Jones, *Supracondylar amputation in the aged,* Calif. Med., 95: 88-91, August 1961.
One hundred and five consecutive supracondylar amputations during a five-year period are summarized according to surgical technique, complications, rehabilitation, and deaths. Approximately 75 per cent could not be rehabilitated. Tables.

Record, E. E., *Surgical amputation in the geriatric patient,* J. Bone Joint Surg. (Amer.), **45A:** 1742-1749, December 1963.
Selection of level of amputation, medical management, and surgical procedure for various levels. Temporary prosthesis is described and advantages listed. Photographs.

Russek, A. S., *Pre- and postoperative management of potential diabetic amputee,* New York J. Med., 66:1659-1662, June 1966.
Emphasizes consideration of peripheral neuritis and loss of sensory perception, peripheral vascular impairment, and the influence of nutritional deficiencies on healing. Procedure for facilitating healing and rehabilitation.

Schmukler, J., *Amputations in peripheral vascular disease,* J. Med. Soc. New Jersey, 53:106-111, March 1956.
Vascular surgery considered from the point of view of diagnosis, preoperative care, optimum time for operation, amputation site, psychological preconditioning, anaesthesia, technique, postoperative care, rehabilitation, and prosthetic ambulation. Statistics on 100 amputations.

Shahnazarian, K., *Rehabilitation of the amputee,* GP, 29:115-118, March 1964.
Brief presentation of cause, surgery, postoperative complications, prosthetic fitting, and training. Drawings.

Thompson, R. G., *The geriatric amputee,* Arizona Med., 21:25-29, January 1964.
General discussion of selection of site of amputation and prosthetic fitting. Suggests all geriatric amputees be evaluated for a prosthesis. Contraindications noted. Photographs.

Tillgren, C, *Obliteralive arterial disease of the lower limbs: a study of the course of the disease,* Acta Med. Scand., 178:103-119, July 1965.
Reports frequency and level of amputation in three groups: arteriosclerotic patients with diabetes, patients without diabetes, and patients with Buerger's disease and other types of arteritis. No obvious difference in survival between patients with and without amputation. Photographs, tables.

SURGICAL MANAGEMENT

Protective Surgery and Other Preventive Measures

Catterall, R. C, *Amputations in diabetes,* Postgrad. Med. J., 33:266-271, June 1957.
Better understanding of the causes of diabetic lesions, and a regime of intensive prophylactic treatment may either obviate the necessity of amputation or allow less drastic operations. Photographs.

Hardy, J. D., and J. H. Conn, *Surgical procedures for leg ischemia in 549 consecutive cases,* Surg. Gynec. Obstet., 117:686-690, December 1963.
Arterial reconstructive operations considered fully justified. Stringent criteria for operation and rigid individualization are stressed. Bypass grafts performed on 56 patients showed one-third to be patent after an average of 23.7 months; thromboendarterectomy performed on 26 patients showed 8 to have good distal arterial pulsation for an average of 23 months. Some benefit resulted in half of the 79 patients who had lumbar sympathectomy. Surgical prodecures not discussed. X-ray plates.

Larmi, T. K., *Adrenalectomy or amputation? Experiences in the treatment of peripheral arteriosclerotic gangrene.* Acta Orthop. Scand. (Suppl.), 61:1-20, 1963.
Of 10 patients on whom adrenalectomy was performed, major amputation was avoided in 7 patients who subsequently improved and were able to work. Unilateral adrenalectomy is worth trying when an arteriosclerotic patient has impending gangrene due to poor skin circulation and all other therapeutic measures except amputation have already been attempted. Photographs, tables, x-ray plates.

Passler, H. W., *How can we reduce the number of amputations in patients with disturbance of*

the peripheral circulation? Angiology, 7:528-531, December 1956.

Conservative preventive measures and surgical treatment programs have made unnecessary the primary amputation of arms and legs and restricted the amount and extent of secondary partial amputation. Photographs and x-ray plates.

Popkin, R. J., *The effect of a disturbed gait on peripheral occlusive arterial disease,* Angiology, 8:394-401, October 1957.

A limping gait increases the work load of the opposite extremity which, in turn, requires an increased arterial blood flow that cannot be met in arterial occlusive disease. Increased work load often leads to an increased number of amputations. Stresses reducing work load by use of cane, shortening the stride, or slowing the pace. Three cases cited in which an injury to one leg resulted in severe ischemic symptoms of the opposite extremity.

Spencer, F. C, and P. R. Winslow, *The treatment of arteriosclerotic gangrene of the foot by arterial reconstruction and local amputation,* J. Kentucky Med. Ass., 63:174-177, March 1965.

Four patients (2 diabetic) were treated by a combination of endarterectomy, bypass grafts, and local amputation. Initial good results continued for 12, 21, 23, and 30 months, respectively. Emphasizes that no amputation should be performed for gangrene limited to the distal half of the foot until arteriography has demonstrated that all three tributaries of the popliteal artery are hopelessly occluded. Surgical technique for endarterectomy is briefly described. Photographs.

Suffness, G., *Indications for surgery in arteriosclerotic occlusive disease,* J. Med. Soc. New Jersey, 72:3-5, January 1965.

Considers various ways of preventing amputation. Restoration of patency in a major artery by surgical means, the use of vasodilating drugs, lumbar sympathectomy, and conservative measures are briefly discussed.

Selection of Amputation Level

Baddeley, R. M., *A trial of conservative amputations for lesions of the feet in diabetes mellitus,* Amer. Surg., 30:431-433, July 1964.

Of 132 patients who underwent amputations involving 167 limbs, 20 died either during operation or within 28 days. Patients were submitted to the most minimal ablative procedure possible. Healing is possible in 50 per cent of patients with ablation at or below the malleoli. Above-knee amputation necessary in only 21 per cent. Four tables.

Baddeley, R. M., and J. C. Fulford, *A trial of conservative amputations for lesions of the feet in diabetes mellitus,* Brit. J. Surg., 52:38-53, January 1965.

Minimal feasible amputation procedures on 167 limbs are evaluated. Forty per cent were at or below the malleoli; 21 per cent were above knee; 26.5 per cent were bilateral. Below-knee stump considered superior to above-knee in terms of rehabilitation. Minimal two-year follow-up. Eleven tables.

Baddeley, R. M., and J. C. Fulford, *The use of arteriography in conservative amputations for lesions of the feet in diabetes mellitus,* Brit. J. Surg., 51:658-663, September 1964.

Arteriograms performed on 63 patients indicate that 70 per cent accuracy in selection of amputation level can be expected using arteriographic findings alone. When assessment includes clinical picture, accuracy is almost 90 per cent. Suggest arteriography be used routinely to select levels. Technique of arteriography and several cases discussed. Tables, x-ray plates.

Block, M. A., and F. W. Whitehouse, *Below-knee amputation in patients with diabetes mellitus,* Arch. Surg., 87:682-689, October 1963.

Of 43 below-knee amputations in 40 patients, only one patient required above-knee amputation because of failure of healing. Most helpful criteria in selection are gross appearance of skin and leg and the presence of hair growth. Majority of patients ambulated with a prosthesis postoperatively. Photographs, tables.

Bradham, G. B., W. H. Lee, and J. M. Stallworth, *Transmetatarsal amputation,* Angiology, 11:495-498, December 1960.

Thirteen patients (11 diabetic) with 15 transmetatarsal amputations are analyzed. Reamputation was necessary in 8 cases. Selection of cases is discussed, including the necessity for objective vascular evaluation before any surgery. Charts.

Bradham, R. R., and R. D. Smoak, *Amputations of the lower extremity used for arteriosclerosis obliterans,* Arch. Surg., 90:60-64, January 1965.

Of 149 patients having 189 amputations for arteriosclerosis obliterans, the over-all failure of the primary amputation to heal was 20.38 per cent with digit and transmetatarsal showing the highest rate. Criteria for selection of amputation level are discussed. Authors suggest a need for more accurate means of evaluating the circulation at the arteriole, capillary, and cell level. Tables.

Case, T. H., and E. Hyland, *Amputation in patients over* 80 *years of age,* J. Amer. Geriat. Soc., 12:868-870, September 1964.

Twenty-six patients, all over age 80, underwent amputation of a lower extremity with mortality rate of 34.7 per cent, all deaths due to cardiopulmonary complications. Amputation at the supracondylar level, performed on 15 patients, advocated for patients of this age unless the extremity is gangrenous. Lumbar sympathectomy not ad vised.

Dale, G. M., *Syme's amputation for gangrene from peripheral vascular disease,* Artificial Limbs, 6:44-51, April 1961.

Twenty-two case reports of patients with Buerger's disease or diabetic gangrene who had Syme's amputation.

Dwyer, W. A., Jr., *Arteriography in localizing the amputation level in arteriosclerosis obliterans,* J. Med. Soc. New Jersey, 59:464-467, August 1962.

Arteriography provides a reliable guide to healing and hence to amputation site. Thirteen cases are summarized, 3 in detail. Photographs.

Eraklis, A., and W. Brownell, *Below-knee amputations in patients with severe arterial insufficiency,* New Eng. J. Med., 269:938-943, October 1963.

Sixteen consecutive below-knee amputations were carried out in 15 patients because of actual or impending gangrene of foot. In no case did gangrene extend above the malleoli. None had a palpable popliteal pulse or calf oscillations. Ten healed primarily, 3 showed delayed healing, and 3 required reamputation at above-knee level. Eleven patients used their prostheses either working or attending to their own needs. Two were bilateral. Urges consideration of below-knee amputation for ischemic gangrene of foot despite decreased circulation at calf level, provided patient's general condition and motivation do not preclude subsequent rehabilitation with use of prosthesis.

Harris, P. D., S. I. Schwartz, and J. A. DeWeese, *Midcalf amputation for peripheral vascular disease,* Arch. Surg., 82:381-383, March 1961.

Of 52 primary closed midcalf amputations, successful healing occurred in 75 per cent. Three postoperative deaths. Ten required reamputation. No correlation between the presence of diabetes and the percentage of healing. Presence of diabetes, osteomyelitis, and the status of the pulse and oscillometries are correlated with results. Tables.

Harris, W. R., and E. A. Silverstein, *Partial amputations of the foot: a follow-up study,* Canad. J. Surg., 7:6-11, January, 1964.

Following review of 49 patients with amputation of the foot, the authors conclude that, from the functional viewpoint, the optimum site is distal to the tarsometatarsal joint. Main reason for failure was poor skin cover and painful stiffness of the stump, rather than mechanical disadvantage. Stump should be covered with healthy, full-thickness skin. Drawings, photographs, tables.

Haslam, E. T., R. Grunsten, and J. Wickstrom, *Changing concepts in managing peripheral vascular disease,* J. Louisiana Med. Soc, 112:178-182, May 1960.

In a series of 73 patients with a total of 104 amputations, hospital mortality rate was 10.9 per cent. In 39 patients, including 24 major amputees, ambulation was preserved. A conservative approach to the site of lower-extremity amputations is described.

Herman, B. E., *Transmetatarsal amputation in arteriosclerotic diabetic gangrene,* New York J. Med., 62:1432-1434, May 1962.

Of 11 cases studied, successful healing occurred in 60 per cent. Average hospital stay was 15 1/2

weeks. Chance for success and expense in time and money must be weighed in considering transmetatarsal amputation. Close adherence to established criteria for operation stressed. Drawings.

Hoar, C. S., Jr., and J. Torres, *Evaluation of below-the-knee amputation in the treatment of diabetic gangrene,* New Eng. J. Med., 266: 440-443, March 1962.

Advise this operation in most cases in which the alternative is low-thigh amputation. Advantages listed. Most obvious sacrifice is a somewhat prolonged postoperative hospital stay. Tables.

Jackson, N. J., and T. E. Hunt, *Supracondylar amputation of the lower limb,* Canad. J. Surg., 7:12-18, January 1964.

Thirty-eight supracondylar amputations are described, 23 Callander and 15 Gritti-Stokes. Operative techniques presented. Author states atherosclerotic gangrene of lower limb usually requires above-knee amputation to obtain primary healing and a durable stump. Supracondylar amputation yields better rehabilitation results. Drawings, photographs, tables.

Kelly, P. J., and J. M. Janes, *Criteria for determining the proper level of amputation in occlusive vascular disease: a review of 323 amputations,* J. Bone Joint Surg. (Amer.), 39A:883-891, July 1957.

Experience with amputation in occlusive vascular disease for a five-year period indicates that the history of onset, physical findings, and the ultimate prognosis should all be considered before embarking on a conservative amputation. Graphs.

Kendrick, R. R., *Below-knee amputation in arteriosclerotic gangrene,* Brit. J. Surg., 44:13-17, July 1956.

Of 59 major amputations, 51 were performed through the calf with 63 per cent healing by first intention. Healing failed in 2 cases and above-knee amputation was required. Mortality was 6.2 per cent. Stress advantages of below-knee amputations. Anaesthesia and technique of amputation presented. Tables.

Klasson, D. H., *Supracondylar amputation with functional stump,* J. Int. Coll. Surg., 38: 547-550, December 1962.

Amputation which preserves some of the thigh muscles retains collateral circulation of the thigh and produces a good stump without flexion contractures or postoperative infection. Indicated when there is occlusive disease of anterior and posterior tibial arteries with gangrene. Diagram of surgical technique.

Lempke, R. E., *et al., Amputation for arteriosclerosis obliterans,* Arch. Surg., 86:406-413, March 1963.

Two hundred and fifty operations were performed upon 200 patients with a hospital mortality rate of 12.0 per cent. When the amputation was performed at the site (toe, leg, or thigh) immediately above or below the most distal pulses, 97.1 per cent and 94.4 per cent respectively were successful. When the amputation was performed two levels below the most distal pulse, only 66.1 per cent succeeded. In this series, lumbar sympathectomy does not increase the proportion of successful amputations or allow more distal amputations to be performed. Ischemia is principal cause of failure in wound healing. Influence of local and systemic factors examined. Statistical data presented in 10 tables.

Lishman, I. V., *The Gritti-Stokes amputation in peripheral vascular disease,* J. Roy. Coll. Surg. Edinb., 10:212-220, April 1965.

Report of 32 cases in which operation was indicated for gangrene, knee joint deformity, and below-knee amputation failures. Advantages include little postoperative pain, better healing than knee disarticulation, and end-bearing characteristic unlike other supracondylar amputations. Surgery described and prosthetic rehabilitation detailed. Photographs.

Martin, P., and J. E. Wickham, *Gritti-Stokes amputation for atherosclerotic gangrene,* Lancet, 2:16-20, July 1962.

Of 80 amputations for gangrene, 5 immediate postoperative deaths occurred. Forty-four patients were fitted with either a pylon or prosthesis. Reamputation was done on five. Authors state that the Gritti-Stokes amputation meets more effectively and safely the requirements for a major amputation for gangrene complicating arteriosclerosis than above-knee or below-knee operations, *or* disarticulation. Drawings, x-ray plates.

Middleton, M. D., and C. U. Webster, *Clinical review of the Gritti-Stokes amputation,* Brit. Med. J., 5304:574-576, September 1962.
Of 25 Gritti-Stokes operations (24 for peripheral vascular disease), the mortality rate was 8 per cent. Suggests Gritti-Stokes is superior to above-knee amputation because of rapid healing, early mobilization, and relatively short hospital stay. Suggests better limb for this type of amputation could be made available. Photographs.

Nayman, J., *Gritti-Stokes amputation for obliterative arterial disease associated with gangrene,* Med. J. Aust., 1:441-444, March 1964.
Experience with 12 amputations in 10 patients. Author considers Gritti-Stokes amputation more effective and safer than above-knee or below-knee amputation. Eight survivors report no pain or phantom limb sensation. Surgical technique is described, also a prosthesis that is mostly ischial-bearing and slightly end-bearing. Photographs, tables.

Pedersen, H. E., R. L. LaMont, and R. H. Ramsey, *Below-knee amputation for gangrene,* Southern Med. J., July 1964. Reprinted in Orthop. Prosth. Appliance J., 18:281-287, December 1964.
Authors substantiate their contention that for the treatment of arteriosclerotic gangrene, the below-knee amputation is the most useful of all lower-extremity amputations and that it is rarely necessary to amputate above the knee. Criteria for selection of suitable candidates are few. Icing extremity practically never indicated. Surgeon must be concerned with total rehabilitation of patient. Photographs.

Robb, H. J., L. F. Jacobsen, and B. Jordan, *Midcalf amputation in the ischemic extremity. use of lateral and medial flap,* Arch. Surg., 91:506-508, September 1965.
Fifteen out of 20 patients requiring leg amputation were selected for amputation in the midcalf. A 100 per cent healing was obtained including delayed healing in 3 cases. Seventy-three per cent used prostheses. Selection of patients and advantage of below-knee amputation discussed. Drawing.

Rosenberg, N., *Midleg amputation in patients with necrotic leg muscles,* Arch. Surg., 81: 614-617, October 1960.
Presents 2 patients with necrosis of leg muscles after acute arterial occlusion. Midleg amputation indicated, providing the overlying skin is viable. Drawings, photographs.

Rosenthal, A. M., *The case for below-knee amputation,* J. Einstein Med. Cent., 9: 233-234, October 1961.
With careful selection of cases below-knee amputation for arteriosclerosis obliterans can be successful. Proposes ways to achieve more below-knee amputations.

Tolstedt, G. E., and J. W. Bell, *Failure of below-knee amputation in peripheral arterial disease. Use of arteriography in determining site of election,* Arch. Surg., 83:934-936, December 1961.
Of 35 patients with occlusive arterial disease, 29 per cent had above-knee reamputations either because of failure of wound healing or because of stump breakdown while patient was wearing prosthesis. Suggests arteriography as valuable aid in determining site of amputation. X-ray plates.

Wheelock, F. C, Jr., J. B. McKittrick, and H. F. Root, *Evaluation of transmetatarsal amputation in patients with diabetes mellitus,* Surgery, 41:184-189, February 1957.
Of 67 patients who had transmetatarsal amputations for neuropathy or infection, only 5 were late failures requiring reamputation. In a group of 366 patients with arterial insufficiency of the involved foot, approximately one-third failed, the majority of failures occurring immediately postoperatively. Transmetatarsal amputation has proved to be sufficiently successful and durable to indicate its continued use in diabetic patients properly selected. Tables.

Procedures

Clarke, R., and M. R. Fisher, *Femoral periarterial sympathectomy for delayed healing after amputation (following arteriosclerotic gangrene),* Lancet, 1:364—366, April 1956.
In two cases of arteriosclerotic gangrene where healing had not followed midthigh amputation,

perifemoral sympathectomy was performed which led to healing.

Crossman, L. W., *Status of refrigeration for amputations and for tissue preservation,* Amer. J. Surg., 91:92-98, January 1956.

Technique of local refrigeration and major reasons for using it in amputations are discussed. Careful attention necessary for impressive benefits. Drawings.

Gibbel, M. I., R. A. Atkins, and A. Burns, *The use of dry ice refrigeration when delaying an inevitable amputation,* Amer. J. Surg., 99:326-329, March 1960.

Method is described. Procedure suggested as safe, economical, and practical for obtaining a physiological amputation. Photographs.

Jeffords, J. B., and J. M. Stallworth, *The use of refrigeration anesthesia (regional hypothermia) for amputation in poor-risk patients with peripheral vascular diseases,* Amer. Surg. 22:998-1004, October 1956.

Describes method used on 10 patients with severe peripheral vascular disease. No evidence of tissue damage or delayed healing because of the anaesthesia. As compared with 14 patients with similar ages and diseases, the average hospital stay was 2 days longer, but with fewer complications such as nausea, vomiting, ileus and urinary retentions. Charts, photographs.

Mohs, F. E., *Chemosurgical amputation for gangrene,* Surgery, 57:247-253, February 1965.

In treatment of 446 gangrenous lesions in 380 patients using a chemosurgical technique, healing took place in 324 (72.6 per cent) instances. The procedure, in which zinc chloride was used for chemical fixation of the tissues, is time-consuming but extends conservative amputation to a considerably larger group of patients than previously possible. Photographs, tables.

Moretz, W. H., W. R. Voyles, and C. B. Thomas, *Value of preoperative physiological amputations,* Ann. Surg., 154:851-858, November 1961.

Forty-eight to 72-hour applications of ice and tourniquet above infected area used in 91 extremities and results compared with 70 extremities in which procedure was not used. Preoperative physiological amputation is recommended when absorption from local areas of infection or necrosis contributes to patient's poor general condition and when inflammatory reaction is so close to the site of proposed amputation that primary wound closure would otherwise be feared or contraindicated. A simple means of producing physiological amputation is described. Tables.

Prioleau, W. H., *Protection of amputation wounds in arterial obliterative disease,* Surg. Gynec. Obstet., 121:119-120, July 1965.

A basket-weave splint providing a cage-like protection to the wound is described. Proper application stressed. Drawings.

Reeves, M. M., and F. W. Quattlebaum, *Lateral flap technique in supracondylar amputations,* Surg. Gynec. Obstet., 102:751-756, June 1956.

Lateral flap supracondylar amputation was performed on 103 patients with arteriosclerotic gangrene whose average age was 71.9 years. Operative mortality rate was 17.5 per cent. Surgical technique is presented. Drawings.

Hospital Mortality and Morbidity

Carney, W. I., and S. J. Goldowsky, *Amputations in peripheral vascular disease,* Amer. J. Surg., 93:795-797, May 1957.

A study of 314 records over a ten-year span revealed a total of 322 thigh amputations for which there was an operative mortality of 11 per cent. The average hospital stay, 43 days, was considered unduly long. Improvement in result must depend on sound surgical principles.

Dale, W. A., and W. Crapps, Jr., *Major leg and thigh amputations; ten-year survey of results,* Surgery, 64:333-342, August 1959.

In this series of 237 patients with 284 amputations, mostly for arteriosclerotic peripheral arterial occlusion, 219 were thigh amputations, 65 were calf. The operative mortality rate was 16.5 per cent; hospital mortality rate was 20 per cent. Arteriosclerosis of a degree necessitating major amputation results in a selected group of patients whose outlook is poor. Emphasis must be placed upon surgical judgment and surgical technique to secure prompt wound healing. Tables.

Dale, W. A., and J. R. Jacobs, *Lower extremity amputation: result in Nashville, 1956-1960,* Ann. Surg., 155:1011-1022, June 1962.

Of 479 amputations on 385 patients, the operative mortality rate was 8 per cent. Failure of primary wound healing and thrombotic vascular complications led to high morbidity and mortality rates. Principles of management before, during, and after amputation are outlined. Anticoagulant therapy and evaluation for direct arterial reconstruction are discussed. Graphs, photographs, and tables.

Dalton, D. H., Jr., H. A. McDowell, and C. Lyons, *Through-the-knee guillotine amputation,* Ann. Surg., 161:614-616, April 1965.

Of 94 knee disarticulations performed on patients with arterial disease, 88 were subsequently converted to above-knee amputations. Patient mortality was 10 per cent; wound complications 13.3 per cent. Surgical procedure described. Management believed to contribute to marked reduction in morbidity and mortality. Tables.

Fisher, M. M., and M. E. Ross, *Simultaneous contralateral prophylactic sympathectomy with amputation to protect the remaining limb: a five-year survival study,* Angiology, 15:471-473, November 1964.

A study of 126 consecutive amputees revealed that sympathectomy did not prolong survival of the opposite limb. The authors suggest that sympathectomy performed at time of amputation of first limb increased the life expectancy of the individual. Further study on a large series is indicated before simultaneous contralateral sympathectomies are performed routinely. Tables.

Ham, J. M., D. C. Mackenzie, and J. Loewenthal. *The immediate results of lower limb amputation for atherosclerosis obliterans,* Aust. New Zeal. J. Surg., 34:97-104, November 1964.

Results of 246 amputations on 190 patients are tabulated and discussed in terms of failures (amputation at higher level), wound complications, major complications, and mortality rates in various groups. Operative mortality rate was 17.5 per cent. Prophylactic anticoagulants should be considered in patients having amputations for atherosclerosis. Prophylactic antibiotics justified in all cases to prevent clostridial infection. Tables.

Lindholm, R., *Features of amputation surgery among civilians during the period 1930-1960,* Acta Orthop. Scand., 35:74-89, 1964.

Statistical data from nearly 1,000 case records are related to reasons for amputation, sex, age, frequency in comparison to other operations, levels of amputation, and mortality rate during the hospital stay. Tables.

Ottman, M. G., and L. H. Stahlgren, *Evaluation of factors which influence mortality and morbidity following major lower extremity amputations for arteriosclerosis,* Surg. Gynec. Obstet., 120:1217-1220, June 1965.

Operative mortality rate in 323 patients was 29.7 per cent in a 5-year period. Of 413 amputations 370 were above-knee with a 42 per cent mortality rate; 10 were below-knee with 30 per cent; and *33* were transmetatarsal with 5 per cent. Increased rate in proximal amputations was related to patient's condition rather than level of amputation. Rate was double in patients who exhibited signs of arteriosclerotic diseases of other systems. Diabetes, detected in 1/3 of the total group, had no influence on mortality rate. Rate not substantially reduced compared to series collected at same hospital 35 years previously. Use of refrigeration, principles of wound care, and other factors in reduction of mortality and morbidity discussed. Table.

Papaioannou, A. N., *Thromboembolism in patients with major amputations,* Ohio Med. J., 58:903-905, August 1962.

In two groups of patients requiring amputation above the foot because of arteriosclerotic gangrene, the first included 113 patients admitted between 1938 and 1942, the second 165 patients admitted between 1952 and 1956. Although over-all mortality markedly improved over the years, deaths from thromboembolism showed no reduction. Treatment of this complication is discussed. Photographs, tables.

Perlow, S., *Amputation for gangrene because of occlusive arterial disease, results in 312 amputations,* Amer. J. Surg., 103:569-574, May 1962.

Patients are divided into three groups: those with amputations performed from 1936 to 1938 before the use of sulfonamides, those from 1939 to 1944 during the sulfonamide period, and those from 1945 to 1958 when antibiotics were available. Hospital and operative mortality and levels of amputation are compared. Local refrigeration, level of amputation, lumbar sympathectomy, choice of anaesthetic, preliminary femoral vein ligation, and management of the amputee are discussed. The authors suggest amputation for ischemic gangrene need never be performed as an emergency. Tables.

Thompson, R. C, Jr., T. L. DelBlanco, and F. F. McAllister *Complications following lower extremity amputation,* Surg. Gynec. Obstet., 120:301-304, February 1965.

Over-all mortality rate for 289 patients who underwent major lower-extremity amputation was 10 per cent of which 8.3 per cent were vascular deaths and 1.4 per cent were due to pulmonary embolism. Prophylactic anticoagulation therapy should be considered in patients undergoing major lower-extremity amputations, especially above-knee. Discussion of high complication rate (38 per cent) in series. Tables.

Tolstedt, G. E., and J. W. Bell, *Sepsis and survival after above-knee amputation for peripheral vascular disease,* Amer. J. Surg., 103:372-375, March 1962.

Hospital mortality rate for 100 patients amputated between 1952 and 1959 was 25 per cent; 39 per cent had wound infections postoperatively. Thirty-nine were discharged from the hospital using artificial limbs. Vascular reconstructive surgery has not reduced the number of patients needing amputation at this institution. Important, points in surgical technique discussed. Drawings, graphs, photographs.

PROSTHETIC MANAGEMENT

FITTING, TRAINING, AND REHABILITATION

Blashy, M. R., and H. V. Morelewicz, *Lower extremity prostheses for patients past fifty,* Arch. Phys. Med., 39:497-502, August 1958.

Criteria for prosthetic prescription related to patient's medical condition, amputation site, and postoperative preparation. Photographs, tables.

Bugel, H. J., and R. I. Carlson, *A study of lower extremity amputees,* Amer. J. Phys. Med., 40:93-95, June 1961.

Of 257 amputations, 150 were for peripheral vascular disease of which 68 received prostheses. Prior to 1954, 71 per cent received prostheses; after 1954, only 26 per cent. Prosthesis not advised if life expectancy is less than two years. Severity of the disease appears to be the most significant factor in limiting prosthetic prescription. Tables.

Eisert, O., *Dynamic exercises after lower extremity amputation; rehabilitation of elderly amputee,* Geriatrics, 11:65-70, February 1956.

Presents preprosthetic coordination exercises modified for the geriatric amputee. Photographs.

Eschen, F. J., *Prosthetic fitting of the older age patients,* Orthop. Prosth. Appliance J., 13:42-47, March 1959.

Medical-psychological, personal and social, and mechanical-technical aspects of fit and alignment of below-knee and above-knee prostheses. Details of socket requirements.

Felder, D. A., *Pain and amputations for circulatory disease,* Phys. Ther. Rev., 40:183-186, March 1960.

When pain is the major symptom, amputation should be performed as soon as possible because the less time pain has persisted the less likely the patient will have pain postoperatively. Causes of postamputation pain are discussed. Postsurgical management emphasizes early and continued binding of stump, instruction in crutch walking, and exercises.

Grynbaum, B. B., and E. E. Gordon, *Rehabilitation of the elderly amputee,* J. Chronic Dis., 4:292-295, September 1956.

Focuses on evaluation and management of the elderly amputee prior to prosthetic fitting. Suggests that success or failure is primarily based on patient's general health status, thus emphasizes need for complete medical examination. Explores briefly the few absolute contraindications in prescribing prosthetics. Looks at the need for community facilities in the purchase of prosthetics and patient training.

Grynbaum, B. B., E. E. Gordon, and S. S. Bluestone, *Rehabilitation of the aged amputee,* Geriatrics, 12:592-597, October 1957.
Paper discusses various problems encountered in evaluating, preparing, and training the elderly lower-extremity amputee. Physical, psychologic, and social aspects are considered. Use of wheelchair may be preferred for certain patients. Photographs.

Haslam, E. T., *et al., Rehabilitation of lower extremity amputees,* Bull. Tulane Med. Fac, 20:23-28, November 1960.
Special problems of amputees include loss of part of the person and permanence of loss. Rehabilitation should begin prior to amputation. Postoperative and prosthetic care summarized. Research needed in patient selection, professional education, prostheses, and amputee capabilities.

House, F. B., *How and why of peripheral vascular disease,* S. Dakota Med. J., 17:19—24, January 1963.
Role of physical medicine in managing patient with peripheral vascular disease. Amputee program described. Photographs.

Koepke, G. H., and J. P. Giacinto, *A clinical appraisal of the plastic total contact above-knee prosthesis,* Orthop. Prosth. Appliance J., 16:318-320, December 1962.
Fifty-one amputees successfully fitted; counterpressure promotes circulation and lessens edema. Photographs.

Liao, S. J., and C. O. Schnell, *A functional above-the-knee prosthesis for geriatric patients,* J. Bone Joint Surg. (Amer.), 46A: 1292-1294, September 1964.
Description of prosthesis successfully fitted to 52 patients. Drawing, photographs.

McLenahan, M. G., *Amputation associated with peripheral vascular disease: case history,* Phys. Ther. Rev., 40:188-189, March 1960.
Rehabilitation of unilateral above-knee amputee with peripheral vascular and diabetic complications.

Olejniczak, S., *Common problems of the aged in physical medicine and rehabilitation in a county hospital,* Mich. Med., 60:893-898, July 1961.
Prevention and treatment of flexion contractures in neuromuscular disease, care and prevention of decubitus ulcers, and training for bowel control are common problems. Temporary prosthesis advocated for those who can hardly walk with crutches, have poor balance, are weak, and have poor circulation in the other leg. Success associated with psychological preparation, below-knee amputation, hygiene, and avoiding bursitis of the head of the fibula. Photographs.

Park, H. W., and R. E. Miller, *Prosthesis and the older patient,* Southern Med. J., 51:27-30, February 1958.
Organization of a prosthetics evaluation board and experience with older amputee patients are reported. By careful screening and early referral, a significant portion of the elderly amputees can be fitted with a prosthesis. Age in itself is not considered a contraindication to fitting or training.

Russek, A. S., *The management of the amputees of the older age group,* Orthop. Prosth. Appliance J., 13:37-41, March 1959.
Overview of surgical procedure. Six classes of functional performance detailed. Photograph.

Tosberg, W. A., *The preprosthetic phase of the comprehensive management of the older amputee,* Orthop. Prosth. Appliance J., 13:47-51, March 1959.
Early institution of stump positioning, muscle reeducation, shrinkage, and use of temporary prostheses advocated. Tables specify rehabilitation results in relation to age, site of amputation, and employment.

Troedsson, B. S., *Rehabilitation of the aged amputee,* Geriatrics, 13:180-188, March 1958.
Presents five case histories, each with a special problem typical of those encountered in rehabilitation of elderly patients. The first case history is given in conference form to show role of clinic team members. Average hospital stay of lower extremity amputees was 140 days

from admission until the patient was able to walk on a prosthesis. Photographs.

Warren, M., *The problem of the aged amputee,* Postgrad. Med. J., 33:436-443, September 1957.

Phases of treatment described in detail are: preoperative care, postoperative, prepylon and postpylon care, maintenance, and follow-up care.

Werner, James L., *Quadrilateral plaster pylon) case report,* J. Amer. Phys. Ther. Ass., 46:506-507, May 1966.

Sixty-one-year-old man with above-knee amputation because of arterial occlusion.

TEMPORARY PROSTHESES

Anderson, A. D., S. A. Levine, and M. Colmer, *The temporary walking device for the mobilization of the elderly amputee,* Geriatrics, 21:186-188, June 1966.

Delayed healing of stump need not be a deterrent to wearing a proximal weight-bearing walking device. Photographs of temporary devices.

Clippinger, F. W., Jr., *Treatment of elderly amputee by temporary quadrilateral socket pylon prosthesis,* Geriatrics, 20:683-687, August 1965.

Pylon prosthesis serves as a stump shrinker, exerciser, and device to help determine patient's potential for using prosthesis.

Clippinger, F. W., Jr., *Use of the temporary quadrilateral socket plaster pylon in elderly amputee,* Southern Med. J., 56:588-592, June 1963.

Describes technique of fabricating a pylon to be fitted early, ideally as soon as sutures are removed. Allows early walking and hastens stump shrinkage. Helps determine patient's potential for using prosthesis. Particularly useful in elderly patients who are borderline candidates for prostheses.

Kay, G. D., and G. F. Pennal, *Rehabilitation of the elderly amputee,* Canad. J. Surg., 2:44-51, October 1958.

Of 79 above-knee amputations necessitated by peripheral vascular disease, only 12 patients obtained satisfactory use from a prosthesis. Advantages of below-knee amputation, the peg-leg, and rational geriatric care discussed. Photographs.

Leavitt, L. A., *Pylons and temporary prosthesis in the rehabilitation of lower extremity geriatric amputees,* South. Med. J., 52:778-782, July 1959.

Use of temporary prosthesis helps to evaluate more objectively the geriatric patient's potential for prosthetic ambulation. A temporary prosthesis can decrease the physiologic stress of ambulation, eliminate prolonged bed rest, and is a better treatment program for the remaining sound limb. Photographs.

Murray, D. G., *The case for a pylon,* Orthop. Prosth. Appliance J., 19:123, June 1965.

Temporary pylon is inexpensive, simple, has characteristics similar to a permanent prosthesis, and is safe.

Tosberg, W. A., *Temporary prostheses,* Orthop. Prosth. Appliance J., 19:142-144, June 1965.

Overview of the advantages of the temporary prosthesis.

Warren, R., *The early rehabilitation of the arteriosclerotic amputee,* Surgery, 41:190-197, February 1957.

Seventy-one per cent of a group of 32 amputees walked with a prosthesis. Temporary prosthesis described. Stresses early ambulation and surgeon's responsibility in rehabilitation. Photographs, tables.

BILATERAL AMPUTEES

Lowenthal, M., A. O. Posniak, and J. S. Tobis, *Rehabilitation of the elderly double above-knee amputee,* Arch. Phys. Med., 39:290-295, May 1958.

Of 49 patients, 50 per cent had second amputation within one year; average interval was 1.9 years. Mortality rate was 29 per cent during 5-year period. Medical status, rehabilitation potential, and prosthetic training program are discussed. Five case presentations. Tables.

McDougall, R. V., *Case history; bilateral above-knee amputee with "stubbies,"* Phys. Ther. Rev., 40:186-187, March 1960.

Case history of a 68-year-old bilateral amputee with vascular disease fitted with bilateral short prostheses.

Watkins, A. L., *Additional notes on rehabilitation of the bilateral lower extremity amputee,* Orthop. Prosth. Appliance J., 12:45-49, December 1958.

Twenty-three amputees, most of whom had peripheral vascular disease, evaluated according to rehabilitation results, etiology, site, duration of treatment. Tables.

Watkins, A. L., and S. J. Liao, *Rehabilitation of persons with bilateral amputation of lower extremities,* J.A.M.A., 166:1584-1586, March 1958.

In a 6 1/2-year study of 500 lower-extremity amputees, 54 had bilateral amputation. Half of the bilaterals were older than 60; 31 had arteriosclerotic changes and were bilateral above-knee. Fifty completed treatment. Seventy per cent were considered rehabilitated with 30 per cent economically independent. Failures were due to lack of motivation and severe medical complications. Tabulations of etiology and site; rehabilitation results; rehabilitation related to age; rehabilitation related to site.

PSYCHOSOCIAL ASPECTS

Brown, J., *The theory and the practice,* Nurs. Times, 19:639-640, May 13, 1966.

Case histories of two elderly patients who underwent amputation of limbs for circulatory conditions. Describes patients' reactions to amputation.

Caplan, L. M., and T. P. Hackett, *Emotional effects of lower limb amputation in the aged,* New Eng. J. Med., 269:1166-1191, November 1963.

Twelve patients ranging in age from 57 to 81 were interviewed for one hour two or three times a week from the early postsurgical period to discharge and followed less intensively as outpatients. Each patient developed a postoperative depression characterized by feelings of hopelessness and impending death which interfered with early rehabilitation. As much attention should be given to emotional aspects as to physical rehabilitation of elderly patients and a prospective amputee should receive a realistic idea of what to expect. One case study. Table.

Haddan, C. C, *Psycho-social implications of the geriatric amputee,* Orthop. Prosth. Appliance J., 16:32-36, March 1962.

Reviews literature on the older amputee and advocates adding psychosocial workers to the clinic teams.

Korin, H., S. A. Weiss, and S. Fishman, *Pain sensitivity of amputation extremities,* J. Psychol, 55:345-355, April 1963.

Subjects were 44 recently amputated lower-extremity unilateral amputees, 24 below-knee and 20 above-knee with well-healed stumps. Ages ranged from 17 to 73, with 20 per cent of each group over 60. Pain sensitivity of amputation limb was heightened and the distal end was more sensitive than the proximal. Peripheral factors play a critical role. The prosthetic practice of designing for "weight-bearing" in the proximal areas of the stump is clearly supported. Drawings, tables.

FOLLOW-UP STUDIES

As used here, the term "follow-up studies" implies a time lapse of one year or more following amputation.

Brice, G. B., *Rehabilitation of the elderly vascular amputee—a ten-year survey,* J. Ass. Phys. Med. and Rehab., 18:138-140, September-October 1964.

Six of 23 geriatric patients observed over a 10-year period are still living. Suggests above-knee amputation is a preferable site for elderly vascular amputees. Stresses expense in attempting to rehabilitate. Table.

Cameron, H. C, J. E. Lennard-Jones, and M. P. Robinson, *Amputation in the diabetic: outcome and survival,* Lancet, 2:605-607, September 1964.

Series includes 63 diabetic patients on whom amputation was performed for gangrene. Reports the number of amputations on each patient, the degree of mobility achieved after amputation at different levels, the length of in-patient stay, and survival after amputation. Graphs, tables.

Chapman, C. E., *et al., Follow-up study on a group of older amputees,* J.A.M.A., 170: 1396-1402, July 1959. Reprinted in Orthop. Prosth. Appliance J., 13:62-73, December 1959.

The authors report on 51 patients over age 55 who were out of the hospital at least one year. Twenty-four were fitted with prostheses, and 16 still used them at least part of the day. Tables show marital status, mode of living, period of hospitalization, pathological condition of those who died, time between discharge and death, mode of ambulation, and prosthetic use. Photographs.

Claugus, C. E., *et al., Amputation of the lower extremity for arteriosclerosis,* Arch. Surg., 76:992-996, June 1958.
Five postoperative deaths occurred in a series of 89 patients who underwent a total of 155 amputations—71 above-knee, 47 below-knee, 1 Syme's, 7 transmetatarsal, and 29 toe amputations. Mortality was 22.5 per cent for first two postoperative years. Authors believe sympathectomy permitted successful operation at a lower level and was influential in avoiding amputation in some cases. Operative techniques are described. Tables.

Cummings, V., *et al., The elderly medically ill amputee,* Arch. Phys. Med., 44:549-554, October 1963.
Of 41 cases, 11 had below-knee amputations, 16 above-knee, and 7 bilateral. All were amputated for vascular insufficiency and classified prior to prosthetic fitting according to functional expectation. Thirty-nine successfully used a prosthesis for at least 6 months; 38 exceeded functional prediction. Tables.

Dejode, L. R., and P. M. Higgins, *Amputation of the lower limb for ischaemic disease—a study of functional results,* Postgrad. Med. J., 41:6-9, January 1965.
In a series of 101 amputation cases, 60 of 71 unilateral and 15 of 30 bilateral amputees were considered mobile, having used prostheses for a period of at least one year. Of the patients under 65, 83 per cent returned to work. Above-knee stumps healed uneventfully in 73 per cent; below-knee in 40 per cent. Rehabilitation management is stressed. Tables.

Goldner, M. G., *The fate of the second leg in the diabetic amputee,* Diabetes, 9:100-103, March-April 1960.
Forty-seven patients of a group of 71 consecutive admissions with diabetic gangrene or amputation of one lower extremity showed involvement of the other leg. Of 41 who had previously undergone unilateral amputations, amputation of the second leg became necessary in 32. In 14 of these only part of the foot was amputated. All patients had been under medical supervision at least since their first leg lesion. The second leg of the unilateral diabetic amputee shares the fate of the first often and relatively soon. The same observation was made 100 years ago. Graphs, tables.

Hanf, L., and J. B. O'Connor, *A follow-up of predominantly older amputees,* Geriatrics, 21:166-172, July 1966.
Of 60 prosthetically fitted patients, 51 had been amputated for disease, principally peripheral vascular disease. At time of follow-up (3 to 50 months), 72 per cent were using prostheses daily. Of 17 in age group 71 to 81 years, 15 were effective users. Tables.

Hansson, J., *The leg amputee: a clinical follow-up study,* Acta Orthop. Scand. (SuppL), 69:1-104, 1964.
This exhaustive study embraced three different groups of patients for which the observation periods, ages, and duration of prosthetic use varied. One series of 586 Gothenburg residents subjected to leg amputations provided information on frequencies and sex distribution; a second series of 331 was analyzed in terms of cause, postoperative course, survival time, clinical function, and sociomedical function; a third series of 133 amputees below age 60 provided information on clinical and sociomedical function of patients equipped with prostheses at an early age. Detailed findings are recorded in charts and tables.

Koepke, G. H., L. E. Wolcott, and D. C. Hunter, Jr., *Prosthetic rehabilitation of the lower extremity amputee with vascular disease,* Univ. Mich. Med. Cent. J., 30:113-115, May-June 1964.
Of 219 patients, 14 per cent died within four weeks following the amputation and an additional 13 per cent died within a year. Of 322 patients, only 99 were given a prescription for a prosthesis, and 82 wore their prostheses for more than a year. Patients selected for prostheses must be capable of walking 200 feet

with crutches without developing claudication. Patient must be motivated. Physiological age important. Tables.

Smith, B. C, *A twenty year follow-up in fifty below knee amputations for gangrene in diabetics,* Surg. Gynec. Obstet., 103:625-630, November 1956.

Of 50 patients, hospital mortality rate was 12 per cent, average survival 51/2 years. Of 44 surviving amputees, 72 per cent wore prosthesis regularly. Twelve per cent survive and walk on prosthesis 15 years after operation. Technique of amputation described.

Wheelock, F. C, Jr., *Transmetatarsal amputations and arterial surgery in diabetic patients,* New Eng. J. Med., 264:316-320, February 1961.

Of 428 patients who underwent transmetatarsal amputation, 63 per cent were healed two years later and 46 per cent were serving satisfactorily five years later. Criteria for selection of patients discussed. Value of arterial surgery discussed for diabetic patients with claudication, gangrene, or rest pain. Suggests procedure is worthwhile in the presence of segmental occlusions in the aorta, iliac, femoral, or upper popliteal arteries. Drawings, tables.

Wilson, A. L., *Survey of the diabetic amputee,* Orthop. Prosth. Appliance J., 20:58-60, March 1966.

Report of all leg amputees who attended artificial limb centers in Scotland during 1964 and were fitted with a prosthesis. Etiology was diabetic gangrene in all cases. Numerous tables summarize data.

Wolters, B. J., *Follow-up survey study of a group of elderly above-knee amputees,* Arch. Phys. Med., 42:68-74, January 1961.

Of 75 above-knee amputees over the age of 50, 21 per cent could not be contacted for follow-up, 31 per cent of those contacted used prostheses to distinct advantage, 21 per cent used prostheses little if at all, 36 per cent had either been refused a prosthesis or died, 10 per cent were working outside the home. Age, *per se,* does not determine degree of success. Physical independence achieved primarily by patient's own resources rather than by any particular rehabilitation effort. Thirteen tables.

Wright, J. S., *Amputations for gangrene in diabetics,* Med. J. Aust., 47:574-575, October 1960.

Of 62 diabetic patients, the five-year survival rate after surgery was slightly less than 55 per cent. Four of 40 above-knee amputees were reamputated; one of two below-knee; and 9 of 20 foot. Half of all amputees had been converted to a state of complete and permanent incapacity. Of the remainder, five had been able to resume a normal degree of independence. Drawings, photographs.

Juvenile Amputees, an Annotated Bibliography

The following annotated bibliography covers articles on juvenile amputees published during the period 1956 through 1966. The purpose of the bibliography is to assist clinicians and educators in the location and selection of published materials without the necessity for extensive library research,

This material has been organized as follows:

[1] This bibliography was compiled by an *ad hoc* committee appointed by the Subcommittee on Prosthetics in Paramedical Education of the Committee on Prosthetic-Orthotic Education. Chairman of the *ad hoc* committee is Miss Mary Poole, Director, Department of Social Work, University of Pennsylvania Hospital, Philadelphia, Pa. Members are Lieutenant Colonel Mildred Anderson, Army Medical Specialist Corps, U. S. Army (Ret.); Mrs. Joan E. Edelstein, Associate Research Scientist, School of Medicine and Post-Graduate Medical School, New York University, New York, N. Y.; Miss Nancy Ellis, Associate Director, Occupational Therapy Courses, College of Physicians and Surgeons, Columbia University, New York, N. Y.; Miss Jamie Lisle, Director of Physical Therapy, Medical College of Virginia, Richmond, Va.; Miss Lena M. Plaisted, Professor of Rehabilitation Nursing, Boston University School of Nursing, Boston, Mass.; and Miss Muriel E. Zimmerman, Associate Chief, Occupational Therapy Service, New York University, New York, N. Y. Colonel Ruth A. Robinson, Army Medical Specialist Corps, U. S. Army (Ret.), Chairman of the Subcommittee on Prosthetics in Paramedical Education, serves as an *ex-officio* member of the *ad hoc* committee. Mrs. Barbara R. Friz, Staff Officer of the Committee on Prosthetic-Orthotic Education, serves as secretary of the *ad hoc* committee.

The Committee on Prosthetic-Orthotic Education is supported by the Training Division of the Vocational Rehabilitation Administration and by the Prosthetic and Sensory Aids Service of the Veterans Administration.

MEDICAL MANAGEMENT

Most of the articles in this section are concerned with the comprehensive medical care of the juvenile amputee. The following guide may be used in locating specific subjects under this classification (the numbers refer to the number of the article within the section):

Classification nomenclature 14, 22, *33,* 34.
Etiology 2, 3, 4, 9, 10, 23, *33,* 35, 51, 54.
Malignancy 52.
Pathophysiology 21, 26, 63.
Prosthetic prescription 7, 10.
Surgery 4, 5, 7, 13, 19, 27, 36, 38, 45, 59, 60, 63.
Thalidomide-associated conditions 23, 30, 36, 37, 39, 46, 47, 48, 61.

1. Aitken, G. T., *Amputation as a treatment for certain lower-extremity congenital abnormalities,* J. Bone Joint Surg. (Amer.), 41A:1267-1288, October 1959.

Congenital abnormalities treated were kyphosis of the tibia, abnormalities of the feet, pseudoarthrosis of the tibia, absence of the tibia, abnormalities of proximal parts of the femur, and a few abnormalities of unknown type treated before coming under the clinic's care. Several cases are cited as examples for each of the six groups. Prostheses for different types of amputees are discussed. No failures occurred in this series in that there were no part-time wearers of prostheses. Photographs, x-ray plates.

2. Aitken, G. T., *Current concepts in the management of the juvenile amputee,* Orthop. Prosth. Appliance J.. 16:257-262, September 1962.

Discusses age of fitting, surgery, postsurgical management of amputations, and anomalies. Most children with amputations or limb abnormalities treated as amputations have a good potential for rehabilitation. Graph shows etiology of trauma.

3. Aitken, G. T., *Hazards to health: etiology of traumatic amputations in children,* New Eng. J. Med., 265:133-134, July 1961.

A study by the Michigan Area Child Amputee Center of 203 traumatic amputations in children over a 12-year period. Graphically represented are seven arbitrary classes of injuries and the number of cases in each in increments of 4 years. Suggests that the age distribution correlates with the expected factors and emphasizes the areas in which prevention may be most helpful.

4. Aitken, G. T., *Surgical amputation in children,* J. Bone Joint Surg. (Amer.), 45A:1735-1741, December 1963.

The cardinal difference between the techniques of amputation surgery in children as opposed to those in adults is that one must save all epiphyses possible in children. Chart shows etiology of trauma in 382 cases. Brief discussion of emergency and elective amputation, complications, and treatment. Photographs.

5. Aitken, G. T., *The lower-extremity juvenile amputee,* Instruct. Course Lect. Amer. Acad. Orthop. Surgeons, 14:329-335, 1957.

Rehabilitation potential, bony overgrowth and its treatment, prostheses types, and surgical conversion are discussed. Mechanically sound prostheses, adequate training, and frequent follow-up are necessary items in good juvenile amputee program. Photographs.

6. Aitken, G. T., and Frantz, C. H., *Management of the child amputee,* Instruct. Course Lect. Amer. Acad. Orthop. Surgeons, 17:246-295, 1960.

Article based on authors' experience with 564 child amputees followed in a well-organized outpatient clinic for 15 years. Uniqueness of the child as compared with the adult is outlined. Types of amputation surgery, bony overgrowth, levels of amputation, types of prostheses, prosthetic fitting, and training are discussed. Pictorial presentation of several child amputees.

7. Amstutz, H. C, and P. D. Wilson, *Dysgenesis of the proximal femur {coxa vara) and its surgical management,* J. Bone Joint Surg. (Amer.), 44A:l-24, January 1962.

Three distinct groups are congenital short femur with coxa vara, congenital bowed femur with coxa vara, and congenital coxa vara. In the first, the most essential step in treatment is fitting a suitable prosthesis; in the second, either a prosthetic device or elevated shoe is necessary. Treatment for congenital coxa vara varies with the severity of the condition. Graphs, photographs, tables, x-ray tables.

8. Armold, J. D., *Education in the management of the juvenile amputee,* Illinois Med. J., 123:518-519, May 1963.

Amputations in children are different from those in adults and demand special considerations. On this premise is based the course on management of the juvenile amputee conducted at Northwestern University. Photographs.

9. Bailer, J. C., and J. Gurian, *Congenital malformations and season of birth,* Eugen. Quart., 12:146-153, September 1965.

Tables show season cycle in births of infants with certain congenital malformations.

10. Bogumill, G. P., *Bilateral above-the-knee amputations: complication of chickenpox,* J. Bone Joint Surg. (Amer.), 47A:371-374, March 1965.

Chickenpox resulted in bilateral lower-extremity gangrene with subsequent amputation. Several previously cited cases suggest that severe gangrene following chickenpox occurred when associated with thrombocytopenic purpura. Condition may be due to the individual's susceptibility to the virus. Photographs.

11. Brooks, M. B., *Prosthesis for child amputees: the program at University of California at Los Angeles,* Calif. Med., 85:293-298, November 1956.

Describes operation of an amputee program and discusses future plans. Illustrations.

12. Brooks, M. B., and R. Mazet, Jr., *Prosthetics in child amputees,* Clin. Orthop., 9:190-204, Spring 1957.

Nine case histories are presented together with conclusions reached after studying, fitting and training 95 children. Observations relate to age for prosthetic fitting, psychological effects of amputations, training programs, and indications for surgery. Photographs, x-ray plates.

13. Brown, F. W., *Construction of a knee joint in total absence of the tibia,* J. Bone Joint Surg. (Amer.), 47A:695-704, June 1965.

Presents three cases of paraxial hemimelia tibia treated by surgical construction of a knee joint, followed by Syme's amputation, and use of an end-bearing prosthesis. Serial roentgenograms suggest adaptive changes resembling formation of a true knee joint. A preliminary report. Photographs, x-ray plates.

14. Burtch, R. L., S. Fishman, and H. Kay, *Nomenclature for congenital skeletal limb deficiencies, a revision of the Frantz and O'Rahilly classification,* Artificial Limbs, 10:24-35, Spring 1966.

Report of Consultants to the Subcommittee on Child Prosthetics Problems indicates a slight modification of the nomenclature to encompass more anomalies. Amelia and meromelia are the only categories, rather than phocomelia and related designations. Numerous diagrams.

15. Caine, D., and A. J. Reeder, *The problem of the congenital amputee,* Med. J. Aust., 50:301-305, March 1963.

Causes and classification are briefly reviewed. Management is related to parental adjustment, limb fitting, and education of the patient. Stresses need for continuous patient care beyond initial fitting and urges development of adequate educational and prosthetic facilities in New South Wales. Photographs.

16. Chittenden, R. F., *Problems related to prosthesis in childhood,* Clin. Orthop., 8:197-208, 1956.

Brief review of etiologic and psychobiologic factors. Psychological preparation of patient and family and a well-guided training program are basis for acceptance of limb. Problems of growth and elective amputation are discussed. Graphs, photographs, x-ray tracings.

17. Dean, C, *Administrative phases of child amputee program,* Amer. J. Public Health, 48:750-753, June 1958.

Describes essentials of a program and outlines the early program of the Michigan Crippled Children Commission.

18. Dresher, C. S., and J. A. MacDonell, *Total amelia,* J. Bone Joint Surg. (Amer.), 47A:511-515, April 1965.

A review of world literature on total amelia led to the conclusion that only 11 of the 27 cases reported could be substantiated as quadrimembral amelia. Two current cases are added. Includes summary of the functional development of one of these children and prosthetic prescription to age seven. Photographs.

19. Entin, M. A., *Reconstruction of congenital abnormalities of the upper extremities,* J. Bone Joint Surg. (Amer.), 41A:681-701, June 1959.

Congenital abnormalities in 120 patients are reviewed and classified. Discussion is confined to a few selected cases which illustrate the complexity of reconstructive procedures and the selection of methods which provide basic functions of the limb. Emphasizes need for constant vigilance to prevent recurrences of the deformity even after successful reconstruction. Photographs, x-ray plates.

20. Epps, C. H., Jr., and F. E. Brennecke, *Juvenile amputee program,* Med. Ann. D. C, 3:295-297, May 1962.

Analysis of patients and steps in management at D. C. General Hospital are outlined. Three case reports. Photographs.

21. Fowler, W. M., Jr., *et al., Pulmonary function and physical working capacity of children who have undergone amputation of an upper extremity,* Arch. Phys. Med., 43:409-413, August 1962.

Measurements on 20 child amputees show vital capacity, maximum breathing capacity, and functional residual capacity reduced as compared to values for normal children. Causative factors suggested. Tables.

22. Frantz, C. H., and R. O'Rahilly, *Congenital skeletal limb deficiencies,* J. Bone Joint Surg. (Amer.), 43:1202-1224, December 1961. Reprinted in Orthop. Prosth. Appliance J., 16:116-138, June 1962.

A classification is presented by the authors in an effort to standardize nomenclature. Derivations of terms are given and each classification is illustrated pictorially and roentgenographically. Also included with each classification is information related to incidence, genetics, associated defects, and synonyms.

23. Frantz, C. H., *Increased incidence of malformed infants in West Germany during 1959-1962,* Illinois Med. J., 123:27-39, January 1963.

An account of a visit to Germany to collect information relative to incidence, type of cases, orthopaedic and prosthetic treatment, parental social-emotional reaction, and plans for the future. Drug-testing is discussed. Suggests three major efforts will result: broader scope of drug-testing and control; increased use of external power in prosthetics research and a wider scope of genetic research relative to cause of malformations in humans. Photographs, tables, and x-ray plates.

24. Frantz, C. H., *The child amputee,* Med. Times, 87:615-631, May 1959.

Groups child amputees into noncongenital, true congenital, and appendicular abnormalities that may be treated as amputees. Discusses the nature of the child amputee and how he differs from the adult. Age of fitting, expected progress, training, and rehabilitation program are presented. Regular follow-up outpatient clinical examinations are mandatory in the growing years. Charts, photographs, x-ray plates.

25. Frantz, C. H., and G. T. Aitken, *The juvenile amputee,* Mich. Med., 57:233-241, February 1958.

The nature of the child amputee is discussed in terms of systemic flexibility, skeletal development, and complications of amputation differentiated from the adult problems. Skeletal growth, classification, age of prosthetic application, amputation level, prostheses, and social adjustment are presented. Numerous photographs and extensive bibliography.

26. Fredell, C. H., *Hemipelvectomy for soft tissue tumor in a child,* Amer. J. Orthop., 6:39-41, February 1964.

A hemipelvectomy performed on a 13-year-old boy yielded an excellent result. Reappraisal at a 3-year follow-up revealed the tumor, originally thought a fibromyxosarcoma, to be an unusual myositis ossificans. Stresses need for definite pathological consultation. Children tolerate radical operative procedures remarkably well and should never be deprived of curative surgery when indicated. Photographs and x-ray plate.

27. Gillis, L., *Amputations in children,* Ann. Roy. Coll. Surg. Eng. 19:355-360, December 1956.

Discusses indications for amputation surgery, problems of growth, long bone deficiencies, and deformities. Specific examples in upper and lower limb surgery and types of prostheses are presented. Numerous photographs.

28. Gillis, L., *Amputations, including congenital abnormalities,* Practitioner, 193:626-633, November 1964.

Very brief reference to management of phocomelias and children with deformed limbs. Photographs, x-ray plates.

29. Gillis, L., *Physically handicapped children. 2. Treatment and management,* Nurs. Times, 61:428-430, March 1965.

Briefly discusses cases and types of congenital deformities. Principles of orthopaedic and prosthetic management of limb deformities of thalidomide babies are outlined.

30. Gillis, L., *Thalidomide babies: management of limb defects,* Brit. Med. J., 5305: 647-651, September 1962.

Congenital amputees learn entirely different movement patterns from those who lose a limb later in life. Conservative correction of deformities, role of surgery, use of prostheses, and new developments in prosthetics field are discussed.

31. Gingras, G., *et al., Congenital anomalies of the limbs. Part I. Medical aspects,* Canad. Med. Ass. J., 91:67-73, July 11, 1964.

A survey of 41 cases of congenital malformations of the limb is reported in terms of classification used, etiology, description, incidence, and management of specific anomalies. Early fitting and cooperation of parents stressed. Photographs, tables.

32. Gingras, G., *et al., Habilitation of patients with congenital limb malformation—present and future,* Canad. J. Public Health, 55:472-479, November 1964.

Reassessment of 21 male and 30 female patients showed that in every case the essentials of habilitation or rehabilitation are the cooperation of the parents, good prosthetic fitting, and adequate training. Conflicts are intensified by the physical anomalies, but always in the same direction taken by the -character structure of the mother. No evidence of major emotional disorders in research subjects. Photographs.

33. Glessner, J. R., *Spontaneous intra-uterine amputations,* J. Bone Joint Surg. (Amer.), 45A:351-355, March 1963.

"The term congenital amputation is misleading •since in limb bud arrest there is not a true amputation as in intra-uterine amputations. A case of proved spontaneous intra-uterine amputation and another occurring shortly after birth are presented and associated phenomena of this condition discussed. Osseous overgrowth occurs paralleling overgrowth seen in children after amputation. Photographs, x-ray plates.

34. Hall, C. B., M. B. Brooks, and J. F. Dennis, *Congenital skeletal deficiencies,* J.A.M.A., 181:590-599, August 1962.

•Classification based on roentgenographical •appearance has assisted in a more logical treatment of cases and provides a valuable tool for further investigation of etiology. Experience based on application of classification to a case population of over 170 children. Examples are cited and fitting and training are •discussed. Advantages of early fitting listed. Drawings, photographs, x-ray plates.

35. Hall, C. B., *Recent concepts in the treatment of the limb-deficient child,* Manitoba Med. Rev., 44:552-557, November 1964. Reprinted in Artificial Limbs, 10:36-51, Spring 1966, with bibliography and illustrations added.

Discusses advances in embryology and teratology, training, prostheses, and surgery of upper and lower extremity amputees. Research indicates that congenital abnormalities are not always "inherited," and may be environmentally induced, caused by chromosomal aberrations, or result from genetic backgrounds.

36. Hall, J. E., *Habilitation of patients with congenital malformations associated with thalidomide: surgery of limb defects,* Canad. Med. Ass. J., 88:964-972, May 1963.

Describes deformities commonly seen in "thalidomide babies." Common denominator of most is some defect in the radial ray. Stresses early fitting of unilateral upper limb deficiencies, describes briefly a limited number of surgical procedures, and illustrates "bucket" for sitting. Externally powered prosthesis indicated for severely involved. Photographs.

37. Hepp, 0., *Frequency of the congenital defect—anomalies of the extremities,* Int. Nurs. Rev., 10:12-20, January-February 1963.

Survey at the University Clinic and Polyclinic, Miinster, reflects upsurge of phocomelic congenital anomalies, 1958-1962. Types of deformities analyzed. Steps to limit or eliminate the damage are outlined, as is advice for relieving the psychic and physical distress of parents. Large-scale research and development program indicated. Photographs and table.

38. Kruger, L. M., and R. D. Talbott, *Amputation and prosthesis as definitive treatment in congenital absence of the fibula,* J. Bone Joint Surg. (Amer.), 43A:625-642, July 1961.

In opposition to more conservative treatment, the authors advocate early amputation of limbs with congenital absence of the fibula which eventuate amputation. Indications for early amputation are leg-length discrepancy, foot deformity, psychological aspects, and economic considerations. Photographs and tables.

39. Lamb, I). W., *et al., The management of upper limb deficiencies in the thalidomide-type syndrome,* J. Roy. Coll. Surg. Edinb., 10:102-108, January 1965.

Report on program for 27 children. Describes powered prosthesis developed at Princess Margaret Rose Orthopaedic Hospital in Edinburgh. Children's daily schedule is given and general management and training are discussed. Drawings, photographs.

40. Lambert, C. N., *The juvenile amputee,* Illinois Med. J., 123:514-517, May 1963.

Discusses briefly the differences between juvenile and adult amputees, classification of juvenile amputees, bony overgrowth, and age of prosthetic fitting. Observations and recommendations based on clinical case load of which 50 percent are juvenile amputees. Photographs.

41. Lambert, C. N., *The juvenile amputee,*

Arch. Orthop. Unfallchir. 56:378-384, June 1964.

Juvenile amputee is denned as one who is not skeletally mature as judged from x-rays of epiphyses. Experiences and conclusions based on 579 child amputees. Bony overgrowth is a frequent complication in acquired amputations, occasionally seen in congenital. Patients with amputation required because of tumor are fitted early, even as early as 3 months post amputation. Social and educational outlook discussed. Photographs.

42. Lambert, C. N., and J. Sciora, *A questionnaire survey of juvenile to young-adult amputees who had prostheses supplied them through the University of Illinois Division of Services for Crippled Children,* J. Bone Joint Surg. (Amer.), 41A: 1437-1454, December 1959.

The purpose of this survey on 182 juvenile amputees was to obtain information which would be helpful in evaluating various services to juvenile amputees. Reported are findings related to surgical procedures, parental attitudes, prosthetic fitting, adjustment and training, follow-up care, and social acceptance. Study revealed the need for dissemination of information to the disciplines concerned with rehabilitation of the child amputee.

43. Lambert, C. N., *Growth potential in children,* Orthop. Prosth. Appliance J., 16:263-267, September 1962.

Changes in body proportions with growth, development of muscles, fat, and bone. Methods of leg length equalization are considered. Graph.

44. Lambert, C. N., and A. J. Novotny, *Amputations and amputees—adult and juvenile,* Surg. Clin. N. Amer., 37:119-134, February 1957.

Various levels of amputations are discussed in terms of prosthetic fitting and expected functional results. Amputations should be done at levels where adequate functioning prostheses can be fitted. The specific differences between juvenile amputees and adult amputees are considered. Juvenile amputees should be fitted early in life. Diagrams.

45. Lawrence, J., and M. S. Dorsch, *Partial foot amputation for severe deformity caused by congenital absence of fibula,* Orthop. Prosth. Appliance J., 19:215—216, September 1965.

Case report of patient with anomaly revised to a partial foot, rather than a Syme's amputation- Prosthesis described.

46. Maier, W. A., *Thalidomide embryopathy and limb defects; experiences in habitation of children with ectromelias,* Arch. Dis. Child., 40:154-157, April 1965.

Brief report of activities of treatment center in. Munich where 135 children diagnosed as "dysmelia" syndrome were treated. Early use of externally powered prostheses is noted. Photographs, x-ray plates.

47. Martin, J. K., *Congenital malformations associated with thalidomide and their management,* Amer. Heart J., 67:284-285, February 1964.

Brief summary of types of deformities and various phases of management.

48. Martin, J. K., and J. C. Rathbun, *Habituation of patients with congenital malformations associated with thalidomide: pediatric aspects,* Canad. Med. Ass. J., 88:959-962, May 11, 1963.

Describes various congenital anomalies associated with administration of thalidomide to pregnant mother. Case report and discussion of care. Photographs.

49. Mazet, R., Jr., and M. B. Brooks, *The prosthetic team and the child amputee,* J. Int. Coll. Surg., 27:70-82, Januarv 1957.

Experience at Child Amputee Prosthetics Project at University of California at Los Angeles, based on one hundred cases. Seven case reports. Lower extremity fitted when child could stand, and upper extremity during the first year. Numerous photographs.

50. McAllister, D., S. G. Wood, and L. Gillis, *The story of Judy,* Nurs. Times, 60: 763-770, June 1964.

Case conference on 3-year-old child who underwent Syme's amputation for frostbite of both feet with subsequent gangrene. Discusses nursing care, prosthetic management, and psychosocial problems of child from a foster home. Photographs.

51. McCollough, N. C, *The juvenile amputee: preliminary report of the problem in*

Florida, J. Florida Med. Ass., 46:302-305, September 1959.

A review of trends in management of juvenile amputees. One hundred and seven amputees up to age 16 are reported under the care of Florida Crippled Children's Commission. Thirty-seven per cent were surgical or post-traumatic amputees of which 17 per cent were due to snakebite.

52. McKenna, R. J., C. P. Schwinn, and N. L. Higinbotham, *Osteogenic sarcoma in children,* Calif. Med., 103:165-170, September 1965.

Report on 130 children with sarcoma seen during 30-year period with at least 10-year follow-up. Survival rate at 5 years was 23 per cent; at 10 years 20 per cent. Amputation is much more effective than radiation in terms of survival. Charts.

53. Pearson, F. A., and B. W. Spiers, *Teamwork in the management of dysmelic children,* Physiotherapy, 52:197-200, June 1966.

Outlines a program of management for the child with severe limb malformations and briefly discusses the associated defects, orthopaedic considerations and early prosthetic training.

54. Pillay, V. K., and K. T. Hesketh, *Intrauterine amputations and annular limb defects in Singapore,* J. Bone Joint Surg. (Brit.), 47B-.514-519, August 1965.

Condition occurs relatively frequently in the Malay people of Singapore. Causes remain obscure. Forty cases are reported and certain patterns of abnormality and their management are discussed. Photographs.

55. Schutt, W. H., *Dysmelia and its management. Habilitation of children with severe limb deformities presents a great challenge,* Clin. Pediat., 4:717-720, December 1965.

A brief overview of various aspects of orthopaedic and general management, including foot training, self care, home modification, and role of parents.

56. Siffert, R. S., *et al.* (Committee for the Care of the Handicapped Child), *A guide for the management of the child amputee,* Bulletin of the Amer. Acad, of Orthop. Surg., 13 (3), December 1965. Reprinted Orthop. Prosth. Appliance J., 20:223-227, September 1966.

Juvenile amputees classified as postsurgical; congenital; and children with anomalous extremities who are rehabilitated with prosthetic devices either with or without surgery. Recommends standards for two main categories of facilities, namely, the crippled children's clinic and the child amputee center.

57. Stamp, W. G., S. Mahon, and H. C. Morgan, *Problems of management of the child with multiple amputations,* Arch. Phys. Med., 46:354-368, May 1965.

Study of 40 children. Discusses complexities of restoring function for the child with multiple amputations. Goals of prosthetic restoration, prosthetic components and adaptations, and prosthetic training are included. Case studies. Photographs.

58. Stamp, W. G., H. C. Morgan, and S. Mahon, *Shriners Hospital amputee clinic,* Missouri Med., 60:130-137, February 1963.

Clinic established in 1960 had 101 children under active treatment to date. Some unique problems of juvenile amputees are presented. Five case histories. Photographs, x-ray plates, and table.

59. Swanson, A. B., *Phocomelia and congenital limb malformation. Reconstruction and prosthetic replacement,* Amer. J. Surg., 109:294-299, March 1965.

Substitutionary patterns, surgical reconstruction, and prosthetic replacement for various types of deformities are discussed. Awareness of the patient's need for prehension with sensation is essential. Photographs and x-ray plates.

60. Swanson, A. B., *The Krukenberg procedure in the juvenile amputee,* J. Bone Joint Surg. (Amer.), 46A: 1540-1548, October 1964.

Reviews the surgical procedure and discusses rehabilitation of the patient and cosmetic effect. Presents four case studies. Advantages for the blind patient or for one with a bilateral hand loss are listed. Photographs.

61. Trueta, J., *Care of thalidomide babies. Experience in Germany,* Lancet, 2:1162, December 1962.

Reports a visit to Germany where four centers are set up to care for "thalidomide babies." Suggests plans for their care in Britain.

62. Vultee, F. E., *Development of motor capacity in the normal child,* Orthop. Prosth. Appliance J., 16:268-270, September 1962.

Attention patterns, motor development, and ambulation age gradients for normal children.

63. Wood, W. L., N. Zlotsky, and G. W. Westin, *Congenital absence of the fibula. Treatment by Syme's amputation,* J. Bone Joint Surg. (Amer.), 47A:1159-1169, September 1965.

Congenital deformities of the fibula are anatomically classified. Indications for early Syme's amputation are discrepancy length of three inches or more, a poorly formed foot, cosmetic or functional problems, and a child who for psychological reasons cannot tolerate repeated hospitalization. Surgical procedure is described. Photographs.

PROSTHETIC MANAGEMENT

UPPER EXTREMITIES

1. Brooks, M. B., and J. Shaperman, *Infant prosthetic fitting: study of the results,* Amer. J. Occup. Ther., 19:329-334, November-December 1965.

Evaluation of effectiveness of fitting 68 congenital unilateral below-elbow amputees before age 5. Description of a prosthesis adjustment scale for rating patient's use and acceptance. Chances of success greater when child is fitted before age 2. Full-time wearing, consistent training, and positive child-parental communication are important factors.

2. Campbell, H. E., and J. Shaperman, *Prosthesis costs for the unilateral below-elbow child amputee,* Rehab. Lit., 26:305-307, October 1965.

Analysis of data gathered in a study of 68 unilateral below-elbow amputees showed it was possible to determine the average yearly cost of providing well-functioning prostheses. Average cost, maintenance of prosthesis, and major factors influencing cost are given.

3. Carroll, L. J., *Prosthetic training techniques for the bilateral upper amelia,* Amer. J. Occup. Ther., 18:97-101, May-June 1964, and 18:144-146, July-August 1964.

Functional training should be accomplished by a series of admissions of 3-5 weeks duration, spaced to coincide with certain levels of development, determined by performance. Description of training for first admission at 20-24 months, second at 30-36 months, third at 8 years, and fourth at 13-14 years. Photographs.

4. Dean, C, *Prosthetic devices for children with emphasis on fitting upper-extremity amputees,* Orthop. Prosth. Appliance J., 12: 91-101, June 1958.

Report of Area Child Amputee Program of Michigan Crippled Children Commission. Development, direction, finances, psychology, prosthetic manufacture, training, follow-up services. Detailed information regarding prescription of prostheses for short below-elbow, and shoulder disarticulation amputees. Photographs and schematic exploded views of prostheses.

5. Dennis, C, *Infant and child upper-extremity amputees: their prostheses and training,* J. Rehab., 28:26-28, March-April 1962.

Survey of graduated fitting and training. starting from time amputee can maintain good sitting balance. Early program stresses parental instruction. Session-by-session account. Follow-up procedures.

6. Epps, C. Ff., *Prosthetic management of the juvenile upper-extremity amputee,* J. Nat. Med. Ass., 54:347-351, May 1962.

Outlines steps taken in clinical program and discusses special considerations, including acceptance of device, age of fitting, terminal device, and prosthetic components. Four case histories. Photographs.

7. Fishman, S., and H. W. Kay, *Acceptability of a functional-cosmetic artificial hand for young children,* Artificial Limbs, 8:28-43, Spring 1964, and 8:15-27, Autumn 1964.

History and purpose of the study, description of the experimental hand (APRL-Sierra Child-Size No. 1 Hand), the research sample, reaction of children and their parents, observation of behavior, and prescription considerations. Performance of standard tasks with the experimental hand, indicating uses and limitations. Drawings, photographs, tables.

8. Friedmann, L., *Special equipment and aids for the young bilateral upper-extremity amputee,* Artificial Limbs, 9:26-33, Autumn 1965.

Numerous photographs depict devices, especially those for the child wearing conventional prostheses and including those for feeding, dressing, and schoolwork.

9. Halpern, C.D., *The child with the upper-extremity amputation,* Amer. J. Occup. Ther., 10:50-56, March-April 1956.

Congenital unilateral below-elbow amputee, his fitting, description of prosthesis, and operational control, with details of check-out and training. Stresses early fitting and follow-up. Photographs.

10. Kay, H. W., *et al., The Munster-type below-elbow socket, a fabrication technique,* Artificial Limbs, 9:4-25, Autumn 1965.

Evaluation of the prosthesis which encases the olecranon and prescription considerations precede detailed instructions for fabrication. Profusely illustrated.

11. Lambert, C. N., *Upper-extremity prostheses in juvenile amputees,* J. Bone Joint Surg. (Amer.), 38A:421-426, April 1956.

Some of the difficulties encountered in making prostheses for juvenile amputees. Photographs.

12. Lund, A., *Observations on the very young upper-extremity amputee,* Amer. J. Occup. Ther., 12:15-22, January-February 1958.

Description of a research program directed toward five objectives; namely, determination of fitting problems, earliest age level suitable for fitting, desirable components of prosthesis, check-out, and training procedures. Charts, photographs, report forms.

13. MacDonnel, J. A., *Age of fitting upper-extremity prosthesis in children,* J. Bone Joint Surg. (Amer.), 40A:655-662, June 1958.

Clinical study of twelve juvenile amputees, ranging from five months to four years, to determine satisfactory age for fitting. Includes prosthetic acceptance, tolerance, and optimum age for conversion from temporary prosthesis to one with an actively controlled terminal device. Charts, photographs.

14. MacNaughtan, A., *The role of the occupational therapist in the training of the child arm amputee,* Phvsiotherapy, 52: 201-205, June 1966.

Bilateral above-elbow amputees and thalidomide-type of deformities are increasingly being fitted with carbon-dioxide prostheses. Describes progressive activities using Heidelberg limbs which are provided between one and two years, following a short period of wearing cosmetic limbs. Training methods for other upper-limb amputees are discussed.

15. Mansfield, O. T., and J. S. Knight, *The treatment of congenital amputation through forearm,* Brit. J. Plast. Surg., 16:23-31, January 1963.

Very young child's stump is fitted with an acrylic cup attached by harness. Acrylic rod is later attached to equalize length and the artificial limb is fitted at time when child would normally learn to w[7]alk. Several case summaries. Diagrams, photographs, tables.

16. Marquardt, E., *The Heidelberg pneumatic arm prosthesis,* J. Bone Joint Surg. (Brit.), 47B:425-434. August 1965.

Main indications for use of the pneumatic prosthesis. Case report of a 22-year-old male with bilateral forequarter amputation. Special problems in children are discussed. Photographs.

17. Mayo, J., *Upper extremity prostheses for children,* Canad. Nurse, 58:145-148, February 1962.

Briefly discusses the prosthetic appliance, cost of devices, training, the parents' role, and phantom limb sensation. Photographs.

18. Parker, A. A., *Institute on child prosthetics,* Canad. J. Occup. Ther., 30:115-116, Autumn 1963.

Report of Institute held at Ontario Crippled Children's Center and Sunnybrook Hospital, Toronto. Sponsored by Government of Canada.

19. Richardson, G., and A. Lund, *Upper-extremity prosthetic training for the young amputee,* Amer. J. Occup. Ther., 13:57-63, March-April 1959.

Step-by-step presentation of training techniques for below-elbow and shoulder-disarticulation amputees with suggested timetable for 2- to 4-year-olds. Photographs and report forms.

20. Shaperman, J., *Orientation to prosthesis use*

for the child amputee, Amer. J. Occup. Ther., 14:17-23, January-February 1960.

Discusses orientation to prosthesis training for very young amputees—one phase of a four-phase program carried out at UCLA. Includes planning with family for daily wear, methods of putting on and taking off prosthesis, and detailed description of maintenance and care by family, therapist, or prosthetist. Drawings and photographs.

21. Shaperman, J., *Learning techniques applied to prehension,* Amer. J. Occup. Ther., 14:70-74, March-April i960.

Reviews studies in field of maturation and learning and suggests these be applied to investigation of children learning to use prosthesis. Suggests steps of prosthesis operation be set up to parallel those of development of normal hand function.

22. Simpson, D. C, and D. W. Lamb, *A system of powered prostheses for severe bilateral upper-limb deficiency,* J. Bone Joint Surg. (Brit.), 47B:442-447, August 1965.

Presents the details of the prosthesis used for 20 children with upper limb disabilities, from bilateral amelia to bilateral phocomelia, due to thalidomide.

23. Sperry, R., *The development of prosthetic infant hand, Part I,* Amer. J. Occup. Ther., 11:102-107, March-April 1957.

Design and evaluation of prosthesis for one infant congenital bilateral below-elbow amputee, based on evaluation of physical and emotional needs and resultant function. Diagrams and photographs.

24. Teska, A., and C. A. Swinyard, *Evaluation of a standardized test for child's APRL-Sierra No. 1 hand,* Amer. J. Occup. Ther., 15:17-18, January-February 1961.

Description of a test designed to meet the evaluation objectives of functional capacity, versatility, and durability of prosthetic hand. Stresses need for test to be stimulating to child and within age and interest level. Used in 16 rehabilitation centers.

LOWER EXTREMITIES

25. Brodsky, R., and H. W. Kay, *The use of the SACH foot with children,* Orthop. Prosth. Appliance J., 15:261-264, September 1961.

Report of fitting 158 feet by Child Prosthetic Studies of New York University. Tables summarize prescription by age and amputation type, foot problems, gait deviations.

26. Damsbo, A. M., *Case report: habilitation of a two-year-old bilateral above-knee amputee,* J. Amer. Phys. Ther. Ass., 43:584-586, August 1963.

Detailed progression of prosthetic training.

27. Hensley, C. D., Jr., *The use of a bilateral Canadian-type hip-disarticulation for congenital absence of both lower extremities,* J. Bone Joint Surg. (Amer.), 41A:417-421, April 1959.

Case history of a 5-year-old child who was fitted with Canadian-type hip-disarticulation prostheses described by Foort and Radcliffe but with modifications required because of the bilateral deformity. Follow-up report nine months after fitting showed that the prostheses had enabled the child to attain a degree of independence impossible with other appliances. Prostheses and training are described in detail. Drawings, photographs.

28. Jones, R. H., and C. C. Nelson, *"Pylon-prosthetic" devices for lower-extremity congenital skeletal deficiencies,* Orthop. Prosth. Appliance J., 19:218-227, September 1965.

Nomenclature and embryology of skeletal anomalies, technical problems of fitting. Four case reports. Numerous photographs.

29. Kitabayashi, B., *The physical therapist's responsibility to the lower-extremity child amputee,* Phys. Ther. Rev., 41:722-727, October 1961.

Emphasis on early fitting, preparation of parent and child for prosthetic use, checking for fit and function, continued follow-up. Suggests activities for lower-extremity prosthetic training.

30. Klein, R., *An experimental prosthesis for lower-extremity amelia,* Med. J. Aust., 1:476-478, March 1964.

Progress with the lower extremities is achieved by instigating a pendular motion above the base and by a slight forward shift of the center of gravity. Photographs.

31. Ogg, H. L., *Gait analysis for lower-ex-*

trentity child amputees, J. Amer. Phys. Ther. Ass., 45:940-945, October 1965.

Points out that, in adequate gait evaluation, consideration must be given to important factors concerning the patient, the prosthesis, and the compatibility of patient and prosthesis. Common gait deviations related to different levels of amputation are discussed. Movies advocated to yield information on which to base the prosthetic program. Photograph.

32. Ogg, H. L., *Measuring and evaluating the gait patterns of children,* J. Amer. Phys. Ther. Ass., 43:717-720, October 1963.

A technique to measure stride length, dynamic base, angle of foot placement, and step distance is described. This technique, which appears to be a valid tool, has proved useful in gait correction approaches. Diagram and tables.

33. Ogg, H. L., *Physical therapy for the preschool child amputee,* Orthop. Prosth. Appliance J., 16:148-150, June 1962.

Therapist is responsible for evaluating developmental status, assisting parents in understanding the physical limitation of their children, preventing deformities, and training in the use of the prosthesis.

34. Radford, J., and J. Steensma, *The lower-extremity toddler amputee training procedures,* Phys. Ther. Rev., 37:32-37, January 1957.

Stages of training for bilateral, unilateral above- and below-knee toddler amputee. Uses of external supportive devices for training. Photographs.

UPPER AND LOWER EXTREMITIES

35. Brooks, M. B., L. L. Beal, and H. L. Ogg, *The child with deformed or missing limbs: his problems and prostheses,* Amer. J. Nurs., 62:88-92, November 1962.

Describes a child amputee program, including child and family evaluation, fitting, training, and progress. Emphasis on early fitting. Photographs.

36. Campbell, H. E., *Prosthesis for the child-research notes,* Orthop. Prosth. Appliance J., 12:57-64, December 1958.

Report of the Child Amputee Prosthetics Project of University of California at Los Angeles. Special problems include elbow-lock mechanisms for phocomelias, harness applications, walking mechanism for bilateral amelia, canted shoulder plates, piston attachment, and swim fin. Charts and photographs.

37. Frantz, C. H., *Prosthetic and orthotic devices for nonstandard prostheses in the management of limb deficiencies,* Orthop. Prosth. Appliance J., 16:271-278, September 1962.

38. Gilpin, R. E., *Habilitation of patients with congenitial malformations associated with thalidomide: prosthetic aspects,* Canad. Med. Ass. J., 88:973-979, May 1963.

Reviews types of prostheses available and stresses role of prosthetist in application of prostheses to congenital deformities. Presents experimental developments in prosthetics. Describes composition and function of clinic team.

39. Lineberger, M., *Habilitation of child amputees,* J. Amer. Phys. Ther. Ass., 42:397-402, June 1962.

Typical progress in prosthetic management for upper- and lower-extremity and bilateral anomalies groups is discussed. Cases demonstrate treatment prescribed for children with most common anomalies. Report from Michigan Crippled Children Commission. Photographs.

40. Lineberger, M., *Children who need prostheses,* Nurs. Outlook, 7:28-30, January 1959.

Description of the Michigan child amputee program including prosthetic fitting and training and progress. Child and family education by the clinic team and public health nurse is discussed. Emphasis on early fitting. Photographs.

41. McKenzie, D. S., *The prosthetic management of congenital deformities of the extremities,* J. Bone Joint Surg. (Brit.), 39B:233-247, May 1957.

A broad classification of limb deformities in relation to prosthetic management is presented. Psychological adjustment is noted and prosthetic devices are described. Each case must be evaluated individually and close liaison between the orthopaedic surgeon and the prosthetist is necessary. Suggests amputation should be confined to cases in which individual cannot be fitted satisfactorily, either for functional or cosmetic reasons. Parents and,

where possible, the children share in the decision.

PSYCHOSOCIAL ASPECTS

The following subjects are discussed in the articles designated:

Family 2, 3, 6, 9, 11, 12, 13, 14, 17, 18, 34.

Phantom 8, 17, 28, 29, 30, *33.*

1. Armstrong, K. S., *Habililation of patients with congenital malformations associated with thalidomide: medical-social aspects,* Canad. Med. Ass. J., 88:980-981, May 1963.

Contribution of the social worker is discussed in terms of three general stages of the child's development: during pre-school and early life when the first consideration is to minimize the disability; in middle years of growth when the problems of education are uppermost; and during adolescence and young adulthood when the individual must face and solve his own problems to become an independent adult.

2. Auerbach, A. B., *Group education for parents of the handicapped,* Children, 8: 135-140, July-August 1961.

Although no specific reference is made to parents of amputee children, the needs of parents and methods of helping them are applicable to parents of all handicapped children.

3. Beal, L. L., *The impact of an anomalous child on those concerned with his welfare,* Orthop. Prosth. Appliance J., 16:144-147, June 1962.

Coping with the shock of a child born without limbs is facilitated by professional guidance and parental counseling. Differentiates between verbal attitudes and emotional reactions.

4. Centers, L., and R. Centers, *A comparison of the body images of amputee and nonamputee children as revealed in figure drawings,* J. Project Techn., 27:158-165, June 1963.

Twenty-six children with upper-extremity amputations were matched with the same number of nonamputee children of the same chronological and mental age and sex. Generally, amputee children in "draw-a-person" test represent their bodies and those of others realistically and nondefensively. Tables.

5. Centers, L., and R. Centers, *Peer group attitudes toward the amputee child,* J. Soc. Psychol., 61:127-132, October 1963.

Data support hypothesis that the presence of amputation represents a threat to the bodily integrity of nonamputees and this is reflected in rejection of the child amputee. Seventeen-item social discrimination questionnaire surveyed attitudes on appearance, social relationships, and popularity. Amputees are liked least and are most often considered the saddest children in the class.

6. Cohen, P., *The impact of the handicapped child on the family,* Social Casework, 43:137-142, January 1962.

Discusses caseworker's attitude and role in helping parents of a handicapped child. Before parents can truly accept the child's handicap, they must work through a series of difficult adjustment stages.

7. Cole, M. G., and L. Podell, *Serving handicapped children in group programs,* Social Work, 6:97-104, January 1961.

Report of a project demonstrating how handicapped children could be incorporated into group work programs of neighborhood centers. Also surveyed attitudes of directors of group work and recreational agencies toward serving handicapped. Tables.

8. Easson, M. B., *Body image and self-image in children. Phantom phenomenon in a 3-year-old child,* Arch. Gen. Psychiat., 4:619-621, June 1961.

Case report of a boy whose left arm was amputated at age 3 and who experienced a very positive phantom limb phenomenon. Discusses concept of psychic image and body image in the formation of total self-image and their importance in childhood psychoses and neuroses.

9. Evans, T. J., *Limb deficient children at Chailey Heritage,* Med. Social Work, Volume 18, April-May 1965.

Chailey Heritage is a hospital school for disabled children up to age 16. Twenty-four are limb-deficient children, most the result of thalidomide. Handling the many problems of parents and children is discussed by the social worker.

10. Frantz, C. H., *Child amputees can be*

rehabilitated, Children, 3:61-65, April 1956.

Report of more than nine years' work in rehabilitation of child amputees in Michigan.

11. Gillis, G., *Physically handicapped children, the nurses approach to the mother,* Nurs. Times, 61:382-383, March 1965.

The nurse can help the mother not only by her attitude but by offering practical advice.

12. Gingras, G., *et al., Congenital anomalies of the limbs. Part II. Psychological and educational aspects,* Canad. Med. Ass. J., 91:115-119, July 1964.

Survey of 41 cases of congenital malformation is discussed in terms of intelligence and education, motor and emotional development, body image, and prophylactic measures. Occurrence of congenital limb deficiency is more intensely felt by the parents who need psvchotherapeutic support at earliest possible date. No relationship found between intelligence and emotional adjustment to disability.

13. Green, M., and M. A. Durocher, *Improving parent care of handicapped children,* Children, 12:185-188, September-October 1965.

Reference to children needing prosthetic and orthotic devices included in article.

14. Gurney, W., *Parents of children with congenital amputations,* Children, 5: 95-100, May-June 1958.

Case examples of parental attitude and help given.

15. Gurney, W., and J. F. Dennis, *Use of community resources in the continuing prosthetic care of the child amputee,* Orthop. Prosth. Appliance J., 15: 165-167, June 1961.

16. Kolodney, R., *Therapeutic group work with handicapped children,* Children, 4:95-100, May-June 1957.

Illustrates value of group experience with normal children, noting special planning which should take place to ensure success.

17. Kyllonen, R. R., *Body image and reaction to amputations,* Connecticut Med., 28: 19-23, January 1964.

Importance of parents' attitude toward the child, his body, and its parts is illustrated by presentation of four child amputees-two congenital and two with acquired amputation. Phantom limb and preparation of child for surgery are discussed. In congenital amputees, if prosthesis is presented during critical stage when "body-image" is forming, child will incorporate limb into his use and action pattern. If amputation occurs later, he must deal with feelings of loss before he can progress to higher levels of adequate development and adjustment.

18. Lazure, D., *Habilitation of patients with malformations associated with thalidomide: psychiatric and psychological aspects,* Canad. Med. Ass. J., 88:962-964, May 1963.

Depression and self-castigation have been the specific psychiatric reactions noted, particularly in the mother. Preferable psychologically to keep child at home. Most children show no intelligence defects. Assessment by a psychiatrist and psychologist indicated at about 6 months.

19. McLeod, M., *Osteogenic carcinoma: a teenager's reaction to radical surgery.* Canad. Nurse, 60:49-52, January 1964.

Related subjectively in form of diary entries.

20. Morse, J., *Making hospitalization a growth experience for arthritic children,* Social Casework, 46:550-556, 1965.

Demonstrates ways of optimizing long hospital experience for children. Five case illustrations.

21. Parmelee, A., Jr., *The doctor and the handicapped child,* Children, 9:189-193, September-October 1962.

Stresses the importance of how parents are informed about their children's handicaps, both those obvious from birth and those which become apparent later. Includes references to children with congenital limb deficiencies.

22. Patton, C. J., and V. Barckley, *Almost all's right with the world,* Nurs. Outlook, 7:31-33, January 1959.

A brief developmental history of a Pittsburgh program for amputees under 21 years of age. Physical and psychological evaluation is followed by prosthesis training and continued schooling during hospitalization. Adverse effect of early separation from the mother and the child's emotional development should be considered with the physical advantages of early prosthesis fitting.

23. Plank, E., *Problems of child care in prolonged hospitalization,* Child Welfare, 39(9):23-26, 1960.

Discusses efforts directed toward helping hospitalized children keep their own identity. A child with paralytic poliomyelitis is cited.

24. Robinson, H. A., and J. E. Finesinger, *The significance of work inhibition in rehabilitation,* Social Work, 2:22-31, October 1957.

Drawing on experience with children with paralytic poliomyelitis, emphasizes meaning of motility. Also discussed are motivation of the individual for job placement, meaning or function of work, and the dynamic social setting of the work situation.

25. Schwartz, D. R., *Incident from a family study,* Amer. J. Nurs., 68:89-90, December 1965.

Story of how a used lower-extremity prosthesis was donated to the World Rehabilitation Foundation, Inc. More than 60,000 prosthetic devices have been sent to rehabilitation facilities in foreign countries.

26. Shottand, L., *Social work approaches to the chronically handicapped and their families,* Social Work, 9:68-75, 1964.

Explains need to understand and meet the emotional crises which develop in families when children have chronic handicaps.

27. Siller, J., *Psychological concomitants of amputation in children,* Child Develop., 31:109-120, March 1960.

Subjects were 27 upper- and 25 lower-extremity amputees, 34 of whom were congenital amputees and 8 traumatic. The children and in most cases one or both parents were interviewed and subjected to a number of tests. Data were analyzed in terms of reactions to disability, parental acceptances, social sensitivity, and general adjustment. Tables.

28. Siller, J., and E. Peizer, *Some problems of the amputee child in school,* Education, 78:83, 1957.

29. Simmel, M. L., *Developmental aspects of the body schema,* Child Develop., 37: 83-95, March 1966.

Past sensory input is a *sine qua non* of the amputation phantom. Phantom as a symptom of a postural-tactile schema depends primarily on a history of a postural-tactile input. Table.

30. Simmel, M. L., *Phantom experiences following amputation in childhood,* J. Neurol. Neurosurg. Psychiat., 25:69-78, February 1962.

Data from several groups of young amputees indicate that phantoms are rarely reported if the amputation was performed before the age of 4. Findings support the hypothesis that the body schema which gives rise to the amputation phantom is basically a postural schema.

31. Simmel, M. L., *The absence of phantoms for congenitally missing limbs,* J. Psychol., 74:467-470, September 1961.

Of 27 patients with congenitally missing limbs who were questioned regarding phantom experiences, 25 reported never to have experienced phantom. One report is of questionable reliability; the other may have been of a true phantom or a contemporaneous kinesthetic illusion. In general, study supports Pick's classical statement that congenitally missing extremities do not give rise to phantoms.

32. Steensma, J., *Problems of the adolescent amputee,* J. Rehab., 25:19-20, 27, March-April 1959.

Experience at Michigan Crippled Children Commission. Discusses behavior related to etiology. Trauma forces adolescent into dependent and regressive behavior. Emphasizes greater problem with upper-extremity amputation. Adolescent is frustrated with respect to his prosthesis and girls are critical of color and shape of lower-extremity prostheses. Study by rehabilitation counselors needed.

33. Switzer, R. M., and M. Clarke, *Camping for severely disabled children,* Rehab. Rec, 5:7-9, September-October 1964.

Describes an Easter Seal day camp program. Children become generally more confident and self-reliant and improve in social skills. Photographs.

34. Weinstein, S., and E. A. Sersen, *Phantoms in cases of congenital absence of limbs,* Neurology, 11:905-911, October 1961.

Time-consuming techniques used in this study resulted in phantom limbs reported by 5 out of 30 patients with congenital limb aplasia. Suggests reasons for past negative reports. Modification of the theory of the body schema is proposed for the existence of phantoms in such cases.

35. Wesseling, E., *The adolescent facing amputation*, Amer. J. Nurs., 65:90-94, January 1965.

Case history of patient with osteogenic sarcoma. Discusses nurse's role in providing milieu for patient and family to express emotional reactions and presents pre- and postsurgical role of nurse. Describes adolescent nursing unit in orthopaedic department of a University of Illinois Hospital. Emphasis on interdepartmental approach to patient care.

36. White, E., *Casework service in a polio respiratory center*, Social Casework, 38:132-138, 1957.

While not specifying amputees, the author does discuss attitudes and problems of the severely handicapped and ways of helping them.

News and Notes

Sixteenth Meeting of CPRD

The Sixteenth Meeting of the Committee on Prosthetics Research and Development was held in the National Academy of Sciences Building and the American Chemical Society Building, Washington, D. C, October 13 and 14, 1966. The Chairman of CPRD, Dr. Herbert Elftman, presided. The Vice Chairman of CPRD, Colin A. McLaurin, was present. Other members of CPRD attending the meeting were Dr. George T. Aitken, Dr. Robert L. Bennett, Dr. Cameron B. Hall, Dr. Robert W. Mann, Professor J. Raymond Pearson, Dr. James B. Reswick, Charles W. Rosenquist, Professor Robert N. Scott, and Howard R. Thranhardt. Mrs. Barbara R. Friz was present as the representative of the Chairman of the Committee on Prosthetic-Orthotic Education. The Children's Bureau was represented by Miss Clara Arrington, the Vocational Rehabilitation Administration by Drs. Loren A. Helberg and Philip A. Klieger, and the Veterans Administration by Drs. Robert E. Stewart and Eugene F. Murphy.

Others attending the meeting were Colonel Peter M. Margetis and Albert B. Colman, Army Medical Biomechanical Research Laboratory; Professor Lawrence Cranberg, University of Virginia; Dr. Verne T. Inman, University of California, San Francisco; Dr. Edward Peizer, Veterans Administration Prosthetics Center; Louis Jordan, Special Consultant to the Chairman of the Division of Engineering, National Research Council; John C. Kohl, Executive Secretary of the Division of Engineering, NRC; S. M. Charlesworth, Assistant Executive Secretary of the Division of Engineering, NRC; A. Bennett Wilson, Jr., Executive Director of CPRD; Hector W. Kay, Assistant Executive Director of CPRD; and James R. Kingham, Staff Editor of CPRD.

Dr. Elftman convened the meeting and invited Mr. Charlesworth to speak on behalf of the Division of Engineering. Mr. Charlesworth extended a hearty welcome from the National Research Council and the two Academies and explained that, owing to other commitments, it was not possible for the Chairman or the Executive Secretary of the Division of Engineering to be present for the opening of the meeting. However, after the meeting came to order on the second day, Mr. Jordan, speaking as one having had long association with CPRD, told the members of his recent retirement as Executive Secretary and his continuing service as Special Consultant to the Chairman of the Division, and then introduced Mr. Kohl, the new Executive Secretary of the Division. Mr. Kohl confirmed the welcome previously extended and expressed his pleasure at being able to listen to some of the deliberations of CPRD.

Mr. McLaurin, Chairman of the Subcommittee on Design and Development, reported that since the Fifteenth Meeting of CPRD there had been one meeting of his subcommittee. After pointing out that virtually all the work of the subcommittee goes on in the various workshop panels, he proceeded to review the work of the panels.

Mr. McLaurin indicated that some of the items presently under consideration by the Workshop Panel on Upper-Extremity Prosthetics Components are: hands, particularly the AMBRL soft hand and the AMBRL electric hand; hooks, including many with new configurations designed by Carl Sumida and the Toronto electric hook; wrists, including the Motis rotator, the Mods flexion unit, and the Sumida quick-disconnect for children; elbows, particularly the AMBRL electric elbow and the Toronto electric elbow; shoulders, particularly the AIPR shoulder; and coordinated arms.

Mr. McLaurin explained that an important function of the panel is to conduct preliminary evaluations of items and then invited Dr. Peizer to demonstrate and explain the Motis wrist rotator. Dr. Peizer said that the wrist rotator is now being redesigned for external power, because, with body power alone, the device tended to overburden body harnessing. Dr. Peizer also demonstrated the AMBRL hook with finger flexion, an AIPR gas-powered actuator for elbows and wrists, and a new AIPR powered hook.

Mr. McLaurin then showed a motion picture depicting a phocomelic child functioning with an electrically powered coordinated arm. It was noted that the powered three-fingered hook on the arm was useful in picking up and using such objects as pens and pencils.

At Mr. McLaurin's invitation, Mr. Colman displayed and described a number of upper-extremity prosthetic items developed at AMBRL: the AMBRL soft hand, the objectionable puffiness of which has now been corrected; the AMBRL flexed hook, which now incorporates a lock; the electric elbow; and the piezoelectric hand.

At Mr. McLaurin's request, Dr. Peizer then showed a film depicting a 38-year-old bilateral, upper-extremity amputee fitted with AIPR pneumatic prostheses. Dr. Peizer explained that the evaluative procedures employed in studying various combinations of components deal with practical, everyday activities. Dr. Peizer also showed a below-elbow "unitized" arm, with cosmetic cover, designed by Carl Sumida, and a Sumida hook of new design.

Mr. McLaurin briefly reviewed the report of a meeting of the Workshop Panel on Upper-Extremity Fitting, Harnessing, and Power Transmission held in Los Angeles during February 1966, pointing out that the meeting had a dual purpose: to define current practice in the fabrication, fitting, and harnessing of upper-extremity prostheses in order to establish a new baseline for further research in the field; and to assist the staff of the UCLA Prosthetics-Orthotics Program in an advisory capacity as to needed revisions in the *Manual for Upper-Extremity Prosthetics.*

At Mr. McLaurin's request, Dr. Peizer showed samples of a new plastic material, Polysar, manufactured by the Polymer Corporation, Sarnia, Ontario. The material can be molded directly on the amputee's stump and is being used for upper-extremity socket fittings at VAPC. The manufacturer makes the material available in preformed cones of various sizes, which can be readily adjusted to the stumps of the individual patients.

In concluding the discussion of upper-extremity fitting and harnessing, Mr. McLaurin said that the problem of pressure in the axilla had still not been solved.

Mr. McLaurin reviewed the report of a meeting of the Workshop Panel on Lower-Extremity Prosthetics Components held in Chicago during July 1966. He then briefly described a hydraulic ankle with automatic lock being developed by Mauch and mentioned the evaluation of hydraulic, pneumatic, and mechanical knee units at VAPC. He said that a number of pylons have been developed by the U. S. Manufacturing Company, by the Manitoba Rehabilitation Hospital, and by UCB. He mentioned the UCB air-cushion socket and, with the assistance of Dr. Inman, described the UCB pneumatic knee control. Also mentioned as being under development were cosmetic coverings for pylons. Mr. McLaurin said there is a definite trend toward the use of pylons with cosmetic covers for below-knee fittings, their advantage being the ease with which changes in adjustment in alignment can be made.

At Mr. McLaurin's request, Dr. Peizer showed the UCB swing-phase control, the Navy intermittent friction knee, and new pylons for below-knee and above-knee temporary prostheses.

Mr. McLaurin showed film strips depicting an amputee walking with a hip-disarticulation prosthesis. He also showed a motion picture of a child without arms or legs using a swivel walker developed at the Ontario Crippled Children's Centre, Toronto. Dr. Aitken reported favorably on the use of such walkers at Grand Rapids, and Mr. McLaurin suggested the possibility of applying the principle of the walkers to devices which could provide mobility for paraplegics.

In reviewing items discussed in the report of a meeting of the Workshop Panel on Lower-Extremity Prosthetics Fitting, Mr. McLaurin mentioned particularly that considerable attention was being given to the possibility of eliminating the use of plaster casting through the technique of suspension casting with malleable plastic and the utilization of standard preforms. Mr. McLaurin said that the dream of eliminating plaster may soon be realized.

Mr. McLaurin then mentioned the development of various fluid-lined sockets and studies being made of pressures inside sockets. At Mr. McLaurin's invitation, Dr. Peizer demonstrated a device developed at NYU for stump-pressure measurements by means of pressure transducers. Dr. Peizer said that the studies had been conducted as the result of a recommendation made by the design and development panel and that the information obtained through use of the device will be published in the near future.

Dr. Peizer also showed a projection slide depicting an instrumented pylon developed at VAPC for the measurement of forces acting between floor and shoe of amputees walking on immediate postsurgical prostheses in Seattle.

Mr. McLaurin briefly discussed the report of a meeting of the Workshop Panel on Lower-Extremity Orthotics, noting that numerous devices were currently under study. He expressed the belief that in time the number would be reduced to a relatively few devices of major significance. The general trend would be to concentrate on the function to be obtained from a particular device and the improvement of the device to provide more function. Mr. McLaurin showed a brace which provided friction control of motion at the ankle.

At Mr. McLaurin's request, Professor Pearson commented on the UM knee brace and Dr. Inman commented on the UCB ankle brace joint. In addition, Mr. Colman mentioned work in plastic bracing at AMBRL, pointing out that the material is easy to form and can be suitably colored for women's wear.

With respect to the Workshop Panel on External Power, Mr. McLaurin noted that there had been no meeting since the conference on the control of external power at Warrenton in 1965. Work had been going on, however, and the trends were toward EMG controls.

At Mr. McLaurin's request, Dr. Reswick described some of the work being done at Case Institute of Technology. Dr. Reswick showed projection slides depicting a generalized scheme for a neural by-pass which he had discussed on his recent trip to Russia. He also demonstrated the operation of transmitters and wires implanted in his own shoulder, and circulated various types of transmitters for inspection. He described his experience in using the transmitter to operate the Bottomley hand, saying that he was able to operate the hand without conscious movement of his muscles, just by "thinking" about what he wanted. He cautioned that the equipment and the procedures are all very new and much remains to be done, but indicated that the learning problem may not be as difficult as once was believed.

Professor Mann then briefly described work being done by the Massachusetts Institute of Technology at Massachusetts General Hospital on a controllable limb. The work is being supported by the Liberty Mutual Insurance Company. Dr. Mann said that not more than ten minutes' experience is required to learn the operation of the limb. The limb is presently being redesigned and one dozen are being fabricated for amputee application and evaluation. The learning rates and abilities of a number of patients are being assessed.

Professor Scott demonstrated an EMG control unit developed at the University of New Brunswick, saying that training is not a problem but feedback is, particularly if the subject has six muscles transmitting signals simultaneously. After showing a number of control units, Professor Scott said that problems included the selection of control sites, electrodes, control units that are too big and too heavy, and unreliable connectors. In conclusion, he expressed the view that EMG signals for prosthetic applications should not be limited to those generated by the muscles of the amputation stump.

In the general discussion following the presentation of the Subcommittee on Design and Development, it was the consensus that CPRD should recognize the importance of spinal and upper-extremity orthotics. It was decided to establish a Workshop Panel on Upper-Extremity Orthotics; however, the appointment of the panel chairman was deferred.

Dr. Aitken, Chairman of the Subcommittee on Child Prosthetics Problems, then reviewed the reports of two meetings of the subcommittee, pointing out that the meetings were held prior to his assumption of the chairmanship of the subcommittee on July 1, 1966. He emphasized the importance of the 22 affiliated child amputee clinics in meeting the needs of juvenile amputees and in clinical application studies, the role of the *Inter-Clinic Information Bulletin* in disseminating information to clinical practitioners, and the great value of the yearly meetings of the clinic chiefs. He said that the presentations made at the last meeting of the clinic chiefs by leading authorities on normal and abnormal embryological development were particularly impressive.

Referring to summaries of projects being conducted under the aegis of the Subcommittee on Child Prosthetics Problems, Dr. Aitken observed that, while the number of patients requiring powered feeding arms is small, a number of electric arms have been made and are being fitted. In addition, a number of fittings have been made of the AIPR pneumatically powered feeder arms. New Brunswick EMG control units and electric hooks are also being studied at several centers.

Dr. Aitken said that the accomplishments of the Subcommittee on Child Prosthetics Problems over the past nine years reflected great credit on Dr. Charles H. Frantz's leadership, the staff, and New York University.

Since it was not possible for Captain F. L. Golbranson, MC, USN, Chairman of the *Ad Hoc* Committee on Immediate Postsurgical Prosthetics Fitting, to be present, Dr. Elftman asked Mr. Wilson to review the history and background of immediate postsurgical prosthetics fitting. This Mr. Wilson did, describing how the technique came to the attention of Americans through a lecture delivered by Dr. Marian Weiss at the Sixth International Prosthetics Course in Copenhagen in 1963. Dr. Weiss, who is Director of the Federal Rehabilitation Center at Konstancin, Poland, reported the successful use of the technique by which patients are fitted with prostheses immediately after surgery and commence ambulation the following day. Here in the United States the technique, or various slight modifications of it, has been employed with dramatic results. Centers using variations of the technique are the Navy Prosthetics Research Laboratory, Prosthetics Research Study in Seattle, the University of Miami (with older patients), Duke University, and Marquette University. Mr. Wilson told of CPRD's formation of an *ad hoc* committee which had developed a data-collection form. He said that it was hoped that the data-collection form will be used by various centers so that a meaningful report can be prepared. UCOPE considered that the technique was ready to be taught, and a draft manual has been prepared. At a July 1966 meeting in Chicago, UCOPE decided to hold a pilot school on immediate postsurgical fitting procedures at one of the three universities in the Prosthetics-Orthotics Education Program. This school is now scheduled for January 1967. Early fitting procedures probably would also be included in the course. Many persons have shown interest in attending the school. Mr. Wilson showed projection slides depicting patients on whom the procedure had been applied in Seattle—one patient was a male teacher who was back in his classroom teaching on the twenty-fifth postoperative day, another was an 80-year-old man who was able to return to his normal activities on the twenty-seventh postoperative day. In concluding his presentation, Mr. Wilson emphasized the need for caution in introducing the technique.

A written report from Dr. Golbranson as Chairman of the *Ad Hoc* Committee on Immediate Postsurgical Prosthetics Fitting arrived during the course of the meeting and was read to the members of CPRD.

In the discussion which followed, Dr. Inman made a plea for the use of the data-collection forms developed by the *ad hoc* committee, and Dr. Stewart said that VA intends to introduce the immediate postsurgical fitting procedure in its hospitals through a rigidly controlled program. Dr. Aitken said that it seemed to him that five considerations requiring attention in the study of immediate postsurgical fitting of prostheses were: the value of rigid postsurgical dressings, alternative sites of amputation, definitions of ambulation, psychological aspects of the procedure, and types of surgery. Dr. Klieger expressed the hope that CPRD would continue to monitor the introduction of immediate postsurgical fitting procedures. It was decided to discharge the *Ad Hoc* Committee on Immediate Postsurgical Prosthetics Fitting with letters of appreciation and to review at a later date the question of reconstituting the committee.

Mr. Thranhardt, Chairman of the Subcommittee on Evaluation, pointed out that evaluation is necessary for the protection of both the consumer and the producer. The attention of the subcommittee is now being focused on clinical evaluation, he said. A number of clinics have indicated their willingness to cooperate in a clinical evaluation program, and a list of items for evaluation has been developed. Mr. Thranhardt indicated that the program would start in December 1966 with a school on the Engen hand orthoses to be held at Baylor University. It seemed probable that the VAPC PTB brace would be the second item to be evaluated.

At the request of Mr. Thranhardt, Mr. Wilson described in some detail the plans for a VRA-sponsored $39,000 pilot study in clinical evaluation to be undertaken by CPRD. He concluded his description by observing that it would be nice if some other organization could phase into evaluation within a year or two, since many items are in need of evaluation. In his opinion, it would be appropriate to devote approximately 10 per cent of the entire research and development program funds to evaluation.

In the discussion which followed, it was brought out that the endeavor of CPRD was intended only as a pilot study and that the CPRD program would use only clinics that treat patients with the focus on patient applications.

Professor Mann, Chairman of the Subcommittee on Sensory Aids, said that because of the fiscal situation it had not been possible to hold a meeting of the subcommittee or to send him as a representative to the conference on blindness at St. Dunstan's. He commented that it is not clear whether the Subcommittee on Sensory Aids is an internal organ or an external organ of CPRD. What is done in the field of sensory aids under the aegis of CPRD is only a small part of what is going on. He said that VA had requested a review of the VA-supported program in sensory aids, and a report had been made.

Dr. Mann said that, with respect to the over-all field of sensory aids for the blind, one happy feature is the supply of literature resulting from the proceedings of four international conferences.

Dr. Mann said that, in the area of communications, two methods are employed to make material available to the blind: Braille and direct access to the printed page.

With respect to Braille, Professor Mann said that the situation is good. The *Wall Street Journal,* for example, could now be put into Braille as fast as it goes into type. The punched *Wall Street Journal* compositors' tape could be read by a device about the size of an attache case. The same could be done with many other publications, since compositors' tapes are in general use. This is something that is realizable now. All that is required is sufficient money to bring it about.

Reading machines (machines capable of reading the printed page directly), Professor Mann said, range from simple, compact devices through more sophisticated devices which relieve the human user of the burden of learning. The simpler devices are in a high state of development, but the spelled speech of the more complex devices is not yet entirely satisfactory.

Obstacle detectors, Dr. Mann said, provide audio and tactile displays to the blind users. Some devices have been highly publicized. But the present level of accomplishment is about like extending the reach of the blind the length of a cane, so far as obstacle detection is concerned. They give little information about the target. Again, there is a problem of funding.

As for sensory aids in general, Dr. Mann said that a federal subsidy is needed. Otherwise, realized devices will atrophy for lack of support.

The Mauch Visotactor was shown to the CPRD members and explained by Dr. Murphy, who said that it is not truly a reading device, since using it is a slow, laborious process. However, Dr. Murphy said, the device has a limited function in that it can give a degree of independence to a blind user.

Professor Mann resumed his presentation on the Subcommittee on Sensory Aids, saying that he considered it highly desirable to hold a small workshop conference and a meeting of the subcommittee to map out on a national basis how technical knowledge can be used to advance the use of sensory aids. He hoped that a "White Paper" describing the country's responsibility would be the outcome. Dr. Stewart indicated that the Veterans Administration would be able to support meetings of the type proposed by Professor Mann.

Professor Pearson, Chairman of the Subcommittee on Fundamental Studies, reviewed the report of the first meeting of the subcommittee, pointing out the complementary nature of the subcommittee's activities in relation to those of the Subcommittee on Design and Development and the Subcommittee on Evaluation. Professor Pearson announced his intention to investigate ways and means of obtaining support for the Subcommittee on Fundamental Studies, saying that two types of funds are needed: funds for the support of the subcommittee and funds for the use of investigators.

Dr. Eugene F. Murphy, speaking on behalf of the Editorial Board, gave a brief progress report on *Artificial Limbs,* the journal of CPRD and CPOE.

In discussing international developments, Mr. Wilson said that four important events occurred in Europe during the past summer: the International Symposium on the External Control of Human Extremities in Dubrovnik, Yugoslavia; an International Course in Prosthetics in Minister, Germany; the Tenth World Congress on Rehabilitation in Wiesbaden, Germany; and the First Seminar on Prosthetics and Orthotics in Warsaw, Poland. CPRD was represented at each of these events.

Mr. Wilson, who attended the World Congress in Wiesbaden (in addition to several of the other events), said that prosthetics occupied a large part of the exhibit space, and that it appeared that Dr. Knud Jansen's international committee on prosthetics would make a smooth transition to a semi-independent status. Mr. Wilson mentioned the regional subcommittees of the international committee. He also briefly mentioned the work of Dr. George Murdoch in Scotland, where he had an opportunity to visit.

Dr. Reswick reported that he had spent two weeks in Russia as a guest of the Russian Academy of Science and four days in Poland as a guest of the Polish Institute for Control Application. He also participated in the conference on controls in Dubrovnik, Yugoslavia, where there were groups from a number of countries and there was a considerable display of equipment. He said that there was an excellent interchange at this conference.

Mr. McLaurin gave a brief account of the prosthetics course in Miinster. The greatest interest there, he said, was in immediate post-surgical prosthetics fittings. In fact, Dr. Vitali of England described a presurgical fitting which was done in order to convince the patient that he would be able to walk after his amputation. Mr. McLaurin said that many types of wheelchairs were displayed, including stair-climbing and voice-controlled models. He expressed amazement at the excellence of the laboratory equipment of Drs. Hepp and Kuhn and said that Miinster is famous for its excellent fittings.

Mr. McLaurin also had an opportunity to visit some research activities in Sweden and was particularly impressed by the electrical actuators that he saw there. In Sweden he also observed EMG studies and work on an electric hand.

Mr. Thranhardt said that he and a number of other persons from the United States participated in the seminar in Warsaw and visited a number of hospitals and limbshops in Poznan.

In summing up the presentation on international developments, Mr. Wilson said that in going to the various countries it was most gratifying to see that the United States' artificial limb program was exerting an influence on the care of patients throughout the world. Also very gratifying is the increased interest in prosthetics research in Europe, where there is a strong desire to cooperate.

Consideration was given to the role of CPRD, and much of the discussion centered upon the financial support of its activities.

Dr. Murphy, in his capacity as liaison representative for VA, pointed out that VA has been a substantial supporter of CPRD. He said that, for the coming fiscal year, VA has available $1 1/3 million for prosthetic and sensory aids research and development. Next year the amount available will be essentially the same as this year. VA also contributes to CPOE. The present fund limitation also affects other VA activities. For example, new personnel cannot be added to expand intra-VA activities.

Dr. Murphy said that 50 copies of the Mauch Model A leg are now available for clinical field testing by VA. He expressed the hope that the leg can be used with immediate postsurgical fitting cases. In this latter connection, he expressed appreciation to CPRD for its special report on the work on immediate postsurgical prosthetics fitting being conducted at the Seattle Prosthetics Research Study.

Dr. Murphy also expressed appreciation for the special report on VA-supported work on sensory aids made by the Subcommittee on Sensory Aids. He said that the report pointed to the need for evaluation and the importance of evaluation.

Dr. Murphy told of the Sixth Reading Conference for the Blind held by VA during January 1966, saying that VA had been fortunate in having people come to these conferences at their own expense.

In conclusion, Dr. Murphy said that VA is pleased with the ability of CPRD to bring together a number of different kinds of people. In behalf of VA, he expressed confidence in CPRD.

Dr. Stewart added his expression of appreciation to CPRD for its 20 years of assistance. He said that VA must maintain its schedule for next year, and there must be better evaluation of research programs because some activities will have to be curtailed.

Dr. Klieger said that he believed VRA is in a position to be helpful, declaring that VRA intends to increase its support of the CPRD evaluation program. Perhaps evaluation by CPRD could become a major supportive program for VRA. Actually, VRA has called upon CPRD for a variety of evaluative actions. All federal agencies have been required to justify every dollar spent. Consequently, VRA must show that every dollar goes into a certain slot for a certain purpose. VRA cannot put its funds into a general pool with other funds. VRA has not reduced the amount of money being spent on prosthetics and orthotics—it spends more than $2 million per year, including its funding of training projects. Dr. Klieger believed that it would be desirable for a delegation from CPRD to meet with VRA. He believed that perhaps the CPRD Subcommittee on Evaluation could receive more support from VRA. In fact, VRA would not like to see CPRD curtail any of its activities. He stressed, however, that VRA support must be on a specific, delineated basis.

Miss Arrington said that the Children's Bureau is very much interested in supporting the activities of CPRD. Congress demands justification for research programs, and so each research project proposal must contain detailed information. In conclusion, Miss Arrington said that the Children's Bureau would like to work more closely with CPRD.

Owing to other commitments, and to illness, it was not possible for a representative from the Committee on Prosthetic-Orthotic Education to make a formal presentation. However, Dr. Elftman commented that a formal report actually was unnecessary because of the excellent cooperation existing between the two Committees in their day-to-day activities.

Concerning the comments from liaison representatives from sponsors of CPRD, Dr. Elftman said that their remarks had been most helpful. CPRD greatly appreciates their support. Appropriate delegations from CPRD would be formed to call upon VRA and the Children's Bureau. Perhaps CPRD could also be of assistance to applicants in the preparation of more explicit research proposals.

By special arrangements through the National Academy of Sciences, Professor Lawrence Cranberg of the University of Virginia made a brief presentation on the development and history of an obstacle detector for the use of the blind.

Professor Cranberg said that he was chiefly responsible for the initial development of the device some twenty years ago at the U. S. Army Signal Corps Laboratories. He was no longer connected with the development of the device. In fact, he had not been so connected for a number of years. He considered that the further development of the device had been seriously impeded because of misassignment. There had been a misplacement with respect to jurisdiction. In his opinion, the program should be relocated with the National Institutes of Health.

Dr. Elftman thanked Professor Cranberg for his illuminating presentation.

Electromechanical Artificial Hand Developed by Army Medical Biomechanical Research Laboratory

Colonel Peter M. Margetis, Director of the Army Medical Biomechanical Research Laboratory, Walter Reed Army Medical Center, Washington, D. C, recently announced the development by AMBRL of an electromechanical artificial hand which provides an amputee with automatic control of grasp.

Dr. Fred Leonard, Scientific Director of AMBRL, who initiated the project, Lloyd Salisbury, Chief of the Biomechanical Devices Division, and Albert B. Colman, Chief of the Biomechanical Design Branch, Army scientists who developed the hand, consider it a major breakthrough in hand design.

The artificial hand has several attributes in common with the human hand. Not only is the appearance of the artificial hand remarkably lifelike, but in providing grasping function the hand mimics the human hand in its ability to sense and apply precisely the required grasping force to permit lifting an object. It accomplishes this through a built-in piezoelectric sensing device located in the thumb.

Piezoelectricity, a phenomenon exhibited by certain crystals, has been known for many years. When mechanical forces are applied to the crystals, they produce electricity When electricity is applied, they contract and expand. Such crystals are commonly used in electronic devices.

Interestingly, it has been recently found that in human skin there are substances that have piezoelectric qualities, and it has been suggested that this characteristic may be responsible for the transformation of physical sensations, such as pressure on the skin during touch, into electrical messages that nerves carry into the brain. If such is the case, the design of the AMBRL hand and that of the human hand utilize a common underlying sensing principle.

A comparison of the operation of both hands brings out remarkable similarities. If the human hand attempts to lift an object found to be heavier than initially estimated and slippage occurs, signals generated in the skin are relayed to the brain, which in turn generates a command signal to muscles, causing the hand to tighten about the object until no further slippage occurs. In the artificial hand, if slippage occurs, the intermittent pressure on the piezoelectric crystal generates an electric signal which is processed in the electronic

Lloyd Salisbury, at left, and Albert B. Colman, staff scientists at the Army Medical Biomechanical Research Laboratory, Walter Reed Army Medical Center, demonstrate the AMBRL electromechanical hand. As Mr. Salisbury pulls on the telephone book, the hand grasps the book more tightly.

"brain" mounted in the artificial hand. This processed signal is sent to a motor causing the fingers of the artificial hand to tighten until the object is grasped with sufficient force to stop slippage.

The AMBRL hand has been developed for use by the very severely handicapped amputee who lacks sufficient control points and power sources on his body to utilize conventional mechanical prostheses. The AMBRL hand is powered by rechargeable nickel-cadmium batteries and a 12-volt electric motor.

In use, the amputee depresses a microswitch by a muscle bulge or other motion, causing the hand to grasp the desired object with a force of approximately 10 oz. This force has been preselected so that the fragile objects handled during normal living, such as ice cream cones, eggs, and the like, will not be crushed. If, on lifting, this grasping force is not sufficient to lift the object, slippage occurs, and the hand instantaneously tightens to grasp the object securely. The amputee then releases the command microswitch, thereby automatically locking the hand and de-energizing the electrical circuit, making it possible for the amputee to hold an object for extended periods of time without any effort on his part or expenditure of electrical energy. To release the object, the amputee simply depresses the command microswitch.

Electromechanical hands have been developed in several other countries. All but one of these are simply open-close devices, and the amputee must rely on his vision to determine how hard he is grasping. In one hand, however, control of grasp is achieved, and the grasp is proportional to an applied muscle force exerted by the amputee. In that case, the amputee is required to remember the force which he previously exerted in grasping. In the AMBRL hand the proper grasp is automatically achieved.

Six additional hands are being manufactured by AMBRL for use in testing by amputees in selected clinics in the United States.

Support of Biomedical Engineering by the National Institute of General Medical Sciences

The National Institute of General Medical Sciences of the National Institutes of Health believes that during the 1970's the problem of living will begin to reach monumental proportions. This stress will produce problems and challenges that will not be resolved overnight. In the midst of these increasing complexities, the nation's health will be a cornerstone for all its future aspirations.

To support the assault being made on the nation's health problems, it is essential that an adequate portion of the expanding capability of engineers to apply science to the nation's health problems be directed to the resolution of these problems.

Biomedical engineering, as the application of the principles and practices of engineering science to biomedical research and health care, holds the promise of spectacular advances in medical science. New instruments, techniques, and systems for the diagnosis of heart disease, cancer, and stroke, the control of prosthetic devices, artificial internal organs, automated clinical pathological laboratories, and hospital information systems are some of the new areas now being developed.

NIGMS considers that, as biomedical engineering pervades all aspects of the health sciences, it is important to ensure adequate and orderly support so that the development of its applied aspects will be matched to the severe demands that will be placed upon it by the growing needs of the nation, and that its theoretical base will be expanded so as to allow for eventual effective application across a broad spectrum of interests and needs.

Biomedical engineering is expanding rapidly; no one knows how large it is at present. A recent study has predicted that biomedical engineering will be one of several industries surpassing the billion-dollar mark in the 1970's. Given the amount of money the country spends for health care and the increasing role that technology plays in this care, it is clear that there is a basis here for a great American industry. In the midst of these developments, it is important that continuing liaison be maintained between the Government, universities, and industries in the interest of developing a planned program for research and development in this area.

Present Program

There is increasing activity at NIH in biomedical engineering, and grantees of several

Institutes are active in research that is pertinent to their individual interests. NIGMS is charged with responsibility for the conduct and support of research in the general and basic medical sciences and natural and behavioral sciences related to health. Its major goal is to support scientifically the disease-oriented programs of other Institutes of NIH and to improve medical care through the development of methods for the study of living systems and for diagnosis and treatment. General support for the field of biomedical engineering through project research, training grants, fellowships, and contracts with industry is a major NIGMS program. Currently supported by this program are engineers, scientists, and physicians who are combining their special knowledge and skills to formulate basic concepts, to develop techniques and systems for discovery of the causes and cures for diseases, and to develop aids for the physician in diagnosing, treating, and rehabilitating his patients.

NIGMS is now supporting ($2,800,000) 69 basic and applied biomedical engineering research projects. These include studies on systems analysis of man's physiological functions, the electrical thermodynamic properties of biological systems, biomaterials applications in the development of artificial internal organs, the development and testing of various instruments for laboratory and clinical application, the development of a television-computer for counting colonies of bacteria and other microorganisms in the laboratory, modular instrumental components for automated clinical laboratories, ultrasonic techniques for the diagnosis of pathological conditions that cannot be adequately portrayed by x-ray investigations of the human body, the development of a hospital information system at the Massachusetts General Hospital, a computerized system that automates the quantitative processing of cine-radiographic and photographic pictorial data, the application of mathematical processes used by utility companies for the study of power transmission lines to study certain aspects of the human nervous system, the computer simulation of mathematical models of body systems, the development of new instrumentation involving new physical processes, the development of new types of biological transducers that are directed toward the day when it may be possible for the deaf to hear and the blind to see, the development of special-purpose computer technology that can aid in the analysis of bioelectrical signals and in pattern recognition in the areas of optical images and speech, automatic monitoring systems, and the application of computer technology for medical information storage and retrieval, patient monitoring, and diagnosis.

During 1966 fifteen doctoral biomedical engineering training programs were supported by NIGMS. There are presently 275 persons enrolled in these programs and the output of the programs to date has been 75 biomedical engineers. As the conditions of medical care continue to change drastically in the next decade and as this change is mediated in part by the application of engineering, computers, and instrumentation to health needs, it is important that plans be laid for the development of manpower appropriate to the expanding needs.

Supplemental funds were appropriated to NIGMS during 1966 to provide support in areas where new knowledge and technology are urgently needed to further the diagnostic and therapeutic capability to conquer heart disease, cancer, and stroke. Biomedical engineering was especially singled out as a pertinent area, as continued progress in the control of these disease processes will depend significantly on the application of engineering methodology for the development of new knowledge and the elaboration of new techniques for the provision of services. Beyond these specific areas, advances in the medical sciences in general will be increasingly dependent upon people with multidisciplinary competence for whom little or no provision has been made in traditional curricula and for which little support has been provided in the past. Accordingly, it was directed that special training efforts involving the coordinated use of training grants and fellowships should be made by NIGMS to increase skilled manpower in biomedical engineering.

Complementing the NIGMS training grants program is the NIGMS biomedical engineering fellowship program. In this the Institute provides predoctoral and postdoctoral fellowships and career development awards for carefully selected persons desiring training in biomedical engineering. During 1966, 63 individuals were supported in this fellowship program. As an example of their interests, one Fellow is a hydraulic engineer studying the motion of red blood cells—research directed toward a better understanding of energy conversion in biological systems.

During 1966 contracts were let to industry for $1,200,000 in the area of biomedical engineering. They are supporting the development of a hospital information system and the development of modular components for automated clinical laboratories. These latter studies are being undertaken because clinical laboratories throughout the country are experiencing a considerable increase in their service requirements. Projections indicate that there will be a two-fold increase in the number of chemical tests performed routinely by 1969. Additionally, the trend is toward more tests per patient per day, and more difficult and more expensive tests.

Automated clinical laboratory equipment will decrease the time required for the tests, increase their accuracy, lower the costs per unit work, and as such is in high demand. Of equal importance is the design of this equipment so that the test data can be fed to a computer for more sophisticated analysis or for storage and later retrieval as may be desired. NIGMS is particularly accenting the computerization of such automated and semiautomated equipment.

Planned Program

In its planned program for the future, NIGMS has selected the following tasks, which stress the theoretical, developmental, and applied aspects of biomedical engineering, as appropriate for support:

1. The development of the theory of information, communication, and control in the life sciences.
2. The development of basic biomedical engineering instrumentation.
3. The development of a broad base for the biomaterials area.
4. Developments in biomedical engineering specific to the needs of the clinical disciplines and areas within the NIGMS sphere of interest, such as: surgery (intensive care units, patient monitoring, biotelemetry), anaesthesia (automated anaesthesia), behavioral sciences (man-machine systems, artificial intelligence) screening and diagnostic testing (automation of clinical laboratories, the development of new techniques for screening, specific diagnostic tests, and the automation of differential medical diagnosis), and modular segments of hospital information systems and systems for the delivery of health services on local and regional levels.
5. Rehabilitation.
6. The development of specialized computer components and theory pertinent to the foregoing biomedical engineering disciplinary tasks.

Particular emphasis will be placed during 1967 on the engineering analysis of physiological systems, clinical patient monitoring, and the use of computers for the solution of biomedical problems. Stress will also be placed on projects devoted to the clinical application of biomedical engineering concepts and techniques, such as the use of ultrasound visualization and its diagnostic applications and the potential use of fiberoptics and lasers for biological research and medical problems. Research in biomaterials concerned with the theoretical and practical application of metals and plastics in repairing or replacing tissues affected by trauma or disease will be encouraged.

As examples of what may be expected in the future, the evaluation and quantification of information processing, communication, and systems control in cells, subcellular structures, and the population of cells and organisms will be events of major importance in the development of the biological sciences. The development of techniques using the full range of physical and biomechanical sciences, biomathematics, and bioengineering and instrumentation will result in new methods of approach to the study of body functions and the treatment of disease. New engineering and instrumentation concepts can lead to the automation of anaesthesia, the automatic control of complicated clinical and other laboratory procedures, and to methods of visualization of cells, tissues, and organs. Advances in computer technology, developments in patient monitoring, new techniques of electron microscopy, and new methods of examining structure by ultrasound and other techniques are areas of major expectation. The study of biological materials and their relationship to basic transfer functions and membrane models has led to the development of artificial kidneys and lungs, and further advances can be confidently predicted in this area. Developments in transistors, in miniaturized circuitry, and in plastics suggest the possibility of rapid progress in the creation of certain artificial internal organs. Diagnosis and treatment of disease will probably be enhanced by new laser techniques and other means using new forms of energy such as ultrasound. The study of the control systems of the body and their feedback circuits is expected to lead to the design of more functional prosthetic devices ranging from artificial limbs to lungs.

In addition to persons trained in the area of biomedical engineering who are needed in departments of engineering, there is a steady demand for such people in departments of medicine, surgery, physiology, biophysics, physics, radiology, and anesthesiology. Current estimates indicate that 200 doctoral biomedical engineers could be placed in these departments immediately. Various industrial groups are also on a constant lookout for the trained biomedical engineer. Most of the companies making biological instruments desire such individuals, and demand also exists for these people in aviation, computer facilities, and the telephone laboratories. The current estimate for these groups is about 400 persons during 1966. Present estimates of the National Aeronautics and Space Administration indicate that the space program could absorb 200 biomedical engineers. Considering current plans for expansion in these areas, it seems likely that the number will be cumulatively in excess of 2,000 by the year 1971.

At present, in the 15 current biomedical engineering programs, there are approximately 275 students. Over the next five years, it is expected that the output of doctoral biomedical engineers from these programs will total approximately 350. It is possible to increase the cumulative output of biomedical engineers by expanding the present programs, as well as instituting other training programs in other graduate centers. However, it is unlikely that it will be possible to do much more than double the total cumulative output of biomedical engineers over the next five years. If this is done, with a total cumulative output of 750 biomedical engineers, the cumulative output will be approximately one-third of the projected needs.

This is a situation of special concern to NIGMS. Over the next five years, NIGMS plans to double the output of biomedical engineers through training programs. It is also expected that the output through NIGMS fellowship programs can be doubled. In this latter group an attempt will be made to accent support at the level of postdoctoral and special fellowships, rather than at the predoctoral level, in the interest of trying to provide an interdisciplinary biomedical engineering education and research experience for those individuals in surgery, medicine, etc., who are in need of such training.

It is planned that over the next five years NIGMS will considerably increase its contracting activities with industry. This is considered warranted on the basis of the success to date with contracting in the hospital information system and automation of clinical laboratory areas and the clear need for increased activity in the area of directed research and development. Of special interest to NIGMS is the development of a variety of types of prototype instrumentation pertinent to the bioengineering area, modular components for hospital information systems, effective techniques in fiberoptics and laser technology, patient monitoring devices, computer control of anaesthesia, and of modular components seen as necessary for the eventual development of efficient health delivery systems. In this latter area particular attention will be given to the development of techniques and systems for diagnosis, treatment, patient care, screening for disease detection, and for the storage and analysis of health data.

NIGMS will be specifically concerned with the development of modular components that will be part of automated clinical pathological laboratories. Because of the increased participation of the Federal Government in providing essential health services, a sharp increase in the demands for the services of clinical laboratories can be anticipated. It has been demonstrated that the workload in clinical laboratories has doubled approximately every five years during the past two decades, and avail-

NATIONAL ACADEMY OF SCIENCES—NATIONAL RESEARCH COUNCIL

THE NATIONAL ACADEMY OF SCIENCES is a private, honorary organization of more than 700 scientists and ei gineers elected on the basis of outstanding contributions to knowledge. Established by a Congressional Act of Incorporation signed by Abraham Lincoln' on March 3, 1863, and supported by private and public funds, the Academy works to further science and its use for the general welfare by bringing together the most qualified individuals to deal with scientific and technological problems of broad significance.

Under the terms of its Congressional charter, the Academy is also called upon to act as an official—yet independent—adviser to the Federal Government in any matter of science and technology. This provision accounts for the close ties that have always existed between the Academy and the Government, although the Academy is not a governmental agency and its activities are not limited to those on behalf of the Government.

THE NATIONAL ACADEMY OF ENGINEERING was established on December 5, 1964. On that date the Council of the National Academy of Sciences, under the authority of its Act of Incorporation, adopted Articles of Organization bringing the National Academy of Engineering into being, independent and autonomous in its organization and the election of its members, and closely coordinated with the National Academy of Sciences in its advisory activities. The two Academies join in the furtherance of science and engineering and share the responsibility of advising the Federal Government, upon request, on any subject of science or technology.

THE NATIONAL RESEARCH COUNCIL was organized as an agency of the National Academy of Sciences in 1916, at the request of President Wilson, to enable the broad community of U. S. scientists and engineers to associate their efforts with the limited membership of the Academy in service to science and the nation. Its members, who receive their appointments from the President of the National Academy of Sciences, are drawn from academic, industrial and government organizations throughout the country. The National Research Council serves both Academies in the discharge of their responsibilities.

Supported by private and public contributions, grants, and contracts, and voluntary contributions of time and effort by several thousand of the nation's leading scientists and engineers, the Academies and their Research Council thus work to serve the national interest, to foster the sound development of science and engineering, and to promote their effective application for the benefit of society.

COMMITTEE ON PROSTHETICS RESEARCH AND DEVEtOPMENT

COMMITTEE ON PROSTHETIC-ORTHOT1C EDUCATION

The *Committee on Prosthetics Research and Development* and the *Committee on Prosthetic-Orthotic Education,* units of the Division of Engineering and the Division of Medical Sciences, respectively, undertake activities serving research and education in the fields of prosthetics and orthotics, when such activities are accepted by the Academy as a part of its functions. Activities of the Committees are presently supported by the Department of Health, Education, and Welfare and the Veterans Administration. Information or reports developed by activities of the Committees are officially transmitted and published through the National Academy of Sciences.