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FROM THE DEPARTMENT OF ORTHOPAEDIC SURGERY
(HEAD: PROFESSOR A. HULTH, M. D.) MALMÖ GENERAL HOSPITAL,
UNIVERSITY OF LUND, MALMÖ.

PERIPHERAL ARTERIAL INSUFFICIENCY

AN EPIDEMIOLOGICAL STUDY OF 2,243 HOSPITAL ADMISSIONS CAUSED
BY ARTERIOSCLEROSIS OBLITERANS, DIABETES MELLITUS, THROMBANGITIS
OBLITERANS AND ARTERIAL EMBOLISM

BY

BJÖRN TIBELL

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ERRATA

Page 15	Previous studies :	Line 3:	Bugár-Mészáros
Page 22	„ „	Line 9:	(1959) should be (1959 and 1960)
	„ „	Line 12:	561 should be 571
	„ „	Line 18:	three should be nine
	„ „	Line 19:	69 should be 79
	„ „	Line 20:	45 should be 43
Page 30	„ „	Line 6:	14 should be 13
Page 33		Line 32:	47 % should be 37 %
		Line 34:	40 % should be 44 %
Page 42	Method	Line 3:	1920 should be 1910

ADDITION

References

- Page 50: BELL, E.T. (1952) A postmortem study of vascular disease in diabetics. Arch. Path. 53:444-455.
- „ „ : BLOOR, K. (1961) Natural history of arteriosclerosis of the lower extremities. Ann.roy. Coll. Surg. Engl. 28:36-52.
- Page 52: KRAUTWALD, A. & VÖLPEL, W. (1960) Häufigkeit arterieller Durchblutungsstörungen der unteren Extremitäten in Beziehung zum Lebensalter und zur Lokalisation der Gefässobliteration. Dtsch, med. Wschr. 85/35:1531-1536.

INTRODUCTION

Although samples of patients with peripheral arterial insufficiency chosen by different methods and with different criteria have been described, no attempts have been made to relate the frequency of these diseases to the population at risk. PERLOW (1962) stated: "Although most people over 60 years of age have some degree of arteriosclerosis, no statistics are available on the number who have circulatory impairment in the lower extremities." Arteriosclerotic changes are becoming more frequent with increasing age (STERNBY 1968). SOLTH et al. (1957) thought that the observed increase of pathological changes in the arteries was caused by increasing survival in the population and he felt that after the age of 70 almost everybody had degenerative arterial disease.

Also, arterial changes in conjunction with diabetes mellitus have been studied and KRAMER and PERILSTEIN (1958) claimed that these conditions have increased between 1921 and 1956. On the other hand BELL (1957) found that the incidence of gangrene in diabetes mellitus decreased during the first half of this century.

It has been suspected that the true incidence of arteriosclerotic changes in the lower limbs is increasing. In the Department of Orthopaedic Surgery in the General Hospital, Malmö, the proportion of patients treated for peripheral arterial insufficiency as well as the number of beds occupied by these cases have increased.

However, this is not sufficient evidence of a true increase in the incidence of this disease. All hospital facilities in the city as well as changes in the distribution of the population at risk would have to be included in a survey of incidence changes. Malmö has previously proved to be suitable for epidemiological studies as demonstrated by BIÖRCK (1955), HALL (1961), SIEVERS (1963), ALFFRAM and BAUER (1962), ALFFRAM (1964), BERGE

(1967) and STERNBY (1968) dealing with problems ranging from rheumatic fever and coronary disease to fractures, cancer and atherosclerosis.

The objective of the present study was to calculate age and sex specific incidence for the major groups of conditions leading to peripheral arterial insufficiency and to study possible changes over a 17-year period. Against the background of the hospital facilities in the city it should also be possible to estimate some socio-economic implications of this group of diseases.

MATERIAL AND METHODS

THE CITY OF MALMÖ

The city of Malmö, the third in population in Sweden, is a center of industry and trade. From the end of 1948 to the end of 1965 the population increased from 185,947 to 249,161,¹ the increase being comparatively steady over the years (Table 1).

Table 1. *The population of Malmö 1948—1965.*

	Men	Women	Total
1948	87,635	98,312	185,947
1949	89,298	99,934	189,232
1950	91,111	100,672	191,783
1951	93,572	102,918	196,490
1952	94,807	103,838	198,645
1953	96,404	105,535	201,939
1954	98,282	107,358	205,640
1955	100,301	109,172	209,473
1956	102,358	110,902	213,260
1957	104,429	112,901	217,330
1958	106,622	115,078	221,700
1959	108,685	116,975	225,660
1960	110,473	118,775	229,248
1961	112,708	120,644	233,352
1962	114,890	122,627	237,517
1963	117,140	124,638	241,778
1964	118,930	126,873	245,803
1965	120,757	128,404	249,161

During these 17 years population census was carried out in 1950, 1960 and 1965. The distribution of age and sex in the population in these three surveys is shown in Table 2.

¹ Department of Statistics, Financial Committee of Malmö.

Table 2. *Age and sex distribution of the population of Malmö.*

Age	1950			1960			1965		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
0—4	8,151	7,876	16,027	7,832	7,411	15,243	8,622	8,246	16,868
5—9	7,837	7,576	15,413	7,894	7,469	15,363	7,991	7,579	15,570
10—14	5,431	5,326	10,757	8,630	8,362	16,992	8,142	7,666	15,808
15—19	4,697	4,964	9,661	8,757	8,609	17,366	9,298	9,365	18,663
20—24	6,134	6,954	13,088	7,389	7,807	15,196	10,776	10,852	21,628
25—29	7,791	8,493	16,284	7,194	7,396	14,590	8,995	8,365	17,360
30—34	8,140	8,542	16,682	7,979	7,978	15,957	7,659	7,456	15,115
35—39	8,070	8,658	16,728	8,553	8,953	17,506	8,173	8,183	16,356
40—44	7,734	8,632	16,366	8,614	8,951	17,565	8,855	9,258	18,113
45—49	6,451	7,337	13,788	8,276	8,894	17,170	8,741	9,166	17,907
50—54	5,397	6,237	11,634	7,782	8,737	16,519	8,351	8,976	17,327
55—59	4,324	5,382	9,706	6,299	7,338	13,637	7,644	8,709	16,353
60—64	3,829	4,848	8,677	4,957	6,073	11,030	5,916	7,278	13,194
65—69	3,241	4,135	7,376	3,733	4,989	8,722	4,422	5,829	10,251
70—74	2,254	3,126	5,380	2,889	4,171	7,060	3,069	4,575	7,644
75—79	1,302	1,762	3,064	2,038	2,914	4,952	2,125	3,484	5,609
80—	770	1,267	2,037	1,497	2,513	4,010	1,812	3,241	5,053
Total	91,553	101,115	192,668	110,313	118,565	228,878	120,591	128,228	248,819*
0—24	32,250	32,696	64,946	40,502	39,658	80,160	44,829	43,708	88,537
25—44	31,735	34,325	66,060	32,340	33,278	65,618	33,682	33,262	66,944
45—	27,568	34,094	61,662	37,471	45,629	83,100	42,080	51,258	93,338

* Disagreements with Table 1 depend on the differences of the dates of calculation.

HOSPITAL FACILITIES

In the city of Malmö almost all hospital facilities are owned by the community and financed by city and state funds including the compulsory state health insurance. On the whole, there are very few private or voluntary hospitals in Sweden and these only in the large cities. In the city of Malmö there are two private nursing homes with altogether 37 beds and facilities for the care of simple cases of chronic disease.

Hospitalization is free of charge except for the care of chronic somatic disease where after six months of hospitalization a small sum, well within the limits of the general pension, is charged.

The city constitutes a defined area for health care with a central administration for the three municipal hospitals: Malmö Allmänna Sjukhus (MAS) for mainly emergency and short time somatic disease, Värnheims Sjukhus (VÄS) for chronic somatic disease, and Malmö Östra Sjukhus (MÖS) for mental disease. MAS is a teaching hospital affiliated to the

Table 3. *Number of hospital beds in the city.*

	MAS		VÄS		MÖS	
	Total	per 100,000	Total	per 100,000	Total	per 100,000
1949	1,367	722	571	302	731	386
1950	1,373	716	571	298	731	381
1960	1,544	674	629	274	872	380
1965	1,631	655	682	274	837	336

University of Lund and receives patients also referred from other districts in the southern part of the country.

Over the years, the number of hospital beds decreased in relation to the population (Table 3). While the number of somatic hospital beds increased by 19 % and the number of beds for chronic somatic disease by 20 % between 1950 and 1965, the population increased by 29 %. In addition, the age distribution during the same period shifted towards higher age groups; the cases of the present study were rarely younger than 45 years at first admission and between 1950 and 1965 the number of residents over 45 increased by 51 %, as compared to 29 % in the total population.

CRITERIA

To be included in the study patients had to answer the following criteria:

- Hospitalization should be caused exclusively by symptoms of peripheral arterial insufficiency in the legs.
- The patient should have been admitted to a hospital in the city during the years 1949—1965.
- The patient should at the time of admittance be a resident of the city.

COMMENT

Cases with peripheral arterial insufficiency have been admitted to the Departments of Orthopaedic Surgery, General Surgery, Internal Medicine, Dermatology and Infectious Disease at the MAS. Patients admitted to the VÄS and to the Department of Chronic Somatic Disease at the MAS have been presented under the same heading—Department of Chronic Somatic Disease. Altogether 10 patients in treatment for peripheral arterial insufficiency were discharged from somatic departments at the MAS to the MÖS where they were treated mainly because of their mental

disorder. In these cases it was not possible to decide in retrospect whether or not the peripheral arterial insufficiency would have caused hospital care.

Since, in Malmö, there was no department specializing in peripheral arterial disease, patients with symptoms of such disease have been treated ambulatorily at the various departments mentioned above. When the symptoms became sufficiently severe to cause hospital admission the patient usually was admitted to the department where he had been treated as out-patient.

All surgical treatment, except for vascular surgery, was given at the Department of Orthopaedic Surgery and 300 first admissions were to this department. To the Department of General Surgery were admitted for the first time, 243 patients, mainly men with arteriosclerosis or thrombangitis obliterans. Of the 206 patients admitted to the Department of Internal Medicine the majority consisted of diabetics and patients with arterial embolism, both groups with primary conditions usually treated in the same department. In the Departments of Dermatology and of Infectious Disease the numbers of first admissions were 40 and 32, respectively. They were cases of painful, chronic, arterial ulcers with or without infection.

Patients at the Department of Chronic Somatic Disease were usually old and suffered from serious diseases such as hemiplegia, cardiac or renal failure or general arteriosclerosis. Also symptoms of impaired peripheral circulation were rather frequent. If such symptoms became so severe that, in outpatients they would have caused admission, the patients, totally 146, from that point in time were included in this study as first admissions.

Only patients who were registered as residents in the city of Malmö were included in the study.

DATA COLLECTION

The annual registers of diagnoses for the years 1949—1965 were examined for each department separately including altogether more than 200,000 admissions. The records were brought out in all cases with the diagnosis of peripheral arterial insufficiency. The records were also studied if the diagnosis raised any suspicion of peripheral arterial insufficiency such as leg ulcer, circulatory insufficiency, diabetes, and claudication. Altogether more than 4,000 records were examined with respect to whether or not the admission had been caused by symptoms of peripheral arterial insufficiency. For patients who had been admitted to several departments at several occasions each admission was recorded separately.

The following information was recorded:

Date of birth
 Name
 Sex
 Year of admission
 Month of admission
 Admitting department
 First admission
 Diagnosis: Arteriosclerosis obliterans
 Diabetes mellitus
 Thrombangitis obliterans
 Arterial embolism
 Time of hospitalization
 Left/right localization
 Diabetes mellitus: Year of onset of diabetes
 Discharged to: Home
 Other somatic department
 Convalescent or nursing home or home for the aged
 VÄS (chronic somatic disease)
 Dead
 Date of death

Except for the data which were available in the records, further information with regard to date of death was obtained from the Department of Taxation, bringing the data up to July 31, 1967.

COMMENT

First admission indicates when the patient for the first time was admitted to hospital because of symptoms of peripheral arterial insufficiency.

The patient has over the years been recorded under the diagnosis made at the first admission. In cases with more than one diagnosis the patient was included only if the peripheral arterial insufficiency was judged to be the main cause of admission. If, for instance, a diabetic patient admitted to the Department of Internal Medicine for his diabetes also had signs of peripheral arterial insufficiency such as a toe-gangrene which *per se* could have been treated ambulatory, this admission was not included.

To get the sampling as complete as possible the records were brought out for closer study if the slightest suspicion of peripheral arterial insufficiency was raised when the register of diagnoses was examined. More than half of the suspected diagnoses could be discarded after the records had been examined. The records from all departments are kept permanently and

easily available which provides opportunities for cross-checking and back-checking of the history in each case. The panorama of peripheral arterial insufficiency in the legs can therefore be presented as completely as is possible in a retrospective study.

For administrative reasons the residency of the patients is an important item in the record and was therefore available and correct. Patients who had been referred from other districts in southern Sweden were not included in the study.

In many cases it was not possible to decide in retrospect whether or not irreversible gangrene had been present at the time of first admission. However, about 90 % of the arteriosclerotics had such gangrenous changes and almost all the diabetics.

CLASSIFICATION

The patients were classified in four groups:

- a) *Arteriosclerosis obliterans*: Patients with symptoms of chronic peripheral arterial insufficiency without diabetes mellitus.
- b) *Diabetes mellitus*: Patients with symptoms of chronic peripheral arterial insufficiency and with diabetes mellitus.
- c) *Thrombangitis obliterans*: Patients with symptoms of chronic peripheral arterial insufficiency diagnosed as thrombangitis obliterans.
- d) *Arterial embolism*: Patients with sudden onset of symptoms of peripheral arterial insufficiency.

COMMENT

- a) *Arteriosclerosis obliterans*: Includes cases with a history of peripheral arterial insufficiency with a gradual onset. None of the patients in this group had diabetes at the time of first admission but in a few this condition was diagnosed later on.
- b) *Diabetes mellitus*: Includes patients with the same type of symptoms as in arteriosclerosis obliterans who had or received the diagnosis of diabetes mellitus at the time of first admission. No attempt was made to differentiate between pathological changes caused by the specific diabetic microangiopathy and of arteriosclerotic changes in the large vessels of these patients, the effect of diabetes mellitus and possible concomitant arteriosclerotic disease was studied as an entity.
- c) *Thrombangitis obliterans*: Includes patients who, at the time of first admission, received the diagnosis of thrombangitis obliterans. The diagnosis was mainly based on clinical criteria including age and sex (young men)

and in some instances supported by angiography or histological examination.

d) *Arterial embolism*: Includes cases with sudden onset of symptoms of arterial occlusion in patients without previous history of symptoms of peripheral arterial insufficiency. All of these patients had a history of cardiac disease such as fibrillation or mitral stenosis, in addition, some had a history of emboli to other organs. Twelve patients in this group also had a history of diabetes mellitus but without previous symptoms of peripheral arterial insufficiency.

Arterial thrombosis was not used as a diagnosis in this study. Cases with a history of chronic peripheral arterial insufficiency with sudden impairment were included in the group of arteriosclerosis obliterans.

DATA REPRESENTATION AND STATISTICAL ANALYSIS¹

Patients who were admitted to hospital because of symptoms of peripheral arterial insufficiency for the first time during the period covered by this study, 1949—1965, are referred to as *first admissions*. When analysing demands on hospital facilities during this period also patients admitted to hospital because of peripheral arterial insufficiency, who already before 1949 had previously been admitted to hospital for the same condition, were included.

The average population of the city for the years 1949—1965 was calculated in the following manner:

Sex-distribution and age-distribution in age-groups of five years were known from census on December 31, 1950, November 1, 1960 and November 1, 1965 and were calculated for men and women separately as follows:

	Dec. 31, 1950	Nov. 1, 1960	Nov. 1, 1965
Men 30—34	a	b	c
Average population of men 30—34	$= \frac{2a + 3b + c}{6}$		

The average frequency of first admissions for each age-group was obtained by dividing the number of first admissions in the group by the calculated average population and expressed as number of cases per 100,000.

The computation of the expected increase of first admissions during the

¹ Statistical adviser was professor Carl-Erik Quensel, Department of Statistics, University of Lund.

For the analysis of the data programming and computer services were provided by the city of Malmö and Data-SAAB, Linköping.

years 1949—1965 because of the changes in number and the shift towards higher ages in the population was made from the known distributions of 1950, 1960 and 1965.

For significance test standard statistical methods have been used, levels of probability of 99 % or better have been referred to as significant.

In order to study what changes have occurred during the 17 years covered by the study the period has been divided into three intervals 1949—1954, 1955—1960 and 1961—1965.

RESULTS

There were 967 first admissions, 550 men and 417 women distributed between the four diagnosis as demonstrated in Table 4.

AGE AND SEX SPECIFIC INCIDENCE

PREVIOUS STUDIES

DRY and HINES (1941), HAIMOVICI (1950), KRAMER and PERILSTEIN (1955 and 1958), SPAULDING (1956), BLOOR (1961), SCHADT et al. (1961), BADDELEY and FULFORD (1965), BUGÁR-MÉZÁROS and BERECHKY (1966), PREUSS et al. (1969) and NIELSEN (1969) used the time of *first onset of symptoms* of peripheral vascular disease in the leg for calculation of age distribution. For the same purpose, SEMPLE (1953), OAKLEY et al. (1956), KAYE et al. (1963), GENSLER et al. (1965) and HAIMOVICI (1967) used the point in time when the patients *first sought medical advice*. The age at which *manifest gangrene* occurred was used by ELIASON and WRIGHT (1926), KRAMER (1932), JOHN (1938), McLAUGHLIN (1943), McLAUGHLIN and WIEDMAN (1950), BÜRGER (1954) and McLAUGHLIN and HEIDER (1955). —SILBERT and HAIMOVICI (1950), SHUMACKER and MOORE (1951), CLAUGUS et al. (1958), WRIGHT (1960), HANSSON (1964), BRADHAM and SMOAK (1965), OTTEMAN and STAHLGREN (1965) and LINDAHL and BOLUND (1969) calculated the age distribution at *amputation* in cases with peripheral arterial occlusion. BELL (1950 and 1957) calculated the age distribution of subjects with gangrene in an *autopsy* material.

The resulting age distributions have differed considerably between the authors depending on the point in the natural history of the disease chosen and the types of vascular disease included. However, also clinical materials which appear to be similar give varying results with regard to age-distribution.

JOHN (1938) surveying the literature found that the average age at the début of diabetic gangrene varied from 51 to 70 years. SCHADT et al. (1961) found that the average age at début of vascular symptoms in diabetics was 52 years and in a mixed group of patients suffering from arteriosclerosis obliterans and diabetes mellitus 56 for men and 61 for women. On the whole, the majority of patients with peripheral arterial disease in

Table 4. First admissions per diagnosis, sex and year.

		Year																		1949--1965
		1949	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65		
Arteriosclerosis obliterans																				
Men	5	5		12	12	12	19	16	18	22	21	31	32	24	22	29	23	308		
Women	2	9		5	6	4	4	9	8	11	12	12	15	12	18	16	11	154		
Diabetes mellitus																				462
Men	6	3	8	8	9	12	3	8	3	10	11	15	12	10	17	14	15	164		
Women	8	13	6	9	16	14	12	12	18	7	11	14	13	17	11	15	13	209		
Thrombangitis obliterans																				373
Men	4	2	2	6	5	3	3	1	1	1		1		2	1	1	1	33		
Women															1			34		
Arterial embolism																				
Men	3		2	4	4	2	1	2	1	5	3	3		2	4	5	4	45		
Women	4	3	2	2		3			4			4	5	8	5	5	8	53		
Total																				98
Men	18	10	17	30	30	29	26	27	23	38	35	50	44	38	44	48	43	550		
Women	14	16	17	16	22	21	16	21	26	22	23	30	33	37	35	36	32	417		
Men+	32	26	34	46	52	50	42	48	49	60	58	80	77	75	79	84	75	967		
Women																				

the lower limbs which have been presented in the literature are in the sixth to the ninth decades, except for thrombangitis obliterans, where the onset of the disease usually takes place in the third, fourth and fifth decades of life.

DRY and HINES (1941) claimed that patients with diabetes and vascular symptoms were on the average 10 years younger than patients with arteriosclerosis and that men usually had their symptoms 10 years earlier in life than women. SHUMACKER and MOORE (1951) found in a group of patients amputated because of vascular disease an average age for arteriosclerotic patients of 71 years, for diabetic patients of 64 years and for patients with thrombangitis obliterans of 41 years. ELIASON and WRIGHT (1926) found in a series of arteriosclerotics an average age of 64 for men and 69 for women, in diabetics 61 for men and 57 for women. GENSLER et al. (1965) as well as HAIMOVICI (1967) could not demonstrate any difference in age between men and women and their diabetic patients were even somewhat older than the patients with arteriosclerosis obliterans. HANSSON (1964) found that the median ages at the time of amputation for diabetics and for patients with arteriosclerotic obliterans were 69 and 72, respectively.

PRESENT STUDY

The distribution of age at first admission is demonstrated in Table 5.

Table 5. *Age distribution at first admission.*

Age	Arteriosclerosis obliterans		Diabetes mellitus		Thrombangitis obliterans		Arterial embolism	
	Men	Women	Men	Women	Men	Women	Men	Women
15—19								
20—24								
25—29	1		1	1	1			
30—34	1				3		1	
35—39	1			1	7			
40—44	4			1	4		1	1
45—49	12	2	3	1	3	1	2	4
50—54	18	2	7	4	5		1	1
55—59	32	4	14	14	7		3	3
60—64	44	11	28	32	1		5	5
65—69	53	10	33	44	1		7	7
70—74	44	23	33	51	1		11	4
75—79	35	39	29	34			7	8
80—84	38	33	10	22			6	11
85—89	22	21	4	4			1	7
90—94	3	6	2					2
95—99		3						
Total	308	154	164	209	33	1	45	53

Table 6. Age at first admission (Average $\pm$ SD).

		1949—1954	1955—1960	1961—1965	1949—1965
Arteriosclerosis obliterans	Men	69 $\pm$ 11	67 $\pm$ 12	68 $\pm$ 12	68 $\pm$ 12
	Women	73 $\pm$ 9	75 $\pm$ 9	79 $\pm$ 10	76 $\pm$ 10
Diabetes mellitus	Men	67 $\pm$ 8	70 $\pm$ 8	67 $\pm$ 11	68 $\pm$ 10
	Women	68 $\pm$ 8	68 $\pm$ 10	71 $\pm$ 7	69 $\pm$ 9
Thrombangitis obliterans	Men	47 $\pm$ 12	50 $\pm$ 10	39 $\pm$ 3	47 $\pm$ 11
	Women	—	—	—	—
Arterial embolism	Men	64 $\pm$ 13	66 $\pm$ 10	74 $\pm$ 10	68 $\pm$ 12
	Women	63 $\pm$ 10	70 $\pm$ 13	76 $\pm$ 9	72 $\pm$ 13

In the present study women with arteriosclerosis obliterans were on the average eight years older than men with the same disease. The difference was significant (Table 6). In cases with diabetes mellitus and in cases with arterial embolism there was no significant difference between the sexes.

Women with arteriosclerosis obliterans were on the average seven years older than women with diabetes mellitus, the difference was significant.

Over the 17 years covered by the study there was no significant change in age at the time of the first admission in men with arteriosclerosis obliterans. Women with this disease were significantly older during the later part

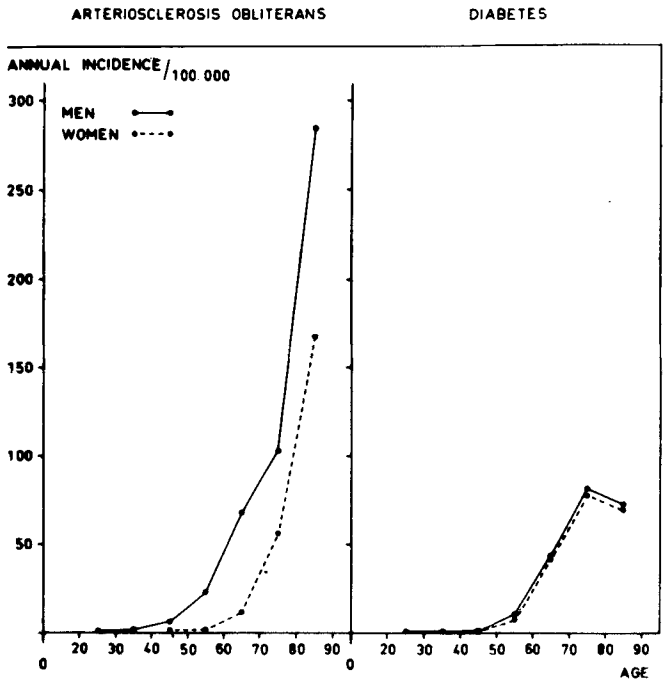


Fig. 1
Age and sex specific incidence of arteriosclerosis obliterans and diabetes mellitus admitted because of peripheral arterial insufficiency in the legs.

THROMBANGITIS OBLITERANS

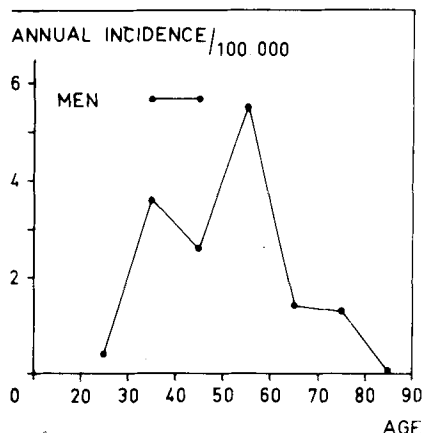


Fig. 2
Age and sex specific incidence of thrombangitis obliterans.

ARTERIAL EMBOLISM

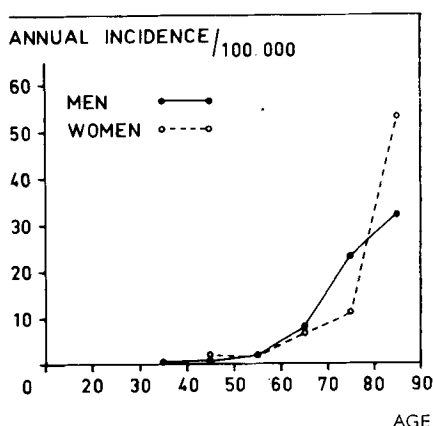


Fig. 3
Age and sex specific incidence of arterial embolism.

of the period. In diabetes mellitus some border-line significant fluctuations were observed but no consistent tendency.

Cases with arterial embolism were significantly older in the later part of the period, men as well as women.

For arteriosclerosis obliterans there was an increasing incidence throughout life in both sexes, the raise in incidence occurred about 10 years later in life in women as compared to men (Figure 1). In the diabetics there was no sex difference and the incidence did not increase further after the eighth decade.

The data on the incidence of thrombangitis obliterans and arterial embolism (Figures 2 and 3) do not permit comparison between groups or sexes. However, the deviation in the incidence pattern of thrombangitis obliterans is obvious.

These data have been calculated and presented without regard to possible changes over the years. As demonstrated below there have been considerable changes in the incidence of peripheral arterial insufficiency.

In Figures 4—10 the observed numbers per year, sex and diagnosis have been presented graphically and related to the change expected from changes in the population. It was found that in men with arteriosclerosis obliterans the observed numbers increased over the years considerably more than could be predicted from the expected values. The same, although to a less degree, was found in arteriosclerotic women. In diabetes mellitus

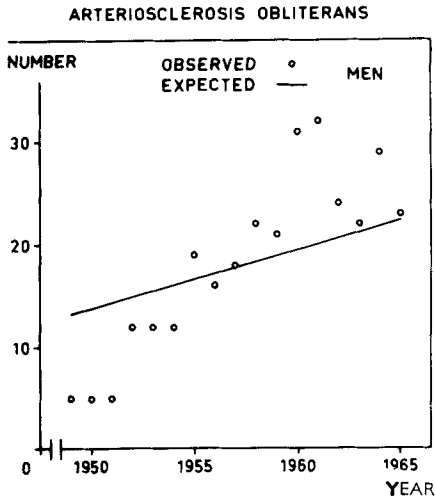


Fig. 4
Comparison between expected and observed numbers of cases of men with arteriosclerosis obliterans.

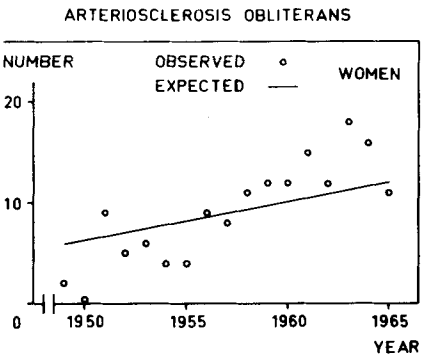


Fig. 5
Comparison between expected and observed numbers of cases of women with arteriosclerosis obliterans.

a similar tendency was found for men but considerably less than in arterio-sclerosis obliterans. In diabetic women the observed number agreed with the expected. Thrombangitis obliterans became a less common diagnosis over the years. The observed rate of men with arterial embolism agreed with the expected number, in women the observed number seemed to increase somewhat above the expected.

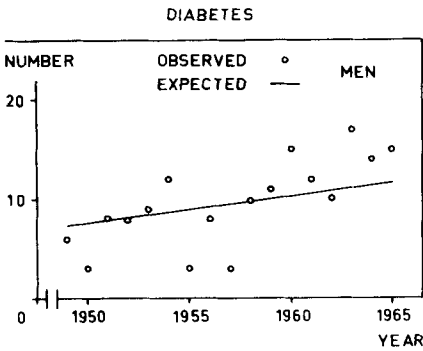


Fig. 6
Comparison between expected and observed numbers of cases of men with diabetes mellitus.

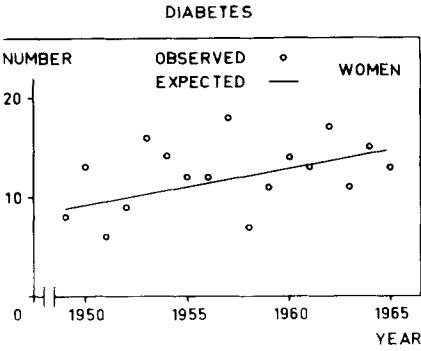


Fig. 7
Comparison between expected and observed numbers of cases of women with diabetes mellitus.

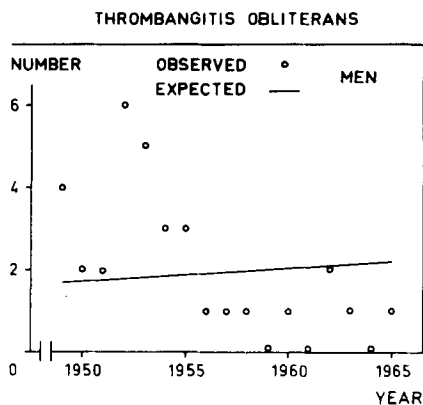


Fig. 8
Comparison between expected and observed numbers of cases of men with thrombangitis obliterans.

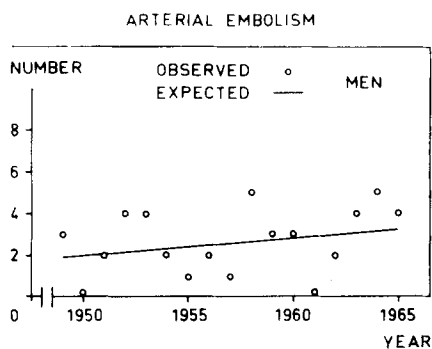


Fig. 9
Comparison between expected and observed numbers of cases of men with arterial embolism.

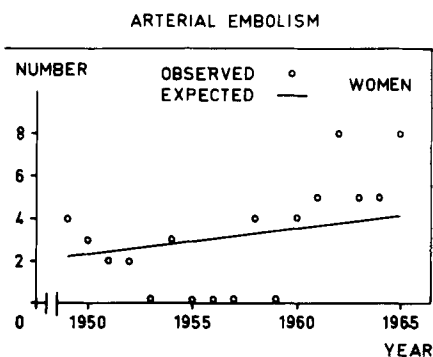


Fig. 10
Comparison between expected and observed numbers of cases of women with arterial embolism.

COMMENT

Peripheral arterial insufficiency has increased in rate in the city and the increase exceeds the increase expected from changes in the population. The increase was most marked although not entirely confined to arteriosclerosis obliterans so that this disease has become the most common in the group, although diabetes mellitus previously has been considered to be, and—during the early part of this study was—the most important condition causing arterial disease in the legs.

During the time of this investigation ENOS et al. (1953) demonstrated

that arteriosclerosis occurred in men as young as 20 years of age. Some of the young patients with the diagnosis of thrombangitis obliterans during the first years of this investigation may thus have been young arteriosclerotics. The changes in age and incidence over the years for these patients seem to support this hypothesis.

LEFT—RIGHT VARIATION

PREVIOUS STUDIES

The pathological changes in these conditions usually are bilateral, even if signs or symptoms of the disease usually become obvious in one limb before the other.

HASSE (1959) found in a series of 1,406 men with claudication onset of symptoms on the left side in 44 %, on the right side in 38 % and bilateral in 18 %, there being no marked side difference. Nor could the same author find any left or right preponderance for arterial occlusion or for the first sign of gangrene.

KRAUTWALD and VÖLPEL (1959) presented 722 patients with various symptoms of arterial insufficiency in the legs, nine per cent of whom were women. There were symptoms from altogether 1,166 legs, 595 left legs and 561 right legs. The difference was not significant.

KAYE et al. (1963) found in a series of arteriographies of 269 patients with arterial insufficiency no side difference neither with regard to occlusion nor to atheromatos lesions.

ELIASON and WRIGHT (1926) found in 100 cases of gangrene of the legs in arteriosclerotic and diabetic patients right side affection in 46, left side in 45 and bilateral in three.

WESSLER et al. (1958) found in 75 patients with 69 episodes of arterial embolism in the legs 45 left-sided and 28 right-sided affections, eight were located in the bifurcation.

PRESENT STUDY

In 957 first admissions in the present study the left—right localization was clearly stated. There were 365 cases right-sided, 398 left-sided and 194 bilateral cases (Table 7). There were no significant differences between sexes, between the four diagnostic groups or in the total material.

COMMENT

It should be noticed that in the majority of the data presented in medical literature as well as in the present study there is a slight but usually not

Table 7. *Left—right localization at the first admission.*

	Right	Left	Bilateral	Total	Unknown
Arteriosclerosis obliterans					
Men	101	125	81	307	1
Women	58	60	31	149	5
Total	159	185	112	456	6
Diabetes mellitus					
Men	69	60	34	163	1
Women	93	89	26	208	1
Total	162	149	60	371	2
Thrombangitis obliterans					
Men	10	11	12	33	
Women	0	0	1	1	
Total	10	11	13	34	
Arterial embolism					
Men	18	20	6	44	1
Women	16	33	3	52	1
Total	34	53	9	96	2
Total	365	398	194	957	10

significant preponderance for left-side affection. These independent observations taken together probably indicate a true preponderance for left-side onset in these conditions.

INVOLVEMENT OF THE CONTRA-LATERAL LIMB

PREVIOUS STUDIES

HASSE (1959) found a bilateral onset of claudication in 18 % of his cases, within one year 61 % had bilateral claudication, within two years 76 % and within five years 92 %.

In an autopsy material BELL (1957) found bilateral cases in 21 % with arteriosclerotic gangrene and in 26 % with diabetic gangrene. In bilaterally amputated cases the interval between the amputations had varied between one month and seven years. CARNEY and GOLDOWSKY (1957) found that the average interval between amputations because of gangrene was 1.5 years. OTTEMAN and STAHLGREN (1965) found the same interval to be on the average 2.5 years.

BADDELEY and FULFORD (1965) found that one fifth of unilaterally amputated diabetics within three years had been amputated on the contralateral leg.

RUSSEK (1966) found the average interval between the two amputations in bilaterally amputated diabetics to be 21 months.

Table 8. *Accumulated risk of contralateral involvement.*

(Per cent of the series. Cases with less than five years follow-up are included only in the calculation of the frequency of bilateral involvement).

	At 1st admission	Within 1 year	Within 3 years	Within 5 years	Within 5 + years
Arteriosclerosis obliterans	24	29	37	40	42
Diabetes mellitus	16	24	43	47	53
Thrombangitis obliterans	38	50	63	63	67
Arterial embolism	9	16	26	29	29

SILBERT (1952) found that 30 % of amputated diabetics who had survived for more than three years also had been amputated on the contralateral side, after five years the percentage was 51.

MAZET et al. (1963) found that following unilateral amputation because of diabetic gangrene the patient had a 10 % chance of losing the other leg within one year, a 20 % chance of losing it within two years and a 40 % chance of losing it within five years, providing he survived.

WHITEHOUSE et al. (1968) claimed that: "A diabetic amputee will probably lose his life before he loses his second leg."

PRESENT STUDY

Bilateral involvement causing the first admission was about 50 % more common in cases with arteriosclerosis obliterans than in those with diabetes. The difference was significant (Table 8). From that point on the majority of admissions because of symptoms from the contralateral leg occurred within the first three years. Totally, bilateral involvement was significantly more common in the diabetics.

Of the 967 patients included in this study 414 were admitted at least once because of symptoms from the contralateral leg. It should, however, be noted that the follow up time for the later cases of the series is short.

COMMENT

The difference between arteriosclerosis obliterans and diabetes mellitus with respect to the development of peripheral arterial insufficiency in the contralateral leg demonstrated in Table 8 is probably, except for the difference in bilaterality at the first admission, caused by the shorter life expectancy in the arteriosclerotics (Figures 17 and 18, p. 38).

SEASONAL VARIATION

PREVIOUS STUDIES

Seasonal variation of peripheral arterial insufficiency has been investigated only for diabetics. GAMBLE and TAYLOR (1969) found that the incidence of début of diabetes requiring insulin increased in the fall. MORRISON (1916) found that diabetics more frequently died in the winter and this, the author felt, was related to the totally increased general death rate in the winter.

JOSLIN (1934) found that diabetics usually died in the winter and in the spring and commented: "It is very easy to understand why gangrene is more common in the winter because the circulation is less good and with cold feet sensation decreases and patients are more liable to burns and frost bites. Furthermore, the feet are much less frequently bathed in the winter than in the summer, in the class of patients from which gangrene is largely recruited."

PRESENT STUDIES

The 967 patients were over the 17 years admitted altogether 2,055 times because of their vascular disease. These admissions were distributed over the seasons as demonstrated in Figure 11. There was a decreased incidence in the late spring and summer and an increase in the fall. When the material was broken down in subsets, the same pattern was obvious in men with arteriosclerosis obliterans, the increased incidence in the fall was observed in all of the main groups except for arteriosclerotic women (Figures 12-15). If only first admissions were included the pattern of seasonal variation was similar.

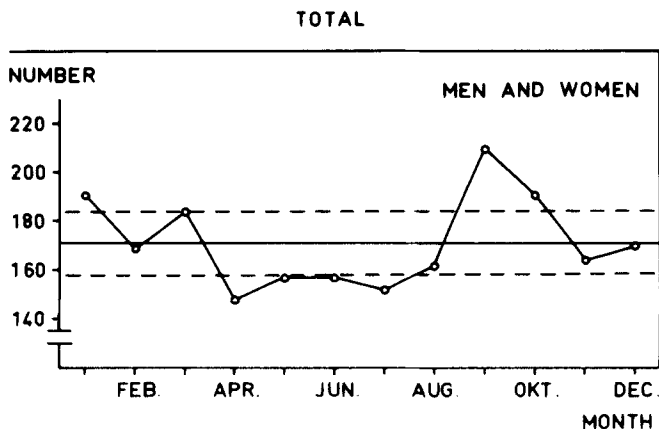


Fig. 11
Seasonal variation
of admissions for
peripheral arterial
insufficiency.

ARTERIOSCLEROSIS OBLITERANS

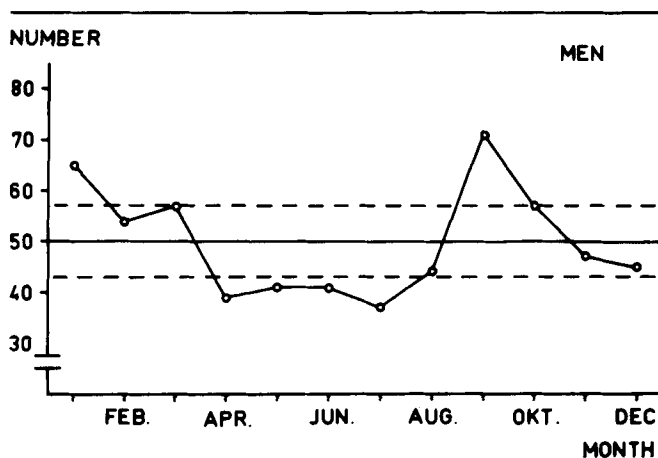


Fig. 12
Seasonal variation
of admissions for
men with arterio-
sclerosis obliterans.

ARTERIOSCLEROSIS OBLITERANS

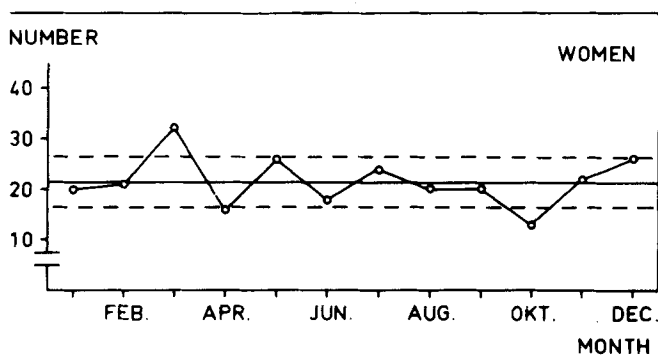


Fig. 13
Seasonal variation
of admissions for
women with arterio-
sclerosis obliterans.

DIABETES

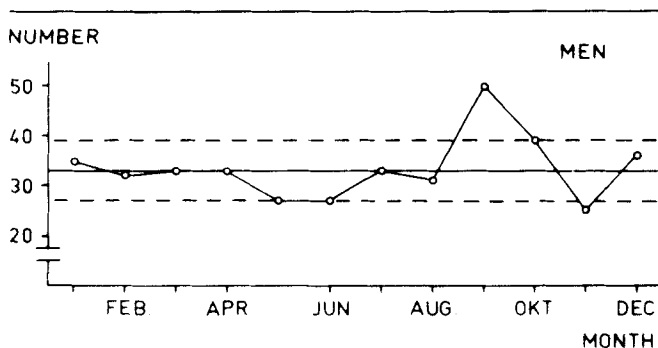


Fig. 14
Seasonal variation
of admissions for
men with diabetes
mellitus.

DIABETES

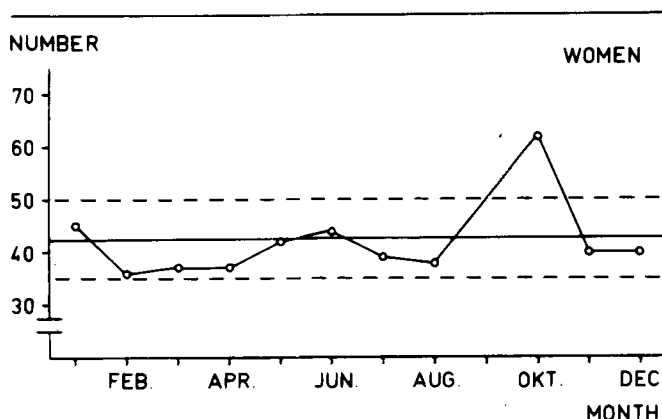


Fig. 15.
Seasonal variation
of admissions for
women with diabetes
mellitus.

COMMENT

There is a tendency of seasonal variation characterized by a decreased incidence in the spring and in the summer. This variation is more pronounced for men and somewhat more in arteriosclerosis obliterans than in diabetes mellitus. However, the variation usually does not reach a level of significance which permits statistical comparisons between the subsets. In thrombangitis obliterans and arterial embolism no pattern of seasonal variation could be distinguished.

The time lag between onset of symptoms or impairment and admission may vary considerably, and therefore the first admission should probably not be regarded as a biological parameter reflecting a true seasonal variation of the disease.

AGE AT DÉBUT OF DIABETES MELLITUS

PREVIOUS STUDIES

Although diabetes may be diagnosed at any age the début in most patients is between 40 and 70. SPIEGELMANN and MARKS (1946), PYKE (1956), BUSCHMANN et al. (1958), SCHLIACK (1959) and JUNG et al. (1968) published somewhat varying figures with respect to the onset of diabetes but all agreed that onset of the disease usually occurred in the middle-aged.

Data derived from authors who have presented their age distribution in age groups are presented in Table 9 and 10.

OAKLEY and COHEN (1954--1955) and GOLDNER (1960) did not find a single case in which the diabetes had originated before the age of 20 among their patients with peripheral vascular disease of the lower limb.

Table 9. *Age at début of diabetes mellitus, per cent of the patients.*

Authors	Observation period	No.	Age at debut of diabetes mellitus							
			0— 9	10— 19	20— 29	30— 39	40— 49	50— 59	60— 69	70— 79 80+
Pavy	<1885	1,352		4	7	17	25	31	13	3 (70+)
Pincus, Joslin & White	1898— 1933	9,853	5	7	8	12	23	27	18 (60+)	
John	1921— 1948	6,000	5	4	6	12	23	27	23 (60+)	
Bell	1910— 1951	1,559	1	4	5	6	15	27	26	13 3
Silwer	1954	1,326	6	8	6	8	13	25	23	9 1
Fitzgerald	1949— 1958	5,441	2	4	5	6	13	26	28	14 1
Hansson	1947— 1956+ 1961	143		1 (<30)		2	11	29	31	20 2 (+4 unknown)
Tibell	1949— 1965	373	1	1	1	4	15	23	34	18 3

Among 3,500 cases of arterial occlusion in the legs DEBAKEY et al. (1964) found only six patients with juvenile diabetes.

PRESENT STUDY

The percentual distribution of age at onset of diabetes in individuals who had their first admission during the years 1949 to 1965 are presented in Table 9 and compared to a series of individuals amputated because of diabetic gangrene (HANSSON 1964) and to data presented by other authors on individuals about whom it is not known whether they had developed vascular complications or not. There was a significant tendency of higher ages in the present series as compared to the other series with one exception, HANSSON (1964), who also dealt with cases of vascular complications in the lower limbs. In Table 10 the data of the present study are compared with respect to age distribution within the sexes and to similar data in diabetics without known vascular complication. The differences between the sexes in age at onset of diabetes were not consistent. In the present study the women had been significantly older at the time of onset of diabetes than had the men (Table 11). There was no change in this respect between the three periods of the study.

Table 10. *Age at début of diabetes mellitus in men and women, per cent of the patients.*

Authors	Observation period	No.	Sex	Age at début of diabetes mellitus								
				0—9	10—19	20—29	30—39	40—49	50—59	60—69	70—79	80+
Pavy	<1885	963	Men		4	7	16	27	29	14	3	
											(70+)	
		389	Women		6	7	18	20	35	11	2	
											(70+)	
Pincus, Joslin & White	1898—1933	4,639	Men	5	7	10	14	23	24	14	3	
											(70+)	
		5,214	Women	4	6	6	11	23	30	16	3	
											(70+)	
Blumberg & Zisserman	1930—	52	Men	(<20:)	2	0	4	15	21	27	15	4 (12 unknown)
	1938	103	Women	(<20:)	2	4	11	13	36	27	2	0 (6 unknown)
Blumberg & Zisserman	1939—1950	80	Men	(<20:)	3	3	5	15	21	19	18	1 (16 unknown)
		167	Women	(<20:)	2	0	5	18	29	25	7	2 (13 unknown)
Silwer	1954	598	Men	7	10	8	12	15	21	18	9	1
		728	Women	5	6	5	5	12	29	28	10	1
Fitzgerald	1949—	2,181	Men	3	5	7	9	16	24	23	11	1
	1958	3,260	Women	1	3	3	4	11	28	32	16	1
Tibell	1949—	164	Men	0	1	2	7	17	26	30	15	2 (1 unknown)
	1965	209	Women	1	1	1	2	13	20	37	21	4 (1 unknown)

COMMENT

The study of Hansson and the present study differ from the other studies with respect to the proportion of patients with début of diabetes mellitus before the age of 40. The former studies include only amputated patients and patients admitted to hospital because of symptoms of peripheral arterial insufficiency, the latter are based on diabetics without special reference to peripheral vascular disease. The difference is due to the small number of juvenile diabetics among cases with peripheral vascular complica-

Table 11. *Age at onset of diabetes mellitus (Average $\pm$ SD).*

	1949—1954	1955—1960	1961—1965	1949—1965
Men	55 $\pm$ 11	56 $\pm$ 13	56 $\pm$ 14	55 $\pm$ 13
Women	59 $\pm$ 12	58 $\pm$ 14	60 $\pm$ 11	59 $\pm$ 13

tion. In the series of Hansson and in the present series 82 and 78 per cent of the patients, respectively, were over 50 at the début of diabetes mellitus as compared to 58 % in the series of Silwer.

TIME-LAG BETWEEN THE DIAGNOSIS OF DIABETES MELLITUS AND FIRST ADMISSION FOR PERIPHERAL ARTERIAL INSUFFICIENCY

PREVIOUS STUDIES

CONWAY and MEIGHER (1942) found an average interval of eight years between the début of diabetes and the first signs of vascular foot lesion and in 20 % of the cases the diabetes was not diagnosed prior to the occurrence of vascular symptoms. BLOCK and WHITEHOUSE (1963) calculated the same variable to be 12,5 years, BRYFOGLE and BRADLEY (1957) to 14 years and HANSSON (1964) to nine years. Authors who have presented the time intervals as distributions are referred to in Table 12.

BADDELEY and FULFORD (1965) found in a series of amputated diabetics that in 39 % the diagnosis of diabetes had been made one year or less before the operation. BARTELS and RULLO (1958) found in patients with symptoms of peripheral arterial insufficiency without previously known diabetes that only 23 % had completely normal glucose-tolerance tests and 20 % were diabetics. JOSLIN (1934) found that patients with diabetes who died with gangrene in the lower limb on the average had had their diabetes for 10 years.

PRESENT STUDY

In the present study the average interval between the début of diabetes and the first admission was 9,6 years, 10,7 for men and 8,7 for women, significantly shorter for women. The time variable was skewedly distributed and is presented in Figure 16. Table 12 presents a comparison between the present series and previous studies in this respect. In 20 % of the cases in the present series the diagnosis of diabetes had not been made prior to the first admission which is one of the highest fractions observed.

COMMENT

The sampling process is not uniformly defined in the studies listed in Table 12 but include various stages of arterial insufficiency. VISKUM (1969) dealt with cases of manifest gangrene. GOLDNER et al. (1959) and HANSSON (1964) described amputated diabetics. Only in the present study the first admission because of peripheral arterial insufficiency was used to

Table 12. *Time-lag between the diagnosis of diabetes mellitus and severe symptoms of peripheral vascular insufficiency.*
(Per cent of patients, the bars indicate the time intervals used by the authors).

Authors	Observation period	No.	Years													Unknown
			0	1	2	3	4	5	10	15	20	25	30	>30		
McLaughlin & Heider	1932—1953	135	13	10	9	16		21			32				0	
	1942—1956	859	15	12		37		19	8	6		3			0	
Perilstein Root & al.	1954	502	8			18			38		30		2		4	
	1950—1953	146		14		18		20	17	18		14			0	
Scheibe & Gallenkamp	1952—1965	66	14			21		9	18	6		18			14	
	1961—1967	157		21		17			28			34			0	
Goldner & al.	1957—1958	71	17			23		24	17		13		3		4	
	1947—1956 +1961	143		11		31		15	17	12		10			4	
Tibell	1949—1965	373	20	0	3	5	6	3	19	17	12	7	4	2	1	

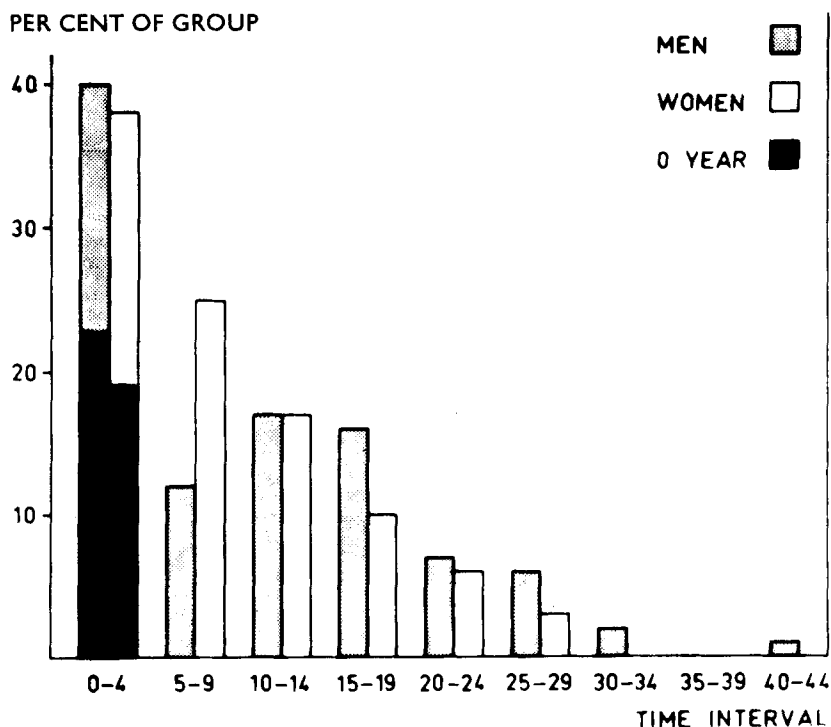


Fig. 16

Time interval between the diagnosis of diabetes mellitus and the first admission for peripheral arterial insufficiency, men and women separately, per cent of group. 0 YEAR means that the diagnosis of diabetes was unknown prior to the first admission.

terminate the time lag. The patients of this series have all reached the point when their peripheral arterial disease necessitated hospital admission. All of them were not amputated on during the first admission and the attitude to treatment of these patients has been fairly conservative and similar to that in the series of Viskum. In this and the present study there were 20 % cases of undiagnosed diabetes. Only in two other previous studies, CONWAY and MEIGER (1942) and BADDELEY and FULFORD (1965), similar percentages were noted.

SURVIVAL

PREVIOUS STUDIES

Survival has been calculated from various points in time in the natural history of peripheral arterial disease.

Starting from the *début of symptoms* of peripheral arterial insufficiency SILBERT and ZAZEELA (1958) found that the 10-year survival for diabetics was 62 % and for non-diabetics 89 %, the mortality was particularly increased in diabetics between 40 and 50, while in the same age-group of non-diabetic patients, the survival did not differ from that of the base population.

Using the *first consultation* because of symptoms of peripheral arterial insufficiency HINES and BARKER (1940) found that 45 % survived for three years. BOYD and BLOOR (1959) had a five year survival of 74 %, a 10 year survival of 39 % and 15 year survival of 22 %.

In cases with femuro-popliteal occlusions verified by *angiography* SINGER and ROB (1960) had a five year survival of 84 %. For patients with aorto-iliacal occlusion the figure was 69 %.

Calculated from the *time of the diagnosis* JUERGENS, BARKER and HINES (1960) found that in cases of femuro-arterial occlusion caused by arteriosclerosis obliterans the five year survival was 80 % and the 10 year survival 57 %, for aorto-iliacal occlusion the figures were 73 and 47 respectively.

In *gangrene* HEINE and SCHMIDT (1966) found a survival of 27 % after four and a half years.

FAXON (1939) found in patients with *peripheral arterial insufficiency* a five year survival of 38 % in arteriosclerosis obliterans, 39 % in diabetes mellitus and 85 % in thrombangitis obliterans. MAZET (1967) published the survival rates for diabetics and non-diabetics sampled from several hospitals. Most findings are in agreement with the statement by SKVERSKY and ZISLIS (1970) that "the outlook for longevity of diabetic amputees and non-diabetic amputees is similar."

SILBERT and HAIMOVICI (1950), DALE and CAPPS (1959), ROSENBERG et al. (1970) and THURSBY and DUNN (1970) all described the survival following *amputation* because of peripheral arterial insufficiency with varying results.

McKITTRICK (1940) found 55 % survival after three years in cases with *diabetic gangrene*. After five years the figure was 47 %. SILBERT (1948) compiled the three year survival after femur *amputation* in diabetics from several hospitals to be 40 %. However, later he (SILBERT 1952) found that the figure had increased to 65 %.

Similarly, SMITH (1956), WRIGHT (1960), BLOCK and WHITEHOUSE (1963), BADDELEY and FULFORD (1965), WHITEHOUSE et al. (1968) and VISKUM (1969) have presented survival rates in cases with *diabetic gangrene* within the same order of magnitude as presented above.

WESSLER et al. (1958) in a series of *arterial embolism* found that 21 % died in hospital, and that the three year survival was about 50 %.

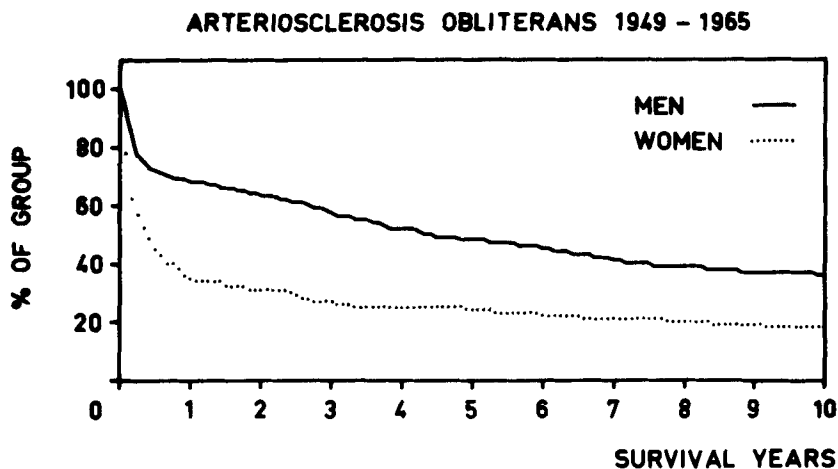


Fig. 17

Survival of men and women with arteriosclerosis obliterans and with first admissions 1949-1965, per cent of group.

PRESENT STUDY

For the purpose of studying survival, all individuals who had their first admission during 1949-1965 were followed up to at least July 31, 1967, the follow-up being complete up to that date.

In arteriosclerosis obliterans there was a considerable difference in survival between the sexes (Figure 17). Three months survival was for men

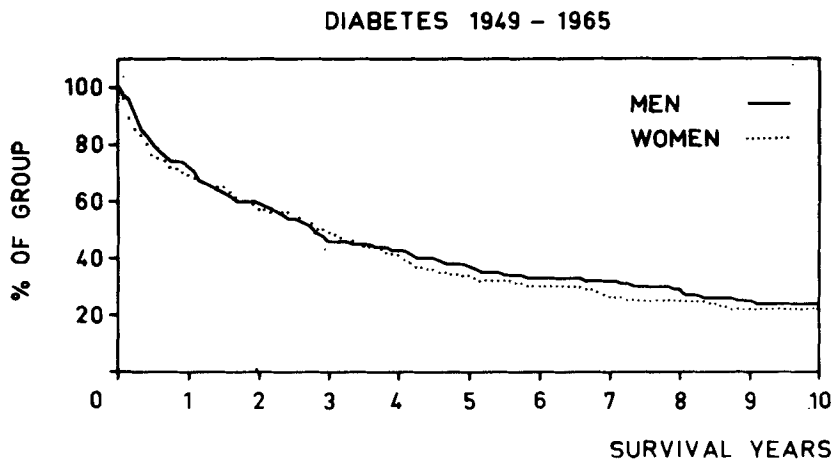


Fig. 18

Survival of men and women with diabetes mellitus and with first admissions 1949-1965, per cent of group.

77 % and for women 57 %, one year survival for men 68 % and for women 45 %, three year survival for men 56 % and for women 27 % and five year survival for men 48 % and for women 24 %.

There was no difference between men and women in cases with diabetes (Figure 18). The survival at three months, one year, three years and five years were for men and for women 90 and 85 %, 73 and 69 %, 47 and 49 % and 37 and 34 %, respectively.

Except for differences between the sexes it can be seen that there were significant differences between diabetes mellitus and arteriosclerosis obliterans. Arteriosclerotic men had a longer survival than had diabetic men, arteriosclerotic women, however, had a shorter survival than had diabetic women.

In thrombangitis obliterans the survival probably did not differ from that of the population by large (Figure 19).

Cases of arterial embolism had a three months survival of only 50 % and the one year survival was the same as for arteriosclerotic women, 45 % (Figure 20). This former group of patients has been established to have a poor life expectancy mainly because of the risk of repeated emboli to other organs. (HAIMOVICI 1950 and WESSLER et al. 1958).

COMMENT

For part of the cases the follow-up time was less than five years. In order to compare possible changes in survival over the years and to study

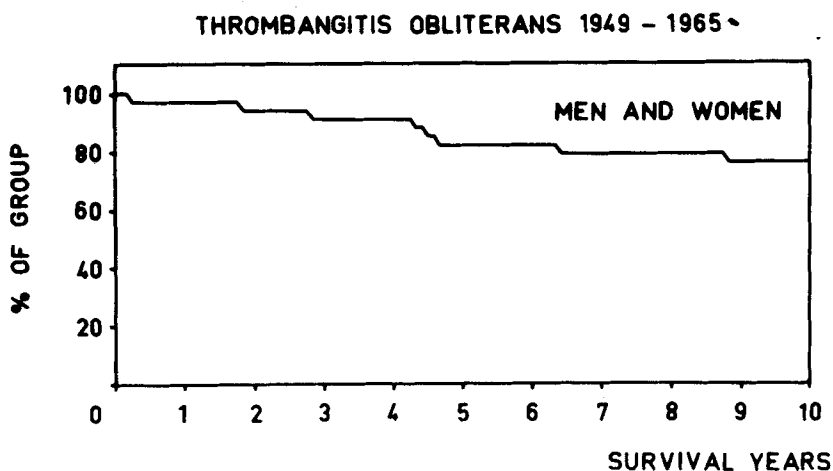


Fig. 19

Survival of patients with thrombangitis obliterans and with first admissions 1949 - 1965, per cent of group.

ARTERIAL EMBOLISM 1949 - 1965

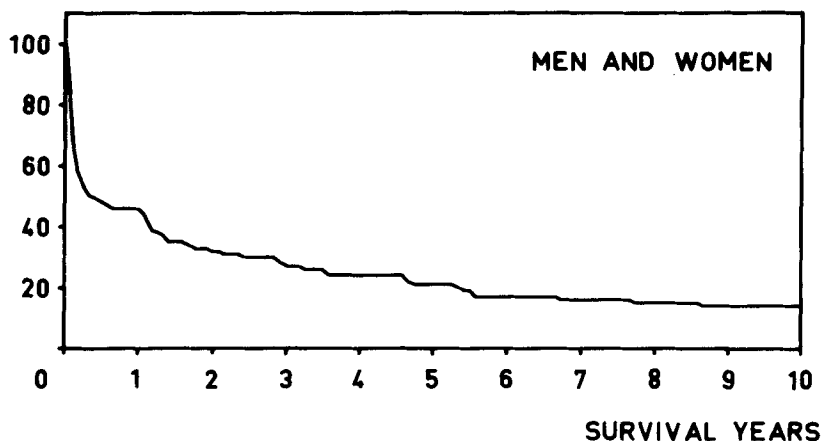


Fig. 20

Survival of patients with arterial embolism and with first admissions 1949—1965, per cent of group.

the influence of the somewhat varying follow-up time the cases of arteriosclerosis obliterans and diabetes mellitus were sub-divided in three groups according to their first admissions: 1949—1954, 1955—1960 and 1961—1965 (Figures 21 and 22). The difference between arteriosclerotics and diabetics was fairly permanent over the years. In the arteriosclerotics the

ARTERIOSCLEROSIS OBLITERANS 1949 - 1965

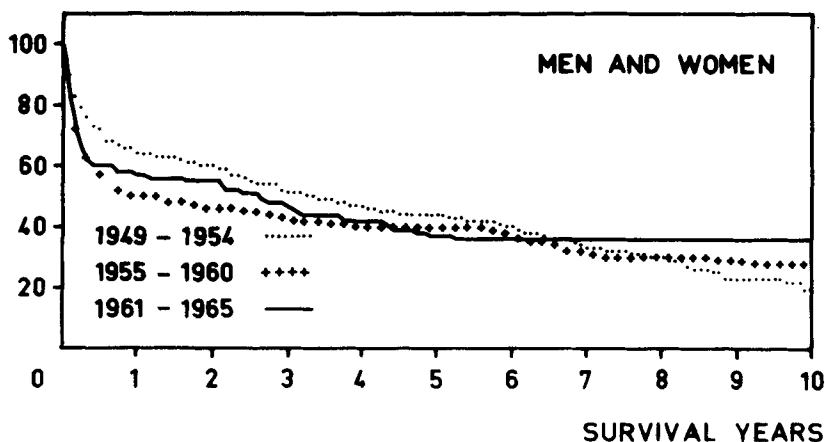


Fig. 21

Survival of patients with arteriosclerosis obliterans and with first admissions 1949—1954, 1955—1960, 1961—1965, per cent of group.

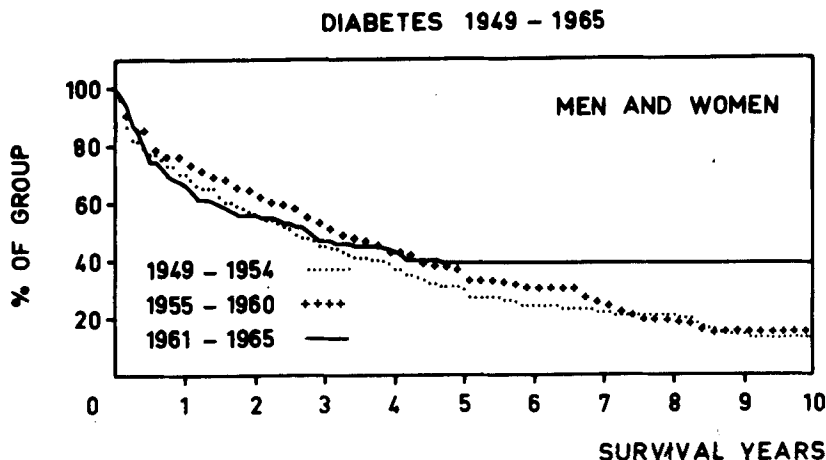


Fig. 22

Survival of patients with diabetes mellitus and with first admissions 1949—1954, 1955—1960, 1961—1965, per cent of group.

death rate in the first months was comparatively high, but from there on the mortality curve flattens out more than in the diabetics. This difference between the diagnoses was most pronounced in women (Figures 17 and 18, p. 34). The short survival of arteriosclerotic women as compared to men is explained by the age-dependent decrease in life expectancy. The women who died within one year after the first admission were five years older than the average age for arteriosclerotic women.

DEMANDS ON HOSPITAL FACILITIES

PREVIOUS STUDIES

The average length of hospital stay for patients admitted because of symptoms of peripheral arterial disease in diabetics or arteriosclerotics has been presented by several authors, ELIASON and WRIGHT (1926), McKITTRICK (1940), McLAUGHLIN and HEIDER (1955), ROOT et al. (1955), CARNEY and GOLDOWSKY (1957), CAINE et al. (1967), WARREN and KIHN (1968). In these studies only one admission is recorded for each patient and the average length of stay varies between 23 and 206 days depending on factors such as the selection of cases, the level of amputation and the rehabilitating resources. CAMERON et al. (1964) in a series of 47 diabetic patients with 67 admissions because of amputation found an average length of stay of 65 days and a total of time spent in hospital after amputa-

tion of 89 days. Sixteen patients who died in hospital after amputation were not included. VISKUM (1969), reviewing a conservatively treated series of diabetic gangrene with an average observation time of 3,8 years found the average length of initial stay in hospital to be 77 days and a total average hospital stay for each patient of 146 days.

There are no studies presented demonstrating the annual or accumulated number of days in hospital for patients with peripheral arterial insufficiency in a defined population at risk. Nor are data available on possible changes with time of the demands on hospital facilities.

PRESENT STUDY

In the calculation of the demands on hospital facilities from patients with peripheral arterial insufficiency all 2,243 admissions over the period were used. This also included 89 patients who had been admitted for the first time before 1949.

For the patients in these complete series the annual demand for hospital days was more than tripled during the time under study (Figure 23). During the same time the population of the city increased by one third.

The changes in different groups were in accordance with changes in incidence.

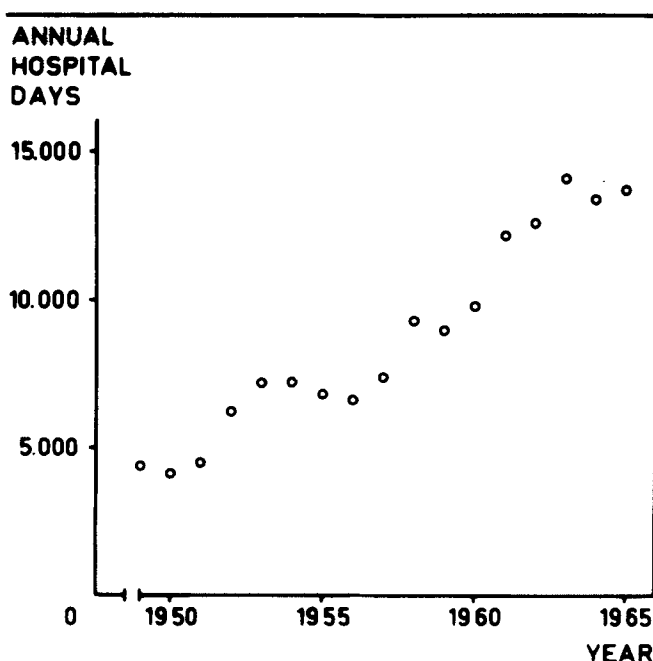


Fig. 23
Days in hospital
required annually
by patients with
peripheral arterial
insufficiency.

Table 13. *Hospital days per admission.*

	Departments of somatic diseases	Department of Chronic Somatic Disease
Arteriosclerosis obliterans		
Men	42	119
Women	50	122
Diabetes mellitus		
Men	55	146
Women	58	141
Thrombangitis obliterans		
Men	33	104
Women	48	—
Arterial embolism		
Men	25	81
Women	37	69

In Table 13 is demonstrated the average time of each hospitalization in days during 1949—1965. Sex, diagnosis and for the departments of somatic disease respectively Chronic Somatic Disease, are presented separately. For each single admission, diabetics were hospitalized longer

Table 14. *Destination at discharge from first admission, per cent of group.*

	Destination				Dead
	Home	Departments of somatic diseases	Home for the aged or convalescent	Departments of Chronic Somatic Disease	
Arteriosclerosis obliterans					
Men	59	15	4	6	16
Women	28	20	1	9	42
Diabetes mellitus					
Men	57	20	2	10	12
Women	52	24	2	7	14
Thrombangitis obliterans					
Men	67	27	3	3	0
Arterial embolism					
Men	33	31	4	2	29
Women	30	25	2	6	38
Total series					
Men	57	19	3	7	15
Women	41	22	2	8	27
Men+Women	50	20	3	7	20

Table 15. *Annual hospital days for patients with peripheral arterial insufficiency in relation to all available and per 100,000 inhabitants.*

Year	Total number	%	Number per 100,000 inhabitants
1949	4,400/645,796	=0,68	2,380
1965	13,750/700,592	=1,96	5,520

than arteriosclerotics or the other groups. Men had shorter admissions in all groups in the somatic departments but not in the chronic somatic departments.

During 1949—1965 totally 960 patients were discharged from their first admission (Table 14). About half of these patients could return to their homes, and in addition a few per cent were discharged to homes for the aged or for convalescents. One fifth were discharged to other somatic departments. About seven per cent were directly transferred to the Department of Chronic Somatic Disease, a rather small number considering the fact that this department becomes the end station for so many of these patients. One fifth of the patients died during the first admission.

There was an obvious sex difference in cases with arteriosclerosis obliterans. Considerably fewer women could return to their homes and more than 40 % died.

COMMENT

The increase in incidence found in the present study may also be put in relation to the total hospital facilities (Table 15). The total requirement of hospital days for patients of this kind was in 1949 0,68 % of the available

Table 16. *Average accumulated number of hospital days per patient.*

	Men	Women
Arteriosclerosis obliterans	104	137
Diabetes mellitus	214	139
Thrombangitis obliterans	103	48
Arterial embolism	63	57

hospital days as compared to 1,96 % in 1965. Again, this points out that the number of patients was tripled and the number of hospital beds available largely unchanged: with an increase in the population 1949—1965 by one third went a 200 % increase of the hospital beds needed by these patients.

To some extent the demands for hospital beds for this category of patients may be related to survival. There was, however, not sufficient change in the rate of survival of these patients to explain the change in the need for hospital beds. Also patients with comparatively short survival rates such as the arteriosclerotic women did not as a group accumulate fewer hospital days over the years than arteriosclerotic men with a better short time survival. Men with diabetes mellitus had a survival very similar to women but accumulated over the years about 50 % more hospital days than the women (Table 16).

DISCUSSION

METHOD

The incidence of gangrene in diabetics and non-diabetics was calculated by BELL (1950) and based on more than 40,000 *autopsy* records covering the years 1920—1947. This study has later been followed up and the same type of data presented for 1948—1955 (BELL 1957).

Also it has been demonstrated that peripheral vascular disease in the legs is becoming an increasingly common cause of *amputation* (ENGSIK-KARUP 1963, LINDHOLM 1964 and HANSSON 1964).

A good portion of these patients were diabetics and the incidence of *peripheral vascular complications in diabetes* has been investigated by RABINOWITZ et al. (1934), DRY and HINES (1941), BÜRGER (1954), McLAUGHLIN and HEIDER (1955), MELLINGHOFF (1955), SCHNEEWEISS and GASSMAN (1955), BUSCHMANN et al. (1958), KRAMER and PERILSTEIN (1958), BUGÁR-MÉSZÁROS and BERECKZY (1966) and LINDAHL and BOLUND (1969).

WIDMER et al. (1964) found *arterial occlusion* in the legs in 11 out of 1,550 women and 64 out of 4,887 men in a study of cardio-vascular disease in 6,400 drug industry employees. The study included only individuals under the age of 65. It was noticed that out of 4,826 men without arterial occlusion not less than 23 % had symptoms such as coldness or paresthesia from the legs, although, out of the 64 men with occlusion 30 % were free of symptoms. Obviously, it is difficult to separate pathological conditions in the peripheral arteries from these occurring with age in a majority of the population. Most of the individuals affected remain free of symptoms. In a fraction of the population there are varying degrees of dysfunction and in some instances arterial occlusion results in gangrene and even death.

For the purpose of the present study *hospital admission* because of severe signs or symptoms of peripheral arterial insufficiency has been the criterion. In the continuum of severity of arterial disease hospital admission is usually indicated at a level of severity when the patient can no longer be managed ambulatorily. At this stage the diagnosis is usually obvious.

Systematic changes in the indications for hospital admission over the years could not be demonstrated. No new therapeutic measures have changed the indications for hospitalization. The attitude towards vascular surgery has been very restricted in Malmö. The number of hospital beds available decreased in relation to the population. The duration of each hospitalization did not increase.

These findings indicate indirectly that no major changes in the attitude towards hospitalization of these cases have taken place.

ASPECTS ON ARTERIOSCLEROSIS

The most prominent finding in the present study was the increase in incidence of arteriosclerosis obliterans in the lower limb in men. In the same population STERNBY (1968) found in autopsies that arteriosclerotic changes were observed earlier in life and also were more common in men than in women. In clinical materials including cases amputated because of arterial insufficiency several investigators (CARNEY and GOLDOWSKY 1957, ALFFRAM and HOLMQUIST 1961, PERLOW 1962, GENSLER et al. 1965, MITTY and ALMEDA 1967, HAIMOVICI 1967) found that the diabetics constituted half or more of their respective cases. In the early years of the present study diabetes was the most important condition in the group of disease causing peripheral vascular insufficiency, but later on, arteriosclerosis became the overwhelmingly most important. In the same population, the city of Malmö, SIEVERS (1963) presented data concerning myocardial infarction. In comparison to arteriosclerosis of the lower limb the incidence of myocardial infarction during an overlapping period of time did not increase appreciably. The two manifestations of arteriosclerotic disease obviously did not develop at the same rate in the population. HENSCHEN (1953) demonstrated that during the Second World War, in Sweden, when the standard of living with regard to food supply was low, the incidence of arteriosclerosis in autopsies decreased. During the time covered by the present study the standard of living, no doubt, improved. This increased standard has except for dietary habits also changed the means of transportation. So have for instance private automobiles become nine times as common. In the meantime the hospital facilities of the city have remained largely unchanged and, in relation to the population, decreased. During the time covered by this study no curative treatment of arteriosclerosis was introduced.

Similar changes are taking place or will take place in other communities

of the world. However, it is not possible to extrapolate from the data of the present study to other types of communities or into the future without great care.

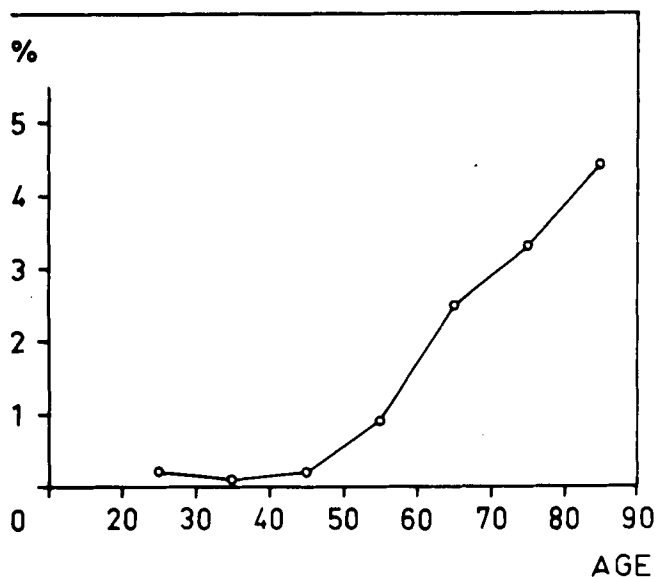
ASPECTS ON DIABETES MELLITUS

Studies on the incidence of diabetes mellitus from different parts of the world and by different authors have yielded varying results. SILWER (1958) found in a survey of 46 studies published between 1916 and 1953 a variation between 0,4 and 43 per thousand. The incidence found by Silwer in an area in the southern part of Sweden was 5,1 per thousand. The Diabetes Survey Working Party (MALINS et al. 1962) found the incidence in England and Wales to be 6,4 per thousand. The same group found that about the same frequency of previously undetected diabetes could be diagnosed in such a survey. REMEIN (1959) surveying 64 similar studies also reported that the incidence of undetected diabetes was about the same as that of known, diagnosed disease. In cases with myocardial infarction SIEVERS (1963) found that in cases which also had diabetes mellitus the latter disease in about 15 % of the cases was undetected prior to the cardiac. In the present study not less than 20 % of the cases were undiagnosed until they had been admitted to hospital because of their vascular symptoms. Values of similar magnitude have been found by other authors (Table 12, p. 31). Against the background of the high incidence of undiagnosed diabetes in the population this number is not surprising. In addition, a stress condition such as myocardial infarction or onset of severe peripheral vascular symptoms may well provoke a latent diabetes in the patient.

The risk of peripheral vascular complication in patients with diabetes has been estimated to be 2—59 % depending on the sampling procedure (CONWAY and MEIGHER 1942, BÜRGER 1954 and KRAMER and PERILSTEIN 1958). RABKIN and FIELD (1962) found that of all diabetic patients admitted to hospital about seven per cent were amputated or subjected to vascular surgery. WHITE (1956) found that out of over one thousand cases of juvenile diabetics who had survived for more than 20 years almost half eventually had developed aortic calcification and that 0,5 % had gangrene. In the present study very few of the cases could be classified as juvenile diabetics.

Data on age and sex specific incidence of diabetes in the city of Malmö are not available. However, SILWER (1958) calculated these data in an area of southern Sweden close to the city (Kristianstad), and there is at the present time no reason to believe that diabetes should have different

Fig. 24
Annual risk for
diabetics to become
admitted to hospital
because of periph-
eral arterial insuffi-
ciency.



patterns in Malmö and other towns in southern Sweden. A projection of the incidence of peripheral vascular complications in the lower limbs on the population of diabetics combining the data of Silwer and the present study demonstrated that for septuagenarians when diabetes was most common so was the incidence of peripheral vascular complications in the legs. However, there was a significant increase of the annual incidence of peripheral vascular complication in diabetics starting in the sixth decade and increasing throughout life (Figure 24). In fact, for octogenarians the annual risk for diabetics of being admitted to hospital because of peripheral vascular insufficiency was four to five per cent.

BELL (1950) found in an autopsy material that gangrene was 40 times more frequent in diabetics as compared to non-diabetics. In the present study the annual incidence of peripheral arterial insufficiency for quinquagenarians was increased by a factor of about 30 in diabetics as compared to the population at risk. For octogenarians the annual risk of peripheral arterial insufficiency in diabetics increases considerably but at the same time the risk of arteriosclerosis in the rest of the population increases even more, so that peripheral arterial insufficiency is only eight times as frequent in diabetics. The data of Bell were obtained before 1950. Since then, as demonstrated in the present study arteriosclerosis as the cause of peripheral arterial insufficiency has become considerably more common which may explain the discrepancy between the two studies.

The true incidence of peripheral vascular complication to diabetes mellitus in the city was increased only in men. KRAMER and PERILSTEIN (1958) claimed that the risk of vascular complication to diabetes increased between 1920 and 1956. The findings of these authors should be seen against the background of the increased risk for diabetic vascular complications with increasing age and the increasing survival of diabetics over the years. In the present study there was no indication that diabetic men should have a longer survival than the women. It may well be that circulatory impairment caused by the microangiopathy of diabetes mellitus remained unchanged over the years while the increased risk for men to have peripheral vascular complications to their diabetes is due to an increased risk of arteriosclerosis in these patients.

ASPECTS ON THROMBANGITIS OBLITERANS

WESSLER et al. (1960) expressed the opinion that thrombangitis obliterans, Buerger's disease, did not exist as a pathological entity. NIELSEN (1969), however, found histo-pathological evidence of thrombangitis obliterans in 28 out of 448 patients with peripheral vascular insufficiency in the legs. MOZES et al. (1970) suggest that young patients with ischemic symptoms from the legs may belong to three groups, one of young arteriosclerotics, one with thrombangitis obliterans and a third with a combination of the two. In the present study it could be demonstrated that the diagnosis of thrombangitis obliterans had been less used in the later part of the period. However, there is no doubt that the diagnosis constitutes a deviating group, as they are almost all men, significantly younger than any other diagnostic group and with a survival that differs from the rest of the material.

ASPECTS ON ARTERIAL EMBOLISM

BELL (1950) found in autopsies arterial embolism in 0,14 %. In cases amputated because of peripheral arterial insufficiency the frequency of arterial embolism has been described to range from 4,5 to 9,8 % (DALE and JACOBS 1962, PERLOW 1962, HANSSON 1964 and LINDHOLM 1964). In the present study the incidence of arterial embolism was no less than 10 %. THOMPSON et al. (1970) claimed that the disease indeed increased not only because of increasing age but also because of improvements in the treatment of patients with cardiac failure. In the present

study, however, it was not possible to demonstrate any significant changes in incidence over the years. On the other hand, the patients were significantly older during the later part of the period covered by this study.

SOCIO-ECONOMIC ASPECTS

McLAUGHLIN (1943), ROOT et al. (1955) and RABKIN and FIELD (1962) presented accounting figures on the costs of hospital care of cases with diabetes and vascular complications. Diabetes was found to be a comparatively expensive disease and particularly so when vascular disease leading to amputation complicated the condition. Also, comparatively many patients needed care in nursing homes or similar institutions after discharge from hospital. In the hospitals involved in the present study the budgeting system does not permit extraction of the cost for separate patients. Basing the calculations on the average daily cost of a hospital bed and changes in the costs of living, it could be demonstrated that, in Malmö, the tripling of the hospital demands by the group of patients described above was associated with an increase of the costs, corrected for changes in the costs of living, in departments for somatic disease by nine times and in departments for chronic somatic disease by eleven times.

Integration into units for the care of cases with peripheral vascular disease, both ambulatory and hospitalized, is probably a requirement for progress in this field. The costs involved are an additional argument for an evolution along these lines.

SUMMARY AND CONCLUSIONS

A retrospective study was carried out on all individuals who had been admitted to hospital in the city of Malmö during the years 1949—1965 because of peripheral arterial insufficiency in their legs. The patients were classified in four main groups according to diagnosis: arteriosclerosis obliterans, diabetes mellitus, thrombangitis obliterans and arterial embolism. During this period 967 cases were admitted to hospital for the first time and from observations on these patients the following conclusions were made:

Women with arteriosclerosis obliterans were on the average eight years older than men and seven years older than men or women with diabetes mellitus. The age at first hospital admission of women with arteriosclerosis obliterans increased during the period covered by the study and this was also demonstrated for patients with arterial embolism.

The incidence of peripheral arterial insufficiency due to arteriosclerosis and diabetes mellitus in men increased over the years, and the increase could only to some extent be explained by changes in age distribution in the population.

Thrombangitis obliterans had been diagnosed less frequently in the later part of the period.

In the present study no preponderance for left or right could be proved. However, if the findings in other studies were taken into consideration it could be suspected that there is a preponderance for the left leg.

Bilateral involvement at the first admission was about 50 % more common in arteriosclerotics than in diabetics.

Most of the hospital admissions because of symptoms from the contralateral side took place within the first three years, and were more frequent in diabetics.

There was a decreased incidence of admission to hospital in late spring and summer with a peak value in the fall, and a true seasonal variation of these conditions could not be ruled out.

Women with arteriosclerosis obliterans had a shorter life expectancy than men with the same disease and died often shortly after the first admission. There was no difference in diabetics in this respect. Arterio-

sclerotic men had a longer survival than diabetic men but arteriosclerotic women had a shorter survival than diabetic women.

Patients with arterial embolism had a poor life expectancy.

Individuals with diabetes and vascular complications in the lower limbs had been older at the time of the diagnosis of diabetes than is usually found in a non-selected material of this disease. Vascular complications to juvenile diabetes were rare.

In 20 % of the cases with diabetes mellitus this diagnosis had not been known prior to the first admission for vascular complication. The average time interval between the diagnosis of diabetes and the first admission was about 10 years and significantly shorter for women.

Altogether 2,243 hospital admissions of 1,056 patients with peripheral arterial insufficiency were used for the calculation of the demand of this group of patients on the hospital facilities in the city.

The men stayed for each admission in hospital somewhat longer than women, i.e. if they were admitted to the somatic departments but not to the Chronic Somatic Department. Patients with diabetes needed longer hospitalization than arteriosclerotics.

When the patients were discharged from their first admission about half could return to their homes and the rest had to use other hospital or nursing facilities except for one fifth who died. Arteriosclerotic women could less frequently than other groups return to their homes and also died more frequently.

The annual hospital days consumed by these patients in the city increased from about 4,000 in 1949 to about 14,000 in 1965. For the four groups the increase was proportionate to the changes in incidence.

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