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Lower limb amputee survival

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Abstract

A total of 1710 primary amputees have been studied over a 25 year period and their survival time has been calculated. These were all consecutive primary lower limb amputees admitted to the Dundee Limb Fitting Centre during the period 1965–1989. Overall, the median survival was 4 yr 9 mth for the below-knee amputee (1019 patients) and 4 yr 3 mth for the above-knee amputee (586 patients). The vascular related amputees had an overall median survival of 4 yr.

In the two decades 1970–1979 and 1980–1989 there were significant differences between the survival time of the below-knee and above-knee amputee. The survival of the amputee has increased during the two decades from 3 yr 6 mth to 6 yr 6 mth ($p>0.001$). For the first decade male above-knee and male below-knee amputee median survival was 3 yr 1 mth and 3 yr 11 mth respectively and for the second the survival was 5 yr 9 mth and 6 yr 11 mth for these levels of amputation.

For 1970–1979 no significant differences were found between male and female peripheral vascular disease (PVD) and diabetes mellitus related amputee survival. For 1980–1989 significant differences were found between PVD related male above-knee amputees (3 yr 10 mth) and male below-knee amputees (6 yr 7 mth) ($p>0.01$). Similar results were found for the female patients.

Operative mortality was found to be 5% over the period 1975–1989 which compared favourably with previous studies.

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Table 1. Population included in the study (1710 patients)

Year of amputation	1965–1969	1970–1979	1980–1989
Female	94	263	339
Male	148	396	470
Total	242	659	809
Diagnosis leading to amputation			
PVD	127	403	489
DM	66	185	194
Other e.g., Tumour, trauma infection	49	71	126
Level of amputation			
HQ	0	0	2
TH	6	7	11
AK	111	190	261
TK	29	33	21
BK	81	392	491
Symes	14	29	23
Partial foot	1	8	—

Overall prosthesis fitting 87%.
Wheelchairs supplied 22%.

Table 2. Tayside survival figures for 70 year old people.

	1974	1978	1980	1988
Male	9.37 yr	9.70 yr	9.46 yr	10.34 yr
Female	12.57 yr	12.88 yr	12.93 yr	13.40 yr

Source: Registrar General for Scotland (Personal Communication).

Note: Figures unavailable before 1974 — new district boundaries introduced in 1973–74.

Introduction

The majority of amputations performed in western society are on elderly people. The main condition leading to amputation is some form of peripheral vascular disease (PVD) (Table 1). The average age of such an amputee is reported as about 70 years old (Murdoch, 1988).

The survival of an average 70 year old male from Dundee is 10.34 years (Registrar General for Scotland, 1988) (Table 2) but the survival of an amputee from the similar group has been reported from two years to five years (Barnett *et al.*, 1976; Whitehouse *et al.*, 1968) (Table 3). The survival of patients after amputation surgery was not reported to have changed over the past thirty years but is markedly less than that of their peers, whose life expectancy has increased.

Table 3. Amputee mortality

Silbert (1952)	3 yr 61% survival
Smith (1956)	5 yr 60% mortality
Hansson (1964)	2 yr 58% mortality
Whitehouse *et al.* (1968)	5 yr 50% mortality
Kolind-Sørensen (1974)	5 yr 50% mortality
Barnett *et al.* (1976)	2 yr 50% mortality (98 cases)
Ebskov and Josephsen (1980)	4 yr 22.5% survival (2,029 patients)
Finch *et al.* (1980)	2 yr 45% mortality 4 yr 25% mortality
Mandrup-Poulsen and Jensen (1982)	1 yr for AK amputation — 54% mortality 1 yr for BK amputation — 17% mortality
Jamieson and Ruckley (1983)	No 5 yr survivors (73 cases)
Cumming *et al.* (1987)	22 month mean survival BK amputees
Harris *et al.* (1988)	1966–1971 3 yr 2 mth 1978–1982 3 yr 11 mth considered N/A (52% = 3 yr) 116 cases (1966–71) 189 cases (1978–82)

Review of the literature shows that operative mortality, defined as death within one month of amputation surgery, varies from 1.7% to 31% (Table 4). Some of the publications also highlight that mortality following above-knee (AK) surgery is higher than surgery following below-knee (BK) amputation.

The limited survival of these amputees emphasises the importance of early fitting and speedy rehabilitation. It is important that the clinic team should make every effort to make these patients mobile and independent as soon as possible so that the remaining short life of an amputee is comfortable and worth living. This is best achieved by developing a comprehensive amputee service (Murdoch, 1988).

This paper studies 1,710 primary amputees admitted to Dundee Limb Fitting Centre (DLFC) over a twenty-five year period and reviews the overall survival patterns. The study also compares the differences between decades 1970 to 1979 and 1980 to 1989 in detail.

Table 4. Operative mortality within 1 month of operation

KCH — 2% in the past 15 years DLFC — 3%	} 5% overall
Shumacker and Moore (1951)	6.6%
Silbert and Haimovici (1954)	7%
Smith (1956)	12%
Schlitt and Serlin (1960)	13.6%
Otteman and Stahlgren (1965)	29.7%
Olejniczak (1967)	24.1%
Burgess *et al.* (1971)	8%
Persson and Sunden (1971)	11.9%
Kahn *et al.* (1974)	9%
Barnett *et al.* (1976)	15%
Finch *et al.* (1980)	15%
Houston *et al.* (1980)	15–37% g (Lit. Review)
Barber *et al.* (1983)	(31% AK; 7.2% BK)
Jamieson and Ruckley (1983)	20%
Mann and Bisset (1983)	1.7%
Pohjolainen and Alaranta (1988)	(27%–3 mth)
Harris *et al.* (1988)	(5% AK; 6% BK)
Pohjolainen *et al.* (1989)	(25.5%–2 mth)

KCH — Kings Cross Hospital, Dundee — The Operating Hospital.

DLFC — Dundee Limb Fitting Centre, Dundee, the rehabilitation facility, to where patients were transferred within an average of 7 days post-operatively.

Method

All patient records are kept in the Centre and are updated regularly.

Prospective information on all primary amputees admitted to DLFC has been recorded, initially on specially designed charts (1965–1981) and since 1982 on an enhanced data sheet. The information has been transferred to an Olivetti M24 PC using dBase III+ (1985).

The information for operative mortality, defined as death within one month of surgery in Tayside, was collected from Scottish Medical Records Form 1 (SMR 1) and from the DLFC data base. The SMR1 form is completed by secretarial staff for al patients on discharge from Scottish hospitals. The SMR1 form, along with other information records the following:

1. reason for admission;
2. date of admission;
3. date of discharge.

The record of the date of death has been obtained from a variety of sources which includes patients' relatives, review of the local newspapers, contact with the general practitioner or hospital doctor looking after the patient prior to death, the Primary Care Division of Tayside Health Board and occasionally by visiting the Registrars Office in Edinburgh where death certificates are recorded for the whole of Scotland. A check was made in June 1990 and survival status in this study was recorded at that date. Those who have moved away from this catchment area which includes Tayside and North Fife region of Scotland or have been lost to follow-up have been excluded from the study.

Survival distributions were compared graphically between subgroups by plotting the survival functions against time. This plot shows the proportion still alive at subsequent times, out of an initial cohort of patients. Information from 'censored observations', that is, patients who are still alive at the date of the study and whose survival times are known only up to that point, was incorporated using the Kaplan-Meier method (see for example Pocock (1983)). A test of the differences between survival distributions in different subgroups of patients used the logrank test. Statistical analysis of data was carried out using Nanostat (1989) computer software.

Results

Some 1,710 patients who had primary lower limb amputations between 15.5.65 and 31.12.89 were included in the study, all being admitted to the DLFC following surgery either under the Tayside Amputation Service, or the surgical units in North Fife. The average age of a patient undergoing amputation was 70 years.

Table 1 indicates the population studied. This includes the sex of the patients in the study, the principal cause of the amputation and the ultimate level of the amputation.

Table 2 shows Tayside survival figures for males and females from 1974 — 1988. The survival has continued to increase from 1974 to 1988, in males from 9.37 yr to 10.34 yr and in females from 12.57 yr to 13.40 yr.

Table 3 shows amputee mortality as reported in the literature. This ranges from 54% mortality for AK amputees at 1 year, to 60% mortality at 5 years.

Table 4 lists Tayside's operative mortality along with other reports from the literature. Dundee mortality at 5% compares favourably with that reported in several publications and is better than some at 31% for AK patients in one paper (Barber *et al.*, 1983).

Table 5 presents the median survival of the whole group studied over 25 years irrespective of causes of amputation. Significant differences were found between BK (4 yr 9 mth) and AK (4 yr 3 mth) ($p<0.004$). Comparing all amputees in the two decades, significant differences were found with 1970–79 (3 yr 6 mth) and 1980–89 (6 yr 6 mth) ($p<0.001$). This shows that the

Table 5. Median survival of the whole 25 year study all diagnoses.

Above-knee		
Male	3 yr 6 mth	4 yr 3 mth
Female	4 yr 8 mth	
Below-knee		
Male	4 yr 8 mth	4 yr 9 mth
Female	5 yr 8 mth	
Below-knee	4 yr 9 mth	$p < 0.004$
Above-knee	4 yr 3 mth	

1970–1979 3 yr 6 mth
1980–1989 6 yr 6 mth } $p < 0.001$

Overall operative mortality (within 1 month of amputation) 5%.

Table 6. Median mortality figures for two decades.

All diagnoses	1970–1979 3 yr 6 mth		1980–1989 6 yr 6 mth	
Male	3 yr 1 mth		5 yr 9 mth	
Female	3 yr 11 mth		6 yr 11 mth	
	DM	PVD	DM	PVD
Above-knee				
Male	2 yr 4 mth	2 yr 6 mth	4 yr 6 mth	3 yr 10 mth
Female	11 mth	3 yr 3 mth	74% (5 yr survival)	6 yr 5 mth
Below-knee				
Male	2 yr 10 mth	3 yr 10 mth	4 yr 0 mth	6 yr 7 mth
Female	2 yr 5 mth	4 yr 0 mth	53% (5 yr survival)	6 yr 11 mth

For 1970–1979 no significant differences were found between male and female PVD and diabetes mellitus or levels of amputation with regard to survival.

For 1980–1989 significant differences were found between PVD related male above-knee and male below-knee amputees ($p < 0.01$). No differences found between the level or sex of diabetic amputees, nor PVD related female cases.

overall survival of the amputees had significantly increased over the period. The BK patients survived longer than the AK amputees.

Table 6 shows the median survival of two decades 1970–1979 and 1980–1989 in relation to level of amputation and main causal conditions, i.e. PVD (without diabetes) and diabetes related amputations. As stated above the survival of all patients has been found to have increased significantly over the study period, but in addition there was found significant differences between the PVD related male AK amputees and the male BK amputees, ($p<0.01$) with survivals of 3 yr 10 mth and 6 yr 7 mth respectively in the latter decade.

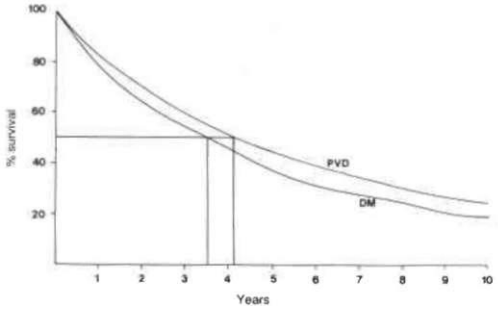
Table 7 shows median survival for PVD with and without diabetes mellitus related amputation. Statistically significant differences are seen between PVD patients without diabetes and those with diabetes mellitus related amputation respectively (4 yr 2 mth) and (3 yr 8 mth) ($p<0.006$). The patients with PVD (without diabetes) related amputations surviving longer than those who had a diabetic related amputation. In addition there were significant differences between male AK (3 yr 6 mth) and male BK patients (4 yr 8 mth) ($p<0.03$).

No significant differences were found between the ages of the patients during the periods of study.

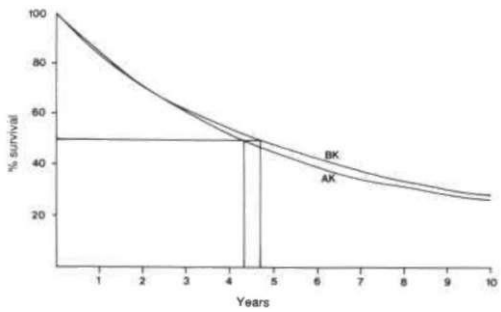
Graph 1 is the survival curve for 10 years of

Table 7. Median survival for the whole 25 year study.

All cases			
	Above-knee male (338)	– 3 yr 8 mth	$p < 0.03$
	Below-knee male (559)	– 4 yr 8 mth	
All vascular cases (1464 overall)		– 4 yr 0 mth	
	Above-knee	– 3 yr 6 mth	
	Below-knee	– 4 yr 2 mth	
	Vascular (non-diabetics) (1019)	– 4 yr 2 mth	$p < 0.006$
	Diabetic cases (445)	– 3 yr 8 mth	



Graph 1. Survival curve for 10 years of 25 year study for PVD with and without diabetes mellitus ($p < 0.006$).



Graph 3. Survival curve for 10 years of 25 year study divided between below-knee and above-knee.

the the 25 year study divided into PVD with and without diabetes mellitus related amputations, showing the increased survival of the PVD amputee over the diabetic patient.

Graph 2 shows the survival curve for 10 years of the 25 year study, for all cases, divided into two decades 1970–1979; 1980–1989. It clearly shows the increased longevity over the two decades.

Graph 3 gives the survival curves for 10 years of the 25 year study of BK and AK amputees. It shows the greater survival of the BK amputee over the AK case.

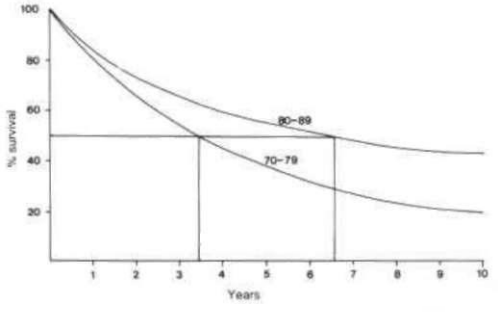
Graph 4 covers the two decades showing the BK and AK amputees for all cases, demonstrating the increased survival for the two decades for both levels of amputation, the BK amputees having a greater survival than the AK in both decades.

Discussion

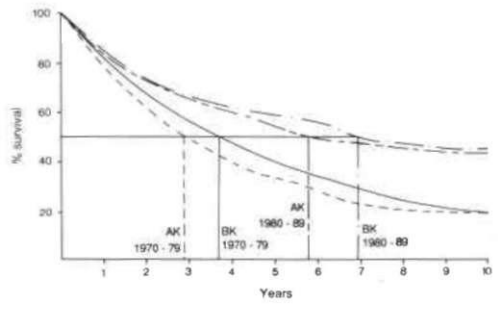
The survival of lower limb amputees has been reported to be from two to five years by various authors (Barnett *et al.*, 1976; Kolind-Sørensen, 1974; Whitehouse *et al.*, 1968) (Table 3). Jamieson and Ruckley (1983) even reported no survivors at 5 years. This study reports on the survival of 1,710 lower limb amputees admitted to DLFC over the last 25 years (Table 1). This prospective study presents the overall survival rate of all patient groups.

The overall survival of patients who had an amputation as a result of PVD was found to be 4 yr (50% survival) (Table 7). When the vascular cases are divided into, those who had diabetes and those who did not, then the survival rate is found to be 4 yr 2 mth for PVD and 3 yr 8 mth for diabetes mellitus (Graph 1).

This difference in survival between the two groups of amputees was significant ($p<0.006$) and is similar to the reports by Smith (1956), (diabetic patients only), but less than those reported by Kolind-Sørensen (1974) and Whitehouse *et al.*, (1968). Silbert (1952) reported a 61% survival at 3 years and 41% at 5 years in a study of 294 diabetic amputees. Ebskov and Josephsen (1980) reported 22.5% survival at 4 years for 2,029 patients which is much less than this group, Pohjolainen and Alaranta (1988) reported 27% mortality at 3



Graph 2. Survival curve for 10 years of 25 year study for all cases divided into two decades, 1970–79 and 1980–89.



Graph 4. Survival curve for all cases divided into below-knee and above-knee for the two decades 1970–79 and 1980–89 ($p < 0.004$).

month and later Pohjolainen *et al.*, (1989) reported a 25.5% amputee mortality within 2 month of amputation (Table 4). Cumming *et al.*, (1987) reported for 48 BK amputees a 22 mth survival only. The diabetic patients in this study have been shown to survive a shorter time than those with only PVD but much longer than in many reported studies.

Review of the Tayside amputees in the decades 1970–1979 and 1980–1989 showed very different and significant results. For all diagnoses during the decade 1970–1979 amputees had a 50% survival of 3 yr 6 mth whereas in 1980–1989 they had a survival of 6 yr 6 mth ($p<0.001$) (Graph 2 and Table 6). This increasing pattern is in keeping with that reported by Harris *et al.*, (1988) who reviewed 116 cases from 1966 to 1971 with a mortality of 3 yr 2 mth and 189 cases over a period of 1978–1982 with a mortality of 3 yr 11 mth (Table 3). Although these figures were not reported as being significant there is the suggestion of a trend towards increasing longevity. The increase in longevity reported in this paper is quite marked and dramatic. There was also an increase in longevity of all Tayside 70 year olds (Table 2). For the period 1970–79 no significant difference was found between the suvival of male and female with PVD or diabetes mellitus. There were however differences found in the 1980–1989 group. The change cannot be explained by differences in the age distributions between the study groups alone, since it was found that there was no significant difference between the ages of the patients in the decades.

For the whole 25 year study the BK amputees survived a median time of 4 yr 9 mth whereas AK amputees only survived a median time of 4 yr 3 mth (Graph 3 and Table 5) ($p<0.004$). Reviewing the survival of the principal levels of amputation shows that there was an increase in the survival of the patients over the two decades (Graph 4).

During the period 1980–1989 the BK male vascular non-diabetic amputee survived 6 yr 7 mth whereas the AK male amputee with a similar pathology survived 3 yr 10 mth ($p<0.01$) (Table 6). Overall a similar survival has found in the whole series 1965–1989 with male BK amputees surviving 4 yr 8 mth and male AK amputees surviving 3 yr 8 mth ($p<0.03$) (Table 7).

The difference presumably reflects the degree and widespread nature of vascular involvement, with AK amputees having significantly worse vascular disease than BK, and it might be assumed worse generalised disease. Associated diabetic cases have significantly shorter survival than the pure PVD associated amputee, 3 yr 8 mth as compared with 4 yr 2 mth ($p<0.006$) (Table 7). This is similar to other reported findings.

Operative mortality (Table 4) is reported as high as 31% for AK (Barber *et al.*, 1983) and as low as 1.7% (Mann and Bisset, 1983). In Dundee with the amputation service providing total patient care, the operative mortality has been 5%. This is still too high but possibly related to the health of the elderly population who require amputation. Troup (1976) reported that many patients had a concurrent disease and this reflects the overall ill-health of the patients. In Dundee in 1983 there were 67% of the amputees admitted to the DLFC with at least one other significant pathology (Stewart, 1985). In the literature the incidence of concurrent disease varies from 43% (Moffat *et al.*, 1981) to 100% (Anderson *et al.*, 1967). Associated cardiac disease is also commonly reported, Malone *et al.* (1979) reported this pathology as occurring in 66% of 133 cases and Kavanagh and Shepherd (1973) recorded 100% of 62 cases as having cardio-respiratory disease. In the previously reported Dundee study it was found to be 30% (Stewart, 1985).

The long term survival of Tayside people surviving to 70 years of age has also changed. In 1974 male survival was 9.37 yr while in 1988 survival had risen to 10.34 yr. Female survival has also risen and is considerably more than male peers. In 1974 female survival was 12.57 yr while in 1988 it had risen to 13.4 yr (Table 2), similarly survival of amputees has also increased but this rise was found to be greater than that of their peers.

It was previously thought that the amputee had a significantly reduced survival but it has been found in this study that in the last decade the survival of the amputee has increased significantly. This increase is much more than the general improvement in the corresponding age group as mentioned earlier. The importance of this is that these patients must be fitted with prostheses wherever possible and offered comprehensive rehabilitation so that the quality of life can be maintained. In this

study 87% of amputees have been successfully fitted with prostheses with 22% of them being supplied with a wheelchair (Table 1).

This series also demonstrates that a high proportion of BK amputations is possible with a well organised co-ordinated amputee service (Murdoch and Donovan, 1988). It was found that male BK amputees had a signficantly longer survival than male AK amputees where the causal condition of amputation was non-diabetic vascular disease, but the survival was less than that of his peer. Diabetic amputees were less fortunate. This presumably relates to the severity of the disease and is often associated with the generalised atherosclerosis. It is likely that the longevity of the BK amputee relates to the lesser vascular involvement than those who require an AK amputation.

Resources need to be available to ensure that all these amputees obtain satisfactory prosthetic care to enjoy an active life in society.

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