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Factors influencing rehabilitation of arteriosclerotic lower limb amputees

G.J.A. Siriwardena, MB, BS, FRCS and P.V. Bertrand, BSc, PhD, FSS, FIS
Department of Clinical Surgery, University of Birmingham, Birmingham B15 2TT UK; School of Mathematics and Statistics, University of Birmingham, Birmingham B15 2TT UK

Abstract—This survey considered 598 arteriosclerotic amputees over a period of 9 years: 267 below-knee; 81 Gritti-Stokes; 195 above-knee; and 55 double amputees.

A walking ability index (WAI) ranging from 1 for a normal gait to 6 for inability to walk was determined for these amputees by clinical grading at 3, 6, 9, and 12 months after prosthesis fitting. Amputees with the below-knee operation had better WAI at 3 and more months than those with either Gritti-Stokes or above-knee operations. There was no statistical evidence for a difference between Gritti-Stokes and above-knee operations at any time of assessment of WAI.

The 50–59 year-old age group had significantly better WAI at 6, 9, and 12 months than did the 60–69 or 70+ age group, but the 60–69 year-old group was not significantly different from the 70+ age group. On an average, the 78 amputees (14 percent) with ischemic heart disease had a poorer WAI at 6 and more months than did those without it; the 46 amputees (8 percent) with hemiplegia were worse at 12 months than those without hemiplegia; and the 15 amputees (11 percent) with bronchitis were worse at 12 months than those without bronchitis. Double amputees had poorer WAIs at 12 months than those of single amputees.

Key words: *amputation surgery, arteriosclerosis, gait analysis, lower limb amputees, prosthesis fitting, rehabilitation, walking ability index (WAI).*

Address all correspondence and requests for reprints to: Dr. P.V. Bertrand, Statistics Group, School of Mathematics and Statistics, University of Birmingham, Birmingham B15 2TT UK.

INTRODUCTION

One objective of this study was to devise a simple method of measuring the walking ability of amputees during their rehabilitation. Another was to assess the progress of that ability in relation to the type of surgical amputation of the lower limb. A walking ability index (WAI) was devised which measures the ability of an amputee to walk for a distance of 10 feet on a flat surface. At 3, 6, 9, and 12 months after amputation, the relationship between the WAI and the type of surgical amputation was statistically analyzed. In this analysis, we simultaneously assessed the effects of relevant covariates (i.e., age, presence of other disabilities) which may also affect rehabilitation.

Three methods of lower limb amputation are being compared: below-knee, Gritti-Stokes (5), and above-knee. The results are important to surgeons in their assessment of appropriateness of operation and prognosis of outcome, and are especially helpful to those monitoring the progress of amputees during their rehabilitation.

METHODS

Five hundred and ninety-eight arteriosclerotic lower limb amputees were seen by Dr. G.J.A. Siriwardena at the Birmingham Artificial Limb Centre over a period of 9 years. Dr. Siriwardena was fully aware of the entire medical history of each patient. These patients were assessed at 3, 6, 9, and 12 months after amputation on their ability to walk a distance of 10 feet on a level, carpeted surface

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in the consulting room. Five hundred and forty-three patients had a single amputation, and 55 were double amputees.

Summary definition of the walking ability index

Score	Walking Ability Index
1.	Normal gait
2.	Abnormal gait
3.	Use of 1 cane or crutch
4.	Use of 2 canes or crutches
5.	Walking with a frame only
6.	Unable to walk (requiring a wheelchair).

Detailed definition of the WAI

1. *Normal gait:* The ability to walk unaided for a distance of 10 feet confidently, without risk of falling, and with a proper sense of balance; and walking, without any distress, with an even, equidistant stride in a clinically perceived rhythmic manner on a flat, carpeted surface.

2. *Abnormal gait:* The ability to walk unaided for a distance of 10 feet with the patient either showing a marked limp or taking arrhythmic or unequally spaced strides without exhibiting signs of distress (e.g., labored breathing), discomfort due to wearing a prosthesis, or the occurrence of stump pain, yet with the confidence to complete the distance without risk or fear of falling.

3. *Use of one cane or crutch:* The ability to walk 10 feet using one cane or one crutch. This implies a lack of balance and the need for such additional aid to walk 10 feet, with confidence, otherwise unaided, without risk or fear of falling, and without distress as specified in definition number 2.

4. *Use of two canes or crutches:* Patients in this category required two canes or crutches to traverse the 10-foot distance with confidence and without risk of falling. All required this additional bilateral arm support to maintain stability in walking without distress.

5. *Walking with a frame only:* These patients required the use of a walking frame in order to traverse the 10-foot distance. Each patient became static after every stride in order to move the frame forward before taking the next stride. The patients were able to complete the distance with confidence and without falling.

6. *Unable to walk:* These patients were unable to travel a distance of 10 feet with or without any of the aids mentioned in categories 1 to 5. Some could take a few steps using a prosthesis which enabled them to stand in front of work surfaces, transfer from bed to toilet, or get in and out of a wheelchair.

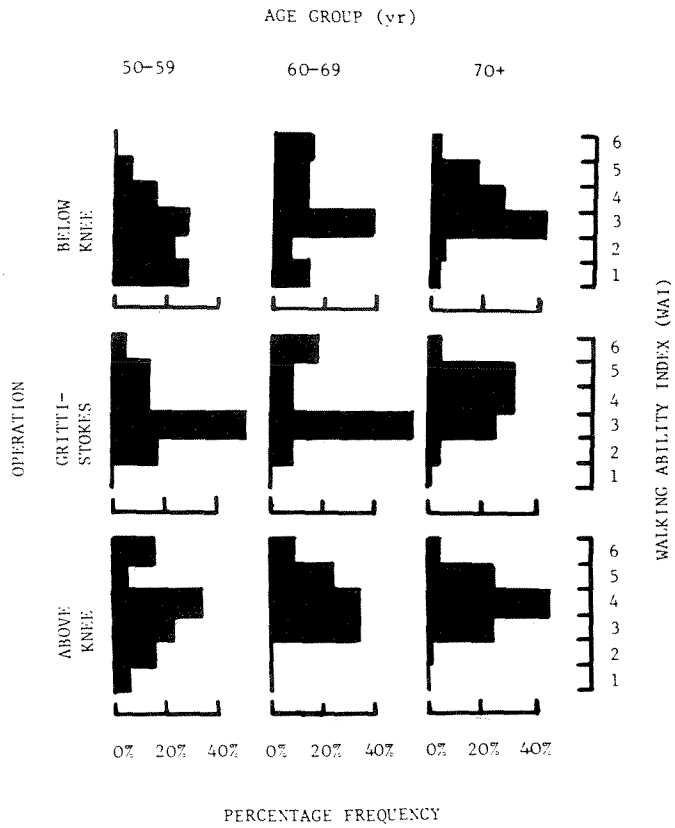

Figure 1.
Percentage frequency distribution of walking ability indexes at month 12 by operation and age.

Ancillary considerations

Each of WAI categories 1 to 5 involves the patient's reintegration and coordination of all of the faculties required to attain that level of mobility. Prior to assessment, all patients had practiced daily in their mode of walking. To attain one of these scores, the patient had to cover the 10 feet with ease, without falling, and with no distress; however, no time penalty was involved.

A mechanical method for assessing gait was not used because we wished to keep the collection of data within a straightforward clinical domain.

An amputee's progress postoperatively was monitored by his or her surgeon, general practitioner, physiotherapist, and/or district nurse. In the majority of cases, patients were referred to the Artificial Limb Centre, with all relevant information, when the amputation stump was healed; in the remaining cases the healing was supervised by Dr. Siriwardena. A prosthesis was prescribed when a stump was healed. The time from amputation to the prescription of the primary prosthesis closely indicated the healing time of an amputation stump.

In this assessment of arteriosclerotic amputees seen by one doctor at the Birmingham Artificial Limb Centre between 1979 and 1988, all except six had a below-knee, Gritti-Stokes, or above-knee amputation. Two cases of disarticulation at the hip and four Syme's amputations are not reported here.

The prevalence of concomitant disease in this group of amputees was also recorded. A statistical analysis was carried out to simultaneously assess the effects of type of operation, age group of amputee and concomitant disease on the WAI, and on "time-to-provision" of the prosthesis. In addition, each amputee was polled regarding satisfaction with the cosmetic effect of the artificial limb provided.

Patients

Data recorded on 543 single amputees with arteriosclerosis included date of amputation, age group at amputation (either 50–59 years, 60–69 years, or 70+ years), type of lower limb amputation (below-knee, Gritti-Stokes, or above-knee) and any associated disease at the time of amputation. These diseases, numbers of patients, and percentages presenting with them were:

Concomitant Disease	Number	Percentage
Diabetes	125	23%
Ischemic heart disease	78	14%
Hemiplegia	46	8%
Severe arthritis	17	3%
Parkinsonism	6	1%
Pneumoconiosis	1	0.2%
Bronchitis	15	3%
Peripheral neuropathy	1	0.2%
Deafness	2	0.4%
Gout	1	0.2%
Glaucoma	6	1%
Cancer of the breast	1	0.2%
Hypertension	17	3%
Epilepsy	1	0.2%
Acromegaly	1	0.2%
Cancer of the lung	1	0.2%
Renal failure	1	0.2%
Ulcerative colitis	1	0.2%
Psoriasis	1	0.2%

Similar data were recorded on the 55 double amputees, but associated diseases are not analyzed here. There were seven patients with one above-knee and one below-knee amputation, seven bilateral Gritti-Stokes amputees, 18 bilateral below-knee amputees, and 23 bilateral above-knee amputees.

Follow-up was done on all amputees at 3, 6, 9, and 12 months and their WAI was assessed on each occasion. Although, at the date the file was closed for analysis, the 6, 9, and 12 month follow-up times were still in the future for a number of amputees. The date of provision of the artificial limb was recorded and the number of days from operation to limb provision was determined.

In an earlier study (as yet unpublished), we found that about five percent of amputees were non-Caucasian, which is approximately the proportion in the relevant age range in this regional population. About 39 percent of amputees were female, and 61 percent male.

Method of statistical analysis

Chi-squared tests on appropriate 2 × 2 frequency tables were carried out to investigate whether or not the occurrence of any one disease was associated with the occurrence of any other disease. Analyses of covariance (10) were carried out on five responses. These were the WAIs at each of the four times of assessment and the time from amputation to provision of limb.

The effects of the types of operation, age groups, interaction between operations and age groups, and the effects of all the disease factors simultaneously on each of the responses were determined by the statistical analysis. After fitting this initial full model containing all factors, the simultaneous effect of all disease categories was determined by fitting the model without them, so that if an effect due to one or more diseases was significant at the five percent level, the individual diseases were examined separately to determine which particular ones were significant at least at the five percent level. The effects of these particular diseases are reported. The significance of the effect of the interaction between operations and age groups was also investigated. Where the interaction was not significant, it was deleted from the model. The model was further reduced by combining operation types and age groups where differences between them were not significant at the five percent level. The effects of the final model fitting each response are reported. The levels of significance of factors are reported together with appropriate means, standard errors, and confidence intervals describing the effects on the responses of interest. The Statistical Analysis System procedure GLM (9) was used for these analyses.

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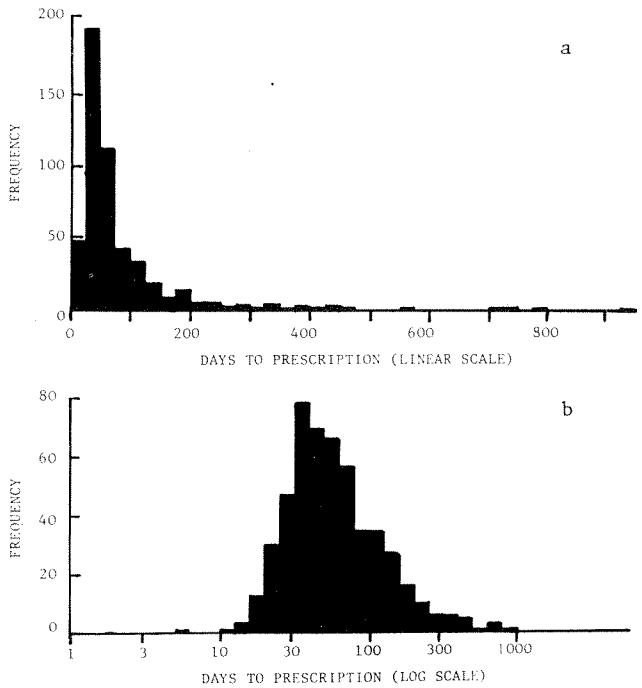

Figure 2.
Frequency distribution of time to provision of prosthesis (543 single amputees).
2a. Time to provision on a linear scale. *2b.* Time to provision on a logarithmic scale.

In a number of critical comparisons, the proportion of subjects with WAI ≤ 2, ≤ 3, and ≤ 4 were analyzed to ascertain whether they differed significantly between the Gritti-Stokes operation and the above-knee operation after adjusting for the effect of the age grouping. The method of logistic regression was used (6) utilizing another statistical analysis package, GLIM (1).

The 12-month WAIs of the four categories of double amputees were compared by using Student's *t*-tests and one-way analyses of variance utilizing the Minitab statistical computing package (7). They were similarly compared with the single amputees.

RESULTS

Analysis of data for single amputees

There were 284 amputees who had no associated disease and 259 who had one or more. The chi-squared tests that were carried out showed that there was no association between the presence of any one disease and any other disease in these amputees. The percentage frequency distributions of WAIs at 12 months in each operation and age grouping is shown in **Figure 1**. Inspection of this figure shows the absence of WAI in category 1 for the Gritti-Stokes group as well as its rarity in those with the above-knee operation. Similarly, a low WAI was rare in the 70+ age group. The distribution of the WAI suggests that the best walking mobility is in amputees with below-knee operations in the younger age group. To ascertain whether this is indeed the case and not due to random fluctuations due to chance, analyses of variance of the data have been carried out to identify the important differences between these distributions. The frequency distribution of the time-to-healing over all amputees is shown on a linear scale in **Figure 2a** and on a logarithmic scale in **Figure 2b**; statistical analyses of these data also have been carried out.

A summary of the analyses of variance of the five responses analyzed is given in **Table 1**. An effect due to one or more of the diseases is apparent at 6, 9, and 12 months but not at 3 months, nor is there any effect of any of the factors on the time to provision of artificial limb. There is no difference between the effects of the operations or age groups on the WAI at 3 months. A significant effect of both factors is evident at 6 months which becomes more pronounced at 9 and 12 months. The interaction between operation and age groups on the WAI is not significant at any time, which means that the differences between the effects of the three operations are the same for each age group.

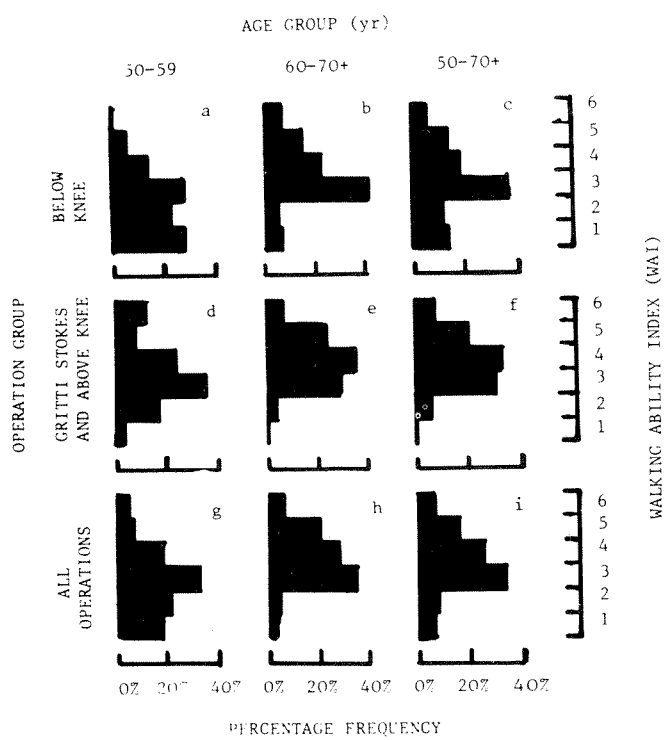

Figure 3.
Percentage frequency distributions of walking ability indexes in combined operation and age group categories at 12 months of follow-up.

Table 1.
Mean squares and levels of statistical significance in the analyses of variance of the effects of operation, age group and associated diseases on walking abilities at various time intervals and on the time to limb prescription.

Variation Source	DF	Walking ability 3 months	6 months	9 months	12 months	Time to limb fitting	Logarithm of time to limb fitting
All diseases		0.6654(17)	1.8175(14) (P<0.05)	1.9567(13) (P<0.05)	3.2218(12) (P<0.01)	5646(19)	0.0827(19)
Interaction: operation × age	4	0.6433	0.2968	1.6748	1.9967	14463	0.1883
Operations	2	0.9563	5.7967 (P<0.01)	11.7820 (P<0.0001)	16.3038 (P<0.0001)	7754	0.2139
Age group	2	0.6682	5.3331 (P<0.01)	10.7683 (P<0.0001)	20.6527 (P<0.0001)	24065	0.1616
Error		0.7401	0.9761	1.1198	1.2905	9168	0.1016
DF for error		(495)	(409)	(328)	(305)	(489)	(489)

Factors significant at the 5 percent level or less on a one-sided test are indicated in parentheses beneath the corresponding mean square. Degrees of freedom (DF) which change with the factors and response being analyzed are indicated in parentheses after the mean square.

Differences between operations

There was no significant difference at any follow-up time between the mean WAI for the Gritti-Stokes operation and the above-knee operation. After 3 months, however, the below-knee operation gave a mean WAI that was significantly less than that for the combined group of Gritti-Stokes and above-knee operation amputees. The difference was: "not significant" at 3 months; 0.29 (SE=0.10, P<0.001) at 6 months; 0.46 (SE=0.11, P<0.0001) at 9 months; and, 0.57 (SE=0.13, P<0.0001) at 12 months. Thus, the percentage frequency distribution of the WAI at 12 months is shown for all below-knee operation amputees in **Figure 3c** and for all of the combined Gritti-Stokes and above-knee patients in **Figure 3f**.

These figures illustrate that at 12 months the observed difference in mean effects is due to a much greater proportion of below-knee amputees being able to walk (14 percent with WAI=1) or walk with one cane (11 percent with WAI=2) than could the Gritti-Stokes or above-knee amputees (one percent with WAI=1 and six percent with WAI=2). Ninety-five percent confidence intervals were calculated at each follow-up time for the true value of the differences between the mean WAI for the Gritti-Stokes operation and that for the above-knee operation. These showed that the WAI for the Gritti-Stokes operation could be on average anywhere between 0.28 greater to 0.05 less at 3 months than that for the above-knee operation, between 0.46 less to 0.16 greater at 6 months, between 0.43 less to 0.07 greater at 9 months, and between 0.59 less to 0.19 greater at 12 months. Similarly, the difference between the mean time-to-healing could be anywhere between 16 days less to 35 days more.

Difference between age groups

There was no significant difference at any follow-up time between the 60–69 year age group and the 70+ age group. After 3 months, however, the 50–59 year age group had a mean WAI that was significantly less than that for the combined group (called 60+ years) of 60–69 year-olds and 70+ year-olds. The difference was "not significant" at 3 months; 0.3 (SE=0.11, P<0.001) at 6 months; 0.6 (SE=0.13, P<0.0001) at 9 months, and 0.8 (SE=0.15, P<0.0001) at 12 months. Thus, the percentage frequency distribution of WAIs at 12 months is shown for 50–59 year-olds in **Figure 3g** and for the 60+ year-old group in **Figure 3h**. These illustrate that the difference in mean effects is due to a greater proportion of 50–59 year-olds either walking unaided (WAI=1) or walking with one cane (WAI=2) than in the 60+ age group.

Operation and age groups

There was no significant interaction between operation and age groups on the WAI at any follow-up time. The distribution of the WAI that occurred in the 50–59 and 60+ year-old age groups is shown in **Figure 3a** and **3b**, respectively, for the below-knee amputees and in **Figure 3d** and **3e**, respectively, for the combined group of Gritti-Stokes

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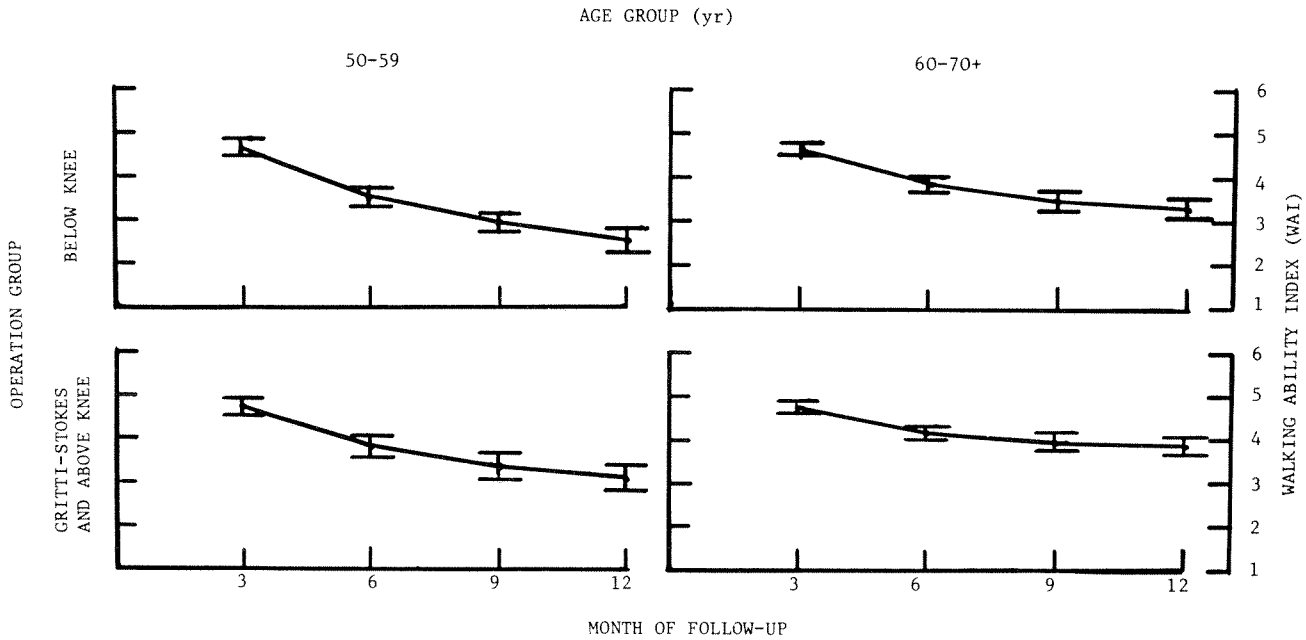

Figure 4.
Mean and Standard Error of mean walking ability indexes at 3, 6, 9, and 12 months of follow-up in significantly different operation and age groups.

and above-knee amputees. These figures contrast the major differences between the groupings.

Because both operation and age groups had effects on WAI, the mean effects and their 95 percent confidence intervals are shown at 3, 6, 9, and 12 months of follow-up for each of the four possible contrasting age and operation categories of a patient in **Figure 4**. Clearly, the below-knee amputees between 50–59 years of age show the most rapid improvement in WAI. The next best group is made up of the 60+ below-knee amputees, then the Gritti-Stokes and above-knee amputees in the 50–59 year-old group, and finally, those showing the slowest improvement in WAI are the 60+ Gritti-Stokes and above-knee amputees.

Inspection of **Figure 1** suggests that the proportion of amputees with a low WAI at 12 months may be greater following the Gritti-Stokes operation than following the above-knee operation. The proportions with WAI$\leq$3 at 12 months were 11/16, 7/11, and 7/22 for patients with the Gritti-Stokes operation in the age groups 50–59, 60–69, and 70+, respectively, and 8/18, 10/30, and 16/60 for above-knee operation patients in the corresponding age groups. The comparison between operations is clearly influenced by the marked difference between age groups, so the difference between operations has to be determined after adjustment for the effect of age groups. This was done with the GLIM statistical computing package using a binomial error structure and a logit link function. A significant effect due to age groups after adjusting for operations was apparent (χ^2_2 =6.66, P<0.05), but the effect due to differences between operations after adjusting for age groups was not quite significant at the five percent level (χ^2_1 =3.82). Effects on WAI$\leq$2 and WAI$\leq$4 at 12 months, and the corresponding WAIs at 9 and 6 months of follow-up were also analyzed, but were not close to significance.

Ischemic heart disease

At 12 months, the WAI of the 78 amputees with ischemic heart disease was on average 0.4 higher (SE=0.19, P<0.025) than those without the disease. It was also on average 0.4 higher at 9 months (SE=0.17, P<0.025) than those without the disease, and at 6 months (SE=0.14, P<0.01), but was not significantly higher at 3 months. The extent to which the presence of this disease increases the mean value of the WAI is shown in **Figure 5** together with 95 percent confidence intervals (+2SE).

Hemiplegia

At 12 months, the WAI of the 46 amputees with hemiplegia was 0.6 higher (SE=0.23, P<0.01) than that of the amputees without the disease. This effect and the nonsignificant effects before this time, together with 95 percent confidence intervals for them, are shown in **Figure 5**.

Bronchitis

At 12 months, the WAI of the 15 amputees with bronchitis was on average 1.0 higher (SE=0.40 $P<0.025$) than the average of the other amputees, but no difference was apparent before this time. The corresponding effects with 95 percent confidence intervals are shown in **Figure 5**.

Gout

There was one amputee with gout at amputation who regained walking ability very rapidly. The difference between this amputee's score and the average of all other amputees was 2.8 (SE=1.22, $P<0.025$) at 12 months, but was not significant at 9 months or earlier. The 95 percent confidence interval for this apparent effect is so wide that it is meaningless to illustrate it. It is wisest to assign little importance to this result since only one amputee is involved and a large number of disease groups have been looked at for significance: it is quite likely that one (or more) effects would appear "significant" when it (or they) are due just to chance.

Other diseases

None of the other concomitant diseases had a significant effect on the WAI. Most had only one or two cases. The largest such group was diabetes (125 amputees), but this did not significantly affect WAI in any way.

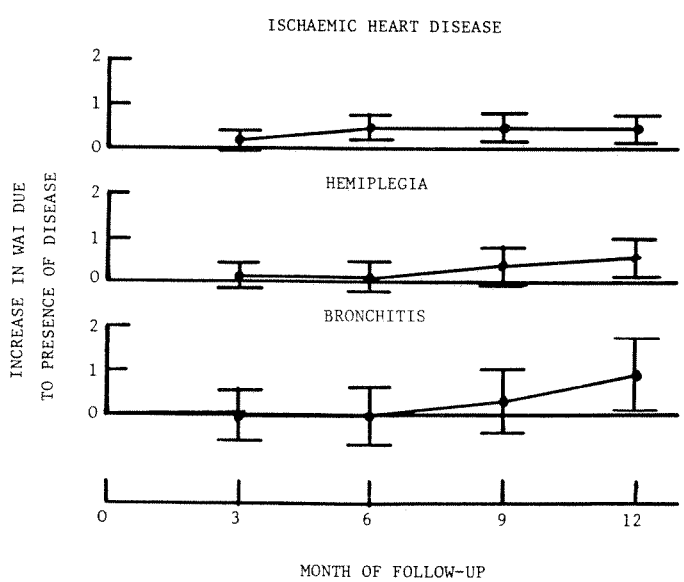

Figure 5.
Increase in mean walking ability index (WAI) due to presence of disease at 3, 6, 9, and 12 months of follow-up. The upper and lower bars on either side of the mean indicate the mean plus and minus two standard errors of the mean (i.e., 95 percent confidence interval).

Time to provision of prosthesis

The time to provision of prosthesis was 81 days on average (range 6 to 931 days, interquartile range 35 to 85 days). Neither operations nor age groups, interactions between them, nor disease categories had any significant effect on this length of time. The distribution of time-to-prosthesis provision (**Figure 2**) has a very positive skew distribution (**Figure 2a**) so it is also shown on a logarithmic scale (**Figure 2b**) where reduced skewness is apparent. Because of the skewness, both time-to-prosthesis provision and logarithms of the times were analyzed and no significant effects of factors were found on either scale of measurement, even though on the logarithmic scale the data were much less skewed and more normally distributed.

Analysis of data for double amputees

In the analyses of the WAIs at 12 months, there were no significant differences between the seven amputees with one above-knee and one below-knee operation (mean WAI=5.7, SEM=0.2), the seven amputees with bilateral Gritti-Stokes operation (mean WAI=5.1, SEM=0.3) and the 23 bilateral above-knee operation amputees (mean WAI=5.7, SEM=0.1). However, the 18 amputees with bilateral below-knee operations (mean WAI=4.4, SEM=0.3) had a mean WAI significantly lower than that of the amputees with one above-knee and one below-knee operation ($P<0.002$), and significantly lower than that of the amputees with bilateral above-knee operations ($P<0.001$). The contrast of the bilateral below-knee amputees with Gritti-Stokes amputees was only significant at the 10 percent level.

Among the bilateral below-knee amputees, there were eight in the 50–59 year age group (mean WAI=3.6, SEM=0.4), six in the 60–69 year age group (mean WAI=5, SEM=0.5) and four in the 70+ age group (mean WAI=5.3, SEM=0.5). The mean WAI of each of these groups was significantly greater ($P<0.05$) than that for the corresponding age group of the single below-knee amputees (**Table 2**).

One-way analyses of the time-to-healing of the double amputees showed no significant differences between the operation groups. Their pooled data had a positive skew distribution with a mean of 33 days (range 18 to 72 days, interquartile range 24 to 40 days).

DISCUSSION

This survey of amputees has provided much useful information. First, it has confirmed the well-known fact that below-knee amputees do better than above-knee

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Table 2.
Single amputees in each operation.

Operation		Age Range 50–59	60–69	70+	All Ages
Below-Knee					
	Total number	71	73	123	267
	Number at 12 months	49	49	71	169
	Mean WAI at 12 months	2.47	3.43	3.62	
	SEM WAI at 12 months	0.35	0.22	0.12	
Gritti-Stokes					
	Total Number	21	26	34	81
	Number at 12 months	16	11	22	49
	Mean WAI at 12 months	3.38	3.73	4.05	
	SEM WAI at 12 months	0.29	0.41	0.21	
Above-knee					
	Total Number	35	55	105	195
	Number at 12 months	18	30	60	108
	Mean WAI at 12 months	3.67	4.10	4.07	
	SEM WAI at 12 months	0.34	0.18	0.11	
All operations	**Total number**	83	90	153	326

WAI = walking ability index; SEM = standard error of the mean.

amputees and Gritti-Stokes amputees (13). Second, we have obtained information on the prevalence of concomitant illnesses among the single amputees. Third, the chi-squared tests showed that there was no evidence of the occurrence of any one disease being associated with the occurrence of any other disease.

There was no statistical evidence that Gritti-Stokes amputees regained walking ability more quickly than did above-knee amputees, although the proportion of amputees with WAI ≤ 3 tended to be about 50 percent greater in the Gritti-Stokes amputees than in the above-knee amputees. If such an effect really exists, then double the number of Gritti-Stokes amputees would be needed to clearly demonstrate it. There was, however, a highly significant effect of age on WAI at 12 months ($P < 0.0001$). It could be that there is heterogeneity between amputees within the age groups, so that what looks like an indication of an effect may be due to a greater proportion of younger amputees in each group having had the Gritti-Stokes operation than had the above-knee operation. Also, the significant effects of some disease categories may influence the raw figures shown in **Figure 1** because different proportions of such amputees in the operation and age-group categories bias any visual impressions. The analysis of covariance of the WAI which was carried out automatically adjusts for such biases, and no significant difference was detected between the Gritti-Stokes operation and the above-knee operation. Further research into the comparison between these operations is required, however. What is really needed is a national database in which all pertinent data may be recorded and the WAI analyzed in relation to operation and disease causative factors.

Gritti-Stokes amputees required a longer time for fitting a prosthesis, therein presenting problems. Also, only 50 percent of Gritti-Stokes amputees were satisfied with their artificial limbs, but 84 percent of above-knee amputees and 94 percent of below-knee amputees were satisfied with the cosmesis of their artificial limbs. The difficulty of providing a cosmetically satisfactory artificial limb incorporating a full knee mechanism that allows for a proper gait is well-known in the field of prosthetics.

The time-to-provision of the artificial limb was on average 81 days for the single amputees. While many arteriosclerotic amputees are fitted with a prosthesis 25–30 days

after amputation, there is a significant number that are fitted many months after amputation due to:

- Delay in wound healing
- Major disease affecting the contralateral limb (a factor not present with double amputees)
- Severe concomitant illnesses
- Lack of motivation for the acceptance of a prosthesis
- Administrative delay—there are a few cases where referral was delayed due to failure of communication.

Siriwardena (11,12) gives examples of delays of many years taking place between amputation and provision of a limb. It is clear that numerous factors can delay limb provision following amputation, all of which tend to lead to the positive skew distribution observed (**Figure 2**).

As is well-known, the WAIs of the double amputees were much worse than those of the single amputees, but those with bilateral below-knee operations did significantly better than the other double amputees. The postural stability of double amputees in wheelchairs was not a problem either in bilateral Gritti-Stokes or above-knee amputees. It affected each group equally when associated with hemiplegia.

Some of the concomitant diseases had significant effects (**Figure 5**). Ischemic heart disease tended to worsen the WAI by 0.4 on average from 6 to 12 months. Hemiplegia worsened the WAI by 0.6 at 12 months, but not earlier. Bronchitis worsened the WAI by 1 at 12 months, but not before that time. There was no interaction detected in the statistical analysis, but the implication is that simultaneous presence of all three diseases in an amputee would lead to an additive worsening of the WAI by 0.4+0.6+1=2 at 12 months which would clearly imply that even an amputee in the younger age group would be likely to have a WAI of 4 or more.

The survey has confirmed the view that below-knee amputation is the best form of operation in arteriosclerosis but it questions the need for Gritti-Stokes amputation, a procedure that is done in the belief that: *a*) it gives a good weightbearing stump (4); *b*) the operation has a lower mortality rate (4,5); and, *c*) there is the ability to maintain postural stability in a wheelchair should the subject become a double amputee (2). There is no particular need for Gritti-Stokes amputation in these patients (8). Possibly a more detailed survey using a greater number of patients would show a slightly better WAI at 12 months among the Gritti-Stokes amputees than in the above-knee-operation patients, because the 95 percent confidence interval showed that the mean WAI for Gritti-Stokes amputees could be anywhere between 0.6 less to 0.2 greater at 12 months than for the above-knee amputees. Narrowing this confidence interval further awaits future research investigations.

The WAI which we have used is extremely simple to determine. It was found to be much easier to use than the activity score proposed by Day (3). We anticipate that a corresponding analysis of such activity scores would provide results similar to those of our analysis of WAIs.

The WAI also provides a simple method for use in Clinical Audit, frequently used at present in medical practice both in hospitals and out, to assess qualitatively the progress in the rehabilitation of lower limb amputees.

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