*Papers and Originals***CAUSES OF DEATH IN TREATED HYPERTENSIVE PATIENTS****BASED ON 82 DEATHS DURING 1959-61 AMONG AN AVERAGE HYPERTENSIVE POPULATION AT RISK OF 518 PERSONS**

BY

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The beneficial effects of hypotensive treatment have led to improved prospects of survival in severe hypertension, particularly when complicated by neuroretinopathy and heart failure. We have already produced evidence that survival is also improved in less severe cases. In an analysis of our clinic experience up to December 31, 1958, Hodge, McQueen, and Smirk (1961) expressed the number of treated patients dying from cerebral vascular accidents as a percentage of the number of persons at risk. The percentage of cerebral vascular accidents in the treated persons was about half of that found among a somewhat milder group of patients who were not receiving treatment. Deaths from coronary disease expressed as a percentage of the number of patients at risk had decreased below the control level, but no claim for statistical significance was made. When, however, the number of patients dying from coronary disease was expressed as a percentage of total deaths there was an increase in the proportion of coronary deaths among the treated patients.

It was decided to examine our mortality figures for 1959, 1960, and 1961, to discover whether this trend in the direction of decrease in the proportion of congestive heart failure and cerebral vascular deaths and increase in the proportion of deaths from coronary disease had changed with improved methods of treatment.

The number of deaths in our hypertensive clinic was 82 in the three years; the average number of patients at risk of all retinal grades was 518. The overall mortality therefore was 5.3% per annum.

Material

The patients whose deaths are analysed include all of those who were on treatment in our hypertensive clinic between January 1, 1959, and December 31, 1961, and who remained so, as far as was practicable, up to the time of death. The drug combinations used differed widely among these patients and will not be detailed. Patients on treatment were seen at intervals of usually less than three months, and all-day tests of blood-pressure were carried out whenever indicated. The aim has been to maintain the blood-pressure at or near normal levels for as much of the day as possible, except where renal failure or impairment of the cerebral or coronary circulations made this unwise. The standard of blood-pressure control, however, has not always been optimal, as difficulty with drug stabilization or lack of patients' co-operation has at times made compromise necessary.

Strong evidence was usually available from recent hospital admissions, from the attending doctor, or from the mode of death, which left little doubt regarding its cause. We have made a practice of interviewing relatives and eye-witnesses, and of corresponding with doctors whenever a clinic patient has died away from hospital. In most cases of this series necropsy evidence was lacking, as many patients died at home. Necropsies were obtained, however,

on 17 patients. Clinical diagnoses were confirmed. Necropsy findings which did not appear to have contributed materially to the fatality, and consequently are not included in the analysis of causes of death, are as follows:

In two of the patients whose deaths were recorded as due to cerebral haemorrhage this cause of death was confirmed; but, additionally, cardiac infarction was present in one of the cases and in the other there was considerable narrowing of right and left coronary arteries.

One diabetic patient dying with uraemia due to Kimmelstiel-Wilson disease had a papillary carcinoma of a ureter not suspected during life.

Another patient dying of uraemia showed considerable narrowing of the coronary arteries and a healed myocardial infarction.

Additional details are: (1) patients who sustained a disability, such as a stroke, which prevented continuance of treatment were counted, if they died, as dying on treatment, even though treatment had been terminated before death occurred; (2) patients who stopped treatment for a few days because of side-effects and died during this time were counted as being on treatment; (3) patients who left the district and were not attending the clinic were not included in the analysis except where the attending physician was known to us as knowledgeable in the field, or where the patient remained on treatment at one of the hypertensive clinics in New Zealand which maintains contact with us; and (4) patients who ceased to co-operate with or to attend the clinic for reasons other than a hypertensive disability were removed from the list of patients on treatment and were not included in the list of patients attending the clinic or in the list of deaths.

As the rate of referral of new patients to our hypertensive clinic has been steady in the last few years, the average of the number at risk on January 1, 1959 (413), and at December 31, 1961 (623) (Table I), has been taken as the average number at risk during the intervening period. This number (518) is a slight underestimate of the patients at risk, as those both joining and leaving the clinic during this period are not included if they lived, but would have been included in the deaths had they died while attending the clinic.

TABLE I.—*Number of Hypertensive Patients at Risk on January 1, 1959, and on December 31, 1961, With the Average Number at Risk During the Intervening Period*

		Retinal Grades				Total
		1	2	3	4	
Persons at risk on Jan. 1, 1959	Male	24	63	34	12	133
	Female	55	148	66	11	280
Persons at risk on Dec. 31, 1961	Male	53	104	50	15	222
	Female	103	204	81	13	401
Average numbers at risk between Jan. 1, 1959, and Dec. 31, 1961	Male	38.5	83.5	42.0	13.5	177.5
	Female	79.0	176.0	73.5	12.0	340.5
	Combined	117.5	259.5	115.5	25.5	518.0

Where death is the result of two causes acting in conjunction a half-mark is allocated to each cause; thus uraemia $\frac{1}{2}$, congestive heart failure $\frac{1}{2}$. In setting out the number of persons in a given category who die from a specified cause the figure, say $10\frac{1}{2}$, would mean that the sum of the number of persons dying solely from a specified cause plus the number of halves add up to $10\frac{1}{2}$.

Results

Among an average of 518 patients at risk in the three-year period under study 82 deaths occurred, giving an average annual mortality of 5.3% (Table II). As might be expected, the proportion of deaths in males was appreciably higher, being 44 out of an average of 177.5 males at risk

TABLE II.—Average Number of Patients at Risk (Subdivided into Retinal Grades) in Relation to Mortality

						Total	
Retinal Grades							
1234							
<i>Average No. of Patients in Various Retinal Grades</i>							
Male	..	..	38.5	83.5	42.0	13.5	177.5
Female	..	..	79.0	176.0	73.5	12.0	340.5
Male + female	..		117.5	259.5	115.5	25.5	518.0
<i>No. of Deaths in Various Retinal Grades in 3-Year Period</i>							
Male	..	..	6	20	15	3	44
Female	..	..	7	16	13	2	38
Male + female	..		13	36	28	5	82
<i>Percentage of Deaths per Annum in Various Retinal Grades</i>							
Male	..	..	5.2	8.0	11.9	7.4	8.3
Female	..	..	3.0	3.0	5.9	5.6	3.7
Male + female	..		3.7	4.6	8.1	6.5	5.3

(mortality 8.3% per annum), as contrasted with 38 out of an average of 340.5 females at risk (mortality 3.7% per annum).

Retinal Grading and Mortality

Subdivision of the patients at risk, using the retinal classification of Keith, Wagener, and Barker (1939), is shown in Table II, together with the number of deaths and percentage mortality in each grade. The Table shows that the overall mortality among the treated patients who were at risk between January 1, 1959, and December 31, 1961, is much less influenced by retinal grading than is the mortality among untreated patients in the many studies published. Thus with an average of 25.5 patients at risk with malignant hypertension the annual mortality was 6.5% as against 3.7% among 117.5 retinal grade 1 patients. This finding is due in part to the fact that in treated patients with severe retinal grading much of the mortality occurred in the first two years, often from disabilities established before treatment began. Most of the cases of malignant hypertension in this series had already been on treatment for several years prior to January 1, 1959.

The retinal grading of the various patients at the outset of treatment is related in Table III to the eventual causes of death. In all retinal grades coronary artery disease is now the most frequent single cause of death, even if sudden deaths without symptoms of previous coronary disease are excluded. The percentage of coronary deaths for the four retinal grades combined was 41.5%, and, in addition, there were 7.3% of sudden deaths, almost certainly cardiac, but otherwise without evidence of coronary disease.

Of the unrelated causes of death five were due to neoplasm, one to a car accident, one to hepatic cirrhosis, and

in three additional patients irrelevant causes contributed materially to the fatal outcome—namely, volvulus ($\frac{1}{2}$), bronchial asthma ($\frac{1}{2}$), tuberculosis ($\frac{1}{2}$).

TABLE III.—Distribution of Deaths by Retinal Grades and Causes of Death. All Patients Were Having Treatment for Hypertension

Causes of Death	Retinal Grades				Total	
	1	2	3	4	No.	%
Coronary ..	5	16 $\frac{1}{2}$	10 $\frac{1}{2}$	2	34	41.5
Sudden cardiac ..	1	3	2		6	7.3
Stroke ..	2	10	7		19	23.2
Uraemia ..	1 $\frac{1}{2}$	1 $\frac{1}{2}$	4	1	8	9.8
C.H.F. ..	1	1 $\frac{1}{2}$	1		3 $\frac{1}{2}$	4.3
Other relevant ..			2*	1	3	3.7
Other unrelated ..	2 $\frac{1}{2}$	3 $\frac{1}{2}$	1 $\frac{1}{2}$		8 $\frac{1}{2}$	10.4
Total ..	13 (15.9%)	36 (43.9%)	28 (34.1%)	5 (6.1%)	82 (100%)	100.2

* 2 reserpine suicides.

Age in Relation to Mortality

The age-grouping at the start of treatment of patients who died while being treated is related to the causes of death in Table IV, and additional information is given in Table V. The approximate percentage mortality from all causes is shown by expressing deaths in each age-group as a percentage of the approximate number at risk. The ages shown are those at the start of treatment.

TABLE IV.—Distribution of Deaths in Treated Patients by Age and Cause of Death

Causes of Death	Age at Start of Treatment					Total	
	70+	60-69	50-59	40-49	<40	No.	%
Coronary ..	2	10	9 $\frac{1}{2}$	9	3 $\frac{1}{2}$	34	41.5
Sudden cardiac ..	1	2	1	1	1	6	7.3
Stroke ..		8	6	5		19	23.2
Uraemia ..		2 $\frac{1}{2}$	3 $\frac{1}{2}$	1 $\frac{1}{2}$	$\frac{1}{2}$	8	9.8
C.H.F. ..		1 $\frac{1}{2}$	1	1		3 $\frac{1}{2}$	4.3
Other relevant ..			2	1		3	3.7
Other unrelated ..		5	3	$\frac{1}{2}$		8 $\frac{1}{2}$	10.4
Total ..	3 (3.7%)	29 (35.4%)	26 (31.7%)	19 (23.2%)	5 (6.1%)	82 (100.1%)	100.2

In all decades studied, coronary artery disease was the main cause of death, even without adding cases of sudden death presumed to be of cardiac origin. Although male deaths predominate, this is not the sole explanation of the high death rate from coronary disease.

Among the 82 deaths 12 occurred at age 70+ and 35 between ages 60 and 69. With the continued ageing of our hypertensive clinic population a higher mortality must be anticipated in future years.

Duration of Survival on Treatment

The number of years survived by males and females dying from various causes is shown in Table V. Of males who died from coronary disease, or who had a sudden death presumed to be cardiac, three died in the first year, one in the second, and four in the third. Six patients in this category died in their fifth year of treatment together with one who died from a combination of coronary disease ($\frac{1}{2}$) and congestive heart failure ($\frac{1}{2}$). Most deaths from uraemia occurred in patients who had considerable renal impairment before treatment began, and more than half of these deaths occurred within the first two years. The main contributory cause of death in the uraemic patients was terminal acute heart failure, usually with pulmonary oedema. Such patients might well have been classified as dying solely from uraemia instead of uraemia $\frac{1}{2}$, heart failure $\frac{1}{2}$, but we have been anxious not to underestimate the part played by heart failure. Our figure of $3\frac{1}{2}$ of the

82 deaths (4.3%) attributable to heart failure is possibly an overestimate for this reason.

When all patients who died during these three years are considered the average period of prior survival on treatment was 5.1 years for females and 4.0 years for males. In our earlier analysis (Hodge *et al.*, 1961) the average survival time for those who died (male and female) was 2.3 years. Much of the longer survival in the present series is due to the fact that most of the persons at risk in the years 1959-61 had already survived many years on treatment.

Comparison of Causes of Death of Patients Who Had Definite or Suspected Coronary Disease Before Treatment Started With Those Who Presented Without Evidence of Coronary Disease

It is not uncommon for hypertensive patients in need of treatment to have complained of angina prior to the starting of treatment. In Table VI the patients who had some evidence suggestive of coronary disease (usually angina) before treatment and those who had no suspicion of coronary disease before treatment are given separately. Thus among 13 females presenting with angina five died from coronary disease, five from stroke, and three from unrelated causes. In 11 males presenting with angina $9\frac{1}{2}$ deaths were attributable to coronary artery disease, 1 to stroke, and $\frac{1}{2}$ (contributory cause) to congestive heart failure. A high mortality from coronary disease occurred

among those presenting with angina or suspected angina (86.4% in males, 38.5% in females). Coronary artery disease remained, however, the most important single cause of death in persons with no evidence of coronary disease at the time of presentation for treatment (27.3% in males, 42.0% in females).

If cases of otherwise unexplained sudden death are included the percentages become 33.3 in males and 58.0 in females. The accounts of these sudden deaths suggested that they were cardiac. Some of them were associated with multiform premature ventricular systoles and the occurrence of the R wave on the T wave phenomenon previously described (Smirk, 1949; Smirk and Palmer, 1960). This myocardial syndrome occurs in many conditions as well as in coronary artery disease.

In this series the survival time on treatment was not greatly influenced by the occurrence of symptoms of angina before treatment started, being 4.1 years in males without and 3.8 years with angina. In females the survival time was 4.7 in those without and 6.0 years in those with angina.

Comparison of Causes of Death of Patients Presenting Initially with Left Ventricular or Congestive Heart Failure with Those Presenting Without These Disabilities

Of 16 patients presenting with left ventricular or congestive heart failure but without evidence of coronary disease

TABLE V.—Number of Years Survived by Those Dying of Various Causes

Causes of Death	No. of Years Survived											Total
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10+	
Males												
Coronary and sudden cardiac ..	3	1	4		6½		1	1		2	2	20½
Stroke	2	2	1				½	2				9½
Uraemia	1½	2½		1		1½		1				7½
C.H.F.	1	½			½	½						2½
Other relevant		1			1							2
Other unrelated	½	1					½					2
Total	8	8	5	1	8	3	2	4	1	2	2	44
Females												
Coronary and sudden cardiac ..	2½	1	1		3	1	5	2	4			19½
Stroke		½		1	1	1	1	3		1	1	9½
Uraemia	½											½
O.H.F.		½	½									1
Other relevant			½	2				1	1			1
„ unrelated	2		½									6½
Total	5	2	2	3	4	2	6	6	6	1	1	38
Grand Total { No.	13	10	7	4	12	5	8	10	7	3	3	82
{ %	15.9	12.2	8.5	4.9	14.6	6.1	9.8	12.2	8.5	3.7	3.7	100.1

TABLE VI.—Causes of Death in Males and Females Presenting or Not Presenting with Coronary or Suspected Coronary Disease

	Total No.	Average Age		Retinal Grades				Causes of Death						
		At Start	At Death	1	2	3	4	Coronary	Sudden, Not Proved Cor.	Cer. Vasc. Acc.	Uraemia	C.H.F.	Other Relevant	Other Unrelated
Persons Presenting with Angina or Suspected Angina														
Females ..	13	55.3	61.3	5	6	2	0	5	0	5	0	0	0	3
Males ..	11	54.2	58.0	0	7	2	2	9½	0	1	0	½	0	0
Total ..	24	54.8	59.8	5	13	4	2	14½	0	6	0	½	0	3
Persons Not Presenting with Angina or Suspected Angina														
Females ..	25	55.4	60.1	2	10	11	2	10½	4	4½	½	1	1	3½
Males ..	33	55.4	59.5	6	13	13	1	9	2	8½	7½	2	2	2
Total ..	58	55.4	59.8	8	23	24	3	19½	6	13	8	3	3	5½
All Cases														
Females ..	38	55.4	60.5	7	16	13	2	15½	4	9½	½	1	1	6½
Males ..	44	55.1	59.1	6	20	15	3	18½	2	9½	7½	2½	2	2
Total ..	82	55.2	59.8	13	36	28	5	34	6	19	8	3½	3	8½

who died, only a half-share of one death could be attributed to heart failure, whereas 5 (31.3%) deaths were attributed to coronary disease and four others were sudden cardiac deaths without other evidence suggesting coronary disease. Four and a half deaths (28.1%) were attributed to stroke.

Of 42 patients with neither heart failure nor evidence of coronary disease at the outset $2\frac{1}{2}$ (6.0%) deaths could be attributed to heart failure, whereas $15\frac{1}{2}$ (36.9%) were due to coronary disease, and 2 additional were sudden. Stroke accounted for $7\frac{1}{2}$ deaths (17.9%).

It is of interest that in a group of persons without an initial history of coronary pain the incidence of coronary deaths was no higher among those presenting with heart failure than among those not so presenting. Had occult coronary disease contributed to the occurrence of heart failure it would have been expected that coronary deaths would be more numerous in the group who presented with heart failure than among those not so presenting. Patients who presented with heart failure plus angina were not included in this separate analysis, which cannot therefore be used to assess the overall importance of coronary artery disease in the pathogenesis of heart failure among hypertensive patients.

Comparison of Causes of Death of Patients Who Had Experienced a Stroke Before Treatment Started With Those Who Presented Without a History of Stroke

Of 18 patients presenting with a history of a stroke but without evidence of coronary disease who died, $7\frac{1}{2}$ (41.7%) deaths were due to coronary disease and $4\frac{1}{2}$ (25.0%) to a further stroke. Of 31 patients presenting without evidence either of a stroke or of coronary disease who died, 12 (38.7%) died of manifest coronary artery disease, 5 (16.1%) others died sudden cardiac deaths, and $8\frac{1}{2}$ (27.4%) died from strokes.

Comparison of Causes of Death in Treated and Untreated Hypertensive Patients

It is of some importance to know whether deaths from individual causes have been reduced by treatment with hypotensive drugs. In our earlier analysis (Hodge *et al.*, 1961) we compared the causes of death in our treated patients with those in a somewhat milder untreated group the composition of which was detailed. These figures have been reproduced in Table VII for comparison with those of the current analysis.

TABLE VII.—Percentage Distribution of Deaths Among Untreated and Treated Hypertensives

	Untreated Series to Dec., 1958*	Treated Series to Dec., 1958*	Treated Series of 1959-61 Inclusive
Congestive heart failure ..	23.2	12.7	4.3
Coronary and sudden ..	17.1	19.2	48.8
Cerebral vascular accident ..	39.6	33.1	23.2
Uraemia	12.2	20.5	9.8
Other	7.9	14.6	14.1
Total No. on which percentages are based ..	82	154	82

* Only patients on treatment for one year or more included.

The treated patients at risk from 1959 onward include 413 who had already been on treatment for periods of up to eight years. Consequently, although they were on average older and had a longer known hypertensive history, there were fewer males, fewer patients with severe retinopathy, and fewer uraemics than in the earlier treated series. The untreated group shown contained a higher proportion

of mild (retinal grades 1 and 2) and symptomless patients than either of the two treated groups. The 1959-61 figures are not sufficiently comparable to permit of dogmatic conclusions. They do, however, suggest a continued trend toward reduction in deaths due to stroke and cardiac failure, with a considerable relative increase in deaths from coronary artery disease.

Discussion

An overall mortality of 5.3% per annum may seem to be satisfactory when the hypertensive population under treatment contains 4.9% retinal grade 4 and 22.3% grade 3 patients; yet a large proportion of the deaths either result from or appear to be related to the hypertension. In terms of views on the pathogenesis (Smirk, 1946, 1949, 1957) some such deaths might have been prevented by more effective control of blood-pressure levels than is at present practicable and if treatment had started before irreversible disabilities developed.

Although among retinal grade 1 and 2 patients the proportion of deaths was only 4.3% per annum, yet the number was 49 out of the total of 82 (59.5%), mostly from causes attributable in part or in whole to hypertensive disease. This is not to assume that all deaths from heart failure, stroke, and coronary disease occurring in hypertensive persons are due to the hypertension, but that the excess occurrence of these causes of death in such persons may be attributed to the higher arterial pressure.

There is need for more precise and simple methods for controlling the blood-pressure of hypertensives, but when full use is made of existing drugs there is a great diminution in the mortality from congestive heart failure (Smirk and Alstad, 1951; Smith and Fowler, 1955; Smirk *et al.*, 1958) and an important but less dramatic decrease in the occurrence of deaths from stroke (Hodge *et al.*, 1961).

The mortality from coronary disease in this series of treated hypertensive patients, when expressed as a percentage of the number of persons at risk, is 2.2 per annum or 2.6 if all sudden cardiac deaths are included with coronary deaths. The figures do not warrant any expression of opinion on whether the death rate from coronary disease, expressed as a percentage of the number of persons at risk, has changed as a result of treatment. Certainly it has not changed as much as the death rate from heart failure and strokes. Consequently the percentage of deaths from coronary disease has increased from 17.1 in our concurrent (after January 1, 1950) series of untreated patients to 41.5 in our recent treated series (1959-61), or to 48.8 if sudden deaths are included. The latter is a better figure for comparison, as sudden deaths were assumed to be coronary in our untreated series.

No deaths in this series could be attributed solely to hypertensive heart failure, but, erring on the generous side in the assignation of heart failure as a contributory cause (in conditions such as uraemia), some 4.3% appears to be the proportion of deaths for which heart failure may be held responsible. This may be compared with 23.4% in our concurrent (Hodge *et al.*, 1961) control sites. In several publications 20 to 60% of the reported deaths in untreated hypertensives are from heart failure. Deaths from stroke in this series were 23.2% of all deaths as against 39.6% in our concurrent untreated series.

It should be noted that, in our treated patients dying in 1959-61, deaths from coronary disease predominate in both male and female (Table V) in those without previous history of coronary disease (Table VI), in all decades studied (Table IV), in all retinal grades (Table III), and in patients

who presented having had a cerebral vascular accident but no previous history of coronary disease.

We feel that improved drug treatment in recent years has been responsible for the altered distribution of deaths among patients who died in 1959-61, as compared with the deaths in our treated series which occurred from 1950 to 1958, and our concurrent control series of untreated persons 1950-8.

A review of other publications provides support for the conclusion that the percentage of deaths from heart failure has decreased. The percentage of deaths from strokes is subject to wide variation. In an analysis of the causes of death in hypertension Smith *et al.* (1950) studied 376 hypertensive patients who came to necropsy at the Mayo Clinic. They listed the percentage mortality from each major cause as follows:

Cause	Males	Females
Heart failure ..	26.7%	24.5%
Coronary disease ..	9.8%	10.0%
Stroke ..	14.7%	15.5%
Uraemia ..	22.5%	14.5%
Other causes ..	26.3%	35.5%
Total ..	100.0%	100.0%

The causes listed are those considered to be responsible for death, but additionally they included the disabilities found at necropsy which were not the actual cause of death. Thus Smith *et al.* (1950) found in the retinal grades 1 to 4 that coronary disease was the cause of death in 7/40 (17.5%), 20/65 (30.8%), 9/65 (13.8%), and 1/97 (1.0%) of patients respectively when deaths from causes unrelated to the hypertension were excluded. The actual occurrence of coronary disease, however, was much more frequent—namely, 26/40 (65.0%), 37/65 (56.9%), 38/65 (58.5%), and 54/97 (55.7%) respectively in the four retinal grades. Coronary disease was by far the most important concurrent disability in patients dying from other causes. This seems to explain why the percentage of deaths from coronary artery disease rises when deaths from heart failure and stroke are reduced.

The percentages of deaths from coronary artery disease from the series of Goldring and Chasis (1944), and Bechgaard (1946), respectively, are 15.4 and 33.0. These percentages would be reduced if their deaths from unrelated causes were included.

Evidently the manner in which the case material has been selected is important. Clawson (1951) gives the causes of death based on necropsy in patients dying of the effects of hypertension. The diagnosis of hypertension was in terms of the presence of increased cardiac weight and a blood-pressure level in most instances of 150/90 or over. He points out that the method of selection used would tend to reduce the incidence of cerebral vascular deaths in his collection of cases.

	4,085 Males	1,850 Females	Males and Females
Heart failure ..	35.3%	41.3%	37.4%
Coronary artery disease ..	46.7%	32.8%	42.2%
Cerebral haemorrhage ..	12.5%	18.5%	14.3%
Uraemia ..	5.3%	7.7%	6.1%

The large proportion of males has increased the proportion of coronary artery deaths and decreased the cerebral haemorrhage deaths. In many series, including our own, all strokes occurring in hypertensives are included. Clawson specifically refers only to haemorrhage. The percentages dying from the various causes specified are increased also by the omission of hypertensive patients dying from unrelated causes.

In our series of untreated patients there is a high percentage of strokes as compared with most published series.

The following comments may be made. Many of the published series concern deaths in hospital or are based on necropsy figures. In our untreated series and in our treated patients the causes of death are recorded for almost all of those who eventually died, irrespective of where the death occurred. The use of this procedure may be a partial explanation of the high death rate (39.6%) from stroke in our untreated series; for when Alstad and Smirk analysed the causes of death (before 1950) in all hypertensives who died in one year in the Dunedin Hospital, the percentage of cerebral vascular deaths (haemorrhage and thrombosis) was 24.8, of congestive heart failure deaths 26.7, and of coronary deaths 9.5. Renal causes accounted for 7.1%, and other causes for 31.9%. The death rate from unrelated causes is higher when the deaths of all hypertensives dying in hospital are contrasted with the deaths, wherever they occur, of a series of untreated patients whose hypertension is specifically the subject of investigation, as distinct from an incidental finding in persons who may have been admitted with another disorder.

Summary

In the years 1959, 1960, and 1961 82 deaths occurred among an average hypertensive population of 518 under treatment. The annual mortality, taking all retinal grades together, was 5.3%.

Coronary artery disease was the predominant cause, accounting for 41.5% of all deaths, or 48.8% if sudden cardiac deaths but without other evidence of coronary disease are included. Coronary artery disease was the predominant cause of death in males and females, in all decades studied, in patients presenting with strokes, and in patients presenting with left ventricular or congestive heart failure.

Probably the main reason for the increase in the proportion of deaths from coronary disease is the reduction in the deaths from heart failure and stroke.

We are indebted to doctors in our city and surrounding districts who have referred patients and co-operated closely with us in their subsequent management. They have helped also with details of the mode of death. Generous supplies of drugs have been made available by Messrs. Merck Sharp & Dohme Research Laboratories, New York; May & Baker Ltd., Dagenham; Ciba Ltd., Basle; Wyeth Laboratories, Philadelphia; Burroughs Wellcome & Co. (Aust.) Ltd. Help in the care of patients by Dr. E. G. McQueen and other physicians at the hypertensive clinic and by Mrs. Hobbs and other technicians is gratefully acknowledged. The expenses of the research were defrayed by the Medical Research Council of New Zealand.

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