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Rehabilitation of the Amputee

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I.

UNIVERSITY OF MINNESOTA MEDICAL SCHOOL
CALENDAR OF EVENTS

May 22 - 28, 1949

No. 249

Sunday, May 22

9:00 - 10:00 Surgery Grand Rounds; Station 22, U. H.

10:30 - 11:00 Fractures of Femur; Leonard Peltier; Rm. M-109, U. H.

Monday, May 23

8:00 Fracture Rounds; A. A. Zierold and Staff; Ward A, Minneapolis General Hospital.

9:00 - 9:50 Roentgenology-Medicine Conference; L. G. Rigler, C. J. Watson and Staff; Todd Amphitheater, U. H.

9:00 - 10:50 Obstetrics and Gynecology Conference; J. L. McKelvey and Staff; M-109, U. H.

10:00 - 12:00 Neurology Rounds; A. B. Baker and Staff; Station 50, U. H.

11:00 - 11:50 Physical Medicine Seminar; Movies on Cerebral Palsy; E-101, U. H.

11:00 - 11:50 Roentgenology-Medicine Conference; Veterans Hospital.

11:00 - 12:00 Cancer Clinic; K. Stenstrom and A. Kremen; Eustis Amphitheater, U. H.

12:00 - 1:00 Physiology Seminar; Turnover and Exchange of C_{14}; W. D. Armstrong; 214 M. H.

12:15 - 1:20 Obstetrics and Gynecology Journal Club; Staff Dining Room, U. H.

12:30 - 1:20 Pathology Seminar; Pathology of Acute Disseminated Lupus Erythematosis; John Coe; 104 I. A.

12:30 - 1:30 Surgery Problem Case Conference; A. A. Zierold, C. Dennis and Staff; Small Class Room, Minneapolis General Hospital.

1:30 - 2:30 Surgery Grand Rounds; A. A. Zierold, C. Dennis and Staff; Minneapolis General Hospital.

1:30 - 2:30 Pediatric-Neurological Rounds; R. Jensen, A. B. Baker and Staff; U. H.

4:00 - Public Health Seminar; 113 Medical Sciences.

5:00 - 5:50 Clinical Medical Pathologic Conference; Todd Amphitheater, U. H.

5:00 - 6:00 Urology-Roentgenology Conference; D. Creevy and H. M. Stauffer and Staffs; M-109, U. H.

4:00 - Pediatric Seminar; Children and the Comics; Joseph Carpentieri; 6th Fl. W., Child Psychiatry, U. H.

Tuesday, May 24

8:30 - 10:20 Surgery Conference; Small Conference Room, Bldg. I, Veterans Hospital.

9:00 - 9:50 Roentgenology Pediatric Conference; L. G. Rigler, I. McQuarrie and Staff; Todd Amphitheater, U. H.

10:30 - 11:50 Surgical Pathological Conference; Lyle Hay and Robert Hebbel; Veterans Hospital.

12:30 - Pediatric-Surgery Rounds; Sta. I, Minneapolis General Hospital; Drs. Bosma, Wyatt, Chisholm, McNelson, and Dennis.

12:30 - 1:20 Pathology Conference; Autopsies; Pathology Staff; 102 I. A.

1:00 - 2:30 X-Ray Surgery Conference; Auditorium, Ancker Hospital.

2:00 - 2:50 Dermatology and Syphilology Conference; H. E. Michelson and Staff; Bldg. III, Veterans Hospital.

3:15 - 4:20 Gynecology Chart Conference; J. L. McKelvey and Staff; Station 54, U. H.

3:30 - 4:20 Clinical Pathological Conference; Staff; Veterans Hospital.

4:00 - 5:00 Pediatric Rounds on Wards; I. McQuarrie and Staff; U. H.

4:00 - 5:30 Physiology-Surgery Conference; Experimental Studies in Sodium and and Potassium Balance; R. B. Harvey, F. Stutzman, and R. Reinecke; Eustis Amphitheater, U. H.

5:00 - 5:50 Urology-Pathological Conference; C. D. Creevy and Staf; Todd Amphitheater, U. H.

5:00 - 6:00 X-Ray Conference; Presentation of Cases by Curtis Nessa, St. Cloud; Todd Amphitheater, U. H.

Wednesday, May 25

8:00 - 8:50 Surgery Journal Club; O. H. Wangensteen and Staff; M-515, U. H.

8:30 - 9:30 Clinico-Pathological Conference; Auditorium, Ancker Hospital.

8:30 - 10:00 Orthopedic-Roentgenologic Conference; Edward T. Evans, Room 1AW, Veterans Hospital.

8:30 - 12:00 Neurology Rehabilitation and Case Conference; A. B. Baker and Joe R. Brown; Veterans Hospital.

11:00 - 12:00 Pathology-Medicine-Surgery Conference; O. H. Wangensteen, C. J. Watson and Staff; Todd Amphitheater, U. H.

12:00 - 12:50 Radio-Isotope Seminar; Crystal Counters -- Their Design, Efficiency, and Practical Value; Douglas Cohl; Rm. 212, Hospital Court, Temp. Bldg.

3:30 - 4:30 Journal Club; Surgery Office, Ancker Hospital.

4:00 - 5:00 Infectious Disease Rounds; Medical Conference Room, Veterans Hospital.

Thursday, May 26

8:15 - 9:00 Roentgenology-Surgical-Pathology Conference; Craig Freeman and H. M. Stauffer; M-109, U. H.

8:30 - 10:20 Surgery Grand Rounds; Lyle Hay and Staff; Veterans Hospital.

9:00 - 9:50 Medicine Case Presentation; C. J. Watson and Staff; M-109, U. H.

10:00 - 11:50 Medicine Ward Rounds; C. J. Watson and Staff; E-221, U. H.

10:30 - 11:50 Surgery-Radiology Conference; Daniel Fink and Lyle Hay; Veterans Hospital.

11:00 - 12:00 Cancer Clinic; K. Stenstrom and A. Kremen; Todd Amphitheater, U. H.

11:30 - 12:30 Clinical Pathology Conference; Steven Barron, C. Dennis, George Fahr, A. V. Stoesser and Staffs; Large Class Room, Minneapolis General Hospital.

12:00 - 1:00 Physiological Chemistry Seminar; Action of Enzymes at a Distance; Fred Bock; 214 M. H.

1:00 - 1:50 Fracture Conference; A. A. Zierold and Staff; Minneapolis General Hospital.

2:00 - 3:00 Errors Conference; A. A. Zierold, C. Dennis and Staff; Large Class Room, Minneapolis General Hospital.

4:00 - 5:00 Bacteriology and Immunology Seminar; Ethylene Oxide Sterilization of Pulvers; Miss E. L. Omernik; 214 M. H.

4:30 - 5:20 Ophthalmology Ward Rounds; Erling W. Hansen and Staff; E-534, U. H.

5:00 - 6:00 X-Ray Seminar; Cancer Detection Cases; F. F. Ruzicka; Todd Amphitheater, U. H.

5:00 - 6:00 Urology Seminar; Examination of the Urine for Neoplastic Cells; Kano Ikeda; E-101, U. H.

Friday, May 27

8:30 - 10:00 Neurology Grand Rounds; A. B. Baker and Staff; Station 50, U. H.

9:00 - 9:50 Medicine Grand Rounds; C. J. Watson and Staff; Todd Amphitheater, U.H.

10:00 - 11:50 Medicine Ward Rounds; C. J. Watson and Staff; E-221, U. H.

10:30 - 11:20 Medicine Grand Rounds; Staff; Veterans Hospital.

10:30 - 11:50 Otolaryngology Case Studies; L. R. Boies and Staff; Out-Patient Department, U. H.

11:00 - 12:00 Surgery-Pediatric Conference; C. Dennis, O. S. Wyatt, A. V. Stoesser and Staffs; Minneapolis General Hospital.

11:30 - 12:50 University of Minnesota Hospitals General Staff Meeting; Blood Coagulation -- Recent Advances; Edward Bell; Powell Hall Amphitheater.

12:00 - 1:00 Surgery Clinical Pathological Conference; Clarence Dennis and Staff; Large Classroom, Minneapolis General Hospital.

1:00 - 1:50 Dermatology and Syphilology; Presentation of Selected Cases of the Week; H. E. Michelson and Staff; W-312, U. H.

1:00 - 3:00 Pathology-Surgery Conference; Auditorium Ancker Hospital.

1:00 - 2:50 Neurosurgery-Roentgenology Conference; W. T. Peyton, Harold O. Peterson and Staff; Todd Amphitheater, U. H.

4:00 - 5:00 Electrocardiographic Conference; George N. Aagaard; 106 Temp. Bldg., Hospital Court, U. H.

Saturday, May 28

7:45 - 8:50 Orthopedics Conference; Wallace H. Cole and Staff; Station 20, U. H.

8:30 - 9:30 Surgery Conference; Auditorium, Ancker Hospital.

8:00 - 9:00 Pediatric Psychiatric Rounds; Reynold Jensen; 6th Floor, West Wing, U. H.

8:00 - 9:00 Surgery Literature Conference; Clarence Dennis and Staff; Minneapolis General Hospital, Small Classroom.

9:00 - 9:50 Medicine Case Presentation; C. J. Watson and Staff; E-101, U. H.

9:00 - 10:30 Pediatric Grand Rounds; I. McQuarrie and Staff; Eustis Amph. U. H.

9:00 - 11:30 Surgery-Roentgenology Conference; Cancer of the Prostate; C. D. Creevy; Todd Amphitheater, U. H.

9:00 - 12:00 Psychiatry Conference; Powell Hall Amphitheater,

10:00 - 11:50 Medicine Ward Rounds; C. J. Watson and Staff; E-221, U. H.

10:00 - 12:50 Obstetrics and Gynecology Grand Rounds; J. L. McKelvey and Staff; Station 44, U. H.

11:00 - 12:00 Anatomy Seminar; Innervation of Dura Mater and Intracranial Blood Vessels, Roger A. Smith; The Anatomy of the Inferior Colliculus, Harold Brody; 226 I. A.

II. REHABILITATION OF THE AMPUTEE

Glenn Gullickson, Jr.
Frederic J. Kottke

Introduction

For centuries amputations have been performed to save life, to remove useless extremities, and to reduce invalidism. Prior to the First World War, the treatment of the amputee following surgery consisted essentially in telling the patient to wait until the stump had "shrunk", and then to see a leg-fitter.[1]

It may be said that all modern amputation surgery and rehabilitation is based on experience gained in handling the amputations of the two world wars. The exigencies of war forced us to concentrate on the problems of amputation en masse. During the first World War it was found that amputees could be treated most effectively in centers which specialize in the problems peculiar to the amputee. Here care was given through all phases of rehabilitation until the amputee was ready to return to work again. A new fund of knowledge has been developed concerning indications for the various types of amputations and specifications for construction and fitting of prostheses.[2] Rehabilitation of the amputee has been recognized to be a medical problem. No longer is the patient discharged as well when he can leave his hospital bed, but rather active therapy is given until he is ready to return to work.

The problem of the amputee in civilian practice is a very serious one. It is estimated that there are 30,000 amputations performed each year in civilian institutions.[3] When we compare this figure with 1,759, the number of amputations performed by the Army Medical Corp from January 1, 1943 to May 1, 1944, we get an indication of the magnitude of the problem.

It is, of course, at least at the present time, not feasible to segregate cicilian patients in amputation centers as is done in the armed forces, However, in large general hospitals, a program can be instituted which will do much to bring about maximum rehabilitation of the amputee, in so far as is possible with the resources available. Because the patients are usually in an older age group, the various complications of old age which must be dealt with make the rehabilitation program much more difficult. However, the majority of these patients do respond to a program of rehabilitation, and they should not be neglected after surgery.

The Amputation

The rehabilitation program for the amputee starts with the surgeon, since he is usually the first medical person to come in contact with the patient. One of the most important functions of the surgeon, even more so than performing the actual surgery, is the preparation of the patient psychologically. Amputation is not only a physical trauma, but is also the deepest kind of psychological insult. Proper psychological preparation counteracts the mental shock and despondency which so often appear. The patient should be imbued from the start with the idea that there is still a definite future ahead that will be livable and economically profitable.[5]

During the whole program of rehabilitation, the psychological approach must be maintained by the personnel who have contact with the patient, continually encouraging, stimulating motivation, and instilling a hopeful attitude rather than despondency. The over all theme should be that the amputee should not and need not be a cripple.[6]

Upon the surgeon also falls the responsibility for the stump the patient is to have following amputation. An amputation cannot be considered successful unless the patient has a satisfactorily functioning stump from a prosthetic standpoint. The stump should be at the maximum functional length, the bone end covered with normal skin and subcutaneous tissue free from redundancy and sinuses, and presenting a linear scar. The muscle and fascia covering the bone end are just

enough to form a band of scar tissue, non-movable and barely palpable. The bone is rounded off at the end and free from disease, spurs or proliferation of any kind.[1] As Thompson says: "Good stumps are made by good surgery".[7] Also the surgeon, in cooperation with the physiatrist and the limb-maker, must decide the type of prosthesis desired before the amputation is made; that is, whether or not it is to be an end weight-bearing stump, and to select the site and perform the amputation accordingly.

Amputation sites:

The limb-maker can fit any stump he is provided, but by experience it has been found that there are certain elective sites that give the best results from a point of view of giving the patient a durable, trouble-free stump with good function during his limb-wearing life.

In lower extremity amputations the sites best suited for good functional recovery are:

1. Through the metatarsals if the plantar flap will cover the bone ends and leave a dorsal scar. Such an amputation causes little disability, and functional return is excellent.

2. The metatarsal-tarsal amputation or Lisfranc amputation. Again the plantar flap should cover the bone ends and leave a dorsal scar. Such an amputation is fully end weight-bearing. Return of function is good and disability is slight. The patient usually needs a toe-pad and an arch support in the shoe for stability.

3. Amputation just above the ankle joint, or the Symes amputation, is the next level at which good function can be obtained. In this type of amputation the heel pad is brought over the distal end of the tibia and fibula and produces a fully end weight-bearing stump. It is not recommended for women because of the unsightliness of the prosthesis.

4. Below the knee amputations. For the best functional results, the amputation should be six and a half to seven inches below the tibial articular surface of the knee. A longer stump is not necessary, and leads to circulatory disturbances and skin breakdown. Good function can be obtained with stumps as short as three or four inches. If the stump must be shorter than three inches it is better to do an above the knee amputation. Weight-bearing is at the medial and lateral condyles and at the tibial tuberosity.

5. Thigh amputations.

   A. The Gritte-Stokes amputation. This is a supra condylar osteoplastic type of amputation. The patella is brought forward and attached directly to the femur, producing a fully end weight-bearing stump.

   B. The Callendar amputation. Because of the lower mortality rate, decreases in infections, and the better healing which occurs in aged patients and patients with arteriolosclerotic and diabetic gangrene, this is the amputation of choice and the one most frequently performed in this hospital. It is a supracondylar amputation through the tendons so that the muscle tissue, which because of the decreased blood supply tends to become easily infected, is not incised. Theoretically it is an end weight-bearing stump, but practically because of the poor skin and circulatory condition of the patients operated on, ischial weight-bearing prostheses are invariably required.

   C. Mid-thigh amputations. The preferable site is ten to twelve inches below the greater trochanter. It is of the utmost importance to maintain the stump length as long as possible in order that function may be at a maximum. The upper limit is a three-inch stump. Above this level, disarticulation, or amputation through the neck of the femur, is recommended, because a better stump from a prosthetic standpoint is obtained. Mid-thigh amputation

stumps are all ischial weight-bearing.

Amputation sites of upper extremities are:

1. In the hand it is important to save as much as is possible, especially of the thumb and index finger, since these digits are structures of prime importance to one's physical and economic well-being.[8] There should be a dorsal scar. Grafts can and should be used where indicated in order to maintain the maximal functional length.

2. When no grasp function whatever can be saved in the hand, maximum function will be obtained with a forearm stump and prosthesis. The best site for amputation is not higher than the middle or distal third of the forearm, preferably two to four inches above the distal end of the radius and ulna. Function decreases as the elbow is approached. At two inches it is better to do an upper arm amputation two inches above the elbow than to attempt to use a two-inch or shorter stump below the elbow.

3. In the upper arm function decreases up to one inch below the axilliary line, the preferable site being two inches above the elbow joint line. In all upper extremity amputations the scar should be terminal since they are not weight-bearing.

Pre-prosthetic care and training

The after-care of the stump begins when the first dressing is applied following surgery, since the tissues, which become relatively fixed within a few days, are easily arranged to give the desired contour to the stump. Unfortunately often the chief concern is not the shape of the stump but rather a secure dressing that will not slip off in bed. This is usually accomplished by a tight circular bandage just proximal to the end of the stump, resulting in a venous obstruction and consequently a bulbous stump. The post-operative dressing should be of elastic adhesive bandage, such as elastoplast, applied longitudinally to the end of the stump in three pieces, with as small an amount of gauze pads to absorb oozing as is possible. A circular Ace bandage is then applied around the end of the stump in a figure eight, the firmest turns being at the end of the stump. This is the only method which will mold the stump tissues and not constrict the venous return.[9]

Immediately following surgery a well-planned regime of physical therapy is indicated and is necessary if the ideal amputation stump is to be obtained. The ideal stump is one with minimal edema, maximal shrinkage, firm and well-toughened skin, absence of tenderness and sense of pain, freely movable scars, a smooth evenly contoured taper, normal muscular power, and a full unimpaired range of motion. As stated previously, the basis for an ideal stump is determined at the operation. However, physical therapy can add or detract from the surgeon's work by the type and amount of post-operative care given. The objectives of therapy are:

1. to prevent or correct deformities
2. provide realignment
3. establish muscle balance
4. increase muscle strength, and
5. assure a normal range of motion.[6]

Because of the hazards of flexion contractures of the adjacent joints which develop very rapidly following surgery, careful attention must be paid to the post-operative position of the stump. It is the duty of the surgeon, nurses, and physical therapists, to see to it that the stump is maintained in the best possible position to prevent contractures. It is much easier to prevent contractures than to correct them. In below the knee amputees, a gutter splint to hold the knee in extension is often advisable. For the above the knee amputation, as well as below the knee amputations, the stump may be placed on a pillow for a few days if necessary until the severe post-operative pain is gone. This procedure is felt by some to minimize hemorrhage and edema.[9-10] However, as soon as the pain has diminished

sufficiently, the pillow should be removed and the patient should turn to the prone position frequently during the day to hyperextend the stump, or lie on his back with a pillow under his buttocks and a sandbag on the stump. For upper extremity amputations, contractures of the proximal joints do not occur as readily so special post-operative care in regard to prevention of contractures is as a rule not necessary, except that the shoulder should be moved through the full range of motion once or twice a day.

An exercise program is instituted immediately post-operatively and should be started pre-operatively if at all possible. The exercise program is instituted early for the purpose of:

1. Improving the circulation and nutrition of the stump
2. Maintaining flexible joints
3. Promoting muscular tone
4. Developing coordination.

As soon as the patient has recovered from the acute post-operative reaction, usually the first post-operative day, so-called pressure exercises are started. These exercises consist of gentle tapping over the dressing with the palm of the hand by the patient or physical therapist, the pressure being gradually increased as tolerated, the object in such a procedure being to toughen the stump. Bed exercises as tolerated are started to maintain and increase the strength of the normal extremities, abdomen, and back muscles. This is particularly important in the older age group, since most of them have been bed-ridden or semi-invalids for an extended period of time with consequent general disuse atrophy and weakness. When the pain has subsided, active graduated exercises for the stump muscles are instituted. At first, these exercises are active assistive, then progressively active, and then resistive exercises, at first using only hand resistance and gradually increasing the resistance until weights are used.

In the case of below-the-knee amputees, quadriceps setting exercises are always given to aid in preventing the flexed knee contracture. In above-the-knee amputations the contracture of the hip that develops is one of flexion, abduction and external rotation. It results from weakness of the hip extensors and adductors because the adductor magnus and hamstrings have been separated from their insertion. The patient is therefore instructed in active exercises of the adductors and hip extensors. Immediate post-operative exercises for the upper extremity are aimed primarily at preventing deltoid and tricep weakness.

At about ten days post-operatively, barring complications, the incisions are usually healed and the patient can then be started on a more active program in the physical therapy department. It is in this period that one must be especially careful against the indiscriminate use of the wheel chair in leg amputees if knee and hip contractures are to be avoided. The important stump conditioning program which was started when the first dressing was applied is continued more strenuously. Whirlpool baths are given which, by the combined effects of heat and gentle massage, aid in the removal of any residual stump edema by increasing the circulation. The baths are followed by massage of a gentle stroking type which improves the circulation, accelerates healing, accustoms the patient to handling the stump, relieves sensitiveness, minimizes adhesions and keeps the tissues pliable.[11-12-17] As soon as the incision is well-healed, friction massage is given to mobilize the scar.

The pressure exercises or stump pounding which the patient started earlier are increased in the amount of force used, the ultimate desire being the production of a stump so tough that it can tolerate a blow by the closed fist, or in the case of a weight-bearing stump, will carry the entire body weight on a hard surface such as a table.[11]

The removal of the large amount of superfluous tissue which invariably follows surgery is an important part of the stump-conditioning program. This is accomplished by planned pressure over the stump. so that maximal shrinkage will

occur, and the stump will eventually take the required cone shape necessary to fit a prosthesis. A properly shrunk stump will stand more hard usage than a fleshy stump. In a fleshy stump the extra tissue leads to increased friction of the skin and is more subject to dermatological complications when a prosthesis is worn.[12] Also in a fleshy stump there is more motion of the bone within the stump and this internal friction is frequently a main cause of nerve pain. Pressure is applied with ace bandages. The application of stump bandages requires care and intelligence. They should be applied by some trained person and not by the patient himself, especially in above the knee amputations. The bandage is applied so that all loose tissue is bandaged away from the end of the stump. The bandage should be carried up to the proximal joint, and should present a smooth conical shape without bulges. The bandage should be changed two to three times a day, is left on at night, and should be worn at all times until the stump is fitted with a prosthesis.

The exercise program started when the patient was bedridden is continued, using heavy resistance exercises as quickly as possible, for general body building and especially concentrating on the muscles of the stump which are to act as prime movers of the stump lever, so that maximum strength and function can be obtained. Stretching out of any contractures which may have developed from improper care is started at this time, first with gentle stretching and then vigorous stretching using weights and special stretching tables.[13]

In cases of unilateral leg amputees crutch walking is started as soon as the patient is out of bed; at first instruction in balancing is given, then walking in parallel bars, and finally with under-arm crutches.

When the stump has been fairly well shrunk, is toughened, is painless, muscle strength is normal and no defects need correcting, it is time to fit the prosthesis. While a limb-fitter can fit a limb to whatever deformity exists, the patient as a result will be held in the position of the deformity. This is seen much too often and is due entirely to neglect in the important pre-prosthetic care and training period. Especially in the older patients, much more time is required to build up muscle strength and to get them physically fit to wear and use an artificial limb. It is essential that time be allowed for the pre-prosthetic program, in order to attain as close to an ideal stump as is possible.

Procurement and fitting of the prosthesis

The fitting of the prosthesis should be arranged as soon as possible if it is decided that the patient is to be provided with a limb. If early fitting and use of a prosthesis is not done, the bones of the stump become atrophic, the muscles weak, flabby and useless. The stump becomes infiltrated with fat and congested from non-use. The crutch habit develops. Deformities and reduction in joint motion occur. The greater the delay in fitting the stump with a prosthesis, the slower the patient's progress in learning its use.[1]

The decision as to whether a patient should be provided with a prosthesis or not is frequently a difficult one to make. There are many factors which must be considered. First is the age of the patient. Patients with thigh or below-the-knee amputations in the fourth to fifth decade of life or younger can learn to walk very well with a prosthesis, usually without an artificial aid such as a cane. Bilateral below-the-knee amputees in this age group can also be taught to walk without aid or with a cane. Bilateral thigh amputees must use canes or crutches but can be taught to walk fairly well. The reason that patients in this age group can be taught fairly easily to walk in that their sence of balance and coordination is still fairly good. The older the patient becomes the poorer becomes his sense of balance and coordination, and in spite of all efforts it is impossible to teach some of the patients in the

older age groups to walk with a prosthesis alone, with canes, or even with crutches. It is our feeling, generally speaking, that past the age of seventy a patient with an above-the-knee amputation is practically impossible to rehabilitate in so far as teaching him to walk correctly with a prosthesis, alone, or with a cane. It may be possible to teach him to walk with crutches and a prosthesis. However, in such cases, the patient usually gets around just as well or better with crutches alone as when the prosthesis is on. Over the age of sixty bilateral thigh amputations are extremely difficult to teach to walk, and it is frequently impossible to do so. There is apparently no upper age limit for below-the-knee amputees to learn to walk.

The second consideration is the general physical condition of the patient. If in spite of advanced age the patient is still in a fairly good physical state, much more can be accomplished than with another person of similar age with general debility or secondary intercurrent disease. We have in one instance been able to instruct a bilateral thigh amputee, eighty-four years old, to walk with prostheses and two underarm crutches. However, he is limited in his activities and his range of walking is essentially about the house.

The third consideration is the reason for the amputation. If the amputation was performed because of extreme trauma, freezing, or some such etiology, there is no contraindication. If, however, amputation was performed for gangrene due to arteriosclerosis or diabetes, the condition of the unoperated leg must be determined and an opinion in regard to the possibility of an amputation of this leg in the near future determined. All too frequently we have fitted a patient of this type with an artificial limb only to have him readmitted within a year for amputation of the other leg, making the problem of rehabilitation extremely difficult, because such patients frequently fall into that class which cannot be taught to use two prostheses. In the case of amputations for carcinoma, or sarcoma, of course the decision of the purchase of a prosthesis is determined by the expected five-year cure rate and the presence or absence of metastasis in the lymph nodes.

Type of prosthesis:

Prosthesis are divided into temporary, provisional, and permanent types. There is quite a difference of opinion as to the type of prosthesis to fit a patient with at the start. A temporary pylon, or peg leg, with a socket of plaster-of-paris or leather is often advised and was used extensively until the last war. It is inexpensive and the socket can be adjusted as the stump shrinks.

There are, however, distinct disadvantages to the use of pylons. They do not meet the mechanical problems of alignment, weight-bearing, and motion, and their use may produce faulty habits difficult to correct when the permanent prosthesis has been fitted.[1-9-14]

Most of the recent literature recommends the use initially of a permanent prosthesis with a provision for change of sockets or the provisional prosthesis such as was employed in the military forces.[1,15,16,17] The provisional prosthesis is a fiber prosthesis which has various size sockets which can be fitted into a basic limb. The socket is made of leather and is molded to the patient's stump, a new socket being made periodically as the stump shrinks. The disadvantages in the use of a provisional prosthesis in a general hospital with comparatively few amputations are that it requires the services of an experienced limb fitter, and a fairly large stock of basic limbs must be kept on hand. It is our feeling for various reasons that the temporary prosthesis or pylon has definite advantages in a general hospital. First there is, as mentioned previously, the age group involved. In the younger persons we follow the general plan of ordering the permanent prosthesis as soon as possible. However, in the older persons, it is much less expensive in the long run to fit them with a temporary prosthesis to find out first of all whether they are able to walk with a prosthesis or not; secondly, it enables

us to get the patient up quicker than if a permanent prosthesis is ordered, since it takes anywhere from six weeks to two months to obtain a permanent prosthesis at the present time. Thirdly, we are able to determine if the added exertion of walking on an artificial limb is going to result in other disabilities or exacerbations of intercurrent disease such as coronary insufficiency and so forth, and whether in cases of peripheral vascular disease the other leg is going to have adequate circulation or whether it too will need to be amputated. The weeding out of these patients who cannot use a prosthesis is important from an economic point of view. The cost of further treatments is reduced, but more important, an artificial limb is not purchased for $200 to $350 which will never be used by the patient.

Our program then consists of fitting all patients over the age of fifty and those in the younger ages with bilateral amputations with a temporary prosthesis. In the case of bilateral amputations, pylons are required for all patients, since the patient learns balance more readily if he is started off with short pylons, usually starting at six inches and increasing in length three to four inches weekly until they are three to four inches shorter than the length that the permanent prosthesis will be. The permanent prosthesis is ordered as soon as it is apparent the patient will be able to use it successfully.

Permanent prostheses:

Mention should be made of the various types of permanent prostheses, because an anputee expects a physician to know about the prosthesis and to advise him concerning the prosthesis which will fit his particular needs, and so that the physician can make an intelligent evaluation of the artificial limb when worn by the patient.

For the lower extremity amputee, the component parts of the prosthesis are the socket, the knee joint, the shin piece, and the foot. These parts are joined together in the proper alignment.

The socket or bucket is the most important part of the prosthesis, and must be shaped and fitted accurately in order to bear weight comfortably and not interfere with the circulation of the stump. It is constructed so that its weight-bearing surface corresponds as nearly as possible to the normal weight-bearing areas of the body. Such areas are the ischial tuberosity, the front of the leg just below the knee, and the heel. Certain areas close to the articular surface of the joint tend to be adapted to weight-bearing. For example, the tibial condyle, tibial tuberosity, and the head of the fibula. The socket for above-the-knee amputations is with one exception always fitted for ischial weight-bearing, although some weight is taken by the lateral surfaces of the thigh and on the greater trochanter. No weight is borne on the end of the stump, except in amputations designed for end weight-bearing, such as the Gritti-Stokes amputation. The medial side of the socket should fit well up in the perineum and the flesh should not roll up or protrude over the top of the socket. The socket must fit in only one position, and one should not be able to shift the socket on the stump. Practially all thigh prosthesis are now suspended and controlled with pelvic suspension and direct stump control rather than the former method of a harness over the shoulders. Pelvic suspension consists of a pelvic band, to which the prosthesis is joined by means of a joint at the hip. This allows only flexion and extension at the hip. The joint should be well anterior to the greater trochanter, at the true axis of the hip joint for flexion and extension. During the past war another method of attaching the prosthesis to the stump was first used in this country, although introduced originally in Germany during World War I. This is the so-called suction socket, which eliminates the pelvic band, It consists of a perfectly-fitted socket, with a valve at the lower end. When a patient puts his stump in the socket the air is forced out and the valve is closed. In a properly fitted suction socket there is absolute unity between the stump and the prosthesis, and

the prosthesis cannot be pulled off until the valve is opened. This type of socket is not yet in general use but probably will be used more and more as experience is gained with it.

The knee joint of an above-the-knee prosthesis has its axis placed posterior to the center of normal knee motion and a friction brake or straps are incorparated which control the forward swing of the shin piece. These are adjusted so that the shin swings forward and fully extends on the knee just at the moment weight is applied on the heel; otherwise instability of the knee results.

The below-the-knee prosthesis socket is the most difficult to fit because of the irregular weight-bearing areas and because certain areas will not tolerate any pressure whatsoever. Below-the-knee weight-bearing sockets are frequently advised against, because of the feeling that the below-the-knee stump cannot tolerate weight-bearing over long periods. This, however, is erroneous and arises from the fact that improperly fitted sockets are used. The weight-bearing points are the tibial condyle, tibial tubercle, and the head of the fibula. The popliteal space can have no pressure applied, Most of the difficulties in below-the-knee prosthesis are caused by pressure in the popliteal area. This pressure interferes with circulation resulting in edema, swelling, and eventual ulceration of the stump. The stump should fit the socket snugly but not tightly, and a certain amount of up and down motion is necessary. The posterior part of the socket should be as high as the anterior part with slight excavations for the hamstring tendons. A frequent error is to cut the posterior border below the popliteal space to allow more flexion. This only results in bulging of the soft tissues of the popliteal space over the top of the socket, posteriorly impairing circulation, and allowing the stump to shift posteriorly away from the anterior portion of the socket. The below-the-knee prosthesis is held on with a thigh cuff or shoulder straps and is joined to the shin piece with hinged side joints at the knee. These side-knee joints must be placed posterior to the center for normal knee flexion, since the normal knee joint axis is not fixed but moves posteriorly in flexion.

The standard foot piece of the lower extremity prosthesis moves only in dorsi and plantar flexion, and is usually fixed in slight equinus so that pressure on the toe causes hyperextension at the knee and gives a firmer locking of the knee. There is usually a toe joint of rubber to simulate metatarsal-phalangeal joint motion.

Upper extremity prostheses are much less satisfactory than those for the legs in so far as function is concerned. Furthermore, it is desirable that an upper extremity prosthesis should be acceptable from a cosmetic viewpoint as well. At the present time there is not a satisfactory prosthesis that satisfies both functional and cosmetic requirements. The patient can either have a functioning prosthesis or a cosmetic one--not both. As a matter of fact, most patients do not use their prosthesis much when they have them. Kessler, in a survey of 276 army amputees, found only twelve per cent wore their cosmetic arms for cosmetic reasons, and only two per cent actually used functional ones. He felt that this low percentage could be greatly improved if the patient were given more extensive supervision and proper training before discharge.[20] The prosthesis which is of the most use is the utility or split hook. The mechanical hand, while cosmetically better, has only opposition of the fingers to the thumb as function, and the grip is poor. Both the utility hook and mechanical hand are opened by pulling with a strap attached over the opposite shoulder, and closed by springs. They are easily interchangeable, and the amputee is usually supplied with both, one for functional use and the other for cosmetic purposes. Prostheses are fitted usually only on amputations of the lower end of the humerus or the mid forearm. Above the lower end of the humerus the prosthesis and harness is so heavy and cumbersome that the patient will not wear one when it is provided.

Cineplasty is one of the newer developments in the treatment of upper extremity amputations in this country. It was first developed in Italy around 1900. The principle involved is the use of the remaining muscles of the stump to activate the prosthesis by means of tunnels made in the muscles themselves and connected by means of pegs through thetunnels with straps to the moveable parts of the prosthesis. Cineplasty is still in an experimental stage and requires further elaboration. However, its use appears very promising for the upper extremity amputee in particular.

Post-prosthetic training

Following the fitting of the prosthesis the patient needs careful guidance and advice in learning to use his prosthesis. This is an important phase of the rehabilitation program and one that is all too frequently passed over hurriedly in order to get the patient out of the hospital and home. In a questionnaire sent to 128 thigh amputees in New York, both veteran and non-veteran, more than 50% stated they had never learned to use their prosthesis correctly; 95% felt they could improve in the use of their prosthesis, all stated they had received no further training on discharge from the hospital. The veteran group received on an average, 2.8 months training. The non-veteran group, 4.3 days of training. More than 50% of the non-veterans stated the training they had received as fair, poor or worthless.[18]

The first thing the amputee must learn following the fitting of the prosthesis is the care of the stump. The skin must be able to withstand the daily abuse of an environment for which it was never intended, or the patient will be greatly handicapped. When skin disorders begin, use of prostheses stops.[19] Strict hygienic measures must be observed. The stump must be washed daily with soap and water and exposed to the air and sunlight as much as possible. No oily or greasy substances should ever be applied because they tend to soften the skin and lead to folliculitis. Frequently talcum powder adds to the patient's comfort. When the prosthesis is worn the stump is covered with a sock of virgin wool, or cotton in the case of those who are sensitive to wool laundered daily. One or more socks are worn according to the fit of the socket. More than three should never be worn. The socket should be revised if more than three socks are needed for a comfortable fit. Attention must be paid that no skin folds occur when the stump is in the prosthesis since these areas first macerate and then become infected, leading to intertrigo, and if not treated, may lead to aczema of the entire stump. Friction burns from improperly fitted sockets are common. Calluses develop from unequal weight distribution; pressure sores and ulcers may devlope instead of the calluses. Boils are common on the adductor surfaces of the thigh due to poorly fitting ischial weight-bearing prostheses and failure to keep this area clean. These conditions must be treated at once and the prosthesis readjusted. Furuncles and folliculitis are especially common in men. Localized miliaria may develop in hot weather. Treatment consists of routine dermalogical measures, avoiding undue softening of the skin.[19]

Once the lower extremity prosthesis is fitted, the patient is taught to walk again. He must be psychologically conditioned to the fact that he cannot expect his artificial limb to compare favorably with his natural leg, but that, with constant effort on his part, he can learn to walk satisfactorily. There are a number of components to good walking with a prosthesis: Balance and muscle coordination, smooth walking rhythm, and equal length of the steps. The patient must learn weight distribution, and the travel pattern of the normal foot, so as to duplicate it with the prosthesis. He must learn to achieve a normal stride and gait pattern. The gait is analyzed continuously for the following points:

1. Weight-bearing on the prosthesis,
2. Motion of step with the normal leg,
3. Weight-bearing on the normal leg,
4. Motion of step with prosthesis.[5]

The teaching of walking must be done

gradually, and the patient warned not to wear the prosthesis too much at first or edema of the stump and pressure sores will develop. The stump will shrink as the patient uses the prosthesis (it takes about six months for shrinkage to occur). This stump shrinkage will cause the patient to sink lower in the socket of the limb, so that stump socks must be added, or a revision of the prosthesis made.

Teaching a patient the use of an upper arm prosthesis consists essentially in teaching him the use of a new tool. Once the stump has been prepared, the prosthesis fitted, and the patient learns to use his opposite shoulder to open the hook, physical therapy is discontinued. Further extensive instruction is given by occupational therapy in teaching him the many procedures possible with the hook and how to best achieve maximum functional use of the prosthesis. As the patient's dexterity increases, his self-consciousness becomes less and his morale improves; therefore, every effort should be used to aid the patient in obtaining self sufficiency. In the case of cineplasty, the patient must be taught the use of the muscle motors in the operation of his hand, but otherwise treatment is essentially the same as for the orthodox amputation of the upper extremities.

Vocational rehabilitation

When the amputee can walk as normally as can be expected, or has learned to use his artificial arm as well as possible, it is time for vocational rehabilitation. In the older age patients, most of them are beyond the so-called "wage-earning period", so that the state vocational rehabilitation service is unable to help them. In the case of unilateral or below-the-knee amputations, most of these patients can return to their former work, such as clerical work, housewives, and so forth if it doesn't require their being on their feet an excessive period of time. Many of the patients are on old-age assistance or relief, so that further rehabilitation beyond the ability to care for themselves is not necessary. The younger age groups are instructed in new vocations if their former ones were not compatible with an amputation and prosthesis. They can be sent to trade or business schools, or in some cases, even college, to learn a new vocation.

Arm amputees, once they have learned how to use their prosthesis, require vocational guidance, training, and selective placement. By selective placement is meant an analysis of the physical demands of the job, and an analysis of the physical and mental capacity of the amputee, and then matching the amputee to the job. For such service the patient is referred to the State Vocational Rehabilitation Division of the Department of Education if he is still in the productive years.

Only slight mention has been made of occupational therapy. However, the importance of occupational therapy cannot be understated. Occupational therapy should be started immediately post-operatively. At first diversional therapy is given to sustain morale and prevent as far as possible the depression that usually occurs following an amputation. Later, when the patient has been fitted with a prosthesis functional therapy is started, using the loom, printing press and bicycle saw to increase muscle power and coordination. In the case of arm amputations, as mentioned previously, they are taught various ways to use their prosthesis, and are given some prevocational training if indicated.

In conclusion it should be emphasized that an over-all program of rehabilitation is necessary to obtain maximum benefit to the amputee so that he can be self-sufficient and self-supporting. As Ficarra stated, "The day is past when our duty terminates at the bedside of the amputee".[21] Although such an extended program as is used by the army and navy is impossible in civilian hospitals, much can be done through cooperation of the surgeon, physiatrist, limb-maker, and vocational counsellor to obtain better results in restoring the amputee to a useful, active life. Mitchell has pointed out that the percentage of persons who have undergone amputations returning to almost complete

activity is capable of increase, not through the adoption of new methods but through more efficient application of principles already known.[12]

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III. MEDICAL SCHOOL NEWS

Faculty News

Dr. Ernst Gellhorn, Professor of Physiology at the University of Minnesota, has been invited to address the Royal Society of Medicine in London, England, on September 13. The subject of Dr. Gellhorn's address will be "The Physiological Basis of Shock Therapy of Mental Diseases."

Dr. E. T. Bell, Professor and Head of the Department of Pathology, delivered the Cap and Gown Day Convocation address on Thursday, May 19. Dr. Bell's address, which highlighted the traditional Cap and Gown Day Observance in honor of the University's graduating classes, was concerned with the subject of "The Future of Medical Science."

Dr. George N. Aagaard, Director of Postgraduate Medical Education and Associate Professor of Medicine, attended a conference on Graduate and Postgraduate Medical Education at Battle Creek, Michigan, on May 18 and 19. The conference, sponsored by the Kellogg Foundation, was called to bring together medical educators who are working in the field of graduate and postgraduate education for physicians. Dr. Aagaard participated in two round tables or panels on the subjects, "The Need for General Practice Residency Programs" and "Continuation Study for the Practicing Physician."

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New Minn. Medical Foundation Members

Dr. B. J. Bouquet, M.D., Wabasha
R. P. Griffin, M.D., Benson
John F. Noble, M.D., Ancker Hospital, St. Paul
John H. Moe, 1935 Medical Arts Bldg., Minneapolis
Cecile R. Moriarty, M.D., 532 Lowry Medical Arts Bldg., St. Paul
Robert A. Glabe, M.D., Plainview

Biographical Briefs -- Professor of Physiology

Maurice B. Visscher was born in Holland, Michigan. He attended Hope College and received his Bachelor's degree in 1922. His major interest during his undergraduate years was biology. He came to the University of Minnesota in 1922 as a graduate student and teaching assistant in the Department of Physiology. In 1925 he received his Ph.D. degree in Physiology from this University.

Dr. Visscher then went to University College in London as a National Research Council Fellow. Here he worked with Dr. Starling, the well-known physiologist. His second year as a Fellow of the National Research Council was spent at the University of Chicago. Here he worked under the stimulating teacher and investigator, Dr. A. J. Carlson.

The years 1927-29 were spent in the Department of Physiology at the University of Tennessee. In 1929 Dr. Visscher went west to the University of Southern California. He spent two years there as Professor of Physiology and Pharmacology. Dr. Visscher spent his summers in undergraduate work in the University of Minnesota Medical School and in 1931 he added his M.D. to the Ph.D. which he received from this institution. The summer of 1931 was spent as an intern on the medical service of Dr. George Fahr at the Minneapolis General Hospital.

In 1931 Dr. Visscher went to the Unisersity of Illinois as Professor and Head of the Department of Physiology. He remained there until 1936 when he returned to the University of Minnesota Medical School as Professor and Head of the Department of Physiology.

Despite his many teaching and research activities, Dr. Visscher has played a major role in numerous scientific societies, editorial boards, and lay organizations.