contrary, the untreated patient may become severely disabled.

It is more difficult to assess the outcome of an operation for a single transient attack, as it is not uncommon for this to be unique in the natural history of the untreated case. This summarizes the results of operating upon what might be called the appropriate artery to a particular "stroke." There is, however, a growing tendency to consider the state of the quartet of arteries to the brain and to regard them not only as supplying blood to their own particular territory but also as contributing to the circle of Willis for general distribution. This concept is the reason for considering a bilateral internal carotid artery disobliteration or an operation contralateral to an inoperable complete block. It also raises the possibility of internal carotid artery surgery to improve oxygenation of the brain-stem.

As yet few operations on the vertebral arteries have been done. There is a steady improvement of surgical technique; by-pass manœuvres, for instance, may replace the need for hypothermia. Until atheroma is curable or, more likely, preventable, surgery may stay as the most certain method of increasing the circulation to the brain.

Summary

The symptoms and signs of 97 patients known to have a lesion of the carotid arteries are analysed.

Details of the investigations and treatment are given. In 61 of the 83 operated upon it was possible to re-establish blood flow in the appropriate artery.

The results of the follow-up examination of all but three of the 72 surviving patients are given.

The following points are briefly made: (1) Atheroma is almost the sole cause of narrowing of the internal carotid artery, which may be partial or complete. (2) The clinical picture varies widely in degree, extent, and duration. These variations bear no constant relationship to the degree of arterial obstruction. The commonest clinical picture is of hemiparesis, which may occur as a single episode or in the form of transient attacks. The addition of contralateral uniocular blindness is almost pathognomonic of insufficiency of the common or internal carotid artery, but is a relatively rare presentation. (3) A complete arterial block is usually associated with a thrombus that has spread intracranially and has adhered to the vessel wall so as to become inoperable. (4) The ideal patient for surgical treatment is one who has suffered from transient and reversible symptoms due to a partial block of an internal carotid artery. In other words, the operation should be regarded as prophylactic and not curative. (5) At present pre-operative arteriography is essential.

There is a growing tendency to study, clinically and arteriographically, all the arteries carrying blood to the brain through the neck irrespective of the presumed site of ischaemia—indeed, to consider improving the blood supply to the circle of Willis rather than to any one part of the brain.

All the operations in this series were done by Professor Charles Rob or by members of the surgical unit at St. Mary's Hospital, London. Our thanks are due to many colleagues who have sent patients from a wide area of the country. One of us (N. G.) wishes to thank the Manchester Regional Hospital Board for a grant of study leave to take part in this work.

REFERENCES

Brain, R. (1957). *Lancet*, **2**, 857.
Eastcott, H. H. G., Pickering, G. W., and Rob, C. G. (1954). Ibid., **2**, 994.
Edwards, C. H., Gordon, N. S., and Rob, C. G. (1960). *Quart. J. Med.*, **29**, 67.
Fairburn, B. (1957). *Brit. med. J.*, **2**, 750.
Gordon, N. (1959). *Brit. J. Ophthal.*, **43**, 257.
Hultguist, G. T. (1942). *Uber Thrombese und Embolie der Arteria Carotis*. Stockholm.
Hunt, J. R. (1914). *Amer. J. med. Sci.*, **147**, 704.
Hutchinson, E. C., and Yates, P. O. (1957). *Lancet*, **1**, 2.
Johnson, H. C., and Walker, A. E. (1951). *J. Neurosurg.*, **8**, 631.
Liversedge, L. A., and Smith, V. H. (1961). *Brain*, **84**, 274.
Lowe, R. D., and Stephens, N. L. (1961). *Lancet*, **1**, 1241.
Rob, C. G., and Wheeler, E. B. (1957). *Brit. med. J.*, **2**, 264.
Symonds, C. P. (1957). In *Modern Trends in Neurology* (2nd ser.), edited by D. Williams. Butterworth, London.

RELATIONSHIP BETWEEN ARTERIAL DISEASE IN DIFFERENT SITES

A STUDY OF THE AORTA AND CORONARY, CAROTID, AND ILIAC ARTERIES

BY

J. R. A. MITCHELL, M.B., B.Sc., M.R.C.P.

AND

C. J. SCHWARTZ,* M.D.

Department of the Regius Professor of Medicine, Radcliffe Infirmary, Oxford

Clinical studies have suggested that patients with arterial disease in one part of the body are likely to show or develop manifestations of disease in other arteries (McDonald, 1953; Richards, 1957; Singer and Rob, 1960; Juergens *et al.*, 1960; Bloor, 1961). This concept of generalized arterial disease has influenced terminology, for patients with cardiac infarction are often described as "atherosclerotic individuals," and studies of patients with infarction or angina pectoris are assumed to be studies of "atherosclerosis" (Report, 1956). Necropsy surveys have, however, suggested that the severity of arterial disease in one site may not correlate with the amount of disease in other arteries (Duguid and Robertson, 1955; Robertson, 1959).

Because of this conflict between the clinical observations and the pathological findings, we have studied the prevalence, severity, distribution, and type of arterial plaques in an unselected necropsy sample and a selected group of patients with myocardial infarction.

Method A

During the first period of the study every tenth patient aged 35 years and over on whom a necropsy was performed at the Radcliffe Infirmary, Oxford, was included in our series, giving an unselected necropsy sample of 137 patients (75 males, 62 females). The age-and-sex distribution of these patients is given in Table I. In this unselected group were 15 patients (11 males, 4 females) with large areas of cardiac necrosis or replacement fibrosis (myocardial infarction—Mitchell and Schwartz, 1962). To obtain more information on the vascular state of such patients we collected a consecutive series of a further 64 patients (46 male, 18 female) with large cardiac lesions. These patients,

*Now at Division of Histopathology, Institute of Medical and Veterinary Science, Adelaide, South Australia.

TABLE I.—*Age-and-sex Distribution of 137 Patients of the Unselected Necropsy Sample in whom Coronary Arteries and Great Vessels were Examined*

Age in Years	No. of Unselected Patients	
	Males	Females
35–54	15	11
55–64	24	19
65–74	20	13
75+	16	19
Total	75	62

together with the 15 from the unselected sample, formed a selected group of 79 patients with large cardiac lesions (myocardial infarcts), and their age-and-sex distribution is presented in Table II.

TABLE II.—*Age-and-sex Distribution of 79 Patients with Myocardial Infarction in whom Coronary Arteries and Great Vessels were Examined*

Age in Years	No. of Patients with Large Cardiac Lesions	
	Males	Females
35–54	9	0
55–64	21	3
65–74	19	8
75+	8	11
Total	57	22

All these patients in the unselected and selected groups were examined in the same way. The intact heart, unopened aorta, and carotid and iliac arteries were removed. The coronary arteries were injected with a barium sulphate–gelatin mass ; the hearts were then fixed in 10% formalin and after fixation serial transverse sections were cut at 4-mm. intervals from the apex to the base. The sections were cleared in methyl salicylate, and the degree of coronary stenosis was assessed under a dissecting microscope, using the grades recommended by the W.H.O. (1958). Arteries lying obliquely in the slices were cut across transversely with a sharp blade: —(*a*) No stenosis: no reduction in the diameter of the lumen. (*b*) Moderate stenosis: some narrowing but more than half the diameter of the original lumen remains. (*c*) Severe stenosis: less than half the diameter of the lumen remains.

Coronary Score.—The maximum grade of stenosis in each of the named coronary arteries (left coronary trunk ; circumflex and marginal ; anterior descending and its two main branches ; right coronary trunk, circumflex, marginal, and posterior descending) was given an arbitrary score: 0=no stenosis, 1=moderate stenosis, and 2=severe stenosis. The scores for the named arterial branches were added together and expressed as a percentage of the maximum possible for that heart. Thus a score of 0 implies that no artery showed any narrowing, and a score of 100 means that each of the named branches had a severe grade of stenosis at some point along its course. These methods are described in detail elsewhere (Schwartz and Mitchell, 1962).

Method B

After the above period of sampling, the aorta and carotid and iliac arteries only were collected from every fifth patient aged 35 years and over on whom a necropsy was performed, and from a further consecutive group of patients with large cardiac lesions. These patients, together with those in whom both heart and vessels had been obtained, formed a combined unselected group of 293 (165 male, 128 female) patients, and a selected group of 116 (82 male, 34 female) patients with large cardiac lesions, from whom the aorta and carotid and iliac arteries had been removed. The age-and-sex distribution of these two groups is given in Table III.

TABLE III.—*Age-and-sex Distribution of 293 Patients of the Unselected Necropsy Sample and 116 Patients with Myocardial Infarction in whom Aorta and Carotid and Iliac Systems were Examined*

Age in Years	No. of Patients			
	Unselected		Large Cardiac Lesions	
	Males	Females	Males	Females
35–54	36	24	12	0
55–64	51	32	31	7
65–74	41	28	25	11
75+	37	44	14	16
Total	165	128	82	34

It should be noted that the unselected necropsy sample will inevitably include some patients with large cardiac lesions (25 of the 165 unselected males and 13 of the 128 unselected females), and these patients are included in both groups for analysis.

In the whole unselected group of 293 patients aged 35 and over the main causes of death were: malignant disease, 67 cases ; disease of the central nervous system (including cerebrovascular disease), 52 cases ; cardiovascular disease, 48 cases ; non-malignant gastrointestinal disease, 33 cases ; respiratory disease, 25 cases ; leukaemia and reticulosis, 19 cases ; pulmonary embolus, 17 cases.

Examination of Aorta and Carotid and Iliac Arteries

The aorta was opened by a longitudinal midline incision along the anterior wall, cut transversely at the level of the upper paired intercostal arteries and at the bifurcation, the segment between these two fixed points being retained for quantitative assessment. The segment was washed in normal saline, fixed in 10% formalin, and stained with Sudan IV. The aorta and its lesions were then traced on waterproof tracing material (" kodatrace "). Four types of plaque were recognized: (1) flat sudanophilic lesions—fatty streaks ; (2) raised non-sudanophilic lesions—fibrous plaques ; (3) raised sudanophilic lesions ; and (4) complicated lesions—plaques showing ulceration, calcification, haemorrhage, or surface thrombosis. The total area of the segment and the area occupied by the different types of lesions was then measured with a rolling wheel planimeter. The details of this method, together with an evaluation of its accuracy, will be described elsewhere.

The carotid arteries were removed to a point 2–3 cm. above the carotid sinus and the iliac arteries were removed *in toto*. These vessels were washed with normal saline, stripped of periadventitial debris, and fixed unopened in 10% formalin. They were then opened longitudinally and the proportion of the surface area of each artery which was affected by plaques, irrespective of their type, was assessed by us jointly, four arbitrary grades being recognized (Schwartz and Mitchell, 1961):—(*a*) Free: no disease. (*b*) Slight: less than 10% of the surface affected. (*c*) Moderate: between 10 and 50% of the surface affected. (*d*) Severe: more than 50% of the surface affected. When we were in doubt about the appropriate grade of disease the lesser of the two possible grades was chosen.

The degree of stenosis was assessed by making multiple transverse sections through affected arterial

segments, and was graded on the same basis as the coronary arteries. The presence and site of plaque ulceration and of arterial occlusion were recorded.

Relationship Between Large Cardiac Lesions and Coronary Stenosis

Fig. 1 compares the coronary scores of men with and without large cardiac lesions within the various age-groups, and shows that large cardiac lesions are associated with a marked degree of coronary stenosis. A similar relationship is found in women (Fig. 2), in

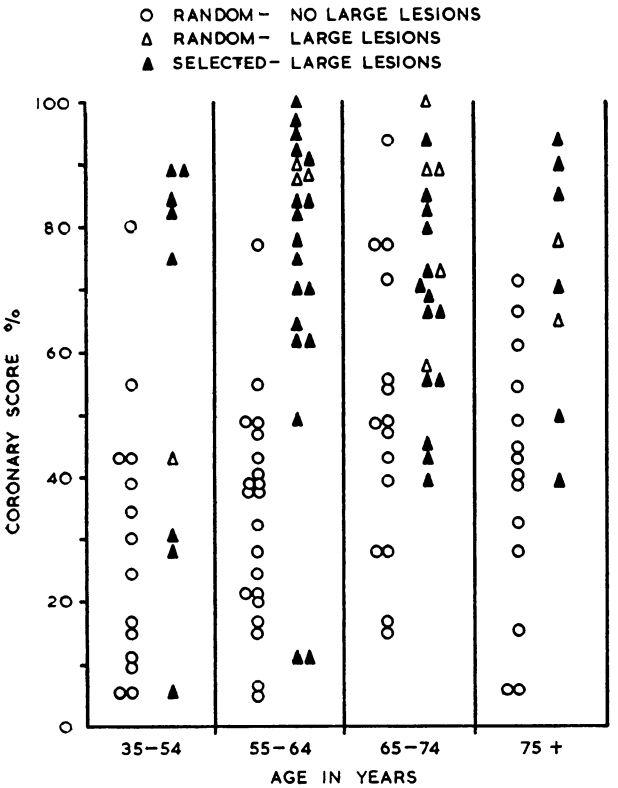

FIG. 1.—Coronary stenosis score in males in the random necropsy sample and in males with myocardial infarction. Patients in the random necropsy sample with myocardial infarction are represented by open triangles.

whom, however, large lesions are much less common at necropsy; when present they occur at older ages than in the men. A group of patients selected on the basis of the presence of large cardiac lesions has therefore more coronary stenosis than patients in the random necropsy sample of comparable age and sex.

Relationship Between Coronary, Carotid, and Iliac Artery Stenosis

Figs. 3 and 4 compare the coronary stenosis scores of individual patients in the unselected series with the grade of stenosis found in their carotid and iliac arteries, and show that in many patients there is a strong correlation between the degree of narrowing in the different sites. The coronary–carotid relationship is present in both age-groups in men and in the older age-group in women, the women aged 35–64 years having relatively low coronary scores and such a low prevalence of carotid stenosis that no clear pattern emerges. There is also a clear relationship between the severity of iliac stenosis and coronary stenosis score in men. This relationship is also seen in women aged 65

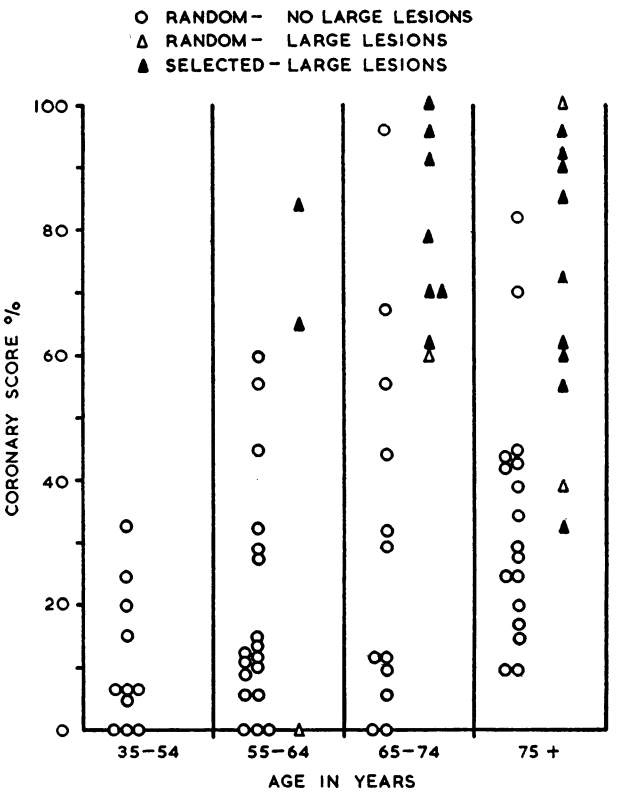

FIG. 2.—Coronary stenosis score in females in the random necropsy sample and in females with myocardial infarction. Patients in the random necropsy sample with myocardial infarction are represented by open triangles.

and over, although they show a much lower prevalence of severe iliac stenosis than men of the same age, and the correlation is therefore less striking. Figs. 3 and 4 show that the pathological process resulting in stenosis does not affect one arterial site alone, and individuals with severe coronary stenosis are also likely to have severe stenosis of their carotid and iliac arteries.

This relationship between coronary, carotid, and iliac stenosis is even more striking when patients with large cardiac lesions and therefore a high prevalence of severe coronary stenosis are considered (Fig. 5). In comparison with the random males (Fig. 3), these patients show a much higher prevalence of carotid and iliac artery stenosis, and severe stenosis of these arteries is most common in those patients with a high coronary score.

Not only is there a relationship between coronary score and the severity of carotid and iliac artery stenosis, but with increasing coronary score there is also an increase in the number of carotid and iliac arteries affected (Figs. 6 and 7). Coronary stenosis score is therefore related to the number of arteries affected by stenosing plaques as well as to the degree of stenosis produced.

Relationship Between Large Cardiac Lesions and Aortic Disease

Table IV shows the mean percentage aortic area affected by the various types of plaques in patients in the unselected necropsy group and in patients with large cardiac lesions. The males in both groups have mean ages which do not differ significantly, but the mean age of females with large cardiac lesions is significantly higher than that of the unselected females,

and this age-difference must be considered when any comparisons are made.

The mean percentage aortic area affected by all four types of plaques together is higher in males with large cardiac lesions (Table IV) than in the unselected group ($P<0.01$). The percentage aortic area affected by complicated plaques also shows a higher mean level in the large-cardiac-lesion group ($P<0.01$). The differences with respect to raised fatty plaques and fibrous plaques are not significant, while fatty streaking affects a smaller percentage of the aortic area in males with large lesions than in the unselected group ($P<0.03$).

The unselected and selected groups of females show similar differences, but owing to the age difference between the groups direct comparison cannot be made.

Relationship Between Large Cardiac Lesions and Aortic Disease Severity According to Age

Table V shows the actual area affected by the various types of plaque in unselected patients and in patients

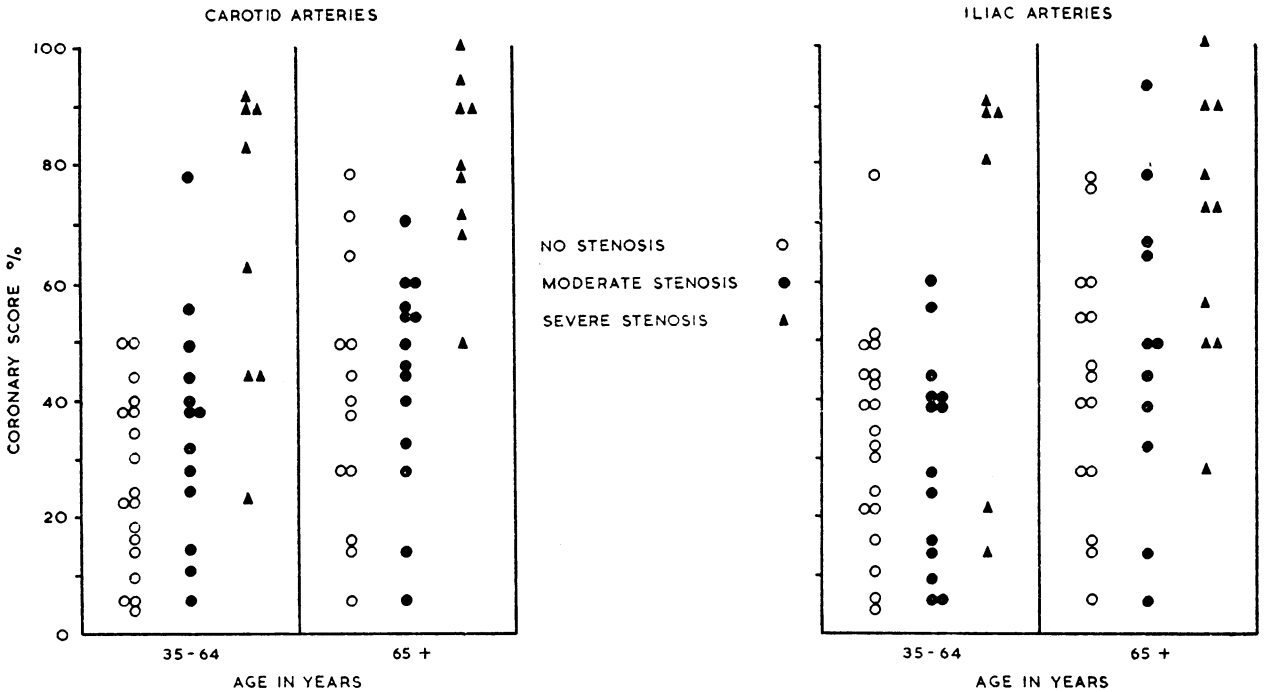

FIG. 3.—Relationship in males in the random necropsy sample between coronary stenosis score and stenosis grade of carotid and iliac systems. Stenosis severity plotted is maximum grade recorded at any point in the following arteries: (*a*) *Carotid system:* innominate and right and left common carotid arteries and carotid sinuses. (*b*) *Iliac system:* right and left common, internal, and external iliac arteries.

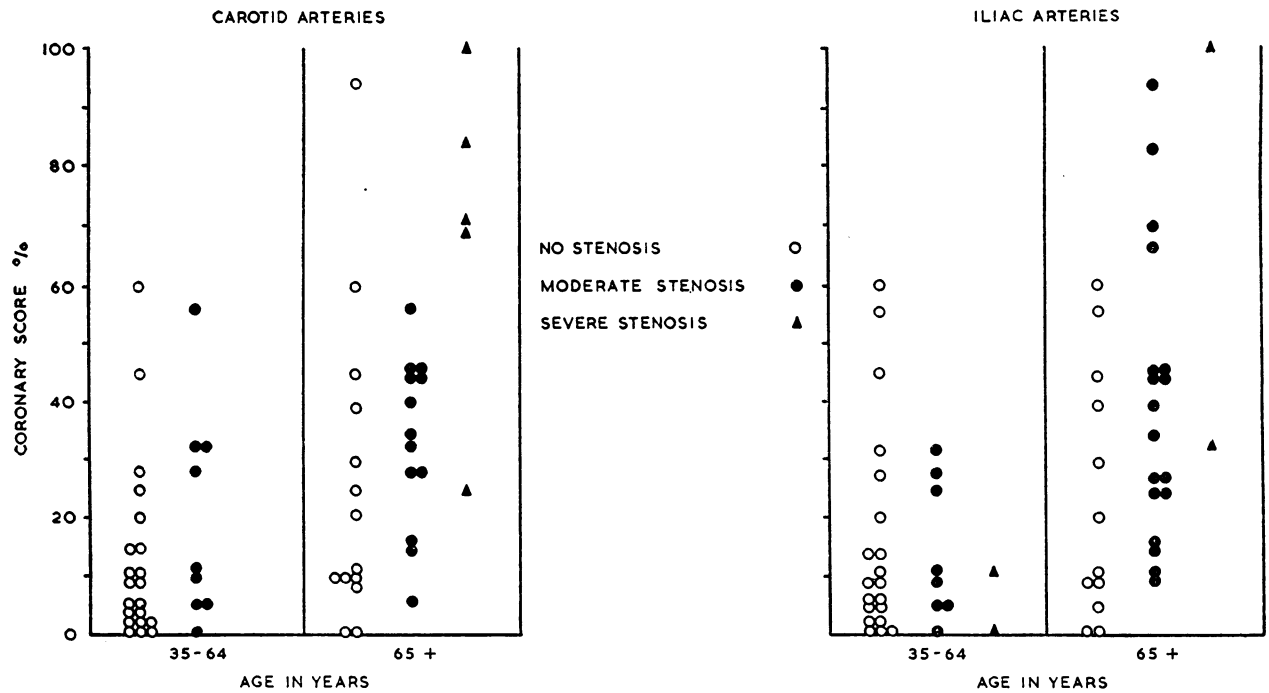

FIG. 4.—Relationship in females in the random necropsy sample between coronary stenosis score and stenosis grade of carotid and iliac systems, on same basis as in Fig. 3.

with large cardiac lesions. In males in the unselected necropsy series the total aortic area affected increases with increasing age, reaching a peak in the age-group 75 years and over. A similar increase with age is found in males with large cardiac lesions, but the peak occurs in the group 65–74 years of age, and at all ages these patients have significantly more aortic disease than the unselected group. This difference is largely due to the marked difference in complicated plaques and to a less extent the raised fatty and fibrous plaques. The area of fatty streaking, on the other hand, remains remarkably constant in the unselected series, but shows a decline with increasing age in the males with large lesions, and thus does not contribute to the greater total aortic involvement in this group. Similar differences are found in the amount of aortic disease in females (Table V), the total area affected being greater at all ages in the selected group of females with large lesions than in the unselected series, and this difference is again largely due to the greater area occupied by complicated plaques. Groups of patients, both male and female, with large cardiac lesions have therefore more aortic disease than patients of an unselected necropsy series of comparable age, and this difference is mainly due to the area occupied by complicated lesions.

Table V shows that aortic area increases with age, and if area is plotted against age for each of the patients studied a linear relationship is seen throughout the age-range. Both men and women show this linear relationship, differing only by virtue of the smaller aortic area in women, and a group of patients between 15 and 34 years of age, to be described elsewhere, show areas which lie on the same regression line. There is no difference in the mean aortic area between patients in the unselected group and those of comparable age and sex with large lesions, although there is a difference

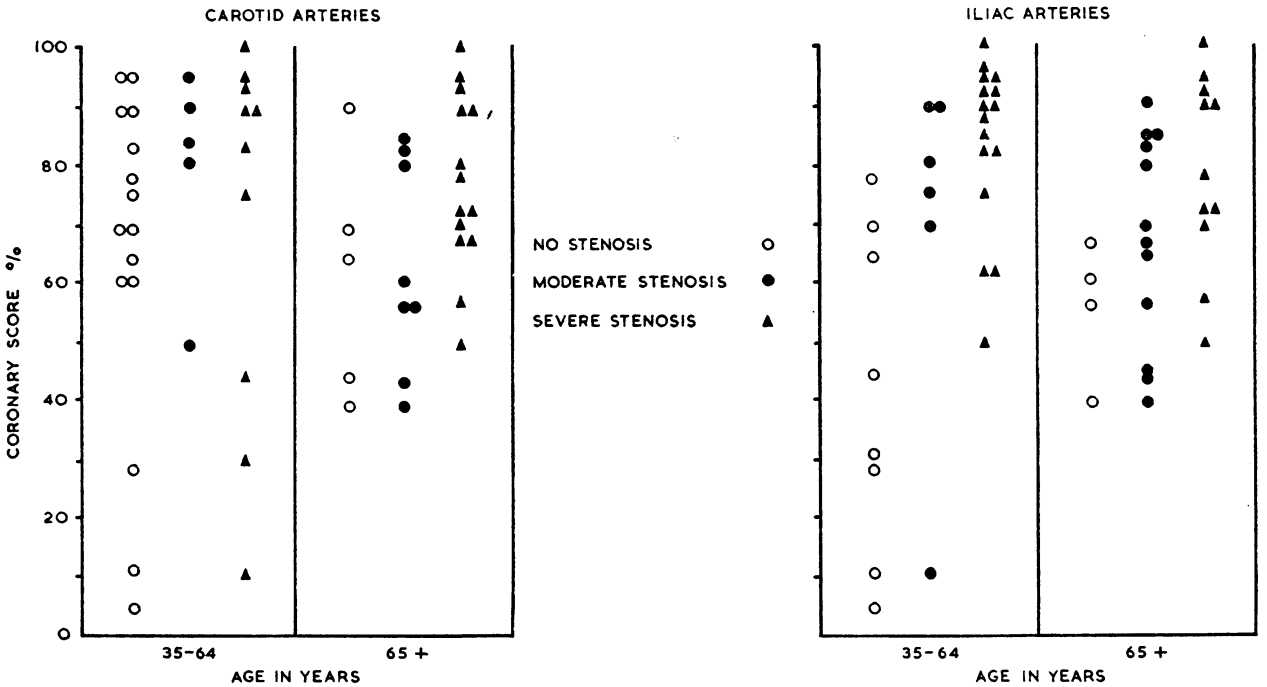

FIG. 5.—Relationship in males with myocardial infarction between coronary stenosis score and stenosis grade of carotid and iliac systems, on same basis as in Fig. 3.

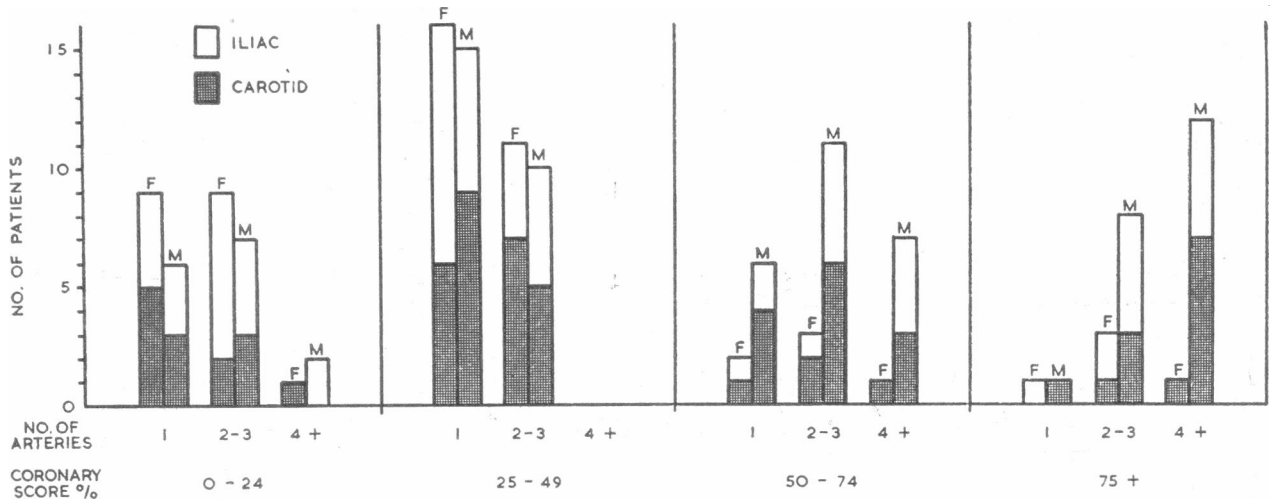

FIG. 6.—Relationship in males and females in the random necropsy sample between coronary stenosis score and number of arteries of carotid and iliac systems showing stenosis of moderate or severe degree. Anatomical extent of these arterial systems is as described for Fig. 3.

between them in the amount of aortic disease. We consider, therefore, that aortic area is not directly related to aortic disease but is an independent ageing phenomenon.

This area change is of importance in assessing the extent of disease and in discussing its evolution. Thus though the actual area of fatty streaking in men in the unselected series is similar throughout the age-range (Table V), because of the increase in aortic size the percentage area involved declines (Table VI). At the present time the majority of studies of aortic disease have used visual grading where the proportion of the aortic area affected is assessed. Comparison of one group with another on this basis can be valid only if the aortic size is similar, and comparison on a percentage basis of men and women, or of patients of differing ages, could give misleading results because of the disparity in aortic size.

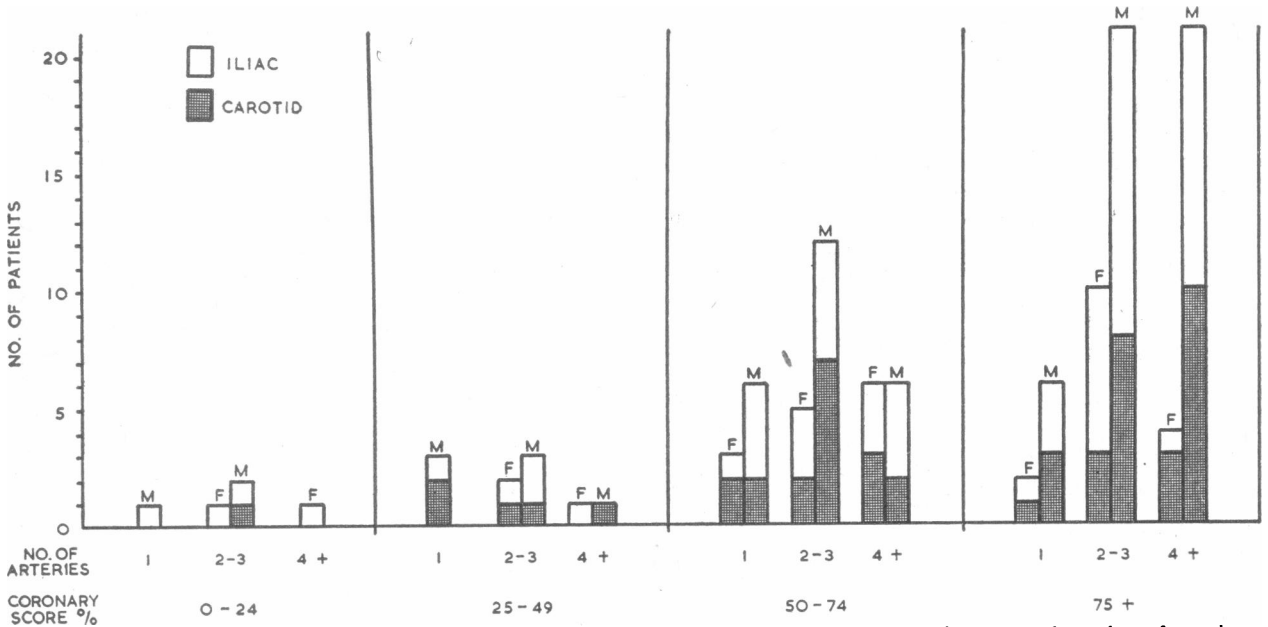

FIG. 7.—Relationship in males and females with myocardial infarction between coronary stenosis score and number of arteries of carotid and iliac systems showing stenosis of moderate or severe degree. Anatomical extent of these arterial systems is as described for Fig. 3.

TABLE IV.—*Age, Aortic Area, and Percentage of Aortic Area Affected by Four Types of Arterial Plaques in Males and Females of the Unselected Necropsy Series, and in Males and Females with Myocardial Infarction. Figures shown are Mean Values and their Standard Errors*

Necropsy Group	Age (Years)	Aorta					
		Area (sq. cm.)	Area Affected (%)				
			Fatty Streaks	Raised Fatty Plaques	Fibrous Plaques	Complicated Lesions	Total
Unselected males ..	63·5 ±0·96	179 ±3·0	11·1 ±0·63	10·8 ±0·56	6·2 ±0·37	12·4 ±1·16	40·5 ±1·4
Males with large cardiac lesions ..	64·3 ±1·2	180 ±4·3	8·4 ±0·56	12·5 ±0·84	7·3 ±0·57	19·5 ±2·11	47·6 ±2·0
Unselected females ..	65·8 ±1·1	151 ±1·7	13·7 ±0·54	9·3 ±0·46	7·0 ±0·34	13·0 ±1·07	43·0 ±0·37
Females with large cardiac lesions ..	72·5 ±1·4	167 ±5·0	12·1 ±1·2	11·9 ±1·4	7·4 ±0·75	31·6 ±3·5	63·0 ±2·6

TABLE V.—*Mean Body Length, Aortic Area, and Actual Area of Aorta Affected by Four Types of Arterial Plaque According to Age in Patients of the Unselected Necropsy Series and in Patients with Myocardial Infarction*

Age (Years)	Unselected Necropsy Series							Patients with Large Cardiac Lesions						
	Body Length (cm.)	Aorta						Body Length (cm.)	Aorta					
		Area (sq. cm.)	Area Affected (sq. cm.)						Area (sq. cm.)	Area Affected (sq. cm.)				
			Fatty Streaks	Raised Fatty Plaques	Fibrous Plaques	Complicated Lesions	Total			Fatty Streaks	Raised Fatty Plaques	Fibrous Plaques	Complicated Lesions	Total
Males														
35–54	179	141	19·8	9·9	5·1	3·5	38·3	180	143	20·5	15·5	5·4	6·9	48·3
55–64	177	166	17·9	19·6	10·1	9·4	57·0	175	168	14·4	23·2	11·3	29·4	78·3
65–74	176	195	17·1	25·3	16·0	38·0	96·4	176	196	12·7	26·7	14·5	56·9	110·8
75+	171	212	19·4	24·3	13·9	43·5	101·1	170	213	13·8	23·1	20·1	53·3	110·3
Females														
35–54	168	113	17·8	3·5	3·4	1·4	26·1	165	146	27·3	25·8	10·7	17·5	81·3
55–64	166	142	23·4	14·9	11·4	7·3	57·0							
65–74	164	161	18·2	17·6	12·5	18·6	66·9	165	166	13·8	17·4	13·1	57·5	101·8
75+	162	172	18·9	18·0	13·9	44·5	95·3	160	169	18·8	16·2	12·7	56·6	104·3

TABLE VI.—*Mean Area of Aorta, and Percentage of Aortic Area Affected by Fatty Streaking and by the Other Three Types of Plaque Combined (Raised Fatty, Fibrous, and Complicated) According to Age in Patients in the Unselected Necropsy Series and in Patients with Myocardial Infarction*

Age (Years)	Unselected Necropsy Series				Patients with Large Cardiac Lesions			
	Aorta				Aorta			
	Area (sq. cm.)	% Area Affected			Area (sq. cm.)	% Area Affected		
		Fatty Streaks	Other Lesions	Total		Fatty Streaks	Other Lesions	Total
Males								
35–54	141	14·1	13·1	27·2	143	14·3	19·4	33·7
55–64	166	10·8	23·6	34·4	168	8·6	38·0	46·6
65–74	195	8·8	40·7	49·5	196	6·5	50·0	56·5
75+	212	9·2	38·7	47·9	213	6·5	45·2	51·7
Females								
35–54	113	15·8	7·3	23·1	146	18·7	36·7	55·4
55–64	142	16·5	23·6	40·1				
65–74	161	11·3	30·3	41·6	166	8·3	53·0	61·3
75+	172	11·0	44·5	55·5	169	11·2	50·6	61·8

Carotid and Iliac Disease in Patients with Large Cardiac Lesions

We have shown that the severity of coronary artery stenosis correlates closely with the degree of stenosis and the number of carotid and iliac arteries affected. Tables VII and VIII show the prevalence of the different grades of plaque severity in the carotid and iliac arteries on a group basis, patients in the unselected necropsy series being compared with patients with large cardiac lesions. In both men and women with large cardiac lesions the percentage of patients showing no disease is lower than that in the unselected series, and severe disease is two to three times as common in men and women of the selected series, this difference occurring consistently in all the arteries studied. It should be remembered that the selected group of women with large lesions is older than the unselected series, but an analysis of groups of comparable age confirms that the difference is not due to age discrepancy.

TABLE VIII.—*Percentage Distribution of Patients in the Unselected Necropsy Sample and Patients with Myocardial Infarcts who Showed Various Grades of Arterial Plaque Severity in Specified Sites. Right and Left Iliac Arteries were Analysed Separately, but the Results were Combined to Simplify Group Comparison*

Necropsy Group	Percentage of Patients with Specified Grade of Plaque Severity											
	Iliac Arteries											
	Common				Internal				External			
	O	SL	M	S	O	SL	M	S	O	SL	M	S
Unselected males ..	0	23	31	46	2	30	33	35	13	56	21	10
Males with large cardiac lesions ..	1	9	30	60	0	11	34	55	9	41	27	23
Unselected females ..	1	18	43	38	1	21	43	35	17	60	14	9
Females with large cardiac lesions ..	0	6	26	68	0	6	21	73	3	45	29	23

O=No disease. SL=<10% surface affected. M=10–50%. S=>50%.

Not only are the carotid and iliac arteries more diseased in patients with large cardiac lesions than in an unselected necropsy series, in terms of the amount of surface covered with lesions, but they also show a higher prevalence of stenosis (Table IX). This difference is even more striking when the prevalence of severe narrowing is compared on an age basis (Table X).

Prevalence of Plaque Ulceration in Patients with Large Cardiac Lesions

All types of plaque have so far been considered together in comparing the severity of disease in the carotid and iliac arteries in the different groups. The prevalence of plaques showing ulceration in the carotid and iliac arteries in the various age, sex, and necropsy groups is shown in Table XI. Ulceration is clearly

TABLE VII.—*Percentage Distribution of Patients in the Unselected Necropsy Sample and Patients with Myocardial Infarction who Showed Various Grades of Arterial Plaque Severity in Specified Sites. Right and Left Carotid Arteries were Analysed Separately, but as there was no Significant Difference Between the Sides the Results were Combined to Simplify Group Comparison*

Necropsy Group	Percentage of Patients with Specified Grade of Plaque Severity															
	Innominate Artery				Carotid Arteries											
					Common				Sinus				External			
	O	SL	M	S	O	SL	M	S	O	SL	M	S	O	SL	M	S
Unselected males ..	6	46	35	13	1	43	48	8	1	26	38	35	16	63	17	4
Males with large cardiac lesions ..	10	26	41	23	1	26	53	20	1	14	26	59	10	57	24	9
Unselected females	14	56	21	9	1	56	36	7	3	34	36	27	23	65	8	4
Females with large cardiac lesions ..	12	38	38	12	0	30	52	18	3	12	24	61	7	60	19	14

O=No disease. SL=<10% surface affected. M=10–50%. S=>50%.

TABLE IX.—*Prevalence of Moderate and Severe Stenosis in Carotid and Iliac Systems in Patients of the Unselected Necropsy Series and in Patients with Myocardial Infarction, Expressed as Percentage of Total Number of Patients in Each Group. Right and Left Sides were Analysed Separately and the Results Combined to Simplify Group Comparison*

Necropsy Group	Prevalence of Stenosis Grades (%)													
	Iliac Arteries						Innominate Artery		Carotid Arteries					
	Common		Internal		External				Common		Sinus		External	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S
Unselected males ..	22	6	27	14	11	4	13	2	16	5	23	9	10	3
Males with large cardiac lesions ..	25	7	38	25	19	4	11	1	22	20	24	16	11	3
Unselected females ..	17	1	22	5	2	2	5	1	12	3	21	6	4	4
Females with large cardiac lesions ..	30	3	48	20	9	4	8	5	31	9	23	22	14	8

M=Moderate stenosis. S=Severe stenosis.

TABLE X.—*Percentage Prevalence of Severe Stenosis in Carotid and Iliac Arteries According to Age in Males and Females in the Unselected Necropsy Series and in Males and Females with Myocardial Infarction. Results from Right and Left Sides Combined as in Table IX*

Age Group (Years)	Necropsy Group	Prevalence of Severe Stenosis (%)					
		Iliac Arteries			Innominate Artery	Carotid Arteries	
		Common	Internal	External		Common	Sinus
		Males					
35–54	Unselected ..	2	6	0	0	4	5
	Large cardiac lesion ..	0	29	0	0	9	0
55–64	Unselected	3	15	4	2	2	4
	Large cardiac lesion ..	10	26	10	3	8	19
65–74	Unselected ..	5	19	6	5	5	17
	Large cardiac lesion ..	6	18	8	8	18	30
75+	Unselected ..	6	12	3	0	3	11
	Large cardiac lesion ..	8	25	0	0	15	29
		Females					
35–54	Unselected ..	0	2	0	0	0	0
	Large cardiac lesion ..	7	22	14	0	14	7
55–64	Large cardiac lesion ..						
	Unselected ..	2	5	3	0	2	0
65–74	Unselected ..	2	4	0	0	0	4
	Large cardiac lesion ..	0	27	0	9	0	32
75+	Unselected ..	0	7	0	3	5	16
	Large cardiac lesion ..	0	13	0	6	10	22

TABLE XI.—*Number of Patients with Ulcerated Plaques in Sites Specified, Expressed as Percentage of Total Number of Patients in Each Group. Results from Right and Left Sides Combined*

Age Group (Years)	Necropsy Group	Percentage of Patients Showing Plaque Ulceration			
		Carotid System		Iliac System	
		Males	Females	Males	Females
35–54	Unselected ..	0	0	8	0
	Large cardiac lesion ..	0	—	8	—
55–64	Unselected ..	2	0	20	6
	Large cardiac lesion ..	10	14	26	43
65–74	Unselected ..	20	4	32	7
	Large cardiac lesion ..	20	18	24	45
75+	Unselected ..	14	7	33	14
	Large cardiac lesion ..	29	6	64	13

an age-dependent phenomenon, its prevalence increasing with increasing age in both men and women. In the unselected series ulceration is much less common in women than in men, and in both sexes it is less common in the carotid than in the iliac systems. Patients with large cardiac lesions tend to show a higher prevalence of plaque ulceration than patients in the unselected necropsy group of comparable age and sex, so these patients not only have more disease and more stenosis but show a greater prevalence of ulcerated lesions, differing qualitatively as well as quantitatively.

Occlusion of Carotid and Iliac Arteries

Of the 293 patients in the unselected necropsy sample, 12 (4%) showed carotid and/or iliac occlusion, as opposed to 13 (11%) of the 117 patients with large cardiac lesions (P for difference <0.02). In 10 of the 12 patients in the unselected necropsy group and 12 of the 13 patients in the large-lesion group, with occlusions, the occluding lesion was found to be thrombus on histological examination, the remaining patients showing "atheromatous" occlusion. Arterial occlusion in sites other than the coronary arteries is thus more common in patients with large cardiac lesions than in the unselected group.

Discussion

Singer and Rob (1960) found that the death rate from myocardial infarction and strokes was much higher in patients with peripheral vascular disease than in the general population of comparable age, and Bloor (1961) showed that the prognosis of a group of patients with intermittent claudication was largely determined by the high prevalence of myocardial infarction and cerebral vascular disease. These clinical observations suggest that arterial disease affects many sites simultaneously, and that overt disease in any one site implies arterial disease elsewhere. Necropsy studies, however (Duguid and Robertson, 1955; Robertson, 1959), have emphasized the lack of correlation between disease in different arterial sites.

We have found that many individual patients in our unselected necropsy sample show an association between the degree and number of stenosing lesions in the coronary arteries as expressed in the coronary score, and the degree and number of the stenosing lesions in the carotid and iliac arteries. We have also studied a group of patients with large areas of cardiac necrosis or scarring in whom we have shown a very high prevalence of thrombotic coronary occlusion and whose lesions can therefore be accurately designated as myocardial infarcts (Mitchell and Schwartz, 1962). These patients have more severe coronary narrowing and a higher prevalence of carotid and iliac disease than the unselected sample, but the relationship between the degree of disease in the three sites in individual patients is retained.

We have shown that patients with myocardial infarction have more aortic disease than an unselected group, this being largely due to a difference in the area of aorta showing complicated plaques (ulceration, calcification, thrombosis, or haemorrhage). Our method of assessing aortic disease has also shown that the aortic area is correlated with age, and we consider that this casts doubt on the value of grading the extent of aortic disease visually, and expressing the results on a percentage basis, when patients with different aortic areas are to be compared (young patients with old patients, men with women, and so on).

Our results also show that as a group the patients with large cardiac lesions have more extensive disease, more stenosis, and more plaque ulceration in their carotid and iliac arteries than groups of unselected patients of comparable age. They also show a higher prevalence of thrombotic occlusion in the carotid and iliac systems, but this could be a result of cardiac infarction, on the basis of embolus or reduced blood flow, and cannot be taken as an indication of a generalized thrombotic tendency in such patients without further evidence.

We have previously stressed the characteristic localization of arterial plaques (Schwartz and Mitchell, 1961), some arteries and, indeed, some segments within a given artery showing severe disease while adjacent segments are invariably spared. Our present study suggests that as well as this striking localization there is a tendency for the disease to develop in parallel in different arterial systems, and in most of the patients examined severe disease in one site was accompanied by severe disease elsewhere.

However, a few patients in our series do show considerable differences between the degree of narrowing in their coronary, carotid, and iliac systems. We should perhaps remember that this is a necropsy survey; that although the disease may progress in parallel in different arterial systems, there will be individual variability; that the vessels studied are of differing size and importance; and that the crucial event in producing clinical symptoms and death in patients with diseased vessels is not the wall disease alone but the occurrence of thrombotic occlusion. Thus patients in whom the wall disease progresses steadily in all affected sites, and who do not develop thrombosis, are more likely to be found in the living population than in a necropsy survey, and in a necropsy study such as ours they will be most common in the older age-groups of the unselected sample. On the other hand, patients in the younger age-groups dying of cardiac infarction or strokes may be those in whom the disease has progressed more rapidly in some arterial sites than in others and in whom thrombosis has supervened.

Summary

The prevalence of coronary artery disease was studied in an unselected necropsy sample of 137 patients and in a selected group of 79 patients with myocardial infarction; arterial plaques in the aorta and carotid and iliac arteries were also studied in these patients and in a further series of 156 unselected necropsies and 37 patients with myocardial infarction (a total of 293 unselected patients and 116 patients with infarction).

In individual patients severe coronary narrowing is often associated with stenosis of the carotid and iliac arteries. A group of patients with myocardial infarction have more aortic disease than a group of unselected patients of comparable age and sex, the area affected by complicated plaques accounting for most of the difference.

A group of patients with myocardial infarction have more stenosis and more plaque ulceration in the carotid and iliac arteries than unselected patients of comparable age and sex. This study suggests that patients who have severe arterial disease in one site are likely to have severe disease elsewhere.

We are grateful to Sir George Pickering for advice and encouragement and to Dr. A. H. T. Robb-Smith and the staff of the Morbid Anatomy Department for access to the necropsy material. Miss Sheila Briers, Mr. Bruce Abrahams, and Mr. Paul Manners gave invaluable technical assistance throughout.

C. J. Schwartz was initially the C. J. Martin Research Fellow of the National Health and Medical Research Council of Australia, and was latterly a member of the external staff of the Medical Research Council. J. R. A. Mitchell was in receipt of a Medical Research Council Clinical Research Fellowship throughout.

REFERENCES

Bloor, K. (1961). *Ann. roy. Coll. Surg. Engl.*, **28**, 36.
Duguid, J. B., and Robertson, W. B. (1955). *Lancet*, **1**, 525.
Juergens, J. L., Barker, N. W., and Hines, E. A. (1960). *Circulation*, **21**, 188.
McDonald, L. (1953). *Brit. Heart J.*, **15**, 101.
Mitchell, J. R. A., and Schwartz, C. J. (1962). In press.
Report of Co-operative Study of Lipoproteins and Atherosclerosis (1956). *Circulation*, **14**, 691.
Richards, R. L. (1957). *Brit. med. J.*, **2**, 1091.
Robertson, W. B. (1959). *Lancet*, **1**, 444.
Schwartz, C. J., and Mitchell, J. R. A. (1961). *Brit. med. J.*, **2**, 1057.
—— —— (1962). In press.
Singer, A., and Rob, C. (1960). *Brit. med. J.*, **2**, 633.
World Health Organization (1958). *Techn. Rep. Ser.*, No. 143.

HUNTINGTON'S CHOREA IN THE MORAY FIRTH AREA*

BY

RAE LL. LYON, M.D., M.R.C.P.Ed.
Senior Medical Registrar, Raigmore Hospital and Royal Northern Infirmary, Inverness

The syndrome of chronic adult chorea accompanied by insanity and with a hereditary basis has for many years been associated with the name of George Huntington following his description of it in America in 1872. In Britain the first recorded account was by West (1887), who described the relationships of an affected family at Stoke-on-Trent. As the syndrome became more widely recognized many individual cases were put on record, so that by the end of the nineteenth century the condition had been demonstrated from Bristol (Clarke, 1897) to Leith (Elder, 1899).

Macdonald Critchley (1934) gave an explanation of how at least some of the American families came of Suffolk stock; he also gave figures which illustrate a fairly wide incidence over Britain.

A comparatively rare disease which runs in families should be found more frequently in some areas than in others, and, in fact, localized collections of cases of Huntington's chorea have been described in Cornwall and Northampton by Bickford and Ellison (1953) and Pleydell (1954) respectively.

A further centre of Huntington's chorea is detailed here. It is hoped to illustrate how the disease can remain localized so long as it is confined to a closed community, but that the current social tendencies have now scattered potential carriers in fact from Ullapool to Southampton, from Canada to Australia.

It has been recognized for some years that Huntington's chorea is common in the Moray Firth area, especially among the fishing families. The point of focus which has the highest incidence and the place from where all the families originate is a small fishing village on the east coast of Ross-shire. Mentioning in particular the surnames of Patience and McLemmon, a note has already been made by McWilliam (1937) to point out the presence of the disease in this area and to ponder its source. The personal details and family connexions of the affected cases have had to wait until now to be disentangled.

Present Investigation

Source.—The origin of these peoples defies all clarification, and it is thus impossible to link them to any of these other known communities. Numerous theories have been advanced. It is clear that men skilled in herring fishing were settled here about 300 years ago, but it is not known if the original families brought Huntington's chorea or if the disease was introduced later by brides who may have come north to boost the weaving industry. For many years this fishing community refrained from marrying outside their own village or at least always married into fisher families. Thus the clans are even yet completely unaffected.

Material.—Many difficulties were unsurmountable because details had to be checked from times too long ago, and other difficulties arose even in the assessment

*Abridged and adapted from a thesis accepted for the Doctorate of Medicine, Edinburgh University.