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New Trends in the Rehabilitation of Lower Extremity Amputees

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INCIDENCE AND CAUSE OF AMPUTATION

The exact number of new amputees is unknown. With certain exceptions it has not been possible to track new amputees in the United States. The National Center for Health Statistics reported 311,000 amputees in 1970. By 1977, this number had risen to 358,000. Of these amputees, 101,000 involved an upper extremity, and 210,000 involved a lower extremity. There are 43,000 amputations each year.[7]

In 1973–1974 the Committees on Prosthetics Research and Development and Prosthetic-Orthotic Education of the National Academy conducted a study of the amputees known to the American Orthotic and Prosthetic Association (AOPA), including 143 prosthetics facilities located in 39 states.[13] The proportion of lower extremity to upper extremity was 11:1 for both males and females. There was a significant increase in lower extremity amputation when compared with a 1961–1963 study (Glattly[8]) of amputees known to AOPA. There was also a significant increase from Glattly's study in the percentage of persons with below-knee amputations, from 36.8 percent to 53.8 percent, and a significant decrease in above-knee amputations, from 44.1 percent to 32.6 percent.

The proportion of males to females in all amputees was almost 3:1 (72 to 28 percent), probably due to a greater injury rate among males. When limited to disease, the sex ratio dropped to 2.1:1, and when limited to tumor, it dropped to 1.3:1. The proportion of males to females among lower extremity amputees is 70:30 percent.

The distribution of below-knee amputees to above-knee amputees varies by cause. Above the age of 40, above-knee amputees account for about one out of every three amputations. Most amputations for vascular disease in persons above the age of 60 had been performed above-knee prior to 1945. However, as medical and surgical techniques have improved, the decision to operate below-knee for vascular disease has increased. In the National Academy Study of 1973–1974, below-knee amputations accounted for 62.4 percent of all lower extremity amputations. The percentage for each decade in above-knee and below-knee was similar; there was no significant difference according to age.

The causes of new amputation are broadly described as trauma, disease, tumor, or congenital. Congenital amputation occurs as the cause in nearly all patients under five years, and it accounts for 2.8 percent of all amputations.[8] Tumors that are malignant and benign tumors where function is reduced may require amputation. This accounts for approximately five percent of all amputations. Malignant tumors may occur in children in the second decade. Amputations due to vas-

cular diseases and infections increased from 58 percent in a previous study to 70.3 percent in the National Academy Study of 1974. Amputations due to trauma account for 22.4 percent of all amputations. This is a slight decrease of 11 percent from a previous study. The largest percentage of cases due to trauma occur in ages 41 and 50, whereas the largest percentage of cases due to disease occur in ages 61 to 70. Although the Kay and Newman study[13] reported multiple amputations, these accounted for only 3.3 percent of the cases, and will not be discussed in detail in this article. Disease was the cause of reamputation in 41 percent of the cases.

REHABILITATION OF THE LEG AMPUTEE

The rehabilitation of the leg amputee requires a multidisciplinary team that treats the medical, psychological, social, and vocational aspects of amputation. Friedmann states that "the primary determinants of success in the treatment of the limbless are the generality of care an amputee receives and the amputee's innate characteristics."[7] Care begins at the preoperative stage and continues until the amputee is helped to readjust to social and vocational roles in the community.

Before amputation the person must be prepared to confront the reality of surgery, but not all its potential consequences. The results of surgery should not be presented all at once to the patient. After amputation, the patient may be given a few facts at a time until he or she has a chance to acknowledge the extent of the physical changes.

In older textbooks on the subject, the goal was to help the patient "accept his loss."[25] Stages of adjustment to amputation proceeded from denial to depression to acceptance of loss. In recent years, the stage theory has been questioned as a uniform analogue for all amputees. Some may not proceed through the same stages of adjustment. Others may never reach the final stage: acceptance of loss. For some patients, healthy denial is an adaptive mechanism that enables them to cope with the multiple losses resulting from amputation. They may deny their disability for the rest of their lives. There is nothing wrong with this method of coping—it works for some people. Rehabilitation professionals must learn to respect the individuality of each amputee and to help each amputee to gain optimal acceptance of the disability.

Early postoperative care requires breathing exercises along with exercises in a prone position in bed for the remaining limbs, on parallel bars, on a frame, and finally on crutches.[11] Immediate fitting of a pneumatic pylon (temporary prosthesis) may permit the patient to walk within a few days after amputation. It also enables the physical therapist and rehabilitation medicine specialist to judge whether the patient can tolerate an artificial prosthesis.

Some patients have difficulty in adjusting to the pylon either because of the poor healing condition of the stump or because of a combination of physical and psychological problems. Patients with heart conditions and elderly patients in poor general health may not tolerate the physical demands of walking with a pylon. From a psychological viewpoint, immediate fitting with a pylon may provide equivocal results. On the one hand, it may inspire confidence in the patient that he or she can eventually learn to walk with a permanent artificial prosthesis. On the other hand, it may not permit enough time for adjustment to loss of a limb. Some patients may require a period of mourning for their lost bodily part before fitting of a pylon. This period may go on for many weeks after amputation; it is a normal reaction to amputation.[4] Too early fitting of a prosthesis cuts short the mourning period and may prevent the patient from integrating the loss with body image. Moreover, some patients who may tolerate a lightweight pylon cannot tolerate a permanent prosthesis.

The phenomenon described as *phantom pain* may occur whether or not there is immediate prosthetic fitting. Many previous studies purported to show that phantom pain really did not exist in a material sense. It was hypothesized that the amputee re-

constructed a mental image of his amputated limb. The image stimulated the sensation of pain which, in turn, reinforced the awareness of a lost bodily part. Current thought is that phantom pain may be attributed to electrical nervous impulses transmitted from the nerves in the stump. When an immediate postoperative prosthesis is fitted, phantom pain is lessened and the patient is better motivated to complete his prosthetic training program.[21]

AMPUTATION PROGRAMS

Rehabilitation of the amputee is optimally achieved by referring the patient to an amputation center. In the United States, several centers are associated with rehabilitation departments, Veterans Administration hospitals, and orthopedic departments in general hospitals. In the United Kingdom, patients may be referred to a community and artificial limb and appliance center. There is a clear advantage to centralizing the professional services for the treatment of amputees, as demonstrated in the following evaluative studies.

Malone and others[16] evaluated the results of two groups of lower extremity amputees who underwent a rehabilitation program at the Tucson Veterans Administration Medical Center and the University of Arizona Health Sciences Center. From July, 1975, to July, 1979, 119 patients underwent 143 lower extremity amputations. For study purposes, these patients were divided into two groups: a group with amputations between July, 1975, and June, 1977; and a group with amputations between July, 1977, and June, 1979. The first group underwent rehabilitation prior to the establishment of the amputation center. The second group underwent amputation in the amputation center. There were no significant differences in age or sex between the two groups. The difference between postoperative mortalities was not significant (one died in group one, four in group two). Amputation level was determined prior to amputation by Xenon skin blood flow tests. The use of Xenon clearance is a measure of capillary skin blood flow for purposes of amputation level selection and predictions of wound healing.

There was a significant difference in primary amputation healing between groups one and two: 63 percent and 97 percent. The overall rehabilitation time was significantly reduced in group two compared to group one: 30.8 days compared to 128.4 days. The rehabilitation time for below-knee amputation was significantly improved in group two compared with group one: 32.5 days compared to 132 days. There was a rehabilitation rate of 100 percent in group two for patients who could walk before amputation. All of them used their prostheses successfully for one to 18 months following discharge. Length of hospitalization was significantly less for group two than for group one (38.1 days compared to 65.8 days). These comparisons indicate the greater program effectiveness of an amputation center in treatment of postoperative amputees within the same institution.

In a clinical study of amputations of the lower limb at the rehabilitation and artificial limb center, K.G.'s Medical college in Lucknow, India, Agarwal and others[1] found that proper postoperative care and rehabilitation were conducive to greater gains. A retrospective study of 525 cases of lower limb amputations showed that the majority of amputations (65.3 percent) were due to trauma (train accidents), 20 percent were due to vascular disease; and seven to eight percent were due to neoplastic lesions. Fifty-seven percent of the cases were below-knee, and 34 percent were above-knee. Stumps of satisfactory length were found in 40 percent of below-knee and 68.2 percent of above-knee cases. Proper postoperative care had been lacking in persons amputated at other centers. The amputation center provided a more efficient, cost-effective way of treating patients.

Few studies examine the economic impact of an amputation program. An ambitious study by Malone and others[17] analyzed the treatment records of the 172 hospital systems of the Veterans Administration to determine the cost impact of alternative methods of theory. The cumulative

cost for patients undergoing 1,933 below-knee amputations in 1976 was nearly 25 million dollars. The authors extrapolated from their experience with 142 below-knee amputations for vascular occlusive disease and/or diabetes mellitus in 133 patients. Their program employed immediate post-operative prosthesis with accelerated rehabilitation for postoperative management. Their results showed no postoperative mortality, 89 percent amputation healing, and 100 percent prosthesis rehabilitation of all unilateral below-knee amputees, with 93 percent rehabilitation of all bilateral below-knee amputees.

Based upon their program results, the VA system could save 18 million dollars by reducing the average hospital stay to 32 days. In the centers at the VA Hospitals, in Tucson and San Francisco, the average time from surgery to rehabilitation had been reduced from 125 to 32 days. Using the per diem cost of $116 per day for 125 days , the minimum cost for the VA section as a whole was $24,899,980. Using the minimum cost of $116 per day for 32 days, the average cost would be $7,175,296.

The authors point out, of course, that the development and maintenance costs of a modern amputation center will be substantial.[17] The need for nuclear medicine to do Xenon flow studies, the need for rapid fabrication of prostheses for physical therapy, and an active rehabilitation program mount up in costs. The total cost to the VA system, when projected over five years, would be $44 million. Nevertheless, even this figure would be less than the current figure of $124 million (at $25 million per year). Therefore, the initial investment is well worth the total cost. Moreover, the ultimate benefits to the patients in terms of accelerated rehabilitation must be balanced against costs. The savings to the VA system over five years was projected to be 80 million dollars.

ABOVE-KNEE AMPUTATION

In a prospective, randomized trial of the ability of physical therapists to manage the immediate post-operative dressing of patients with sarcoma receiving above-knee amputations, Thorpe and others[23] evaluated the characteristics of wound healing, post-operative gait, duration of pain, course of rehabilitation, and psychological adjustment. In addition, the authors evaluated the effect of immediate ambulation compared with delayed ambulation on rehabilitation. All patients with a diagnosis of lower extremity sarcoma were eligible for the study. Treatment was given by the Surgical Branch of the National Cancer Institute, Bethesda, Maryland. In a 2×2 factorial design, one factor was type of ambulation (immediate versus delayed), the other factor was type of treatment agent (physical therapist versus certified prosthetist).

The results of the study indicated that there were no significant differences with respect to age, sex, average stump length, pre- and post-operative gait characteristics, and average number of days to healing. Phantom limb sensation, phantom pain, and wound pain were evaluated in the four groups. Less analgesia was used in patients treated by therapists compared with patients treated by prosthetists. Non-phantom pain was significantly less in patients with delayed ambulation treated by a prosthetist than in patients with delayed ambulation treated by a therapist. No psychological differences were found among the four groups. Patients with casts applied by therapists used their prostheses more than patients with casts applied by prosthetists. Time to prescription of final prosthesis was not statistically significant among the four groups. Most patients were ready for final prosthesis 70 days after the operation, a 46-day improvement over historical NIH controls not fitted with rigid dressing. The authors concluded that the reason for success by physical therapists compared to certified prosthetists was that therapists remained continually in the hospital while the patient was undergoing rehabiltation. The in-house therapist is more enthusiastic, more accessible, and more communicative with the surgeon. The authors also suggested that ambulation shall begin at the time of suture removal,[23] al-

though there is no contraindication to immediate ambulation to pylon.

In a study of 59 above-knee amputations, stump healing was correlated with the local skin perfusion pressure.[10] "SPP is measure preoperatively as the external pressure required to stop isotope washout using ^{131}I- or ^{125}I- anti-pyrine mixed with histamine." It has been shown that wound complications in below-knee amputations can be predicted by preoperative measurement of local SPP. This study was undertaken to predict wound complications in above-knee amputations and to aid in the selection of stump length. Sixty-two above-knee amputations for gangrene or intolerable pain at rest were studied over a two-year period. Forty-five persons did not have diabetes mellitus; 17 persons did have diabetes mellitus. Nine patients had a previous contralateral major amputation; in 15 patients a major amputation at a more distal level had failed, 14 of them below the knee, one through the knee. Forty-nine patients were walking prior to the above-knee amputation.

Fourteen patients (24 percent) died during hospitalization following amputation; six patients died with severe wound infections of the stump. Six patients died with well healed stumps and two died with sutures not yet removed from stumps. Skin perfusion pressure below 30 mmHg was predictive of 82 percent of cases with severe wound complications. In 48 cases with SPP above 30mmHg, only four cases (eight percent) suffered severe wound complications. Patients returned to their own homes in 58 percent of the cases. Forty-one percent of 49 patients who could walk prior to amputation could walk with a prosthesis following above-knee amputation. The average length of time from amputation to rehabilitation was 15.8 weeks. Twenty patients who were discharged as walking spent an average of 15.3 weeks in the hospital. Eight patients who failed at an attempt to walk spent 24.1 weeks in the hospital. The authors concluded that wound healing correlated significantly with the pre- and post-operative skin perfusion pressure. The findings with respect to an SPP below 30 mmHg presented to the selection of a short stump in cases of inadequate blood supply in a weak patient. "Only if the blood supply is inadequate should a long stump, which is more comfortable during sitting and when moving in bed, be chosen."[10]

BELOW-KNEE AMPUTATION

Despite the attempt to preserve circulation to the lower extremities, each year there are approximately 30,000 amputations in the United States. The majority of lower extremity amputees are below-knee amputees in which an effort is made to preserve the knee joint even in patients with marginal circulation due to arterial occlusive disease. Preservation of the knee joint in older patients may make the difference in ability to walk great distances.

The records of 50 patients with below-knee amputation for arterial disease performed at the New England Medical Center from 1971 to 1979 were examined to determine how many went on to successful rehabilitation and independent ambulation.[3] The patients ranged in age from 49 to 89, with a mean of 67 years; 43 patients (86 percent) had ulceration or necrosis involving the foot or toes, and seven patients had rest pain without tissue loss. Twenty-seven patients (54 percent) had diabetes mellitus. Other illnesses included angina, congestive heart failure, chronic obstructive lung disease, hemiparesis, and senile dementia. The classification of patients into five functional categories for rehabilitation was made. These categories were: 1) complete independence, 2) patient requires a cane, 3) patient requires a crutch or walker, 4) patient was independent in a wheelchair and in transfer, and 5) complete dependence. Age, operative method, and preoperative functional limitations were compared with healing and rehabilitation outcome.

The results indicated no operative deaths. Major complications occurred in 14 patients (28 percent). There was a cumulative five-year survival rate of 60 percent. Overall rate of healing was 86 percent, pri-

mary healing was 66 percent. Early stump complications occurred in 17 patients; late stump complications occurred in seven patients. The average length of stay in a short-term care facility was 43.5 days. Thirty-five percent required amputation of the other limb within three-and-a-half years. Follow-up of 43 patients, whose stumps ultimately healed, was maintained for eight years with an average of 3.4 years. Twenty-five unilateral amputees (71 percent) were ambulatory with a prosthesis at time of follow-up. Ten unilateral amputees who were walking prior to amputation were not ambulatory. Four patients at first used a prosthesis but later discarded it for a wheelchair. Of eight bilateral amputees, two below-knee amputees were ambulatory with prosthesis, and two were not ambulatory. One below-knee and above-knee amputee was ambulatory with prosthesis, but another three who combined below-knee and above-knee were not ambulatory. Factors associated with successful rehabilitation were the condition of the oppositive limb, coexistent disease, postoperative complications, and healing failure.

Patients should be evaluated preoperatively by functional assessment scales in order to assess the impact of amputation on self-care, mobility, energy requirements, and family adjustment. This may be especially helpful in cases in which the chance of a nonhealing below-knee amputation is high. In this paper, a more formal functional assessment was not completed. A classification of patients by five categories of ambulation was completed.

Fleurant and Alexander[5] evaluated the outcomes of 353 below-knee amputees resulting from diabetic or ischemic gangrene, trauma, osteomyelitis, malignancy, Buerger's disease, or congenital malformations. Eighty-seven percent resulted from diabetic or ischemic gangrene. Sixty-five percent had diabetes; 20.7 percent arteriosclerosis; and 10.3 percent experienced trauma. Fifty-eight of the 353 patients were treated at one institution and were analyzed separately—32 men and 26 women. A total of 63 amputations was performed; seven double amputees, five double below-knee and one patient with above- and below-knee amputation. An immediate postoperative prosthesis was applied in almost all cases.

The healing rate was 82.8 percent; primary healing rate was 73.3 percent. These figures compare favorably with studies by Malone[17] and Castronuovo.[3] Mortality was five percent. A permanent prosthesis was fitted on 288 patients; 253 of them were fitted within 31 days. Successful rehabilitation was measured in terms of the ability to lower the level of amputation and to achieve primary healing. The ability to preserve the knee joint contributes to survival after amputation and to greater rehabilitation. If a patient has gangrene at the knee or severe fixed contraction at the knee joint, he should not be given a below-knee amputation, since vascularization cannot be accomplished after surgery. Other factors militating against below-knee amputation are thrombosis of the popliteal artery, poor bleeding after skin incision, and segmented systolic arterial pressure below 70 millimeters of mercury. If a patient has diabetes mellitus, it is important to educate him or her both pre- and post-operatively on the importance of care for the other foot.

One of the major problems of lower extremity amputation is to provide sufficient circulation to the leg prior to amputation. By increasing circulation to the leg, a surgeon can perform an amputation more distantly, healing after amputation is increased, and ambulation and functional independence are enhanced.

In a study of 150 arterial reconstructures performed for peripheral ischemia at the Harborview Medical Center, University of Wahington School of Medicine, Johansen and others[12] found that successful arterial reconstruction can lower the amputation level and improve rehabilitation potential. Ten of 36 patients who had gangrene of the lower extremity underwent arterial reconstruction prior to amputation. Nine of the 10 patients were long-term survivors, and eight of these nine were rehabilitated to independent gait. Six had procedures which permitted limited amputation at the level of the foot. One died of a complication resulting from chronic hemodialysis; prior

to death, he underwent limited amputation of the foot. On the whole, amputation level was performed at least one level lower than originally recommended by clinical tests before arterial reconstruction. The authors concluded that arterial reconstruction preserved limb length and increased independent gait by prosthesis.

Skin perfusion pressure (SPP) can predict wound healing in below-knee amputations. As with prediction of above-knee wound healing, SPP can predict wound complications and can be used to select better candidates for amputation at a lower level.

AMPUTATION FOR CANCER COMPARED TO VASCULAR AND TRAUMATIC AMPUTATION

Until recently, rehabilitation of the person with lower extremity cancer was not a common procedure. According to Glattly[8] and Reinstein,[19] cancer and benign tumors may account for only five percent of all amputations. Nevertheless, within the age range 10-19, cancer is the most frequent cause of amputation.[19] With the advent of the latest surgical procedures, more persons are surviving cancer and consequently greater attention needs to be given the management of the cancer patient after amputation.

Following amputation, the patient is given exercises to strengthen the upper extremities and the other, uninvolved lower extremity. When there is no incidence of cancer having spread to other systems and organs, the patient will be fitted for a Canadian hip disarticulation prosthesis. When cancer has already metastasized or when there is a question of spread, then a permanent prosthesis may or may not be provided, depending upon life expectancy, general health status, energy requirements for gait walking, the psychological outlook of the patient, and the financial resources—both public and private—available to the patient. A patient may be provided with a temporary prosthesis for the available life expectancy period, or may be given a wheelchair.

Reinstein[19] compared the psychosocial adjustment of the cancer patient with the patient with peripheral vascular disease and with amputation after trauma. In cases involving trauma, the patient awakens after surgery and is confronted with sudden loss of an extremity. No preparation has been given. The patient may proceed through the classic stages of shock, denial, and depression, as originally outlined by Dembo, Leviton, and Wright.[4] The patient may be expected to "mourn" the amputated limb as something valuable, something which up to a few hours before surgery was functioning well, an object to be prized by the outside observer. It may take many months, even years, for the patient to adapt to the amputated limb; it may never happen.

The patient with peripheral vascular disease, on the other hand, expects the amputation, may be prepared for it, and is resigned to it as a means of saving his life. The patient will feel depressed, of course, but will adapt more quickly to the loss.

The patient with amputation due to cancer is in a unique position, because he or she may be uncertain about the immediate future. Cancer may spread or may hold the potential of threatening life in the near future. Even when surgery has been successful, the patient may feel the Damocles' sword above him at all times. Apprehension about the future causes anxiety, hostility, and depression.[9] Of the three causes, cancer presents the most difficult course for adjustment.

In a retrospective study of 199 amputations for malignancy performed at the Mayo Clinic between 1965 and 1969, Subbarao and McPhee[22] reviewed their case histories to determine diagnosis, level of amputation, duration of hospital stay, complications during hospital stay, whether immediate prosthetic fitting was done, whether or not patients received a permanent prosthesis, and the interval between amputation and prosthetic fitting. Patients were asked whether they were wearing their prosthesis, whether they changed occupations or returned to the same job, and whether they attended school.

The results showed that 51 percent (102 patients) died within the five years' interval. Of the 115 dead at follow-up, 93 were due to cancer related causes: four to heart attack, one to another cause, and 17 unknown causes. The probability of surviving one year with a prosthesis was .886, compared to .586 without a prosthesis. This is not a causal relationship; it only indicates an association between survival and prescription of a prosthesis. There were 77 survivors. Of the 77, 66 had a prosthesis. Thirty-eight of them were able to return to full-time normal activities; 17 were able to return to 75 percent of normal activity; three to 50 percent; one to 25 percent; and one had no normal activity. Thirty-nine used their prosthesis all waking hours; four for most of the day; one for less than four hours per day; two for only an hour or two; and 16 never wore their prosthesis. Thirty-seven used their prosthesis to the best advantage; 16 felt their prosthesis was useless.

In the past, amputation for malignancy was not encouraged, since it was felt that the life expectancy of the patient did not justify the expense. Also, higher level amputations were performed on patients with cancer and they were often not fitted with a prosthesis. The study by Subbarao and McPhee shows that cancer clients can be fitted with a prosthesis and that within five years 49 percent have survived.[22] Compared to the mortality in vascular amputees, which ranges from 19 percent within 30 days[2] to 50 percent in five years,[24] cancer patients survive favorably for comparable periods. Moreover, patients who lose a lower extremity due to vascular disease have a 33 percent chance of losing the extremity on the other side within five years. The rehabilitation of vascular amputees, as measured by good functional outcomes in independent lifestyle, is not significantly better than cancer amputees, and in some studies, less successful.[14]

FUNCTIONAL ASSESSMENT OF AMPUTEES

The functional changes of amputees following surgery have been recently evaluated by Kegel,[14] Kegel, Webster, and Burgess[15] and O'Toole, Goldberg, and Ryan.[18] Kegel, Carpenter, and Burgess[14] showed that below-knee amputees were significantly more independent than above-knee and bilateral amputees. The authors measured the activities of daily living (ADL) in amputees by means of a questionnaire mailed to 350 patients (at least three months after discharge to a maximum of 12 years) who had undergone a variety of lower extremity amputations at several Seattle hospitals. The level of functional achievement was related to the site of amputation, age, and cause of amputation. ADL activities were categorized by percentages of responses to items on the questionnaire.

As age increased, functional level of independence decreased. Below-knee amputees were more independent than above-knee and bilateral amputees, but above-knee amputees were not more independent than bilateral amputees. There was a significant interaction between age and level of amputation, indicating that the above-knee amputee's functional independence decreased more rapidly with age, when compared to the below-knee amputee. With respect to cause, patients with amputation for tumor were functionally more independent than patients with amputation due to congenital disease, trauma, and peripheral vascular disease.

Kegel's study,[14] was very well done. The major limitations were that data were collected retrospectively after a minimum of three months' discharge, and that there was no way of comparing their functional independence from admission to discharge. Also, patients were asked to report their own level of independence, without corroborative evidence by a health professional.

In a study of the recreational activities of lower extremity amputees, Kegel, Webster,

Means and Standard Deviations for Barthel, PULSES, and ESCROW of Lower Extremity Amputees on Independent Subjects

(n = 45)

	Mean PULSES Score	*Mean Barthel Score*	*Mean ESCROW Score*
One month before admission	9.77		
Admission		66.15	13.40
Discharge	11.46	94.20	12.59
Follow-up at six months	10.58		15.10

Table 1.

Significant Differences in Functional Outcomes of Lower Extremity Amputees from Pre-Admission to 6 Months Follow-up

(n = 45)

	t	*df*	*p*
PULSES			
Pre-admission to discharge	4.68	44	0.001**
Pre-admission to follow-up at six months	1.98	26	0.05*
Discharge to follow-up at six months	0.81	26	0.42
ESCROW			
Admission to discharge	1.21	31	0.23
Admission to follow-up at six months	1.93	27	0.06
Discharge to follow-up at six months	2.44	24	0.02*
BARTHEL			
Admission to discharge	16.45	43	0.001**

*$p < .05$
**$p < .001$

Table 2.

and Burgess[15] reported the participation of 100 amputee patients in recreational activities. Corroborative data were supplied by 10 physical therapists and six prosthetists. Sixty amputees were active in some form of recreational activity. Forty of them wore a prosthesis while participating in sports. Their activities included snow skiing, swimming, fishing, bowling, hunting, golf, horseback riding, and jogging. Level of amputation and sex did not make a significant impact upon their ability to participate in recreation. The most active patients were younger and had undergone amputation for trauma. The study presents new statistical analyses of amputees' recreational activities.

In order to evaluate the changes made by 60 peripheral vascular amputees from admission to six months' follow-up after attending a rehabilitation hospital, O'Toole, Goldberg, and Ryan[18] designed a prospective study of functional outcomes measured at one month prior to admission, discharge, and six months after discharge. A secondary purpose of the study was to test the differences between above-knee and below-knee amputees in their physical, emotional, and psychosocial independence. Three standardized instruments were used for functional assessment: the Barthel Index—consisting of 15 measures of self-care and mobility, ranging in score from 0 to 100, and yielding two subtotals of self-care and mobility and a combined score; the PULSES Profile—consisting of physical, sensory, intellectual, and emotional components, and ranging in score from 6 = the highest score, to 24 = the lowest score; and ESCROW—consisting of six categories that measure the degree to which the patient may require social supports, ranging from 6 = the highest score, to 24 = the lowest score. The sample was further divided into a paired group of 15 patients who were admitted twice for rehabilitation and an unpaired group of 45 independent subjects. All data were subjected to *t*-tests for unrelated and related pairs in order to test the differences in functional independence over successive intervals. A two-way analysis of variance was used to test the interaction of above-knee versus below-knee amputation with the four test periods.

Table 1 shows the means and standard deviations on the functional assessment measures for the 45 independent subjects. Table 2 shows the significant differences on the three measures from one month before admission to follow-up.

Significant Differences in Functional Outcomes of Lower Extremity Amputees on Paired Subjects

(n = 15)

	Mean Admission	*Mean Discharge*	*t*	*df*	*p*
PULSES					
Pre-admission to discharge	10.6	12.8	2.60	14	0.02*
BARTHEL					
Admission to discharge	70.5	80.5	2.84	14	0.01**

*$p < .05$
**$p < .01$

Table 3.

Significant differences occurred on PULSES from pre-admission to six months follow-up, and on Barthel from admission to discharge. There was no significant difference on ESCROW from admission to follow-up, though there was a significant difference between discharge and follow-up. The differences on the Barthel were in favor of an increase in independent function. This finding indicates change in function as a result of the rehabilitation intervention. PULSES showed a decrease in independence from pre-admission to discharge, but then a subsequent increase in independence from discharge to follow-up at six months. However, patients did not return to their pre-amputation level before admission. This finding indicates that more social services could be offered them in the community. PULSES gives a profile of strengths and weaknesses; as a summary score for independent function it is not as useful as Barthel. The pre-admission scores were taken prior to amputation; the decrease shows the drop in function from the pre-morbid level to post-amputation. Changes in ESCROW, especially their ability to make decisions (0), showed that their need for support decreased while in the hospital but after they moved into the community they declined to their original level.

There were no significant differences attributed to amputation level on any functional measure at any testing period. However, above-knee amputees had a greater proportion of angina, whereas below-knee amputees had a greater proportion of depression, as measured by chi square tests of association.

The results for the paired subjects were approximately the same, as shown in Table 3.

The only significant differences occurred with respect to Barthel (admission to discharge) and PULSES (pre-admission to discharge). On Barthel, patients increased their scores; on PULSES Profile they decreased their scores. The authors concluded that patients with vascular disease who underwent amputation made moderate gains in their functional outcomes from admission to discharge and from discharge to six months follow-up. Some gains were made in psychosocial functioning, although some patients adapted poorly as their physical condition worsened six months after discharge. Their need for social and economic supports increased significantly after they were living in the community for at least six months. This finding is understandable; once they left the protective setting of the rehabilitation hospital, they required help with housing, transportation, and homemaking. An unexpected finding was that the level of amputation had no impact on functional outcomes and rehabilitation progress. We can only speculate that patients may adapt to their disability on the basis of psychological mechanisms, irrespective of the level of amputation. Additional studies need to be conducted to test this observation.

Patients with less functional limitations—for example, below-knee amutees—may have more difficulty in adapting to their disability than patients with more functional limitations, such as above-knee or bilateral amputees. The closer one approaches normality, the more difficult it is to accept deviation from the norm. Any new study must extend beyond functional assessment measures of physical, sensory, self-care, and mobility independence.

SEXUAL ADJUSTMENT

In our culture the worship of the beautiful young body results in defamation of any deviation from the normal. Amputation poses an additional threat: loss of a body part is symbolic of castration, and ultimately of death. Little empirical evidence is available on the sexual adjustment of the lower extremity amputee. Reinstein, Ashley, and Miller[20] interviewed 60 amputees (39 men, 21 women) after they became independent in ambulation by prosthesis. The patient's medical history, social situation, and past and present sexual behavior were reviewed. Frequency of sexual intercourse before and after amputation was obtained in interviews as reported by the patient to the interviewer.

Thirty men (77 percent) reported decreased sexual intercourse following amputation, including 17 who had not resumed intercourse after amputation. Of the 28 men who had reported having intercourse at least once a week before amputation, nine reported no change after amputation. Eight women (38 percent) reported decreased sexual intercourse following amputation, including seven who had not resumed sexual relations. Decrease in sexual relations was significantly greater for above-knee male amputees. Cause of amputation and difficulty in positioning were not significant factors in decreased sexual activity. Regularity of sexual activity in marriage was a significant determinant in the resumption of sexual relations; more unmarried patients were affected than married patients.[20] The results of this study raise the question whether psychological factors, such as loss of self-esteem, impaired body image, and lowered sense of masculinity or femininity may be more closely related to decreased sexual relations than are the physical factors involved in decreased mobility, difficulty in positioning, and impaired sexual functioning.

VOCATIONAL REHABILITATION

Vocational adjustment after amputation has depended on the previous vocational development of the amputee. Persons with realistic vocational plans; professional, managerial, or clerical skills; stable work history; and vocational interests allied with aptitudes and a realistic acceptance of disability tend to adjust better following amputation. Persons who relied on their physical ability may be required to make an adjustment to sedentary work. Lower extremity amputees are less impaired than upper extremity amputees. With proper fitting of a prosthesis and with gait training, a lower extremity amputee can be taught to ambulate sufficiently well to return to his former job with some modifications. A job sample evaluation arranged by the state vocational rehabilitation agency may be used to determine whether the amputee can return to former employment.[6] Persons requiring a job change should be referred to their local state rehabilitation agency.

Even when amputation does not affect a person's ability to conduct his or her job or to engage in social and recreational activities or to live independently, it still has an enormous impact on a person's self-esteem. Feelings about body image, sexuality, and interpersonal competence that may have been buried for years suddenly reawaken. The professional worker, the business executive, the secretary whose vocational skills are unimpaired may focus their attention on the loss of normal physical appearance. What before was taken for granted now must be compensated for by camouflaging their disfigurement. They require psychological counseling to adapt to their work environment.

SUMMARY AND CONCLUSIONS

The rehabilitation of a lower extremity amputee requires a multidisciplinary approach that is optimally achieved by referring the patient to an amputation center or a rehabilitation department in a general hospital or in a rehabilitation facility. Although several measures have been used to predict for successful rehabilitation outcome after amputation, including Xenon

clearance, local skin perfusion pressure, above-knee versus below-knee amputation, age, diabetes mellitus, angina, depression, obesity, and lesion on the other foot, none of these measures has been completely successful with amputees with various etiologies. Level of amputation is not an important predictor with vascular amputees whose general physical condition and advanced age (mean of 70 and above) are better indicators of rehabilitation outcome. Amputees due to tumor (malignant or benign) are functionally more independent than amputees due to congenital disease, trauma, and peripheral vascular disease.

Functional assessment scales are used to evaluate the changes after amputation in self-care, mobility, social supports, physical condition, and intellectual adaptability. Nevertheless, we concluded that current measures do not include many psychological aspects of disability, such as measures of body image, self-esteem, control of one's environment, and changes in values. New assessment scales must include the psychological, sexual, and vocational aspects of adjustment to amputation. Amputation has an enormous impact on social adjustment, evern when functional changes on current assessment scales cannot be demonstrated.

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