HYPERTENSION CONTROL AND THE RISK OF MYOCARDIAL INFARCTION AND STROKE IN THE HUNTER REGION OF NEW SOUTH WALES

BY

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I hereby certify that the work embodied in this thesis is the result of original research and has not been submitted for a higher degree to any other University or Institution.

(signed) Khaldoon Al-Roomi .....

Khaldoon Al-Roomi

"In God we trust, others must provide data."

Anonymous

PUBLICATIONS ARISING FROM THE WORK REPORTED IN THIS THESIS

Al-Roomi KA, Dobson AJ, Heller RF and Leeder SR (1986). Hypertension and the risk of ischaemic heart disease. Med J Aust;145:249-51.

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ABSTRACT

A series of studies was designed to explore the importance of hypertension and its control during treatment on the occurrence of myocardial infarction and stroke in the Hunter Region of New South Wales, Australia.

The main hypotheses were:

(i) that a higher proportion of patients with acute myocardial infarction or stroke, in comparison with a random sample of the general population, will have a history of hypertension;

(ii) that a lower proportion of those myocardial infarction or stroke cases with a history of hypertension than of community controls with a history of hypertension, will be on current treatment; and

(iii) that, among those myocardial infarction or stroke cases currently receiving treamtent, blood pressure control and follow-up care will be less adequate than with those of the random population sample currently receiving treatment.

In the first study, a survey of blood pressure in the general population was undertaken in a random sample of 1,200 adults living in the Hunter Region of New South Wales, whose names were selected from the Electoral Roll. The survey revealed that a large proportion of the population had undergone a blood pressure measurement in the recent past, with 89 percent of respondents having had their blood pressure measured in the past three years. Women were more likely than men to have had their blood pressure measured and to have reported both a knowledge of hypertension and, if hypertensive, their current treatment status. Since a large proportion of the population has undergone a blood pressure measurement in the past three years, it appears that most of the hypertension in the community has already been detected and thus the value of further hypertension screening in the community is probably limited.

In the subsequent studies, subjects with first-time acute myocardial infarction and first-time stroke, aged 35-69 years, were identified from community-based heart

attack and stroke registers and compared with control subjects in the same age group, obtained from a random population sample from the same community. A total of 781 first myocardial infarction cases and 190 first stroke cases were available for comparison with 477 community control subjects. Even though 51 percent of first stroke patients and 37 percent of first myocardial infarction patients were currently on treatment for hypertension, compared with 21 percent of community controls, this did not prevent them from suffering stroke (odds ratio adjusted for age, sex and several other possible confounding variables: 3.5; 95 percent confidence interval 2.3 to 5.4) or coronary events (adjusted odds ratio 2.3; 95 percent confidence interval 1.6 to 3.1). Amongst those who had been told at some stage that they had hypertension, 73 percent, 71 percent and 62 percent of stroke cases, myocardial infarction cases and community controls, respectively, were currently receiving treatment for hypertension.

In those patients who were on current treatment for hypertension, blood pressure measurements taken before the coronary or stroke events (or survey, for community controls) were obtained from their general practitioner's records. Ninety percent of stroke patients, 91 percent of myocardial infarction patients and 91 percent of control subjects on current treatment for hypertension had had a blood pressure reading in the 3 months before the event (or survey, for controls). Despite similar pre-treatment levels, the latest blood pressure measurement (either before the survey or the development of myocardial infarction or stroke) was higher among those who then developed myocardial infarction or stroke than those in the community. The pattern was consistent, both in matched and unmatched analyses, for both systolic and diastolic blood pressure levels and also across age and sex groups.

Overtreated hypertensives (those with a treated diastolic blood pressure less than 80mmHg) appeared to be at higher risk of developing an acute myocardial infarction than were those with a treated diastolic blood pressure of 80-89mmHg (adjusted odds ratio 1.6; 95 percent confidence interval 0.7 to 3.4). Although the difference is not statistically significant, the increased risk among overtreated hypertensives is consistent with other recent reports. This effect, together with the adverse effects of antihypertensive agents on blood lipids and glucose levels, could explain the failure of randomized controlled trials to demonstrate a significant reduction in the rates of acute myocardial infarction in response to a reduction in blood pressure.

Twenty-two percent of community controls were current cigarette smokers compared with 33 percent of first stroke cases (adjusted odds ratio 1.5; 95 percent confidence interval 0.9 to 2.5) and 40 percent of first myocardial infarction cases (adjusted odds ratio 3.2; 95 percent confidence interval 2.3 to 4.5). Seventeen percent of treated hypertensive subjects in the community were current smokers compared with 30 percent of treated hypertensives who later developed stroke (adjusted odds ratio 1.6; 95 percent confidence interval 0.6 to 4.5) and with 28 percent of treated hypertensives who developed myocardial infarction (adjusted odds ratio 2.2; 95 percent confidence interval 1.2 to 4.4). The proportion of all cases of first stroke that occurred in the study population which were attributable to hypertension (defined as currently receiving treatment) and current cigarette smoking were 30 percent and 8 percent, respectively (the aetiologic fraction). The comparative figures for acute myocardial infarction were 16 percent for hypertension and 24 percent for current cigarette smoking.

Finally, a register of patients with hypertension was established and maintained in a sample of general practitioners' surgeries in the Hunter Region in order to discover the rates of control of hypertension in general practice. Eight hundred and thirty-nine hypertensive patients were entered on the registers, the majority of whom (95 percent) were currently receiving pharmacological treatment for hypertension. However, 38 percent of treated hypertensive patients aged 25 years or older had a diastolic pressure equal to or greater than 90mmHg (poorly controlled blood pressure). Hence, it is essential to explore the reasons for the inadequate control of blood pressure in order to decrease the rates of cardiovascular disease in the community.

The principal conclusion of this work is that in this population, the presence of hypertension and its poor control despite treatment may be important aetiologically both for myocardial infarction and stroke occurrence. This is unlikely to be due to failure to detect hypertension, to start treatment or to provide adequate follow-up care, since the majority of subjects in the community had had a recent blood pressure measurement taken and the majority of those with a history of hypertension were on therapy and reported a recent visit to a doctor, but is consistent with low compliance with antihypertensive therapy. It is possible that patients' poor compliance with antihypertensive medication is related to the development of stroke and myocardial infarction and future studies should explore this issue in an attempt to reduce the community burden of these diseases.

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GEOGRAPHIC AND DEMOGRAPHIC CHARACTERISTICS OF THE STUDY AREA: THE LOWER HUNTER REGION OF NEW SOUTH WALES, AUSTRALIA

The Hunter Region is located on the east coast of Australia about 150 kilometres north of Sydney as shown in Figure i. Subjects were identified from the residents of the Lower Hunter Region of New South Wales, comprising the five urban Local Government Areas of Newcastle, Lake Macquarie, Cessnock, Maitland and Port Stephens. The total population of the study area was 390,102 at the 1981 Census (Australian Bureau of Statistics, 1983a), and had increased to 405,089 by the 1986 Census (3.7 percent change) (Australian Bureau of Statistics, 1987). The age and sex characteristics of the study population at the 1986 Census are shown in Table i and an outline map of the Lower Hunter Region is shown in Figure ii.

The study area is predominantly urban, centered around the industrial city of Newcastle, the sixth largest city in Australia. Newcastle City covers an area of 213 square kilometres and is the smallest Local Government Area in the Hunter Region, although with the highest population density (population 106,042 in June, 1986). The City of Newcastle is a major industrial and commercial centre with one of the largest ports in Australia (Port of Newcastle). To the south lies the City of Lake Macquarie, centered on one of the largest lakes in Australia, with dormitory suburbs in the north, east and north-west. In the southern and south-western areas of the city are more open rural areas. Lake Macquarie is one of the most populous residential Local Government Areas with a population of 116,140 at the 1986 Census.

To the north of the City of Newcastle is the Port Stephens Shire (population 26,579 at the 1986 Census) which is predominantly rural in nature apart from its coastal holiday and retirement towns. Port Stephens is unique in that its rapid population growth is due to people retiring to the coastal resort centres, as well as growth in the Air Force Base. Between Newcastle and the Upper Hunter Valley lie the cities of Maitland and Cessnock. Maitland (population 32,267 at the 1986 Census) began as a river port and centre for trade and agriculture but is increasingly providing dormitory suburbs for Newcastle and has scattered industries upon which suburban housing is encroaching from Newcastle. Cessnock, a predominantly rural area, spreads over 1,962 square kilometres

and accommodates a large number of wineries which have made the area a major tourist destination for both domestic and international tourists. The Cessnock area contains several mining towns based on Cessnock coal fields which commenced production around 1900. Today a substantial part of the work force is still associated with mining although a large aluminium smelter and several manufacturing industries have also been established. It had a population of 31,083 at the 1986 Census.

The main fields of employment in the Hunter Region are steel manufacturing and heavy engineering, coal mining, electricity generation and related activities, as shown in Table ii (Australian Bureau of Statistics, 1987; The Hunter Valley Research Foundation, 1989). In 1988 the area had a higher (9.9 percent) unemployment rate (the number of unemployed as a percentage of the labour force) than the total for the State of New South Wales (7.1 percent) and for Australia as a whole (6.8 percent).

The distributions by age, sex, and marital status of the study population are similar to those for Australia as a whole (see Table iii). In addition, the Hunter population is relatively stable (3.7 percent increase between the 1981 Census and the 1986 Census), of a convenient size (Table i) to allow for obtaining an adequate sample size needed for this work, and apart from a low immigrant population (Table iii) and relatively few people in professional and administrative occupations and many in skilled and semi-skilled occupations, especially mining, than elsewhere (Table iv), the Hunter population is representative of the Australian community as a whole. While the differences outlined above between the Hunter community and the Australian community as a whole must be considered when deciding the generalizability of the findings of this series of studies, there is no reason to believe that the results of this work cannot be generalized to other parts of Australia.

Figure i. Map of Australia; the geographical location of the study area (the Lower Hunter Region) in relation to the Australian Continent.

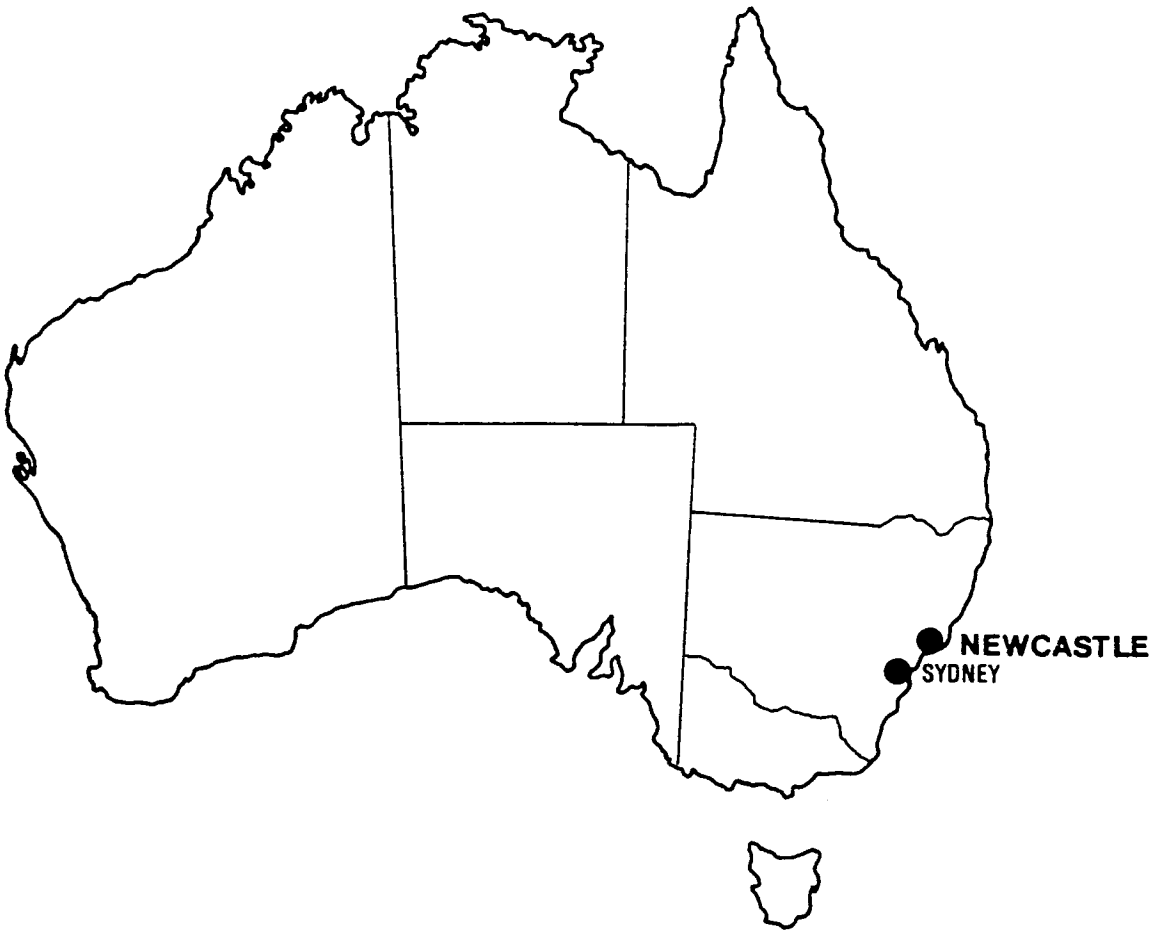


Figure ii. Outline map of the study area: the Lower Hunter Region of New South Wales.

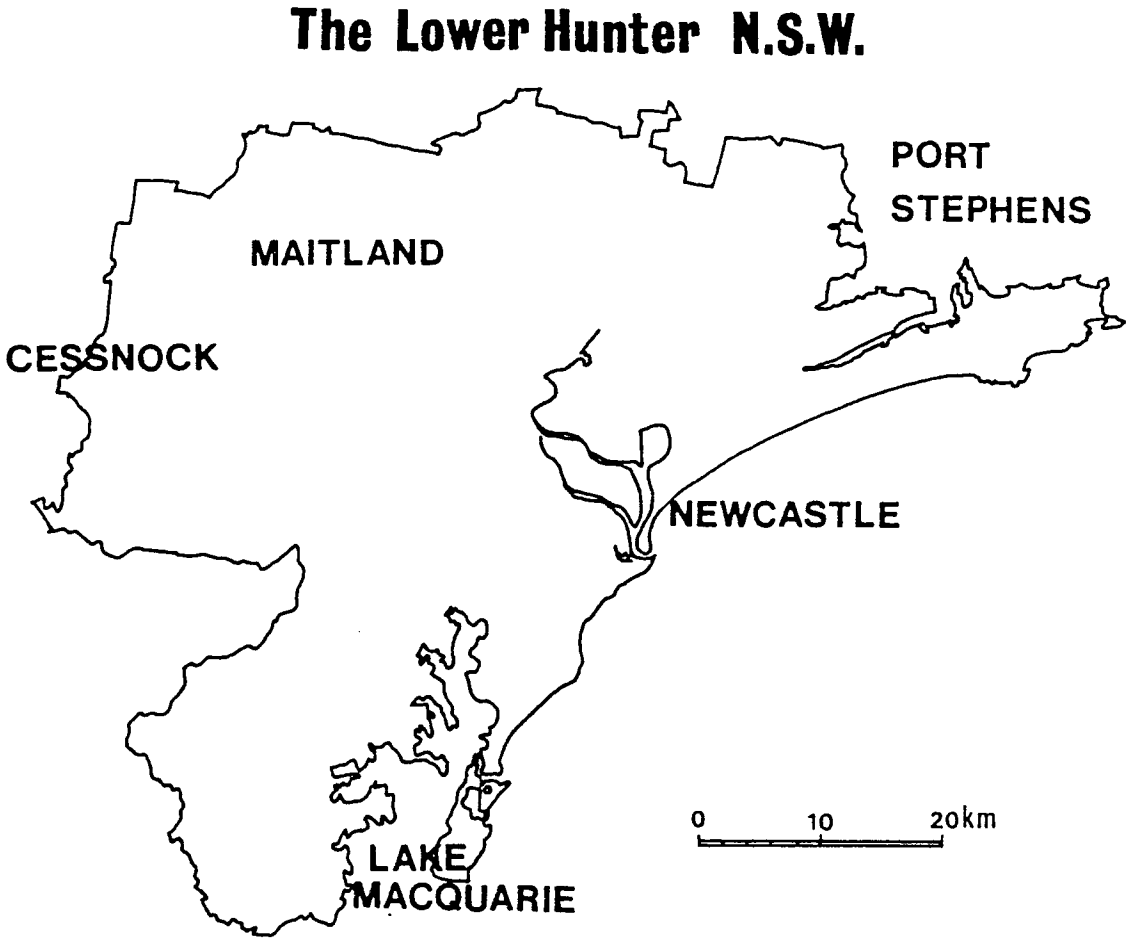


Table i. Population in the Lower Hunter Region at June, 1986 Census.

Age Group (years)	Men (n)	Women (n)	All Persons (n)
Less than 20	64150 (32)*	59235 (29)	123385 (30)
20-29	33413 (17)	31821 (16)	65234 (16)
30-39	31016 (15)	30490 (15)	61506 (15)
40-49	22734 (11)	22023 (11)	44757 (11)
50-59	19550 (10)	19960 (10)	39510 (10)
60-69	17813 (9)	19327 (9)	37140 (9)
70-79	9586 (5)	13079 (6)	22665 (6)
80 and over	2639 (1)	8253 (4)	10892 (3)
Total	200901 (100)	204188 (100)	405089 (100)

* Percentages in parentheses.

Source: Australian Bureau of Statistics, the 1986 Census of Population and Housing.

Table ii. Distribution of employment in the Hunter Region of New South Wales.

Number of People in the Labour Force	1981 Census 187,477	1986 Census 181,879
Agriculture, Forestry, Fishing and Hunting	3.8%	4.0%
Mining	5.4%	6.5%
Construction	7.8%	6.6%
Manufacturing	21.4%	16.6%
Electricity, Gas and Water	3.3%	3.5%
Wholesale, Retail	15.1%	17.7%
Transport and Storage	5.1%	5.6%
Communication	1.4%	1.5%
Finance, Property and Business Services	6.3%	7.6%
Public Administration and Defence	4.1%	5.1%
Community Services	13.4%	16.6%
Recreational, Personal and Other Services	5.0%	5.8%
Not Classified/Not Stated	7.9%	2.9%
Total Labour Force	100%	100%

Source: The Hunter Valley Research Foundation, 1989.

Table iii. Comparison of the distributions by age, sex, marital status of the Hunter Region with those for Australia as a whole, at June 1986 Census*.

	Hunter Region Percentage	National Percentage
Number of People	**405,089**	**15,602,156**
Age group (years):		
Under 15	22.9	23.3
15 - 24	16.1	16.6
25 - 39	23.3	24.1
40 - 64	25.8	25.4
65 and over	11.9	10.6
Total	100.0	100.0
Sex:		
Males	49.4	49.8
Females	50.6	50.2
Total	100.0	100.0
Marital Status:		
Never married	26.0	28.4
Married	58.7	57.8
Separated not divorced	2.5	2.6
Divorced	5.3	4.7
Widowed	7.5	6.5
Total	100.0	100.0
Birthplace:		
Australia	88.6	77.6
Other Oceania	0.8	1.5
U.K. & Ireland	4.1	6.9
Southern Europe	2.3	5.3
Other Europe & U.S.S.R.	0.4	0.5
Asia	0.4	1.2
Others	2.2	5.4
Not stated	1.2	1.6
Total	100.0	100.0

* Source. Australian Bureau of Statistics, the 1986 Census of Population and Housing

Table iv. Comparison of the distribution of occupations in the Hunter Region with that for Australia as a whole in people aged 15 years and over, at June 1986 Census*.

Number of People in the Workforce	Hunter Region Percentage 151,680	National Percentage 6,513,515
Managers and Admin.	6.8	11.7
Professionals	10.5	11.8
Para-professionals	7.1	6.5
Tradespersons	18.3	15.3
Clerks	14.4	17.1
Sales & Personal Services	12.6	12.4
Plant & Machine Operators	11.3	8.2
Labourers & Related Workers	16.6	14.4
Inad. Described & N.E.I.	1.3	1.5
Not Stated	1.1	1.1
Total	100.0	100.0

* Source: Australian Bureau of Statistics, the 1986 Census of Population and Housing

CHAPTER I

GENERAL INTRODUCTION

BACKGROUND

Cardiovascular Disease in Australia: A Major Public Health Problem

Cardiovascular disease has been the leading cause of death in Australia over the past thirty years, accounting for almost half of all deaths each year. Table 1.1 shows that there were 55,262 deaths in Australia attributable to cardiovascular disease in 1986, representing 48.1 percent of all deaths in that year. Of these, ischaemic heart disease accounted for 27.8 percent of all deaths, stroke was responsible for 10.9 percent and 9.4 percent of all deaths were due to other cardiovascular disease (National Heart Foundation of Australia, 1987). This compares with 24.3 percent of all deaths which are ascribed to malignant neoplasms and 2.6 percent due to traffic accidents during the same year (National Heart Foundation of Australia, 1987).

Although there have been declines in death rates of 52.4 percent and 56.6 percent in the last twenty years from ischaemic heart disease and cerebrovascular disease respectively (Al-Roomi *et al.*, 1989), death rates from cardiovascular disease in Australia remain high compared with those in many other countries. Uemura and Pisa (1985), from the World Health Organization, have produced tables for the death rates which occurred in 1980 in 27 industrialized countries from ischaemic heart disease and other cardiovascular diseases; Australia ranked the eighth highest for ischaemic heart disease and was midway down the tables for all cardiovascular diseases.

Table 1.1. Causes of deaths in men and women in Australia in 1986*.

Cause of Death	Men		Women		All Deaths	
	No.	% of Total	No.	% of Total	No.	% of Total
Cardiovascular Disease						
Ischaemic heart disease	18055	29.0	13946	26.4	32001	27.8
Stroke	5000	8.0	7491	14.2	12491	10.9
Other cardiovascular	4891	7.9	5879	11.1	10770	9.4
All cardiovascular	27946	44.9	2731	51.7	55262	48.1
Cancers	15701	25.2	12194	23.1	27895	24.3
Traffic accidents	2132	3.4	855	1.6	2987	2.6
All other causes	16416	26.4	12404	23.5	28820	25.1
All causes (total)	62195	99.9	52769	99.9	114964	100.1

* Source: National Heart Foundation of Australia, 1987.

Thom and his fellow researchers, (1985) compared trends in total mortality and mortality from ischaemic heart disease in 26 countries from 1950 to 1978 in men and women aged 45-64 years. Despite a fall in mortality from ischaemic heart disease in Australia over the period from 1950 to 1978 of roughly 20 percent for men and 25 percent for women, death rates from ischaemic heart disease were the eighth highest for men and the twelfth highest for women of the 26 countries. The proportionate mortality from ischaemic heart disease (percent of total mortality due to heart disease) in Australia remained around 40 percent throughout the 28-year span indicating that ischaemic heart disease continues to be the most common cause of death in Australia and a major public health problem.

In addition, ischaemic heart disease is the greatest cause of permanent disability and is responsible for more days of hospitalization than any other single disorder. In 1981, a survey conducted by the Australian Bureau of Statistics of 33,000 households and 723 institutions throughout Australia revealed that an estimated 375,000 Australians were suffering from some degree of disability due to cardiovascular disease. The cost of heart disease in 1984 was estimated to be in the region of $1,500-2,000 million (Ballarat College of Advanced Education, 1984): this consisted of the hospital, medical and pharmaceutical costs that were related to treatment during 1984 ($600 million) and the cost of loss of future productivity attributable to illness and premature death ($900-1,400 million). In 1984, patients who were suffering from ischaemic heart disease, stroke and other circulatory disease occupied 16 percent of hospital beds and the cost of medications prescribed for these patients accounted for 17 percent of the total cost of medications (Commonwealth Department of Health, 1985).

Cardiovascular Disease in the Hunter Region of Australia

The Hunter Region of New South Wales, Australia, comprising the city of Newcastle and surrounding areas, (see the Preliminaries, Pages xxiii to xxvi), has exceptionally high morbidity and mortality rates from ischaemic heart disease and cerebrovascular disease compared with other countries (The Principal Investigators of the MONICA Project, 1987), and with other parts of Australia (Dobson, Gibberd and Leeder, 1980; Leeder *et al.*, 1983). A comparison of the age-standardised mortality rates from ischaemic heart disease and other cardiovascular diseases which occurred in 1984 in 32 study populations in 26 countries revealed that death rates from ischaemic heart disease

in Newcastle were the eighth highest for men and the fourth highest for women. In addition, the death rates from cerebrovascular disease ranked the fifteenth highest and the twelfth highest for men and women, respectively, (The Principal Investigators of the MONICA Project, 1987).

A comparison between the death rates from ischaemic heart disease in three Australasian MONICA Centres (Newcastle, Auckland and Perth) showed that in 1982-1984, the age-standardised death rates from ischaemic heart disease in Newcastle were 44 percent higher for men and 95 percent higher for women than in Perth (Western Australia), and in the same period they were 13 percent and 45 percent higher for men and women respectively than in Auckland (New Zealand). The cardiovascular risk factor levels are also higher than in both Perth and Auckland (MONICA Centres: Auckland, Newcastle and Perth, 1988). In the period 1979-1983, the age-adjusted death rates from both ischaemic heart disease and cerebrovascular disease in the Hunter Region were high compared with most other parts of the state of New South Wales. This was the case for both men and women (O'Connell, Lam and Gibberd, 1987).

Examination of the major disease categories for acute public hospital admissions in the Hunter Region during the period from 1984 to 1986 (Hunter Health Statistics Unit, 1987) reveals that cardiovascular diseases ranked in the top ten diagnostic categories, both in the number of cases and in the number of in-hospital bed days. Patients with ischaemic heart disease (patients given hospital diagnoses with the 9th revision of the International Classification of Diseases codes 410-414) used 4 percent of the total bed days and patients with cerebrovascular diseases (patients given hospital diagnoses with International Classification of Diseases codes 430-438) used 6 per cent of the total bed days. The average length of stay in hospital was approximately 11 days for patients with ischaemic heart disease and approximately 30 days for patients with cerebrovascular disease (Hunter Health Statistics Unit, 1987). This highlights the importance of cardiovascular disease as a major source of morbidity in the Hunter Region.

risk factors related to the development of cardiovascular disease. Both epidemiological studies of individuals (e.g., the Framingham Study, Dawber, 1980) and international comparative studies of populations (e.g., The Seven Countries Study, Keys *et al.*, 1980) have identified elevated blood pressure, cigarette smoking and raised serum cholesterol as the most important treatable risk factors that predispose individuals to the development of ischaemic heart disease - "the Big Three Risk Factors". In addition, epidemiological studies have also identified many other contributing factors to ischaemic heart disease which have either been less consistently predictive, or their effects are mediated by the three major risk factors. Such risk factors include, among others, obesity (Ashley and Kannel, 1974), impaired glucose tolerance (Fuller *et al.*, 1980), occupational or socio-economic status (Marmot *et al.*, 1978), family history (Conroy *et al.*, 1985), physical inactivity (Scragg *et al.*, 1987) and haemostatic factors (Mead, Imeson and Stirling, 1987).

The relative importance of the major risk factors is quite different in the cerebral and coronary circulations. Whilst both cerebrovascular and coronary events are strongly correlated with the level of systemic blood pressure, neither raised serum cholesterol levels nor cigarette smoking has been shown to be as clearly related to the incidence of stroke as to the incidence of myocardial infarction. More recently, a study of Hawaiian men of Japanese ancestry has demonstrated that cigarette smoking was associated with an increased incidence of both thromboembolic and haemorrhagic strokes (Abbott *et al.*, 1986).

Studies have also found that the relative importance of these risk factors in ischaemic heart disease changes with age. Serum cholesterol levels and smoking were the strongest predictors of disease in younger age groups and their importance decreased with age, in contrast to blood pressure which remained an important predictor throughout the age range (Doll and Peto, 1976; Kannel and Gordon, 1978).

In recent years a number of reports have been produced on the prevention of cardiovascular disease in Australia, each containing recommendations concerning the prevention of ischaemic heart disease and other cardiovascular disease through the reduction of modifiable cardiovascular risk factor levels in the community (Department of Health in New South Wales, 1985; Better Health Commission, 1986; Health Targets and Implementation Committee, 1988). While the modification of all risk factors in the

community is desirable, the justification for these recommendations rests on the associations demostrated in overseas epidemiological studies which have linked risk factors such as raised serum cholesterol levels, elevated blood pressure and cigarette smoking to the development of ischaemic heart disease (the Pooling Project Research Group, 1978). Many epidemiological studies have reported high prevalence rates of cigarette smoking and raised blood pressure in communities where ischaemic heart disease is rare such as Japan
and China (The WHO MONICA Project, 1988), while the unusually high death rates from ischaemic heart disease in South Asians overseas do not appear to be related to the standard cardiovascular risk factors (McKeigne, Miller and Marmot, 1989).

Thus, it is vital that the role of the main aetiological risk factors in the development of ischaemic heart disease and cerebrovascular disease in the Australian community is established in order that preventive programmes can be implemented effectively.

Hypertension as a Cardiovascular Risk Factor

One of the foremost public health problems in Australia, the United States and most other economically developed countries is hypertension. The disease is also becoming increasingly recognized as a major national contributor to mortality and morbidity in many of the less developed countries (Nissinen *et al.*, 1988). Despite substantial improvements in the control of hypertension in the past decade, studies have persistently shown that a large proportion of the population still has high blood pressure. A 1983 Risk Factor Survey (Alexander *et al.*, 1986) found that, in the Hunter Region of Australia, 34 percent of men and 29 percent of women aged 35-64 years were hypertensive (they either had a diastolic blood pressure of at least 90mmHg or were on treatment for hypertension). Fifty-seven percent of these hypertensive men and 34 percent of the hypertensive women were not taking medication. Of those on treatment, the blood pressures of 49 percent of men and of 34 percent of women were not being adequately controlled (i.e., they had a diastolic blood pressure of at least 90mmHg).

Results from a nationwide survey conducted in 1976-1980 in the United States found that 34 percent of hypertensives aged 18-74 years had their blood pressure controlled (160/95mmHg or less). When the stringent criterion of blood pressure less

than 140/90mmHg was applied, the blood pressures of only 11 percent of the hypertensive population of the United States were estimated to be under control (Subcommittee on Definition and Prevalence of the 1984 Joint National Committee, 1985).

In 1983, The Australian Health Survey estimated that 1.5 million men and 0.8 million women took medications for heart disease or high blood pressure* during the two weeks before interview (Australian Bureau of Statistics, 1983b). In addition, hypertension has become the most common reason for initiating lifetime medication. The Australian Health Survey (Australian Bureau of Statistics, 1983c) found that hypertension was the main reported reason for consulting a doctor in the two weeks prior to the survey.

Hypertension is a well-established risk factor for ischaemic heart disease and cerebrovascular disease. A major source of information on hypertension as a risk factor for cardiovascular disease has been and continues to be the Framingham Study, for which a 30 years' follow-up has recently been published (Stokes *et al.*, 1987; Stokes *et al.*, 1989). The original findings have not changed: hypertension is a consistent and modifiable contributor to ischaemic heart disease and stroke. The risk is proportional to the degree of blood pressure elevation, systolic or diastolic, persistent or occasional. This conclusion is based not only on the epidemiological evidence (reviewed by Kannel and Stokes, 1985) but also on results from intervention studies, which have demonstrated that the reduction of blood pressure reduces the risk of cardiovascular events occurring (Hypertension Detection and Follow-up Program Cooperative Group, 1988).

* *The survey question was worded: "Were you taking heart, blood pressure medicines or fluid tablets in the last two days?".*

Demonstration of a statistically significant association between a risk factor such as high blood pressure and the subsequent development of ischaemic heart disease does not prove that this association is causal. While randomized placebo-controlled trials have demonstrated that the pharmacological modification of serum cholesterol levels (Lipid Research Clinics Program, 1984) and the cessation of cigarette smoking (Hjermann *et al.*, 1981; Rose *et al.*, 1982) reduce the risk of death from ischaemic heart disease, no placebo-controlled trial of antihypertensive therapy has demonstrated a reduction in the incidence of ischaemic heart disease. Indeed, the treatment of hypertension is mainly justified by the reduction it produces in the incidence of stroke (Australian National Blood Pressure Study Management Committee, 1980; Medical Research Council Working Party, 1985).

The Hypertension Detection and Follow-up Program Cooperative Group (1979) examined the risk of cardiovascular events occurring in two groups: a stepped-care group, which was given a specific step-wise pharmacological programme, and a control (referred-care) group, which received treatment of an unspecified regimen. In addition, the stepped-care group received a comprehensive, vigorous, free system of medical care as opposed to the traditional fee-for-service system available to the control group. Although the results from the Hypertension Detection and Follow-up Program Cooperative Group showed that the incidence of both stroke (1982) and coronary events (1984) was lower in the stepped-care group, which achieved better control of blood pressure than the referred-care (control) group, some researchers have questioned the findings of the Hypertension Detection and Follow-up Program Cooperative Group (1979) because of the above differences in the nature of the overall system of medical care between the two groups (Alderman, 1986).

Examination of the randomized placebo-controlled trials related to hypertension reveals that the results differ markedly for cerebrovascular disease and ischaemic heart disease. Cerebrovascular disease has the stronger relationship to elevated blood pressure and the more consistent response to blood pressure reduction. Table 1.2 shows that antihypertensive therapy reduces the incidence of stroke by an average of 46 percent, suggesting that the increased risk is largely reversible by treatment. However, the results of the trials of antihypertensive therapy have generally shown no change or small reductions in the incidence of myocardial infarction, averaging about 7 percent (Table 1.3).

Table 1.2 **Randomized placebo-controlled drug treatment trials in hypertension: difference in incidence of strokes (combined end point of fatal and non-fatal).**

Trial	Active Treatment		Placebo Treatment		
	Number of Strokes	Number of Patients	Number of Strokes	Number of Patients	Difference (per cent)
USPHS	1	193	6	196	-83
VA1	1	68	3	63	-67
VA2	5	186	20	194	-75
ANBPS	13	1,721	22	1,706	-41
MRC	60	8,700	109	8,654	-45
EWPHE	32	416	48	424	-33
Total	112	11,284	208	11,237	-46

Source of Information and Abbreviations:

USPHS (The United States Public Health Service Trial, Smith, 1977)

VA1 (Veterans Administration Cooperative Study Group on Antihypertensive Agents, 1967)

VA2 (Veterans Administration Cooperative Study Group on Antihypertensive Agents, 1970)

ANBPS (Australian National Blood Pressure Study Management Committee, 1980)

MRC (Medical Research Council Working Party, 1985)

EWPHE (The European Working Party on High Blood Pressure in Elderly Trial, Amery *et al.*, 1985).

Table 1.3. **Randomized placebo-controlled drug treatment trials in hypertension: difference in incidence of myocardial infarction (combined end point of fatal and non-fatal).**

Trial	Active Treatment		Placebo Treatment		
	Number of Myocardial Infarctions	Number of Patients	Number of Myocardial Infarctions	Number of Patients	Difference (per cent)
USPHS	14	193	15	196	-7
VA1	0	68	2	63	$-\infty$
VA2	7	186	5	194	+40
ANBPS	33	1,721	33	1,706	0
MRC	222	8,700	234	8,654	-5
EWPHE	48	416	59	424	-18
Total	324	11,284	348	11,237	-7

Source of Information and Abbreviations:

USPHS (The United States Public Health Service Trial, Smith, 1977)

VA1 (Veterans Administration Cooperative Study Group on Antihypertensive Agents, 1967)

VA2 (Veterans Administration Cooperative Study Group on Antihypertensive Agents, 1970)

ANBPS (Australian National Blood Pressure Study Management Committee, 1980)

MRC (Medical Research Council Working Party, 1985)

EWPHE (The European Working Party on High Blood Pressure in Elderly Trial, Amery *et al.*, 1985).

A recent study of 34,000 subjects with mild to moderate hypertension (diastolic blood pressure ranging from 85 to 120mmHg), pooled from eight community-based randomized trials of pharmacological treatment of hypertension (Hebert *et al.*, 1988), reported highly significant reductions of approximately 40 percent in total (fatal and non-fatal) stroke events (odds ratio 0.60; 95 percent confidence interval 0.51 to 0.71) and fatal stroke (odds ratio 0.58; 95 percent confidence interval 0.44 to 0.77). This is unlike the odds ratios for either total myocardial infarction events (0.91; 95 percent confidence interval 0.82 to 1.01) or for fatal myocardial infarction (0.92; 95 percent confidence interval 0.78 to 1.08) which did not achieve statistical significance. However, although the 9 percent reduction in incidence of myocardial infarction is of a lower magnitude than that for stroke, the study indicates that treatment for hypertension may be beneficial in reducing the risk of myocardial infarction in the intervention group. A summary of the findings of this statistical overview is presented in Table 1.4.

Table 1.4. A statistical overview of eight community-based randomized trials of pharmacological treatment of mild to moderate hypertension*.

	Odds Ratio	95% Confidence Interval	P Value**
All cause mortality	0.88	0.79-0.97	0.01
Vascular mortality	0.82	0.72-0.93	<0.003
Non-vascular mortality	0.97	0.84-1.13	0.72
All stroke	0.60	0.51-0.71	<0.0001
Fatal stroke	0.58	0.44-0.77	<0.0002
All myocardial infarction	0.91	0.82-1.01	0.19
Fatal myocardial infarction	0.92	0.78-1.08	0.33

* These trials were:

(1) The US Public Health Service Study (Smith, 1977)

(2) The Veterans Administration - National Heart, Lung and Blood Feasibility Study (Perry *et al*, 1978)

(3) The Hypertension Detection and Follow-up Program Cooperative Group (1979)

(4) Medical Research Council Working Party (1985)

(5) Australian National Blood Pressure Management Committee (1980)

(6) The European Party on High Blood Pressure in Elderly Trial (Amery *et al*, 1985)

(7) The Oslo Study (Helgeland, 1980)

(8) The Elderly Patients in Primary Care Trial (Coope and Warrender, 1986).

** Two-sided P value.

Several explanations have been proposed for the failure to achieve a reduction in the incidence of coronary events as a result of antihypertensive therapy. Earlier explanations concentrated on the inadequate sample size of the individual trials to detect the more likely small, but clinically important, differences in morbidity and mortality between treated and untreated patients. However, it is unlikely that this explanation would account for the inability of studies to demonstrate significant effects of therapy on the incidence of ischaemic heart disease because recent studies, which combined the data from individual trials and thus increased the statistical power of the analysis, have failed to demonstrate a significant effect of antihypertensive therapy on the risk of myocardial infarction (Hebert *et al.*, 1988; Cutler, MacMahon and Furberg, 1989).

A more likely explanation is the adverse effects of antihypertensive therapy. Since most trials used mainly diuretics as the primary antihypertensive agent, which were found to increase blood cholesterol levels by about 3-5 percent (Medical Research Council Working Party on Mild to Moderate Hypertension, 1981; Weidmann, Gerber and Mardasini, 1983), such an effect on serum cholesterol might be expected to increase the risk of ischaemic heart disease by about 6-10 percent (Lipid Research Clinics Program, 1984). This effect alone could substantially offset the potential benefits of blood pressure reduction, which might have reached a reduction in risk as great as 15-20 percent (rather than the 10 percent reduction in the incidence of myocardial infarction demonstrated in trials - Table 1.4). Another possible explanation for the lack of demonstrated reduction in risk of myocardial infarction is the reduction of perfusion to below a critical level in the coronary circulation by lowering blood pressure in those individuals with pre-existing ischaemic heart disease (Cruickshank, Thorp and Zacharias, 1987a).

RESEARCH METHODOLOGY

The Purpose of the Study

Because the prevention of both ischaemic heart disease and cerebrovascular disease is a major public health priority (Better Health Commission, 1986) and because hypertension is highly prevalent in the Australian community (National Heart Foundation of Australia Risk Factor Prevalence Study No. 2, 1985), any efforts at trying to prevent the occurrence of myocardial infarction and stroke in the Australian population must start by discovering both the extent to which hypertension is currently contributing to the aetiology of myocardial infarction and stroke and the extent to which this hypertension has been controlled adequately. If the control of blood pressure of those who later develop stroke or myocardial infarction has been less than adequate, this will emphasize the need for improving control of hypertension in the community as a preventive measure.

Study Design

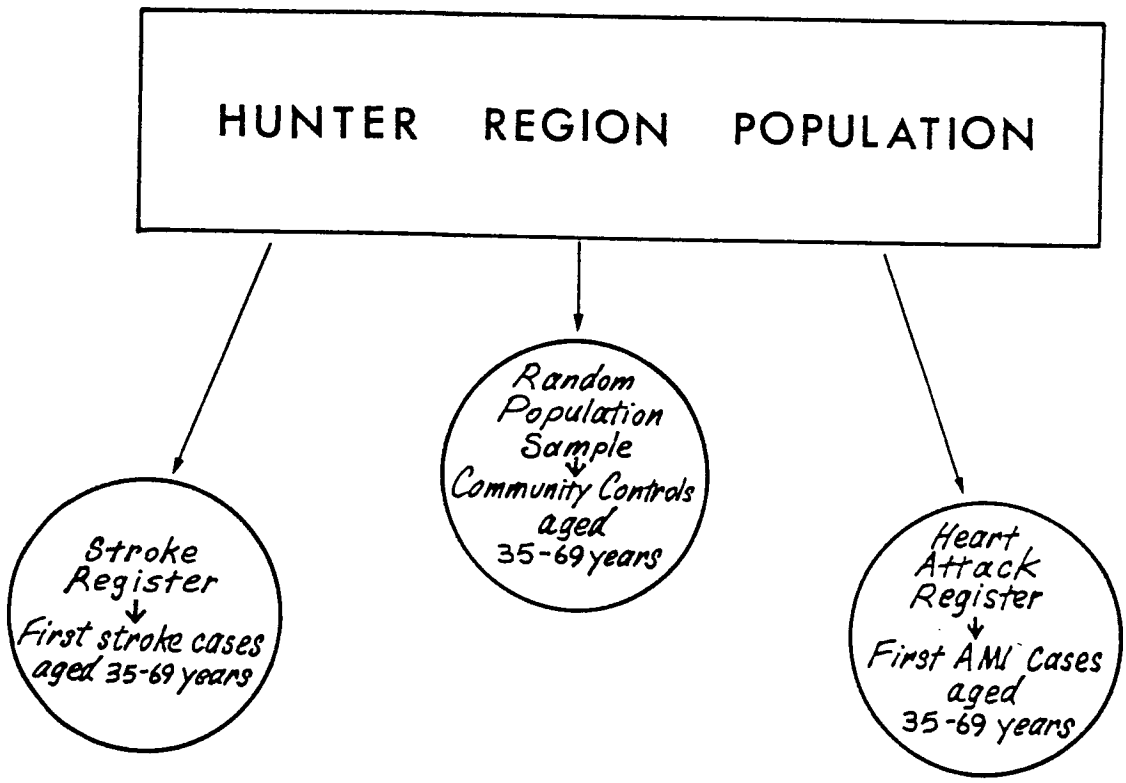
Not only are experimental studies rarely feasible in epidemiological research but, moreover, prospective, randomized placebo-controlled trials in patients with moderate to severe hypertension (those with a diastolic blood pressure equal to or greater than 105mmHg) are unacceptable for both ethical and practical reasons (Veterans Administration Cooperative Study Group on Anti-hypertensive Agents, 1967). Therefore, more indirect methods of investigation must be employed when examining the relationship between the control of hypertension and the incidence of acute myocardial infarction and stroke.

The case-control study design can be viewed as a longitudinal study backwards (Greenland and Morgenstern, 1988). However, from a practical standpoint, the case-control design has the chief advantage of being more efficient in terms of time and cost than the follow-up design. In addition, all the persons with the disease in the study population are identified in the case-control study design in contrast with follow-up studies which suffer from the problem of the sizeable number of subjects from the original study cohort which are lost to follow-up, which can adversely affect the validity of the study (Greenland, 1977).

Case-control studies commend themselves when the outcome of interest is rare or the disease has a long latent period and therefore would require a large number of subjects to be studied over a long period of time to allow the natural incidence to produce sufficient cases for statistical interpretation (in the Framingham Study Cohort, of 2,282 men free of ischaemic heart disease, 365 men developed myocardial infarction over 24 years of follow-up) (Dawber, 1980, Page 33). Thus, case-control studies are well-suited to situations in which there is urgency about the research question or in which research resources are limited. In addition, the case-control design offers the opportunity to investigate multiple aetiological factors for a single disease simultaneously (Rothman, 1986, Chapter 6). This is particularly advantageous in this research project as the case-control design provides an opportunity to examine the role of selected modifiable risk factors, other than hypertension, in the aetiology of myocardial infarction and stroke in the Australian population.

The logistic and practical reasons discussed above made the case-control study design desirable for this research project which aims to investigate the relationship between the control of hypertension and the development of myocardial infarction and stroke. Cases of first myocardial infarction and first stroke are identified from community-based heart attack and stroke registers and compared with control subjects obtained from a random population sample from the same community. Cases of first myocardial infarction are compared with a representative group of community controls from the same population using identical questions for both cases and controls. In addition, treated hypertensive subjects who developed myocardial infarction are compared with persons on treatment for hypertension in the same community in order to examine the relationship between blood pressure control and the occurrence of myocardial infarction. The relationship between blood pressure control and the occurrence of stroke is also investigated using similar methodology to that described for myocardial infarction. A flow chart of the design of this study is shown in Figure 1.1.

Figure 1.1. Flow chart of the sources of cases of acute myocardial infarction (AMI) and stroke and community controls.



Sample Size

The sample size required in each group of cases and controls was determined from the sample size tables for unmatched case-control studies published by Schlesselman (1982, Appendix A). The study size is based on the statistical sample size formula (Schlesselman, 1974), which relates the size of the study to the following variables:

1. Level of statistical significance (alpha-error);
2. Chance of missing a real effect (beta-error);
3. Magnitude of the expected effect*;
4. The proportion of exposure among cases*;
5. The proportion of exposure among controls*.

The following formula was used to calculate the sample size (Schlesselman, 1974):

$$n = [Z_{\alpha}\sqrt{2\bar{p}\bar{q}} + Z_{\beta}\sqrt{(p_1q_1 + p_0q_0)}]^2 / (p_1 - p_0)^2$$

where $p_1 = p_0R / [1 + P_0 (R - 1)]$

$\bar{p} = {}^1/_2 (p_1 + p_0)$

$\bar{q} = 1 - p$

$q_1 = 1 - p_1$

$q_0 = 1 - p_0$

* *Footnote: The estimates of the baseline population which is exposed to the study factor and the estimates of the expected magnitude of effect are usually based on previously published reports.*

in which p_0 = the proportion of exposure among community controls;

R = the relative risk;

Z_α = value of the standard normal distribution corresponding to a significance level of alpha (e.g., 1.96 for a two-sided test at the 0.05 level);

Z_β = value of the standard normal distribution corresponding to the desired level of power (e.g., 0.84 for a power of 80 percent);

n = sample size for each group.

From the tables published by Schlesselman (1982, Appendix A), at the conventional alpha level of 0.05 and beta level of 0.20, assuming a minimum relative risk of 2.0 for myocardial infarction (based on data from the Framingham Heart Study, Dawber, 1980), and a prevalence of current treatment for hypertension of at least around 15 percent among community controls (based on data from the National Heart Foundation Risk Factor Prevalence Study No. 2, 1985), it is estimated that approximately 200 cases of myocardial infarction aged 35-69 years and a similar number of community controls aged 35-69 years would be needed.

Applying a similar formula for the stroke study, and assuming at least a relative risk of 2.5, it is estimated that approximately 110 patients with stroke aged 35-69 years would be needed in order to allow an 80 percent chance of detecting a difference in the exposed proportion between these stroke patients and the community controls at a significance level of 5 percent.

Because these sample size calculations are merely a minimum estimate of the desired sample size for the study, since the formula is based only on the estimate of the overall crude associations between exposure and disease and does not take into account any potential adjustment for confounders through stratification, it was decided to enlarge the size of the study (doubling the calculated numbers from the formula), aiming to obtain 400 community control subjects, 400 patients with myocardial infarction and 200 patients with stroke.

Study Population

The study population consists of all persons aged 35-69 years normally resident in the five urban local government areas in the Lower Hunter Region of New South Wales (Newcastle, Lake Macquarie, Cessnock, Maitland and Port Stephens); a population of 156,500 persons at the 1986 Census (75,400 men and 81,100 women, with a male:female ratio of 48:52). A detailed description of the demographic and geographic characteristics of the study area has been given earlier (see Preliminaries, Pages xxiii to xxx).

Aim

To examine the degree of control of hypertension and the contribution that a history of hypertension and the way it has been controlled might make to the aetiology of myocardial infarction and stroke in the community in the Lower Hunter Region of New South Wales.

Hypotheses

1. The proportion of subjects with a history of high blood pressure among patients with acute myocardial infarction and those with stroke is higher than among community controls.

2. The proportion of subjects on current treatment for hypertension among patients with acute myocardial infarction and those with stroke is higher than among community controls.

3. The percentage of hypertensives who are on current treatment for hypertension is lower among the myocardial infarction cases and the stroke cases than among the community hypertensive controls.

4. The percentage of poorly-controlled hypertensives (treated diastolic blood pressure equal to or greater than 90mmHg) is higher among patients with myocardial infarction and those with stroke than among community hypertensive controls.

Major Objectives

1. A Blood Pressure Survey of People in the Lower Hunter Region Community (Chapter II).

a. To conduct a population survey of a random sample of people living in the Lower Hunter Region, using the Electoral Roll as a sampling frame, seeking the following information: the date of the last visit to a doctor; whether the blood pressure was measured then; if not, when the last blood pressure meaurement was made; whether the subject was ever told that he/she had high blood pressure; whether treatment was ever given; if treatment is currently being given and which medication is being prescribed (Chapter II).

b. To test the repeatability of answers to the questions concerning blood pressure by sending a follow-up questionnaire is sent to respondents aged 35-69 years and to obtain information about cigarette smoking, alcohol intake, family history of high blood pressure, heart attack and stroke and demographic data. People on treatment for hypertension are asked to give the name and address of their general practitioner and are asked to give permission for researchers to contact their regular doctor (Chapter III).

c. To contact the regular doctors of those subjects who answered that they were currently receiving treatment for hypertension to ask about the date of the last blood pressure measurement taken before the survey and its level, and the pre-treatment blood pressure level. In addition, doctors are asked to provide the name/s of the antihypertensive medication prescribed.

2. Hypertension control and the Risk of Myocardial Infarction (Chapter IV).

a. To identify all patients aged 35-69 years with a diagnosis of acute myocardial infarction who were admitted to each of the seven main acute public hospitals in the Lower Hunter Region over a one year period (Chapter IV).

b. To administer to these patients or to the relatives of dead patients a questionnaire seeking information on history of blood pressure measurement and detection and

treatment of hypertension (Chapter IV).

c. To obtain, in addition, information about cigarette smoking behaviour, alcohol consumption habits and demographic data (Chapter IV).

d. To contact the general practitioners of those myocardial infarction patients and control subjects who answered that they were currently receiving treatment for high blood pressure to ask about the date of the last blood pressure measurement taken before the myocardial event or survey and its level, the pre-treatment blood pressure level and to confirm the type of antihypertensive medications prescribed (Chapter IV).

e. To compare this information with similar data obtained from a random sample of people aged 35-69 years living in the same community (Chapter IV).

f. To calculate the measures of strength of the associations outlined above (Chapter IV) and the proportion of all patients suffering their first myocardial event that are attributable to hypertension and cigarette smoking (Chapter IV).

3. Hypertension Control and the Risk of Stroke (Chapter V).

a. To identify all patients aged 35-69 years with a diagnosis of stroke admitted to each of the seven acute public hospitals in the Lower Hunter Region over a one year period (Chapter VI).

b. To administer to these patients (or to their relatives if the patients are unable to communicate) or to relatives of dead patients, a questionnaire seeking information on the history of their blood pressure measurements and the detection and treatment of their hypertension (Chapter V). To obtain, in addition, information about cigarette smoking habits, alcohol consumption behaviour and demographic data.

c. To obtain details of pre-treatment and last recorded blood pressure levels before the event from the regular doctors of those stroke patients who answered that they were on current treatment for hypertension. In addition, to ask doctors for the name/s of the antihypertensive drugs prescribed (Chapter V).

d. To compare this information with data obtained by the same methods from a random sample of people living in the community and from patients admitted to hospital with a myocardial infarction (Chapter V).

e. To calculate the measures of strength of these associations and the proportions of all first stroke cases which are attributable to hypertension and cigarette smoking (Chapter V).

4. Management of High Blood Pressure in General Practice (Chapter VI).

a. To develop a simple registration system of people in the Lower Hunter Region who have hypertension (i.e., who are receiving treatment for hypertension or who have had high blood pressure recorded) (Chapter VI).

b. To pilot this simple registration system in a small, geographically confined area of the Hunter Region (Port Stephens) (Chapter VI).

c. To compare the degree of control of high blood pressure and the prescription patterns for hypertension among the general practices in the above region (Chapter VI).

Subsidiary Objectives

a. To investigate the ability of researchers to obtain medical information from the general population in the Hunter Region using a postal questionnaire (Chapter II).

b. To compare the prevalence of risk factors among treated hypertensives who had a myocardial infarction with people on treatment for hypertension in the community (Chapter IV).

c. To compare the prevalence of cardiovascular risk factors among treated hypertensives who had a stroke with treated hypertensives in the community and with myocardial infarction patients on treatment for hypertension (Chapter V).

d. To examine the role of selected modifiable risk factors, other than hypertension, in

the aetiology of myocardial infarction and stroke in the Hunter Region community (Chapters IV and V).

Statistical Methods and Data Analysis

Details of the procedures employed for data management and statistical analysis are described in the relevant chapters. All collected data are computerized and the SAS (SAS Institute Inc., 1985) and BMDP (Dixon *et al.*, 1985) statistical software packages are used for data management and statistical analysis. Analyses are carried out using the standard methods of odds ratio analysis (univariate and multivariate) used in case-control studies (Breslow and Day, 1980, Chapter 4; Schlesselman, 1982, Chapter 7). These include the Mantel-Haenszel method (Mantel and Haenszel, 1959) and logistic regression for unmatched analyses of case-control studies (Schlesselman, 1982, Chapter 7).

Compared with stratified analysis, the chief advantages of modelling are that it allows one to control more potential confounders than one could in simple stratified analysis and that it provides a direct estimate of the odds ratio after adjustment for potential confounders without the need for extensive stratification for all confounders. In addition, modelling allows one to estimate the variation in effect of exposure across levels of other risk factors (Greenland, 1989).

A general strategy, proposed by Greenberg and Kleinbaum (1985) and Greenland (1989), for employing stratified and modelling methods to evaluate the exposure to a risk factor and the occurrence of the disease is adopted. According to these guidelines, the first step in the multivariate analysis of epidemiological data should start by defining the disease and main exposure, along with the independent risk factors to be assessed as potential confounders; then a series of stratified and modelling analyses involving the same variables are performed in order to compare the results of the model with those obtained using the stratified data analysis; then one should perform the modelling exercises that cannot be directly validated against parallel stratified analysis; assess two-factor interactions in the model; assess confounding; finally calculate the adjusted odds ratio and the 95 percent confidence interval of the adjusted odds ratio from the logistic regression model.

For case-control data the linear logistic regression model for the probability (Pr)

that a sample subject is a case is derived from the equation (Greenland, 1989):

$$Pr\ (\ Case\ /\ x,\ Z_1,\ .....,\ Z_n)\ =\ 1\ [\ 1\ +\ exp\ (\ -\ q\ -\ bx\ -\ C_1Z_1\ -\ .....\ C_nZ_n].$$

The logistic models are fitted by the method of the maximum likelihood in the "PLR" procedure of the BMDP computer programmes (Dixon *et al.*, 1985).

The adjusted odds ratio ($\overline{OR}$) is calculated from the logistic model, from the equation (Greenberg and Kleinbaum, 1985):

$$\text{adjusted } \overline{OR}\ =\ exp\ [\ \beta\ (E^*\ -\ E^0\ )\ ]\ .$$

where ß is the regression coefficient for the exposure variable
and E^*, E^o are the levels of exposure
i.e., E^* = 1, exposed
E^o = 0, unexposed.

Using the estimated correlation matrix of the estimated coefficients and the estimated standard errors (SE) which are part of the BMDP LR output (Dixon *et al.*, 1985), one can calculate the 95 percent confidence interval (CI) of the adjusted odds ratio ($\overline{OR}$ [1,0]) from the equation (Lemeshow and Hosmer, 1984):

$$\ln\ (\overline{OR}\ [1,0])\ \pm\ 1.96\quad SE\quad [\ln\ \overline{OR}\ (1,0)]$$

The risk estimate is regarded as significant if the 95 percent confidence interval of the adjusted odds ratio did not include unity.

SUMMARY

A series of studies is undertaken in order to explore the degree of control of hypertension and the contribution that a history of hypertension and the way it has been controlled might make to the aetiology of myocardial infarction and stroke in the Hunter Region of New South Wales, Australia.

Firstly, a population survey is undertaken in a random sample of the adult population in order to discover its pre-existing blood pressure experience.

Secondly, a population-based case-control study is conducted to examine the relationship of the control of hypertension to the development of myocardial infarction and stroke in persons aged 35-69 years in the Lower Hunter Region of New South Wales. Cases of myocardial infarction and stroke are identified from community-based heart attack and stroke registers and the control subjects are obtained from a random population sample of the same community. Cases of first myocardial infarction are compared with a representative group of community controls from the same population, using identical questions for both cases and controls. In addition, treated hypertensive patients who develop myocardial infarction are compared with persons on treatment for hypertension in the same community.

Thirdly, the relationship between hypertension control and the occurrence of stroke is investigated using similar methodology to that described for myocardial infarction. In addition to the case-control analysis, a case-case analysis is performed using patients with myocardial infarction as controls.

Finally, a small scale study is mounted in a small, geographically confined area of the Hunter Region (Port Stephens Shire) in order to discover the rates of control of hypertension in general practice and to explore methods of improving the control of hypertension in the community.

CHAPTER II

A SURVEY OF BLOOD PRESSURE IN THE GENERAL POPULATION

INTRODUCTION

In recent years, both the medical profession and the public have been paying increasing attention to the detection and treatment of hypertension. About 15 years ago, surveys in Australia (Prineas, Stephens and Lovell, 1973) and the United States (Wilber and Barrow, 1972; Apostolides *et al.*, 1974) were finding: that only 50 percent of people with hypertension were aware of their condition; that about 50 percent of those aware of their hypertension were on treatment; and that the hypertension of only 50 percent of those on treatment was being controlled - in other words, only 12 percent of those with hypertension were being effectively treated. However, recent surveys in Australia (National Heart Foundation of Australia Risk Factor Prevalence Study No. 2, 1985), the United States (Folsam *et al.*, 1983; Phillips *et al.*, 1988) and other western countries (Birkett *et al.*, 1986) have shown a spectacular improvement in blood pressure control, with up to 70 percent of those with hypertension estimated to have their condition under control and only 5 percent of those with hypertension to have had their condition undetected.

These recent impressive treatment results raise questions about the value of further blood pressure screening. In many national (for example, National Heart Foundation of Australia Risk Factor Prevalence Studies Nos. 1 [1983] and 2 [1985]) and local (for example, the Hunter Region Risk Factor Prevalence Survey, Alexander *et al.*, 1986) population surveys, people were asked about past and/or present treatment for hypertension but were not asked whether their blood pressure had been measured in the past. This question has important implications concerning the need for screening services

to detect hypertension (attempts to identify hypertensive cases among apparently healthy individuals). If a minority of the population has undergone a blood pressure measurement, screening might detect unknown cases of hypertension. However, if most of the people in the community have had their blood pressure measured, screening would tend to discover hypertension that has been detected but not yet treated.

A population survey was undertaken in a random sample of the general population to determine the number of persons who had undergone a blood pressure measurement in the recent past. This chapter looks at the proportion of subjects who had undergone a blood pressure measurement in this sample of the general population, the prevalence of hypertension in this sample and investigates ways to achieve improvements in the control of hypertension in the community.

Hypothesis

A large proportion of the general adult population in the Lower Hunter Region has undergone a blood pressure measurement in the past three years.

Study Objectives

1. To select a random sample of people aged 18 years or older normally resident in the Lower Hunter Region of New South Wales, using the Electoral Roll as a sampling frame.

2. To send a postal questionnaire to those people chosen for the study, seeking the following information: the date of their last visit to a doctor; whether their blood pressure was measured on that occasion; if it was not measured, when their last blood pressure measurement was made; whether the subject was ever told he/she had high blood pressure; whether treatment was ever given; if treatment was currently being given and which medication is being prescribed.

3. To discover how many members of the general adult population have had a blood pressure measurement taken in the recent past; i.e., in the past three years.

Subsidiary Objectives

1. To investigate the ability of researchers to obtain medical information from the general population in the Lower Hunter Region using a postal questionnaire.

2. As an additional part of the study, respondents aged 35-69 years will be sent a second questionnaire which seeks information on: cigarette smoking habits; alcohol drinking behaviour; previous history of cardiovascular disease; height, weight and other demographic data. This additional information is required for comparison with similar data currently being collected from patients aged 35-69 years with a diagnosis of myocardial infarction in the same population. This additional part of the study will be described and discussed in Chapter III.

3. To test the repeatability of answers to the questions concerning blood pressure status.

STUDY METHODS

Study Population

The study population consisted of all persons aged 18 years and over normally resident in the Local Government Areas of Newcastle, Lake Macquarie, Cessnock, Maitland and Port Stephens (i.e., the Lower Hunter Region of New South Wales); a total population of 278,700 people (136,400 men and 142,300 women with a male:female ratio of 48:52) at the 1986 census (Australian Bureau of Statistics, 1987).

Choice of Sampling Frame

For the purpose of this study, it was decided that the sample should be taken of individuals and not of households. Apart from the Electoral Roll, there are no accessible sampling frames in Australia for drawing samples of names and addresses of individuals. Voting in Australia is compulsory and 97 percent of persons who are eligible to vote* are thought to be registered (Australian Electoral Office, 1983).

Although telephone directories and local authority rating records may provide alternative frames, only three-quarters of households have the use of a telephone (Australian Bureau of Statistics, The 1986 Census of Population and Housing, 1987) and local authority rating records can yield information for owner-occupied dwellings, but not for rented accommodation. Another disadvantage of the use of such sampling frames is that it would be necessary firstly to sample individual addresses, and then to sample persons living at these addresses. There is also the possibility of introducing a selection bias because people living in single-person households would have a greater chance of inclusion than people in multi-person households. In addition, there is no

* *To be eligible to enrol for Federal or New South Wales (State) Elections a person must be an Australian citizen, aged 18 years or older and have lived at the proposed enrolment address for at least the last month. British subjects who are not Australian citizens may re-enrol for Federal or State elections if they were on a Commonwealth or State Electoral Roll on 25th January ,1984 (Source: Australian Electoral Commission).*

evidence that these sampling frames are likely to provide a more representative sample of the population than can be gained from the Electoral Roll. The Electoral Roll was thus chosen as the sampling frame for this blood pressure survey.

Considerations in the Use of the Electoral Roll as a Sampling Frame

Despite the many advantages in using the Electoral Roll as a sampling frame, there are also well known limitations in its use which must be considered when a sample is selected. These limitations include the following: first, certain groups in the community are under-represented on the Electoral Roll, either because people have failed to register; e.g., younger people (paricularly those aged 18-24 years) or because persons are ineliglible to vote; e.g., new immigrants to Australia. A second problem in the use of the Electoral Roll is that the names of individuals, but not their date of birth, are listed. Thus, age-specific samples of the population cannot be obtained. The sample cannot be chosen directly for a particular target age-group and over-sampling would be needed to allow for wastage of those outside the required age-range. In addition, the researcher would have no information on the age of the non-respondents without undertaking an extensive follow-up of those who do not reply. Thirdly, because of the mobility patterns of adults in Australia, it is estimated that about 3.5 percent of listed voters will have moved from the address which appears on the roll within the first six months of its publication. By the twelfth month, this figure increases to about 5 percent (Australian Electoral Office, 1983). Thus, for sampling, the useful life of the Roll is probably the 12 month period following its publication.

The Timing of the Survey

At the time of planning this study, the most recently published Electoral Roll was the one produced for the Federal Election in December, 1984. It was felt important to perform the main survey before the Festive Season holidays (December, 1985) when normal living patterns can be interrupted. This would also have the advantage of being within the 12 month period following the publication of the current Roll and would minimize poor response due to persons having changed their address.

It was therefore decided to conduct a pilot survey in August, 1985 immediately

after the schools' mid-year holiday and to commence the main survey in October, 1985, with a follow-up of non-respondents in March, 1986.

The Pilot Survey

A random sample of 50 people was selected from the Commonwealth Electoral Roll of the Division of Newcastle using random number tables. Newcastle was chosen to pilot test the study because previous surveys in the Hunter Region have consistently reported that response rates are lower in Newcastle than in other parts of the region (Alexander *et al.*, 1986). This would allow the sample size estimates for the main survey to be calculated on the basis of the lowest expected response rate and might help to clarify techniques, which could improve the response rate to the survey.

The electors of each polling subdivision are numbered sequentially from 1 upwards in the Roll, according to the alphabetical listing of their surnames. A constant proportion sampling technique was used in order that the number selected from each subdivision would be proportional to the total number in that subdivision. In this way, larger numbers are selected from the larger areas and smaller numbers from the smaller areas. Those chosen for the pilot study were sent an introductory letter and a questionnaire with a reply-paid envelope.

Of the 50 questionnaires (initial mailing was carried out on 26th July, 1985), one letter was returned by the Post Office which advised that the person had recently moved from the address. Twenty-nine persons replied to the first letter (a response rate of 60%). Those who had not replied after two weeks were sent a reminder letter which included a copy of the original letter, a questionnaire and another reply-paid envelope. A second reminder letter, which included a copy of the questionnaire and a reply-paid envelope, was sent to those who had not replied by the fourth week from the initial mailing date of the first letter. This produced a further 10 replies - in all 39 replies. This represents an overall response rate of 78 percent (39/50) or 80 percent of those who could have replied (39/49).

There were postal delays in receiving reply-paid envelopes through the University of Newcastle (it took some 5-7 days for the author to receive the reply letters from the

date of their posting) which resulted in some people receiving a reminder letter after they had sent their replies. Two respondents telephoned our research unit to complain of receiving the reminders and only one person returned a second questionnaire. While duplicate replies could have been used as a test for the repeatability of the answers to the questions, it was felt difficult to justify in view of the irritation that it could cause to some members of the public. This, in turn, could have depressed the response rates. Thus, it was decided to change the timing of the reminder letter for the main study to avoid such a possibility.

Of the 39 persons replying, 36 (92 percent) reported having had a blood pressure measurement taken within the past three years. Of these persons, 32 (82 percent) reported having had such a measurement taken in the past year. Ten people had been told that their blood pressure had been raised in the past (26 percent) and 7 were currently receiving treatment for hypertension (18 percent of the total sample, or 70 percent of those with a history of raised blood pressure).

A study nurse visited the addresses of 5 non-respondents (a follow-up of a sample of one in two non-respondents). It was found that two had recently moved from the address in question, one person did not wish to be involved with the study, one person was not known at that address and the fifth person could not be identified due to insufficient address. Thus it appeared that at least a part of the lack of response was due to people having moved and the present occupier of that address not returning the letters to us.

On the basis of this pilot survey, it was felt that a reasonable response to a postal questionnaire in the Hunter Region could be expected and that the questionnaire, the technique of implementing the survey and the follow-ups were all feasible.

Sample Size Estimates

The required sample size for the main study was calculated using the prevalence estimates of the factor it was most important to estimate accurately; that is, the number of people who had had a blood pressure measurement.

The following formula was used to calculate the sample size (Cochran, 1977):

$$n = \frac{p \times q}{(2 \times SE)^2} = \frac{0.82 \times 0.18}{(2 \times 0.01)^2} = 369$$

where SE = Standard Error, p = Proportion with blood pressure measurement, q = 1-p, n = Sample size. Thus, to have a 95 percent chance of being within 1 percent of the correct figure (SE = 1 percent), the results from the prevalence estimate of 82 percent found in the pilot study indicate that at least 369 subjects would be needed.

However, taking into consideration that only 50 percent of the voting population, i.e., adults aged 18 years or older, was in the 35-69 year age group (to allow comparability with the prevalence of hypertension estimates for patients aged 35-69 years with a diagnosis of myocardial infarction - Chapter IV) and assuming a 78 percent response rate with 95 percent confidence interval (± two standard errors) of 66 to 90 percent

$$\left(SE = \frac{p \times q}{n} = \frac{78 \times 22}{50} = 5.9 \right),$$

a sample of 1,118 subjects would be needed

$$\left(369 \times \frac{100}{50} \times \frac{100}{66} = 1118 \right).$$

Therefore, it was decided to send the questionnaires to approximately 1,200 people, and a 0.5 percent sample of the voting population on the relevant part of the Electoral Roll was decided upon.

Sampling Method

In the Electoral Roll the sampling units are electors. For each polling subdivision, the electors are listed in alphabetical order of their surnames (this listing of individuals is different, for example, from that employed in Britain where the electors are listed in alphabetical order of street names and follow the numerical order of house numbers). Although it is less time-consuming to draw a systematic sample than a random sample from the Electoral Roll, it was felt that the alphabetical listing of names may constitute a pattern (e.g., names of ethnic origin) that might introduce bias into systematic samples drawn from the Electoral Roll. Random sampling methods were therefore chosen.

Because hypertension is widespread throughout the community and occurs in reasonable frequency in all parts of the Hunter Region (Alexander *et al.*, 1986), a general survey with low sampling ratio was thought to be appropriate (Cochran, 1977).

A fresh random sample was drawn from each of the 24 subdivisions corresponding to the lower Hunter Region using random numbers. In total, 1,200 Australian citizens aged 18 years or older (563 men and 647 women) were identified by random sampling from the Commonwealth Electoral Rolls (published for the Federal Election in December, 1984).

The Main Survey

The design of both the explanatory and the follow-up letters and the procedures implemented in sending and retrieving the questionnaires were those originally designed by Dillman (1978). The high response rates reported from studies in which this design method was used (Dillman, 1978) and the ease of its application made it desirable for this survey. The method is simply a collection of all those techniques which have been found in past research to improve the response rates to postal surveys: for example, personalization of correspondence (Dillman and Frey, 1974); official sponsorship of the survey/surveys (Clark, 1949; Filipello, Berg and Webb, 1958); shorter questionnaires (Spry *et al.*, 1989); addition of title under sender's name (Roeher, 1963; Blumberg, Fuller and Hare, 1974); assurance of confidentiality (Brandt, 1955; Bunning and Cahalan, 1973) and the use of follow-up letters (Nichols and Meyer, 1966; Dillman,

1972).

The Dillman design method for mail surveys relies heavily on personalization throughout the implementation process. In this way it is hoped to convey to the potential respondents the critical message that this is an important study and that the respondent's participation is important to its success. The text of the letters was stored in a computer. A secretary was employed for the study to type individually the respondent's name and address with the exact date the letter is to be mailed in normal business letter fashion. The individual letters were then printed through a high-speed printer connected to a computer terminal. The letters were on the "Hunter Region Heart Disease Prevention Programme" letterhead paper of the standard A4 (approximately 21cms x 30cms) size. The names and the logotypes of the University of Newcastle and the World Health Organization, and the name of the Faculties of Medicine and Mathematics appear on the letterhead. The personalization of the letters was completed by adding the researchers' individually applied signatures. An identification number was stamped on the cover of the questionnaire but the subject's name did not appear on the questionnaire itself.

University of Newcastle business envelopes to match the letters were used (white envelope of the standard 235mm x 108mm size). The University of Newcastle logotype and the name and address of the author appeared in the top left-hand corner of the envelope with a clearly marked message: "If not delivered, please return to sender". It was hoped that this would attract sufficient attention to guarantee that the envelope would be opened because it contained something important which, in case it was not delivered, was to be returned to the author. The relatively small sized envelope used had the advantage of reducing the cost of postage and would give the impression to respondents that the questionnaire which it contained should not take much time to complete. Standard ordinary mail postage was used (33 cents) and names and addresses were individually typed on to the envelope itself as is the standard practice for business letters from one person to another.

The questionnaires were sent out during the week commencing Monday 21st October, 1985. In addition to the questionnaire, each subject was sent an explanatory letter and a reply-paid envelope. The initial letter explained the subject of the study and its benefit to the community, emphasized the importance of the individual respondent to

the study's success and promised complete confidentiality. Those who had not replied after four weeks from the original mailing date were sent a reminder letter which included a copy of the original letter, a questionnaire and another reply-paid envelope. A second reminder letter, which included a copy of the questionnaire and a reply-paid envelope, was sent to those who had not replied by the last week of January, 1986 (the 14th week from the initial mailing date of the first letter). The second reminder letter was delayed until after the festive season holidays to avoid non-response because of people being on holidays. Both follow-up letters stressed the importance of each respondent to the study's usefulness and they promised anonymity. Other methods described by Dillman (1978) to boost response rates, such as sending a third follow-up letter by certified mail to ensure delivery, were considered but were felt unnecessary in view of their high cost, provided that the earlier procedures would produce an acceptable response rate.

The questionnaire design included questions on the last visit to a doctor, whether blood pressure was measured then, when the last blood pressure measurement was made, whether the subject had ever been told that he or she had high blood pressure, whether treatment had been given, if treatment was being administered, and the type of tablets that had been prescribed.

A thank-you letter was sent to all those subjects who replied. Samples of the letters and the questionnaires are shown in Appendices A.1 to A.4. Each questionnaire had the appropriate identification number pre-coded in the column "For office use only". The questionnaires were coded by the author on their return and checked by another researcher, and when the survey was completed, a computer operator entered the data from the coded questionnaire into a data box on a microcomputer. Back-up copies were kept on floppy discs at each entry session. After the data had been entered, a text file was created from the data box file, and this was transferred to the study account on the University of Newcastle VAX Cluster using the Kermit package. The SAS statistical package (SAS Institute Inc., 1985) was used for data management and statistical analysis.

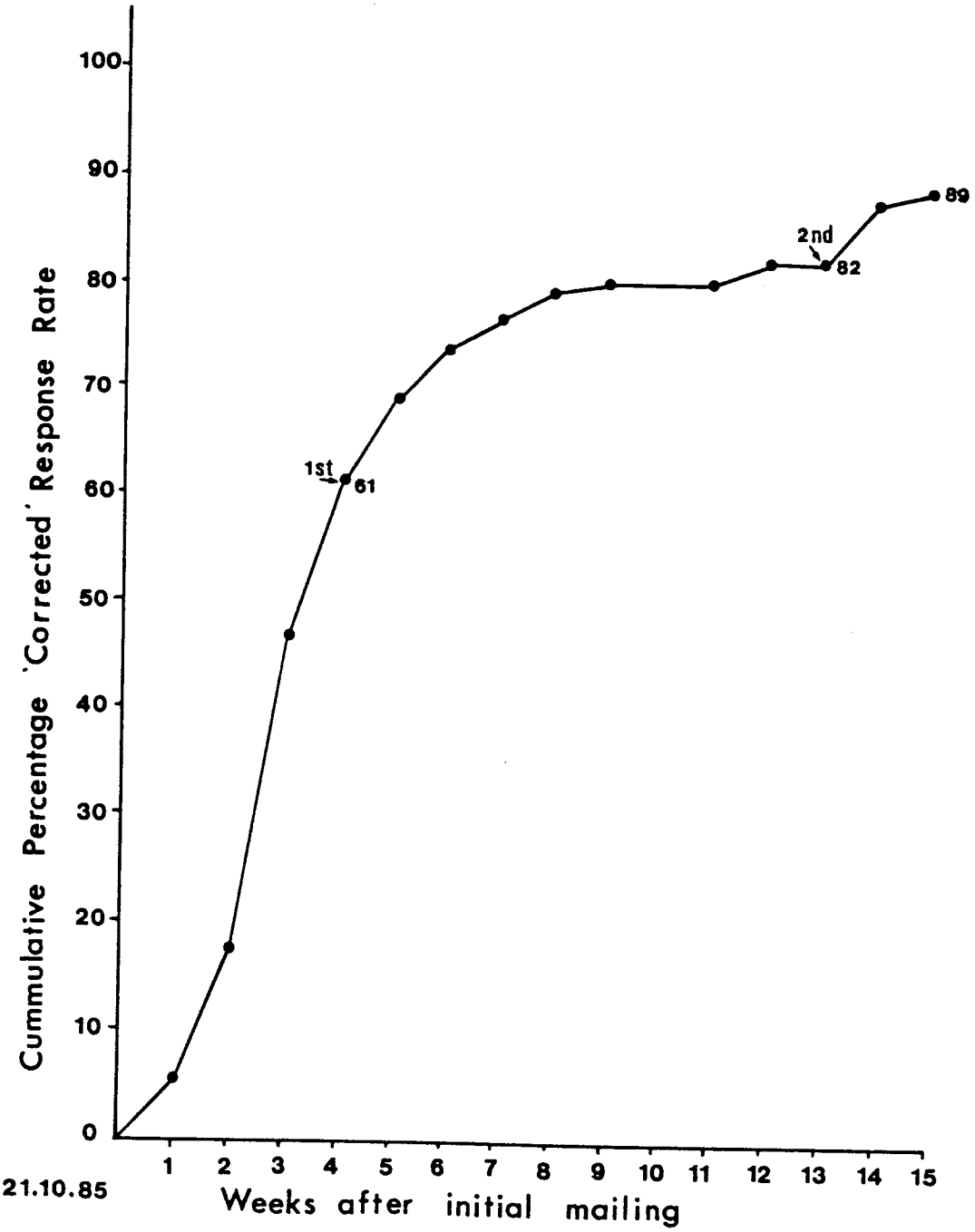
RESULTS

The Mailing and its Response

The cumulative response to initial mailing and the reminder letters is plotted in Figure 2.1. Of the 1,200 questionnaires sent out, replies were received from 694 persons (58 percent) in response to the initial letter, 206 replies (17 percent) to the first reminder and a further 62 persons (5 percent) replied to the second reminder. Thus, altogether, 962 persons (435 men and 527 women) replied - 80 percent of the total (crude response rate calculated as

$$\text{Response Rate} = \frac{\text{number returned}}{\text{number in sample}} \times 100).$$

Figure 2.1. The cumulative response to the initial letter and effect of reminder letters.



Note: * Outward mail on Week 1.

* Weeks 9-11 were Christmas and New Year holidays.

* Arrows point to the week of posting of the reminder letters.

One hundred and eighteen letters were not delivered to potential respondents. The reasons for our failure to get a response from all persons are shown in Table 2.1. Ninety-eight questionnaires (8 percent of the total sample) were returned by the Post Office or by other persons who lived at the address to which the letters had been sent, with the statement that the subject had moved. The forms of 13 people were returned by relatives with the information that the subject had died, and a further 3 subjects were either too ill to reply or in hospital. In addition, 4 forms were returned by the postal service because the address did not exist. Consequently, the corrected response rate (the percentage of the population that could have replied) was 89 percent

$$\text{(Corrected Response Rate} = \frac{\text{number returned}}{\text{number in sample - (non-eligible + non-reachable)}} \times 100\text{).}$$

A further three persons returned their forms without responses saying that they did not want to participate. Three questionnaires were received after the data had been analysed and so were not included in the results.

Table 2.1. Subjects' response to the questionnaire.

Response	Number (%)
Replied 962 (80.2)*	
Refusal (did not reply)	120 (10.0)
Died	13 (1.1)
Moved from address	98 (8.1)
Too ill, or other reasons	3 (0.3)
Address unknown	4 (0.3)
Total	1,200 (100)

* Percentages in parentheses.

The response rates were higher for women (527/647 = 81 percent, or 91 percent corrected for those who could not have replied) than for men (435/563 = 77 percent, or a corrected response rate of 86 percent). This is consistent with the findings reported in a risk factor survey which was conducted in the same area in 1983 (Alexander *et al.*, 1986) and may suggest a need to compensate for a relatively lower response rate among men when sampling.

Among the Local Government Areas, corrected response rates were lowest in Newcastle (82 percent of those who could have replied), highest in Cessnock (96 percent) and fairly uniform elsewhere. The higher response rate in Cessnock may have been a direct result of media publicity suggesting that people in Cessnock should give greater attention to their life-styles and drinking habits (The Newcastle Herald series of articles during the period from the 8th to the 11th January, 1986) which followed the publication of the results of a 1983 survey of risk factors for heart disease in the Hunter Region in the Medical Journal of Australia on 6th January, 1986 (during the time this study was undertaken). The area of Cessnock was found to have the highest mortality rates from ischaemic heart disease in the Hunter Region, which was paralled by high cardiovascular risk factor rates (Alexander *et al.*, 1986).

Age and Sex Distribution of the Respondents

The age and sex distribution of those who replied is shown in Table 2.2. Twenty-one people (8 men and 13 women) did not state their age and are excluded from the table. Apart from an under-representation of persons in the under-25 years age group, the distribution of age and sex for 941 respondents was similar to their distribution in the population of the Hunter Region (as estimated from the 1986 Census), which indicated that this random sample was representative of the regional population.

Table 2.2. Comparison of the age and the sex of the subjects who responded with those of the estimated* adult Hunter Region population in 1986.

	Men		Women	
Age (years)	Estimated population*	Number of respondents	Estimated population*	Number of respondents
17 - 24	20%	58 (14%)	19	59 (12%)
25 - 34	21%	82 (19%)	19%	11 (22%)
35 - 44	16%	82 (19%)	15%	80 (16%)
45 - 54	13%	59 (14%)	13%	80 (16%)
55 - 64	16%	73 (17%)	16%	95 (18%)
65 - 74	10%	49 (11%)	12%	59 (11%)
75 and over	5%	24 (6%)	6%	29 (6%)
Total	100%	427** (100%)	100%	514** (100%)

* Estimated from the 1986 Census (Australian Bureau of Statistics, 1987).

** Ages missing for eight men and 13 women.

Table 2.3 shows that the proportion of respondents in the under-35 years age group was higher among late respondents (54 percent) than among early respondents (30 percent) which may reflect a lack of interest in the subject of the questionnaire (blood pressure) among young people (aged 17-34 years). This trend of age differences between early and late respondents was similar for both men and women. The sex of the subjects stated in the answers to the questionnaire was identical to that stated on the Electoral Roll (100 percent agreement).

Table 2.3. Comparison of the age of the early and late respondents.

Age group (years)	Letters to which Subjects Replied		
	Initial letter (N = 694)*	1st reminder (N = 206)	2nd reminder (N = 62)
17 - 34	205 (30)**	71 (36)	33 (54)
35 - 64	364 (54)	86 (43)	21 (34)
65 and over	111 (16)	43 (21)	7 (12)

* Ages missing for 21 persons (14 to initial letter, 6 to 1st reminder and 1 to 2nd reminder).

** Percentages in parentheses.

Table 2.4 shows the tendency of the respondents to have had medical contacts in the previous three years. Ninety-one percent of respondents had visited a doctor in the previous year and over 95 percent of subjects had in the previous three years. Women were more likely to have visited a doctor in the last three months (69 percent) than were men (60 percent). However, the proportions became more similar when the comparison period was extended to include the past year (93 percent of women and 90 percent of men).

Table 2.5 shows that women in the child-bearing age (aged under 45 years) have had the highest rate of medical contact in the previous year with 96 percent of 251 women who were aged under 45 years having visited a doctor in the previous year compared with 87 percent of 222 men in the same age group. The proportions of subjects who had visited a doctor in the older age groups were 90 percent of 132 men and 86 percent of 175 women who were aged 45-64 years, and 78 percent of 73 men and 91 percent of 88 women who were aged 65 years and over.

Answers to the Blood Pressure Questions (all respondents aged 17 years or older)

Prevalence of Medical Contacts in the Previous Three Years.

(Question: When did you last visit a doctor?)

Table 2.4 **Numbers and cumulative percentages of subjects who reported their last visit to a doctor.**

	No. of men	No. of women	Total no.
In the last three months	261 (60)*	365 (69)	626 (65)
In the last six months	77 (77)	81 (84)	158 (81)
In the last year	56 (90)	45 (93)	101 (91)
In the last three years	24 (96)	30 (99)	54 (97)
More than three years ago	17 (100)	6 (100)	23 (100)

* Percentages in parentheses.

Table 2.5. **Numbers and percentages of subjects who had visited a doctor during the past year.**

Age (years)	No. of men	No. of women	Total no.
17 - 44	193 (87)*	241 (96)	434 (92)
45 - 64	119 (90)	151 (86)	270 (88)
65 and over	58 (79)	80 (91)	137 (85)
Total	370 (87)	472 (92)	842 (89)

* Percentages in parentheses.

Sixty-nine percent and 70 percent of men and women respectively reported having had a blood pressure measurement taken during their last visit to a doctor. The likelihood of having such a measurement taken increased with age. Young women (under the age of 35 years) were more likely than men in the same age group to have had their blood pressure measured (Table 2.6). People aged 55 years or older were more likely to have had their blood pressure measured during their last visit to a doctor, with 79 percent of men aged 55 years or older having their blood pressure measured compared with 51 percent of men aged 17-54 years. The comparative figures for women were 59 percent and 74 percent for the age groups 17-54 years and 55 years and over respectively.

Frequency of Blood Pressure Measurements in the Previous Three Years *(Question: When was your blood pressure last measured?)*

Seventy-nine percent of the subjects stated that they had had their blood pressure measured during the previous year (75 percent of men and 82 percent of women). The percentage for the previous 3 years is higher: 89 percent (85 percent of men and 93 percent of women). Only 5 percent of men and one percent of women stated that they had never had their blood pressure measured (Table 2.7).

Frequency of Blood Pressure Measurement During the Last Visit to a Doctor *(Question: Was your blood pressure measured then?)*

Table 2.6. **Numbers and percentages of subjects who reported a blood pressure measurement during their last visit to a doctor.**

Age (years)	No. of men	No. of women	Total no.
17 - 34	48 (38)*	95 (56)	143 (48)
35 - 54	85 (68)	101 (71)	186 (70)
55 - 74	103 (93)	113 (83)	216 (87)
75 and over	20 (91)	22 (92)	42 (92)
Total	266 (69)	331 (70)	597 (70)

* Percentages in parentheses.

Table 2.7. **Numbers and cumulative percentages of subjects who reported their last blood pressure measurement.**

	No. of men	No. of women	Total no.
In the last three months	194 (45)*	291 (55)	485 (50)
In the last six months	60 (59)	71 (68)	131 (64)
In the last year	73 (75)	73 (82)	146 (79)
In the last three years	43 (85)	56 (93)	99 (89)
More than three years ago	42 (95)	33 (99)	75 (97)
Never measured	23 (100)	3 (100)	26 (100)

* Percentages in parentheses.

The proportion of subjects who had had their blood pressure measured during the past year is shown in Table 2.8. Fifty-nine percent of men and 79 percent of women aged under 45 years, 80 percent of men and 79 percent of women who were aged 45-64 years, and 90 percent of men and 93 percent of women who were aged 65 years and over had had their blood pressure measured in the last year. The percentage of respondents who were under the age of 45 years who had had a blood pressure measurement in the past three years was 72 percent for men and 93 percent for women. In the same period, 85 percent of men and 90 percent of women who were aged 45-64 years and 92 percent of men and 93 percent of women who were aged 65 years and over had undergone such a measurement.

Table 2.8. **Numbers and percentages of subjects who had had their blood pressure measured during the past year.**

Age (years)	No. of men	No. of women	Total no.
17 - 44	131 (59)*	198 (79)	329 (70)
45 - 64	120 (89)	153 (88)	273 (89)
65 and over	67 (91)	80 (91)	147 (91)
Total	318 (74)	431 (84)	749 (79)

* Percentages in parentheses.

Table 2.9 shows the respondents' knowledge of and the treatment for raised blood pressure. Women were more likely than were men to report knowledge of and treatment for hypertension. This pattern is consistent with that reported in a 1983 nationwide risk factor survey (National Heart Foundation of Australia, 1985). Sixty percent (61/101) of men with a history of high blood pressure were receiving current treatment compared with 58 percent (96/167) of women. The proportion of subjects with a history of high blood pressure who received treatment increased with age. Of those with a history of high blood pressure, 30 percent of 129 subjects who were aged less than 55 years were receiving treatment compared with 80 percent of 139 persons who were aged 55 years or older.

Ninety-six percent of 268 respondents with a history of raised blood pressure, and 100 percent (157 persons) of those who were receiving treatment currently, had visited a doctor in the past year - Table 2.10. Ninety-two percent of persons with a history of raised blood pressure, and 100 percent of persons who were receiving treatment currently, reported that they had undergone a blood pressure measurement in the past year.

Frequency of Raised Blood Pressure and of Treatment

(Questions: Have you ever been told you have high blood pressure? Have you ever had treatment for high blood pressure? Are you receiving treatment for high blood pressure at the present time?)

Table 2.9. Reported knowledge of and treatment for hypertension.

	Ever told		Ever treated		Receiving treatment	
Age (years)	Men (n=101)	Women (n=167)	Men (n=75)	Women (n=133)	Men (n=61)	Women (n=96)
17 - 24	7%	5%	0	2%	0	0
25 - 34	11%	20%	5%	9%	0	2%
35 - 44	24%	25%	11%	15%	8%	8%
45 - 54	36%	35%	29%	29%	26%	21%
55 - 64	28%	50%	25%	45%	22%	35%
65 - 74	38%	48%	38%	48%	31%	44%
75 and over	38%	52%	38%	48%	33%	37%
All ages	24%	32%	18%	25%	14%	19%

Table 2.10. Numbers and percentages of subjects with high blood pressure who had visited a doctor and/or had had their blood pressure measured in the past year.

	Ever told	Receiving treatment
Last visit to a doctor:		
In the last 3 months	223 (81)*	152 (95)
In the last 6 months	25 (9)	6 (4)
In the last year	14 (5)	2 (1)
Blood pressure measured then:		
Yes	239 (87)	158 (99)
No	35 (13)	2 (1)
Last blood pressure measurement:		
In the last 3 months	212 (77)	151 (94)
In the last 6 months	25 (9)	7 (5)
In the last year	18 (7)	2 (1)

* Percentages in parentheses.

Investigation of the Non-respondents

The characteristics of those who did not reply was investigated in three ways:

1. Discrepancies in Comparison with the 1986 Census

As mentioned earlier and shown in Table 2.2, the youngest age group (17 to 25 years) was significantly under-represented in the sample. This may be because they do not answer questionnaires or their names are not on the Electoral Roll or they are not currently living in the electorate where they are enrolled.

2. Trend of Replies from Early to Late Respondents

The analysis performed by response category (Table 2.3) showed that those who only replied after intensive effort (late respondents) were more likely to be younger subjects (54 percent were aged 17 to 34 years) than were early respondents (30 percent were aged 17 to 34 years).

Table 2.11 shows that early respondents were more likely to have had their blood pressure measured in the past year than were late respondents. Although there was no consistent trend in the proportion of subjects who reported having been told in the past that their blood pressure was raised (Table 2.11), late respondents were less likely to be on current treatment for hypertension. Since late respondents were more likely to be younger subjects (54 percent were aged 17 to 34 years - an age group that is less likely to be on treatment), it is not surprising then that late respondents were less likely to be on current treatment for hypertension. Thus, using this kind of analysis, one would expect non-respondents to be mainly young subjects, and less likely than the respondents to be on treatment for hypertension.

Table 2.11. Blood pressure experience according to timing of response.

Variable	Timing of response			All respondents
	Early	Middle	Late	
Number	694	206	62	962
Blood pressure measured in the last year	77%	84%	71%	79%
Hypertension:				
Ever told	28%	27%	24%	28%
Ever treated	22%	20%	15%	22%
On current treatment	18%	16%	9%	17%

3. Intensive Follow-up of Non-respondents

An intensive follow-up of a systematic sample of one in eight persons of those who had not replied (114 persons) was undertaken in March, 1986. A study nurse went to each of the 14 addresses (114 divided by 8). In this way it was found that 8 of these 14 persons (57 percent) were no longer living at the address in question and people currently living at that address did not return the letters to us. One person had died but his family had not bothered to take the person's name off the Electoral Roll. Four of the 5 subjects identified at the address were under the age of 35 years.

These results indicate that the number of true non-respondents was small. Thus non-response bias will not have had much influence on the estimated proportion of persons who have undergone a blood pressure measurement in the recent past in this study.

Validation of the Questionnaire

The repeatability of answers to the questions was examined in three ways:

1. Duplicate Replies

In spite of the timing of the reminder letters, because of postal delays a number of people received a reminder letter after they had posted their replies and 13 persons returned a second questionnaire. The kind of person prepared to reply twice may be different from the others and the number of duplicate replies was small. This does not allow generalization of the results of the comparison between the responses to the original and the duplicate questionnaires to the rest of the study. However, while there is no external "truth" against which these responses could be validated, it can indicate which questions produce different answers on different occasions, thereby showing up inconsistencies in people's response.

Table 2.12 shows that there was 85 percent (11/13) agreement in responses for the question *"When was your blood pressure last measured?"* ; that is, the factor most important to estimate accurately in this survey.

Table 2.12. **Comparison of the responses to the question *"When was your blood pressure last measured?"* among 13 pairs of original and duplicate replies.**

Last time blood pressure was measured	**Original**	**Duplicate**
In the last 3 months	7	6
3 - 6 months	2	4
7 - 12 months	3	2
1 - 3 years	-	-
More than 3 years ago	1	1
Never measured	-	-
Total number	13	13

Three persons answered "Yes" to the question *"Have you ever been told you have high blood pressure?"*, of which two stated that they were on treatment for high blood pressure. The responses did not change between the original and the duplicate reply (100 percent repeatability to both questions).

The comparison of the answers to the blood pressure measurement question and the hypertension prevalence questions suggest that the repeatability* of the answers to the questions was good.

2. Comparison with a Subsequent Questionnaire

Subjects aged 35-69 years were sent a second questionnaire, within three months of the original questionnaire, seeking further information on their risk factor status. This was needed for comparison with similar data obtained from patients with a diagnosis of myocardial infarction in the same age group - Chapter IV. This provided an opportunity to test the repeatability of the answers to the three blood pressure status questions** by asking the same people the same questions at different times.

* *"Repeatability" is defined here as the proportion of the replies which were exactly the same on both occasions and is expressed as a percentage of the total number of replies.*

** *The questions:*
Ever told = Have you ever been told you have high blood pressure?
Ever treated = Have you ever had treatment for high blood pressure?
On current treatment = Are you receiving treatment for high blood pressure at thepresent time?

The percentage of agreement corrected for chance between the responses given to the original and the subsequent questionnaires was calculated using Cohen's kappa statistic (k) (Cohen, 1960):

$$k = \frac{\text{observed agreement - expected agreement}}{\text{1 - expected agreement}}$$

The agreement between the replies given on both occasions was high with a kappa statistic of 0.84 for the question *"Have you ever been told you have high blood pressure?"* (Table 2.13); 0.87 for the question *"Have you ever had treatment for high blood pressure?"* (Table 2.14); and 0.89 for the question *"Are you receiving treatment for high blood pressure at the present time?"* (Table 2.15). The results are encouraging and indicate that for all hypertension screening questions repeatability was good and that the replies are likely to be accurate.

Table 2.13. **Repeatability of answers to the question *"Have you ever been told you have high blood pressure?"*.**

	Original questionnaire (first response)		
Subsequent questionnaire (second response)	**Yes**	**No**	**Total**
Yes	156	23	179
No	13	311	324
	169	334	503

Observed agreement = 0.9284

Expected agreement = 0.5472

Kappa statistic (k) = 0.8419

Estimated variance of k = 0.0006

Estimated standard error of k = 0.0253

Table 2.14. **Repeatability of answers to the question *"Have you ever had treatment for high blood pressure?"*.**

	Original questionnaire (first response)		
Subsequent questionnaire (second response)	**Yes**	**No**	**Total**
Yes	129	16	145
No	10	348	358
	139	364	503

Observed agreement = 0.9483

Expected agreement = 0.5947

Kappa statistic (k) = 0.8724

Estimated variance of k = 0.0006

Estimated standard error of k = 0.0245

Table 2.15. **Repeatability of answers to the question** ***"Are you receiving treatment for high blood pressure at the present time?".***

	Original questionnaire (first response)		
Subsequent questionnaire (second response)	**Yes**	**No**	**Total**
Yes	98	12	110
No	6	387	393
	104	399	503

Observed agreement = 0.9642

Expected agreement = 0.6650

Kappa statistic (k) = 0.8932

Estimated variance of k = 0.0006

Estimated standard error of k = 0.0247

3. Comparison with Information from Doctors

Letters were sent to the regular doctors of subjects aged 35-69 years who had answered that they were currently receiving treatment for high blood pressure (110 persons). Information on hypertension treatment status and the name/s of antihypertensive medications that were being taken by those subjects was obtained on 104 persons. This method of validating the replies provided a comparison of the answers given by hypertensive patients with that obtained from their doctor's medical records and will be described in Chapter IV. However, evidence of this comparison with general practitioners' records indicated that the hypertension treatment stated by subjects was correct for all patients (100 percent agreement) with 90 percent (94/104) agreement on the type of antihypertensive medications. This is explained by the fact that the patients' doctors were approached for the information 6-9 months after the main survey, during which time the antihypertensive regime of some patients had been changed (10/104 = 10 percent). It could be expected that those subjects who stated that they were on current treatment for hypertension and who actually named the hypertensive medications that were being taken were indeed on such treatment, as fabrication of medication names would be difficult. Similar findings were reported by other researchers. Golditz and his co-workers (1986) examined the validity of self-reports of hypertension obtained from respondents to a postal questionnaire in the United States. This research team (1986) found a 100 percent agreement between self-reports of hypertension and that obtained from patients' medical records.

The results of the validation studies suggest that the information obtained was accurate and that the repeatability of answers to the blood pressure status questions was good. Given that previous validation studies of this questionnaire (Heller, 1976) reached similar conclusions, that is, that the repeatability of answers to the questions was good, it is considered that this questionnaire is a reasonably accurate method of obtaining medical information.

DISCUSSION

The Use of the Postal Survey Technique

Questionnaires are in widespread use as a convenient tool in medical research for the collection of data from the general population. Performing a survey by post has the potential advantages of: saving time and expense; the low cost per interview compared with face-to-face interview; and that interviewer and social desirability bias can be greatly diminished (Dillman, 1978; Worsley, 1984). Accordingly, a postal survey technique is more suitable for large random surveys of the population - such as this study.

At one stage it was thought that postal surveys were synonymous with poor response rates, but now it is well recognised that with two reminders, response rates of around 85 percent can usually be obtained. Dillman (1978) has shown that very high response rates from random samples (80 to 90 percent) can be attained using such a technique. Another concern is about the quality of data obtained by mail strategies. However, most studies have found that data quality is not affected by mode of survey data collection (Hochstim, 1967; Locander, Sudman and Bradburn, 1976; O'Toole *et al.*, 1986; Rolnick *et al.,* 1989). O'Toole and his fellow researchers (1986) compared the quality of data obtained by three health survey methods: mail, telephone and face-to-face interview from 600 men who had been in the Australian Army during the period from 1962 to 1972 (the time of Australia's involvement in the Vietnam conflict). O'Toole and his co-workers, (1986) found that the reliability was high for medical questions whatever the method of data collection. Further, the reliability results indicated that questionnaire responses are more reliable when questions are confined to a specific condition which would require a diagnosis for subjects to be able to report them - for example, history of heart attack (100 percent), than for vague conditions - for example, outbursts of temper (79 percent).

As the population sample was representative of the regional population (Table 2.2) and the knowledge of and treatment for hypertension was found to increase with age (Table 2.9), the data can be considered to be reasonably reliable. The encouraging response rate (89 percent) attained in this study, together with the results of the validation studies suggest that this is a good way to obtain medical information from the Australian

population.

The Total Design Method for Postal Surveys

While the Dillman design technique for mail surveys was found to be an easy method to implement, the need for the ultimate personalization procedures (such as individual names on letters and real signatures) is questioned because of being impractical in large sample population survey, in particular adding real signatures to each respondent's letter. In fact Dillman (1978, Pages 197-198) himself questioned the wisdom of the need for such a technique in his book "...It seems a high priority that carefully designed experiments be conducted to determine whether response and response quality are affected by elimination of personalization procedures such as individual names on letters and pressed ball point pen signature from some of the mailings.".

We conducted a small exercise after this study was finished on the lines of the pilot study in which we selected a new random sample from the Newcastle Division of the Electoral Roll. The same procedures were repeated but this time with letters printed by the multilithing process from a master copy which had the researchers' signatures on it. Names and addresses were then added by a typist using the same type as the original letter. The typist aligned the inside address with the margin of the letter to give the letter a highly personalized appearance.

This test gave a total response rate of 74 percent (37/50) as compared with 78 percent (39/50) for the pilot study. While no firm conclusions can be drawn from these comparisons, it is felt that adding real signatures to the individual letters may not be, after all, such a distinct advantage. In fact, many researchers believe that the most important factor which is likely to have a substantial effect on response rates is the subject matter of the survey (Cartwright, 1983, Chapter 9) and that higher response rates to health surveys would be expected, since health is a topic about which people are concerned.

Implications of Non-response

In most study designs it is important to obtain a high response rate from the selected study population to avoid non-response bias. There are well documented differences between respondents and non-respondents (Criqui, Barrett-Connor and Austin, 1978; Sheikh and Mattingly, 1981). Thus, respondents in a study with a low response rate are unlikely to be representative of the study population. Studies therefore require high response rates or need information about the non-respondents so that the nature of this bias may be determined.

The results of this study have been examined according to the timing of responses to try to extrapolate the replies from those replying early through to late respondents and for the non-respondents. In this way, an age trend was established in the replies from early to late respondents with younger subjects more likely to be late than early respondents, although that could not be confirmed because the age of all persons selected in the study was not available as it is not published in the Electoral Roll. A better method is to draw a small random sample from the non-respondents, and vigorous efforts are then made to investigate the reasons for non-response and the characteristics of this sample of non-respondents would indicate the extent of bias among non-respondents as a whole. The intensive follow-up of a systematic sample of non-respondents in this study has not only shown some of the age characteristics of the non-respondent but has also identified a major reason for non-response in this country; that is, subjects have moved from the address in question and people living at that address did not return the letters to us. If the estimate that almost half of the people who did not reply were not true non-respondents was correct, then the response rate to the study corrected for those who could not have replied may have been around 93 percent. It would appear that it may be appropriate to send a third reminder letter to the random sample selected on non-respondents by certified mail to ensure delivery and identify those subjects not living at the address before undertaking more vigorous measures such as home visits. This should result in time and cost saving when investigating non-respondents. Since the non-response rate in this study was low (10 percent), serious bias of the results would not be expected to have occurred in estimating the prevalence of hypertension in the community.

Discrepancies in the Electoral Roll

The selection of a random sample from the Electoral Roll was found to be an easy method because each person is individually identified with a number on the roll. There are, however, some discrepancies in the Electoral Roll which were detected in this study. It was found that up to 10 percent of the random sample of persons on the roll had moved. Use of the Electoral Roll as a sampling frame will, therefore, under-estimate the population to some extent - the nearer to publication that the sampling is performed, the smaller will be this under-estimate. Another source of discrepancy found was that the names of people who have died are not removed from the Roll as it is the responsibility of the deceased person's family to notify the Australian Electoral Commission accordingly - one of the persons selected in this study was found to have died 13 years ago. In addition , it would appear that there are also addresses on the roll of people and places which do not exist - one of the addresses was found to be vacant land. However, because of the small number of these discrepancies (just over one percent, 13 people had died, 4 addresses did not exist), the Electoral Roll remains one of the best available sampling frames in this population.

Similar observations were reported by Dr. Adele Green in a paper presented to the 1987 annual meeting of the Australasian Epidemiological Association in Sydney (27th August, 1987). Dr Green conducted a population-based case-control study of possible aetiological factors for melanoma in Queensland, Australia (Green *et al.*, 1986). Eleven percent of subjects in the random population sample obtained from the Electoral Roll in Brisbane, Queensland, was found to have moved, 2 percent had died and 2 percent of addresses did not exist.

Answers to the Questionnaire

Previous Blood Pressure Measurement and Medical Contact

The discovery that 79 percent of the 962 respondents in a sample of the general population had undergone a blood pressure measurement in the previous year, 89 percent in the previous three years and 95 percent at some stage in the past, is information which has not been obtained previously from the general population in Australia.

These findings suggest that most of the hypertension in the community has been detected. This is consistent with the findings of two mass screening surveys that were conducted in the same area in 1977 (Hardes and Leeder, 1979) and 1983 (Alexander *et al.*, 1986), both of which indicated that only a very small proportion of the screened population was confirmed as having been diagnosed as being hypertensive for the first time.

Studies such as this one, based upon responses of persons in the community, have been shown to provide a more accurate estimate of the proportion of the population having undergone a blood pressure measurement than studies based upon general practice records (Heller and Rose, 1977). Studies based upon general practice records tend to underestimate the proportion of persons who have had a recent blood pressure measurement taken, both because no account is taken of readings made in hospital, at work and elsewhere, and because general practitioners do not record all contacts with patients in notes or may omit noting normal blood pressure readings (Barlow *et al.*, 1977; Heller and Rose, 1977; Fleming and Lawrence, 1981).

In spite of the knowledge that hypertension is more dangerous in men than in women - The Framingham Study (Dawber, 1980) - men were less likely to have undergone a blood pressure measurement than were women. The difference was clearly displayed in the age group that was under 45 years of age, in which 79 percent of women had undergone a blood pressure measurement in the year prior to survey compared with 59 percent of men. Although the prevalence of hypertension is low among younger people, this is an age group in which a blood pressure measurement would be worthwhile in terms of early detection before any overt evidence of damage has occurred (Dawber, 1980, Chapter 7). These findings suggest that there is room for improvement in the detection of hypertension in younger men.

The age of the subject seems to be a major motivating factor in whether a blood pressure measurement is taken or not, as shown by the proportion of men (80 percent) who were aged 45-64 years who had had such a measurement taken within the last year, compared with 59 percent of men aged 17-44 years. In addition, younger subjects (aged 17-34 years) were less likely to have had their blood pressure measured during their

last visit to a doctor than were subjects in the older age groups (Table 2.5).

Overall, men were less likely to have had their blood pressure measured than were women during their last visit to a doctor (Table 2.5). A possible explanation may be, as suggested by Verbrugge (1982), that women are more likely than men to make use of preventive medical visits. In addition, women make routine visits for reproductive health care which include tests such as blood pressure measurement. This may account for the sex differences in blood pressure measurement.

The proportion of the population which had visited a doctor in the previous year (90 percent) was slightly higher than that which was found by the Australian Health Survey conducted by the Australian Bureau of Statistics in 1983 (82 percent) (Australian Bureau of Statistics, 1983d). This may be due to the relative under-representation in this survey of subjects who were under the age of 25 years - a group which is less likely to have had a recent medical contact. It would appear, then, that medical practitioners have access to a significant proportion of the general population and thus are in a unique position to make a much greater contribution in case-finding of high blood pressure (in which the doctor attempts to detect hypertension during contacts initiated by the patient for a possibly unrelated condition).

Detection of and Treatment for Hypertension in the Community

Persons under the age of 55 years with a history of high blood pressure were less likely to be receiving treatment (30 percent) than were those aged 55 years and over (80 percent). It is possible that the degree of hypertension which was detected in the younger age groups was mild and, if this is the case, it is not surprising that little treatment was prescribed.

The youngest age group (17 to 25 years of age) was significantly under-represented in the population sample. This may be due to the fact that their names are not on the Electoral Roll or because they are highly mobile. Since the youngest age group is a group in which hypertension is uncommon, the results could show an over-estimation of the proportion of the population with a raised blood pressure.

The finding that over half of the men and women with a history of raised blood pressure were currently receiving treatment for hypertension suggests that most hypertension in the community is being treated. It comes as no surprise that those patients with a knowledge of their hypertension were also more likely to have had medical contacts and to have undergone a blood pressure measurement in the past year (Table 2.10).

The National Heart Foundation of Australia conducted two cross-sectional studies in the Australian urban population (States Capital Cities) to determine the prevalence of cardiovascular risk factors among people aged 35-64 years. The first Risk Factor Prevalence Survey was conducted in 1980 (National Heart Foundation of Australia, 1983) and the second in 1983 (National Heart Foundation of Australia, 1985). In parallel with the second survey (National Heart Foundation of Australia, 1985), the Hunter Region Heart Disease Prevention Programme conducted a Risk Factor Prevalence Survey (Alexander, *et al.*, 1986) in people normally resident in the Lower Hunter Region aged 35-64 years. In these studies people were asked about a possible history of raised blood pressure *(Question: "Have you ever been told you have high blood pressure?")* and current treatment for hypertension *(Question: "Are you on tablets for blood pressure?")**, but not if they were ever on treatment for hypertension.

A comparison was made between the blood pressure statements of the respondents aged 35-64 years in the National Heart Foundation surveys and the findings in this survey. Table 2.16 shows that there is a consistent pattern in all the surveys with

* *In this survey, respondents were asked whether they were on "treatment" for blood pressure (Question: "Are you receiving treatment for high blood pressure at the present time?"), whereas in the National Heart Foundation surveys respondents were asked whether they were on "tablets". Thus, the two definitions are slightly different. The question on history of blood pressure "Have you ever been told you have high blood pressure?" was the same in this survey and the National Heart Foundation surveys.*

more women than men being aware of their hypertension status and more women than men being on treatment for hypertension, although both men and women who were aware of their hypertension were equally likely to be treated. Although the replies to the blood pressure status questions were obtained using self-administered questionnaires in all these surveys, there were substantial differences in response rates (which were highest in this survey; i.e., 89 percent, lowest in the 1983 Hunter Region Survey; i.e., 73 percent and 76 percent and 75 percent in the 1980 and 1983 National Heart Foundation Surveys, respectively). It is known that risk factor levels among persons who participate readily in risk factor studies are lower than among those who only reply after several follow-up attempts and that non-respondents are likely to have higher risk factor levels than both early and late respondents (Criqui, Barrett-Connor and Austin, 1978). Thus, the effect of the response bias would be to increase the apparent proportion of subjects with hypertension in the survey with highest response rates (this study) and to decrease those in the National Heart Foundation surveys (lower response rates), and so comparison between hypertension prevalence rates in these surveys may not be appropriate. However, this should not affect the comparison between the proportions of men and women with hypertension within the same survey. In addition, the higher proportions of women than men who were aware of their hypertension status or who were on current treatment for hypertension are not inconsistent with reported results from other western communities (Birkett *et al.*, 1986; Plasencia, Ostfeld and Gruber, 1988).

These sex differences in awareness and treatment for high blood pressure may be due to the fact that women are more likely than men to visit a doctor (Table 2.4) and to have their blood pressure measured (Tables 2.6 and 2.7). This implies that efforts to identify unaware hypertensives should be concentrated more on men than on women.

Plasencia, Ostfeld and Gruber, in a recent study (1988), investigated the possible factors which may explain the male-female differences in awareness of and treatment for high blood pressure. Although part of the discrepancy could be accounted for by differences in health care utilization, health habits, demographic characteristics and knowledge of high blood pressure, the sex of the subject still reflected differences in awareness and control of hypertension.

Table 2.16. High blood pressure status of men and women aged 35-64 years in Australia during the period 1980-1986.

Survey	Number		Hypertension status			
			Ever told		On treatment	
	Men	Women	Men	Women	Men	Women
States Capital Cities - 1980[1]	2268	2200	22%	29%	10%	15%
States Capital Cities 1983[2]	2985	2912	25%	33%	11%	14%
Hunter Region - 1983[3]	1220	1246	25%	33%	15%	19%
Hunter Region - 1986[4]	214	255	28%	36%	18%	22%

Source of information: 1 = National Heart Foundation of Australia, First Risk Factor Study, 1980.
2 = National Heart Foundation of Australia, Second Risk Factor Study, 1983.
3 = Hunter Region Risk Factor Survey, 1983.
4 = This study.

Twenty percent of adult Australians in the Hunter Region aged 35-64 years were found to be currently on antihypertensive treatment. This raises serious concern about the possibility of overdiagnosing hypertension. In a recent study, Pickering and co-workers (1987) found that one-quarter of patients with borderline hypertension may have been treated unnecessarily. In Australia, about two million adults were estimated in 1983 to be on medication for high blood pressure (Australian Bureau of Statistics, 1984). Once started, the treatment will usually be continued for life and the pharmacological cost alone per year for treatment with one of the major antihypertensive agents ranges from $150 to $350 (Table 2.17). There is also the direct cost of physician services, other professional fees, prescription fees, cost of supplemental medication (potassium supplements for patients on diuretics) and cost of laboratory testing (McCarron, Hare and Walker, 1984). Using an estimate of $600 to $800 for management of one patient, the cost of maintaining on treatment all patients with hypertension would be between $1.2 to $1.6 billion annually. If only one-fifth of these treated patients have been misdiagnosed, the financial loss alone would be about $280 million each year - which is four times as much as the amount spent on medical research in this country! In addition, there are also the costs of the side effects of long-term drug treatment (Grimm *et al.*, 1981; Medical Research Council Working Party on Mild to Moderate Hypertension, 1981; Field and Lawrence, 1986) and the adverse effects of premature labelling of persons as hypertensives which may result in an increase in morbidity in the labelled group (Haynes *et al.*, 1978).

While few people would dispute the need to treat moderate to severe hypertension, the therapeutic dilemma of benefit versus risk with drug therapy in those with milder degrees of blood pressure elevation (Freis, 1986; Miall, 1987) should stimulate research on the use of non-pharmacologic approaches to hypertension treatment. In this regard, recent evidence suggests that nutritional therapy to control high blood pressure, particularly weight reduction, salt restriction and moderation of alcohol consumption, may be substituted for drugs in a sizeable proportion of hypertensive patients or, if drugs are still needed, can lessen some of the unwanted biochemical effects of drug treatment (Stamler *et al.*, 1987).

Table 2.17. Yearly patient costs for antihypertensive drug prescriptions*.

Product	Most common tablet size (mg)	Average daily consumption (tablets)	Cost/day ($)	Cost/year ($)
Diuretics				
Hydrochlorothiazide	500	1	0.05	20
Triamterene plus Hydrochlorothiazide (Diazide)	50/25	1	0.14	52
Amiloride plus Hydrochlorothiazide (Moduretic)	5/50	1	0.07	26
Beta-Adrenergic Blocking Agents:				
Atenolol (Tenormin)	50	1	0.21	78
Propanolol (Inderal)	40	3	0.08	31
Alpha-Adrenergic Agonists:				
Alpha Methyldopa (Aldomet)	250	2	0.49	179
Alpha-Adrenergic Antagonists:				
Prazosin (Minipress)	1	2	0.13	46
Angiotensin Converting Enzyme Inhibitors:				
Captopril (Capoten)	25	2	0.71	261
Enalapril (Renitec)	5	1	0.54	200
Calcium Channel Blockers:				
Nifedipine (Adalat)	20	2	0.62	229
Verapamil (Isopten)	40	3	0.09	32
Potassium Supplements:				
Slow-K	600	3	0.04	14
K. SR	600	3	0.04	14

* Estimates of costs are based on prices available to hospitals only, supplied direct from manufacturer. Source of the antihpertensive drug prescriptions: MIMS Annual, 1989.

Community Screening for Hypertension - Why it Should be Abandoned

The finding that a large proportion of the population reported that they had undergone a blood pressure measurement in the past three years (i.e., 89 percent)* suggests that most of the hypertension in the community has already been detected. In general, men were less likely to have had their blood pressure measured during their visit to a doctor than were women despite similar proportions of men (90 percent) and women (93 percent) who had visited a doctor in the past year, and younger men (aged 17-44 years) appear to be at a particular disadvantage in this respect. Recently, Birkett and his fellow researchers (1986) reported similar findings from a Canadian blood pressure screening survey and called on physicians to direct special attention towards diagnosing and controlling hypertension in young men.

While possible variations in response from different population areas should be considered before generalizing these findings, it is unlikely that the Hunter Region has paid greater attention to hypertension than have other areas of Australia, in view of the persistently high rates of ischaemic heart disease and stroke in the region (Leeder *et al.*, 1983; The Principal Investigators of the MONICA Project, 1987).

It would appear, then, that the value of further screening for high blood pressure is probably limited in view of the large proportion of the population who have had a blood pressure measurement taken in the recent past. However, an improvement in case finding, by the measurement of blood pressures of all male patients who are aged less than 45 years who visit a doctor for any reason, may be worthwhile.

* *The Question: "When was your blood pressure last measured?" was added to the questionnaire used in the current 1988/89 Hunter Region Risk Factor Prevalence Survey. The preliminary analysis showed that 84 percent of respondents aged 35-69 years had undergone a blood pressure measurement in the previous year and 92 percent in the previous three years (Personal Communication). The figures are even higher than those reported in its 1986 survey and are in accordance with the suggestion that most hypertension in the community has been detected.*

SUMMARY

In order to discover how many members of the general adult population have had a blood pressure measurement taken in the recent past, a postal survey of a random sample of 1,200 persons aged 18 years or older who lived in the Lower Hunter Region of New South Wales was performed. Nine hundred and sixty-two people replied (total response rate of 80 percent). Excluding those who could not have replied, this gives a corrected response rate of 89 percent.

Ninety percent of 962 respondents had visited a doctor in the previous year and 69 percent of them reported that they had had a blood pressure measurement taken at their last visit. Eighty-nine percent of the 962 respondents reported that they had undergone a blood pressure measurement in the past three years. Although 79 percent of the respondents reported a blood pressure measurement in the past year, only 59 percent of men who were aged 45 years or less had undergone such a measurement during that period.

Women were more likely than men to have had their blood pressure measured and to have reported a knowledge of and treatment for hypertension. Twenty-four percent of men and 32 percent of women reported having been told in the past that they were hypertensive and 14 percent of men and 19 percent of women were receiving treatment. In other words, about one-sixth of the general adult population are on current treatment for hypertension. The high proportion of the population on blood pressure treatment suggests a need to explore the possibility of overtreatment.

In view of the finding that a large proportion of the population reported that they had undergone a blood pressure measurement in the past three years, it appears that most of the hypertension in the community has already been detected and thus the value of further blood pressure screening in the community is probably limited. However, it would appear that a need remains for an improvement in the detection of hypertension in young men under 45 years of age.

CHAPTER III

CARDIOVASCULAR RISK FACTOR LEVELS IN THE HUNTER REGION IN 1986

INTRODUCTION

In order to establish the prevalence of current cigarette smoking and other selected cardiovascular risk factors in the Hunter community, respondents to the blood pressure questionnaire (described earlier in Chapter II), aged between 35 and 69 years, were asked to fill in a second questionnaire seeking further information on their risk factor status. This information was needed primarily for comparison with similar data obtained from patients with myocardial infarction (Chapter IV) and patients with stroke (Chapter V) in the same age group. A second aim was to test the repeatability of answers to the questions concerning the blood pressure status (described in Chapter II).

METHODS

The original blood pressure questionnaire was answered by 962 persons aged 17 years or older (Table 2.1). Of these, 523 respondents (232 men and 291 women) were aged between 35 and 69 years. A second questionnaire was mailed to all these respondents aged 35-69 years within three months of receiving their reply to the original blood pressure questionnaire.

The second questionnaire sought a complete smoking history by asking whether the subject had ever regularly smoked cigarettes. If so, the following information was elicited for each episode of smoking: the age that the person started smoking; whether the person had given up smoking and when the subject gave up smoking, if the subject had stopped smoking. In addition, information was obtained on alcohol intake, previous history of cardiovascular disease, family history of cardiovascular disease, height and weight and other demographic data. Evidence from several epidemiological studies indicates that self-administered questionnaires provide accurate information on weight and height (Stewart, 1982), cigarette smoking habits (Petitti, Friedman and Kahn, 1981; Krall *et al.*, 1989) and amount of alcohol consumed (Krall *et al.*, 1989).

With the questionnaire, each subject was sent an explanatory letter and a reply-paid envelope. Those who had not replied after two weeks from the initial mailing date (1st February, 1986) were sent a reminder letter, which included a copy of the questionnaire and a reply-paid envelope. A third mailing to non-respondents was followed by a telephone call (a phone number was identified for 72 percent of potential respondents) from the Study Investigator (the author). The design of the explanatory and the follow-up letters was similar to that described for the original blood pressure questionnaire (Chapter II). Samples of the letters and the questionnaire are shown in Appendices A.5 to A.8.

Upon the return of the questionnaires, answers to the questions were checked and coded by the author. A computer operator entered the data from the coded questionnaire into a data base on a microcomputer. The collected data were computerized and the SAS Package (SAS Institute Inc., 1985) was used for data management and statistical analysis. A combination of subjects' study number, sex and date of birth was used to merge the data files of subjects' responses to the two questionnaires.

Smoking behaviour was classified as "current smoker", "ex-smoker" and "non-smoker". A "current smoker" was defined as "a person smoking at least one cigarette per day", an "ex-smoker" was defined as "a person who had given up smoking for at least six months" and a "non-smoker" was defined as "a person who had never smoked regularly".

Alcohol intake was measured by combining the questions which assessed the usual frequency (Question: "*How often do you usually drink alcohol?* ") and the amount of alcohol consumed (Question: "*On a day when you drink alcohol, how many drinks do you usually have?* "). According to the number of drinks consumed per week (1 drink = approximately 10 grams of alcohol), subjects were classified into three alcohol consumption categories: "non-drinkers", which included people who do not drink and ex-drinkers; "light drinkers", those who take fewer than 8 drinks per week; and "moderate to heavy drinkers", those who take 8 or more drinks per week.

RESULTS

The Response to the Questionnaire

Of the 523 respondents (232 men and 291 women) aged 35-69 years, who answered the original questionnaire, 503 (219 men and 284 women) were successfully recontacted and answered the additional questionnaire (a response rate of 96 percent). Of the non-respondents, fourteen subjects (9 men and 5 women) had moved and could not be located, three persons objected to the additional contact, two persons had died (according to the death certificates, one died from acute myocardial infarction and one from chronic renal failure), and the date of birth of one (male) respondent did not match that on the original questionnaire and the questionnaire was thus omitted from the analysis.

Table 3.1 shows that the response rates were similar for men (94 percent) and women (98 percent). Men aged 35-54 years had a lower response rate (91 percent) than that for men aged 55-69 years (100 percent). No such difference was seen among women, with similar response rates among younger (35-54 years) and older (55-69 years) women.

Table 3.1. Numbers of respondents to the questionnaire.

Age (years)	Men		Women	
	Original Questionnaire	Subsequent Questionnaire	Original Questionnaire	Subsequent Questionnaire
35-54	141	128 (91)*	160	157 (98)
55-69	91	91 (100)	131	127 (97)
Total	232	219 (94)	291	284 (98)

* Percentage of subjects who were recontacted and who answered the additional questionnaire.

Prevalence of Cigarette Smoking in the Hunter Region in 1986

The age and sex distributions of cigarette smoking status among subjects aged 35-69 years in the Hunter Region are presented in Table 3.2. Only 23 percent of respondents aged 35-69 years were current smokers (31 percent of men and 16 percent of women). The higher proportion of current smokers among men (31 percent) than among women (16 percent) and among younger than among older age groups (Table 3.2) are both consistent with the findings of previous surveys in the Australian population (National Heart Foundation of Australia, Risk Factor Prevalence Study No. 2, 1985).

Table 3.2. Smoking status of subjects aged 35-69 years in the Hunter Region in 1986.

Age (years)	Non-smoker	Ex-smoker	Current Smoker
Men:			
35 - 44	34 (42)*	21 (29)	22 (30)
45 - 54	19 (37)	16 (31)	16 (31)
55 - 64	16 (25)	24 (38)	23 (36)
65 - 69	8 (29)	13 (46)	7 (25)
Total	77 (35)	74 (34)	68 (31)
Women:			
35 - 44	45 (57)	14 (18)	20 (25)
45 - 54	60 (77)	12 (15)	6 (8)
55 - 64	59 (71)	15 (18)	9 (10)
65 - 69	29 (66)	4 (9)	11 (25)
Total	193 (68)	45 (16)	46 (16)
Both sexes:			
35 - 44	76 (50)	35 (23)	42 (28)
45 - 54	79 (61)	28 (21)	22 (17)
55 - 64	77 (52)	39 (26)	32 (22)
65 - 69	38 (52)	17 (24)	18 (24)
Total	270 (54)	119 (24)	114 (23)

* Percentages in parentheses.

Prevalence of Alcohol Consumption in the Hunter Region in 1986

Table 3.3 shows the age and sex distributions of alcohol consumption behaviour among subjects aged between 35 and 69 years in the Hunter Region in 1986. There were no consistent age differences in the proportion of moderate to heavy alcohol drinkers. However, the proportion of moderate to heavy drinkers was higher among men (15 percent) than among women (4 percent). Similar observations have been reported from previous studies. A 1983 risk factor prevalence survey which was conducted in the same region in 1983 found that 10 percent and 4 percent of men and women respectively were moderate to heavy alcohol drinkers (Alexander *et al.*, 1986).

Table 3.3. Alcohol consumption of subjects aged 35-69 years in the Hunter Region in 1986.

Age (years)	Non-drinker	Light Drinker	Moderate - Heavy Drinker
Men:			
35 - 44	16 (20)*	51 (68)	10 (12)
45 - 54	14 (27)	29 (57)	8 (16)
55 - 64	8 (12)	45 (71)	10 (16)
65 - 69	7 (28)	16 (59)	5 (14)
Total	45 (21)	141 (64)	33 (15)
Women:			
35 - 44	40 (51)	39 (50)	0 (0)
45 - 54	40 (51)	36 (48)	2 (2)
55 - 64	54 (65)	24 (30)	5 (5)
65 - 69	28 (64)	12 (30)	4 (7)
Total	162 (57)	111 (39)	11 (4)
Both sexes:			
35 - 44	55 (36)	88 (59)	10 (6)
45 - 54	54 (42)	65 (51)	10 (7)
55 - 64	62 (42)	71 (49)	15 (9)
65 - 69	36 (49)	28 (41)	9 (10)
Total	207 (41)	252 (50)	44 (9)

* Percentages in parentheses.

Distribution of Hypertension, Smoking and Alcohol Consumption According to Response Category

The respondents aged 35-69 years were analysed according to their response group: those replying after the initial letter (early group, 134 men and 209 women); those replying after the first reminder letter (middle group, 55 men and 53 women); and those replying only after a second reminder letter and a telephone call (late group, 30 men and 22 women).

Table 3.4 shows that current cigarette smoking was strongly related to these response categories in both men and women. Twenty-eight percent of men in the first response category were current smokers compared with 40 percent of those in the late category. Women showed a similar trend with 14 percent and 32 percent being current smokers in the early and late response categories, respectively. Similarly, heavy alcohol drinking was related to the response categories, that is, those replying after repeated reminders being more likely to be heavy drinkers.

In contrast to current cigarette smoking, hypertension (history of high blood pressure and treatment for hypertension) did not appear to be related to the response category - in fact, those replying early had a slightly higher rate of treatment for hypertension than those who replied to the second reminder. This may suggest that people who have an interest in the subject matter of the survey are more likely to respond. The observed trends were similar among young age groups (35-54 years) and older age groups (55-69 years), as shown in Table 3.4.

Table 3.4. Prevalence of hypertension, smoking and alcohol consumption among men and women aged 35-69 years according to response category.

	Early			Middle			Late		
Numbers	**Men 134**	**Women 209**	**All 343**	**Men 55**	**Women 53**	**All 108**	**Men 30**	**Women 22**	**All 52**
Hypertension:									
Ever told	41(31)*	78(37)	119(35)	20(36)	22(42)	42(39)	8(27)	10(45)	18(35)
Ever treated	32(24)	65(31)	97(28)	18(33)	19(36)	37(34)	6(20)	8(36)	14(27)
On current treatment	25(19)	67(32)	92(27)	13(24)	15(28)	28(26)	4(13)	4(18)	8(15)
Smoking status**:									
Non-smoker	46(34)	146(70)	192(56)	24(44)	36(68)	60(56)	7(23)	11(50)	18(35)
Ex-smoker	51(38)	33(16)	84(24)	12(22)	8(15)	20(19)	11(37)	4(18)	15(29)
Current smoker	37(28)	30(14)	67(19)	19(35)	9(17)	28(26)	12(40)	7(32)	19(37)
Alcohol consumption**:									
Non-drinker	26(19)	119(57)	145(42)	15(27)	34(64)	49(45)	2 (7)	9(41)	11(21)
Light drinker	92(69)	84(40)	176(51)	32(58)	18(34)	50(46)	19(63)	10(45)	29(56)
Moderate-heavy drinker	16(12)	6 (3)	22 (6)	8 (5)	1 (2)	9 (8)	9(30)	3(14)	12(23)

* Percentages in parentheses.

** See the text for definition of categories.

DISCUSSION

The Response

In common with many other studies (Savitz *et al.*, 1986; Severson, Henser and Davis, 1988), less than one percent of the respondents who were recontacted objected to the additional questionnaire. Four factors may have contributed to the high recontact completion rate: firstly, the respondents may have been aware of the importance of a study in cardiovascular disease prevention; secondly, the nature of the questions was non-sensitive and the questionnaire was short; thirdly, there was only a short interval between the initial and the subsequent contacts; and finally, people wishing no part in the study did not respond to the original questionnaire and thus the pool of subjects aged 35-69 years available for recontact may have been more co-operative than the original pool.

The proportion of current cigarette smokers was significantly higher among late respondents (37 percent) than among early respondents (19 percent). Similar observations were reported from the 1983 National Heart Foundation of Australia Risk Factor Prevalence Survey where smoking habits were analysed by subjects' response categories (Armstrong, Butler and Martin, 1983). However, while smoking habits were strongly related to the response categories in the additional questionnaire in both men and women (Table 3.4), no such clear trend of smoking status was demonstrated in subjects' response to the original blood pressure questionnaire (which did not include questions about smoking habits), although the proportion of current cigarette smokers among early respondents to the original questionnaire (22 percent) was slightly lower than among late respondents (26 percent). This suggests that asking people about their smoking habits is viewed by current cigarette smokers as a sensitive question which may discourage them from responding to self-administered questionnaires to which they may otherwise have responded had such questions not been asked.

Unlike cigarette smoking habits, hypertension status (defined as a history of high blood pressure and treatment for hypertension) was not related to the response categories. This is consistent with other reports (Silman and Locke, 1982). The result of this analysis by response categories implies that research workers concerned with maximizing response rates to blood pressure screening surveys should consider the negative aspects of

asking about smoking habits.

Prevalence of Current Cigarette Smoking in the Hunter Region in 1986

In 1986, the prevalence of current cigarette smoking among both men (31 percent) and women (16 percent) aged 35-69 years in the Hunter Region was lower than that reported in a Risk Factor Prevalence Survey (Alexander *et al.*, 1986) which was conducted in the same region in 1983, that is, 36 percent of men and 23 percent of women. However, although the replies to the smoking habits questions were obtained using self-administered questionnaires in both surveys, there were differences in the response rates (which were highest in this survey; i.e., 89 percent, and lowest in the 1983 survey; i.e., 73 percent). Thus, the 1983 survey may have underestimated the prevalence of current cigarette smoking in the Hunter Region and the fall in the prevalence of current cigarette smoking may have been greater than that observed in this comparison. This fall in the prevalence of current cigarette smoking in the Hunter Region is in line with similar declines reported from nationwide surveys in Australia (Dobson, 1987; Hill, White and Gray, 1988).

Further support to this decline in the prevalence of cigarette smoking in the Hunter Region comes from a 1988 risk factor prevalence survey* which is currently being undertaken in the same area (personal communication). The 1988 survey found that only 20 percent of respondents aged 35-69 years were current cigarette smokers (23 percent of men and 17 percent of women). In addition, the proportion of ex-smokers in the current survey was even higher (32 percent) than that found in this 1986 survey (24 percent). While the decline in the prevalence of smoking in the Hunter Region, in line with the national trends (Hill, White and Gray, 1988), is encouraging, health professionals cannot afford to be complacent, for the habit of smoking is far from being extinguished in Australia.

* *The information is based on preliminary analysis of the first part of that survey.*

SUMMARY

Five hundred and three of the respondents to the blood pressure population survey (219 men and 284 women), aged between 35 and 69 years, answered an additional questionnaire on smoking and alcohol consumption habits. Twenty-three percent of respondents aged 35-69 years were current cigarette smokers (31 percent of men and 16 percent of women) and 9 percent were heavy alcohol drinkers (15 percent of men and 4 percent of women).

A detailed analysis of the data on smoking habits by response categories was undertaken. This showed that the proportion of current smokers was significantly higher among late respondents to the additional questionnaire (37 percent) than among early respondents (19 percent). However, no such marked differences in smoking habits were found between different response categories to the original questionnaire (which did not include questions on smoking history). In contrast to smoking, hypertension (defined as a history of high blood pressure and treatment for hypertension) was not related to the promptness of subjects' response to either the original or the additional questionnaire. Thus it appears that, unlike questions concerning smoking history, questions about history of hypertension do not have an adverse effect on response rates.

CHAPTER IV

HYPERTENSION AND THE RISK OF MYOCARDIAL INFARCTION

INTRODUCTION

In an attempt to explore the contribution that a history of hypertension and the way it has been controlled might make to the aetiology of myocardial infarction in the Australian community, cases of first-time acute myocardial infarction are compared with a representative group of community controls from the same population (first described in Chapter II). In addition, treated hypertensives who developed myocardial infarction are compared with persons on treatment for hypertension in the community (who have not developed acute myocardial infarction) in order to examine the relationship between blood pressure control and the occurrence of acute myocardial infarction. If the control of blood pressure of those who later develop myocardial infarction has been less than adequate, this will indicate the need to explore ways of improving the control of hypertension in the community as a preventive measure.

Hypotheses

1. The proportion of subjects with a history of high blood pressure among patients with acute myocardial infarction is higher than among community controls.

2. The proportion of subjects currently on treatment for hypertension among patients with acute myocardial infarction is higher than among community controls.

3. The percentage of hypertensives who are currently on treatment for hypertension among the myocardial infarction cases is lower than among hypertensive controls in

the community.

4. The percentage of poorly controlled hypertensives (treated diastolic blood pressure of 90mmHg or higher) among myocardial infarction patients is higher than among hypertensive controls in the community.

Study Objectives

1. To identify all patients aged 35-69 years with a diagnosis of acute myocardial infarction in the Lower Hunter Region over a one year period.

2. To administer to these patients or to the relatives of dead patients a questionnaire seeking information on the history of blood pressure measurement and on the detection and treatment of hypertension.

3. To obtain, in addition, information about cigarette smoking behaviour, alcohol consumption habits and demographic data.

4. To compare this information with similar data obtained from a random sample of people aged 35-69 years living in the same community (see Chapter II).

5. To contact the general practitioners of those myocardial infarction and control subjects who indicated in the questionnaire that they were currently receiving treatment for high blood pressure to ask them for the following information: the date of the last blood pressure measurement taken before the infarction or before the survey, as appropriate; the precise measurement; the pre-treatment blood pressure reading; and the type of antihypertensive medications prescribed.

Subsidiary Objectives

1. To compare the utilization of medical services for hypertension by patients who developed myocardial infarction with that by subjects in the community.

2. To examine the role of treatable risk factors, other than hypertension, in the aetiology of myocardial infarction in the Hunter Region community.

3. To compare the prevalence of cardiovascular risk factors in hypertensives who have had a myocardial infarction with that in hypertensives in the community.

SUBJECTS AND METHODS

THE STUDY POPULATION

Subjects are chosen from residents of the Lower Hunter Region of New South Wales, which comprises the five urban local government areas of Newcastle, Lake Macquarie, Cessnock, Maitland and Port Stephens. The total population of the study area was 405,000 at the 1986 Census. For this project, the study population consisted of all persons aged 35-69 years normally resident in the Lower Hunter Region of New South Wales; 156,500 people at the 1986 Census (75,400 men and 81,100 women, with a male:female ratio of 48:52).

MYOCARDIAL INFARCTION CASES

Ascertainment of Myocardial Infarction Cases

Cases of acute myocardial infarction were identified from a community-based heart attack register in Newcastle, The Hunter Region Heart Disease Prevention Programme, which aims to identify all suspected cases of acute myocardial infarction and coronary deaths among residents of the study area aged 25-69 years. This register is part of the World Health Organization co-ordinated MONICA (MONICA is derived from Monitoring Trends and Determinants in Cardiovascular Disease) Project (Tunstall-Pedoe, 1988), which involves continuous surveillance of all suspected fatal and non-fatal heart attacks in defined populations and the monitoring of risk factor patterns and medical management of ischaemic heart disease (Tunstall-Pedoe, 1988).

The MONICA Project, a worldwide multi-centre venture, was established to monitor heart disease over a period of 10 years. Some centres also are monitoring stroke during the same period, although none of the Australasian centres are doing so. Thirty-nine centres have participated in the MONICA Project in 26 countries (Tunstall-Pedoe, 1985; The WHO MONICA Project, 1989), some of which are

experiencing a decline in mortality from cardiovascular disease (such as Australia*, New Zealand, Scotland, Japan, Canada and the United States), and in some of which (such as most countries in Eastern Europe) cardiovascular disease is increasing (Uemura and Pisa, 1988). The general objective of the MONICA Project is to analyse differences in attack rates and mortality trends across participating centres in terms of differences in risk factor prevalence, medical care and sociodemographic characteristics between centres (The Principal Investigators of the MONICA Project, 1987).

Since 27th August, 1984, the Hunter Region Heart Disease Prevention Programme has registered all suspected cases of acute myocardial infarction in the study population aged 25-69 years. The surveillance procedures involve intensive monitoring of all hospital admissions and separations and the review of all death certificates. Details of the methods of case-finding and assessment of registered cases adopted by this heart attack register have been the subject of two recent comprehensive reports (Dobson *et al.*, 1988a; Dobson *et al.*, 1988b).

In brief, the case-finding methods involved regular surveillance of hospital admissions by trained registered nurses. Nurse/ interviewers visited all the seven public acute care hospitals in the study area (Royal Newcastle Hospital, Mater Misericordiae Hospital, Belmont District Hospital, Wallsend District Hospital, Maitland Hospital, Cessnock Hospital and Kurri Kurri Hospital) and the Lingard Private Hospital regularly; the larger hospitals every second day, the other public hospitals two or three days a week and Lingard Hospital, which opened an intensive care ward in 1987, fortnightly. Hospital admission lists and emergency ward books were scrutinized for any possible cases of heart attack. Visits were made to all coronary care units and all major wards likely to have had heart disease patients. In addition, surgical wards were checked regularly. Nursing staff assisted the study team to identify cases which may have satisfied the criteria for registration. All patients who may have satisfied the criteria were asked to participate in the study. If they agreed, as almost all did, they were interviewed (after giving their written consent) by the nurse. A standardized interview (Appendix A.9) was used to obtain information on the patients' symptoms, medical history and other

* *In Australia, Newcastle and Perth are the two centres involved in the MONICA Project.*

demographic and life-style characteristics. Data about cardiac enzyme levels and medications were recorded from the patients' medical notes. Photocopies of electrocardiograms were made for subsequent coding and classification.

A questionnaire seeking information concerning the history of blood pressure measurement and the detection and treatment of hypertension was developed and added to the main MONICA interview schedule for the purpose of this study during the one year period from 27th August, 1985, to 26th August, 1986, (Appendix A.9, Pages 12 and 13). Whenever possible, patients were interviewed while still in hospital by a nurse involved with the study. Further information was obtained from hospital case records and other sources.

The blood pressure information collected from myocardial infarction cases was similar to that collected from subjects in the community (Chapter II) and included the date of the last visit to a doctor; whether the blood pressure was measured then; if not, when the last blood pressure measurement was made; whether the subject was ever told that he/she had high blood pressure; whether treatment was ever given; if treatment was currently being administered; and the type of tablets that had been prescribed.

In addition, information was obtained on cigarette smoking habits, alcohol drinking behaviour, previous history of vascular disease, family history of high blood pressure, heart attack and stroke, height, weight and other demographic data.

In addition to surveillance of hospitals, all death certificates for the study population held at the local Registry Office of Births, Deaths and Marriages were scrutinized at regular intervals. All death certificates which mentioned that death was due to, or the result of a sequence of, causes which included acute myocardial infarction or any form of ischaemic heart disease (or any synonymous term) in either Part I or Part II of the certificate were considered for registration provided that there was no competing cause of death that would disqualify the case. As specified by the MONICA protocol, examples for disqualification included disseminated cancer, a form of total body failure or any other fatal condition of which myocardial infarction was likely to have been a complication rather than a cause; e.g., non-cardiogenic shock, hyperviscosity syndromes.

Whenever there was uncertainty about the death fulfilling MONICA criteria, the case was discussed by a clinician and/or the Director or the Project Manager. Pathologists conducting autopsies in the Hunter Region assisted by routinely completing a data form for each autopsy conducted (Appendix A.10).

For cases of myocardial infarction leading to death, information similar to that collected from live patients was obtained from relatives or other informants through telephone interviews or postal questionnaires (this has been the practice since February, 1986). Other information on fatal cases was obtained from death certificates using a structured form (Appendix A.11), hospital medical records and from postal questionnaires sent to the doctors certifying the deaths. Autopsy information was obtained on registered fatal cases whenever available.

Myocardial infarction patients who were on current treatment for hypertension were asked to give the name and address of their usual general practitioner. They were also asked to give permission for researchers to contact their doctor. For fatal cases relatives were approached for the same information.

To check the completeness of the heart attack register, the log books of all cases considered for registration were compared periodically with computer records of hospital separations compiled independently by the Hunter Health Statistics Unit and any discrepancies were investigated. In addition, the annual mortality data for the Hunter Region released by the Australian Bureau of Statistics were compared with registrations of deaths in the study. Such a procedure had the advantage of identifying deaths due to heart disease in residents of the study area whose death certificates had been filed elsewhere.

The quality control audits and comparisons with hospital morbidity data indicated that almost all cases of myocardial infarction in the study population have been registered.

Selection of Myocardial Infarction Cases

Inclusion Criteria

All cases of a first-time acute myocardial infarction (fatal or non-fatal) in the study population aged 35-69 years registered during the one year period from 27th August, 1985, to 26th August, 1986, were included in this study. The cases were diagnosed as definite acute myocardial infarction or possible acute myocardial infarction according to diagnostic criteria developed by the World Health Organization (Tunstall-Pedoe, 1988; The WHO MONICA Project, 1989). The criteria are based on characteristic symptoms of: chest pain; changes in levels of cardiac enzymes; changes in electrocardiograms - coded according to the Minnesota Code (Prineas, Crow and Blackburn, 1982); past history of ischaemic heart disease; and post-mortem findings in fatal events (Tunstall-Pedoe, 1988; The WHO MONICA Project, 1989).

Both definite acute myocardial infarction and possible acute myocardial infarction were included in the present study because the distinction between them is somewhat arbitrary and the prognosis is thought to be similar (Schroeder, Lamb and Hu, 1980). In addition, the MONICA diagnostic classification is affected by the availability of data, for instance, autopsy rates or whether the patient survives long enough to have serial electrocardiograms and serial measurements of cardiac enzymes.

Diagnostic Classification of Myocardial Infarction Cases

The diagnostic classifications employed by the MONICA study may not always correspond to the clinical diagnosis but in order to maintain stable, reliable and standard classifications, the definitions in the World Health Organization MONICA Project Manual of Operations are strictly adhered to (MONICA Memo 30, World Health Organization, 1983).

Diagnostic Categories

Below are the diagnostic categories from MONICA Memo 30, World Health Organization, 1983, pages 20-22:

(1) definite acute myocardial infarction;
(2) possible acute myocardial infarction or coronary death;
(3) ischaemic cardiac arrest with successful resuscitation not fulfilling criteria for definite or possible myocardial infarction;
(4) no acute myocardial infarction or coronary death;
(5) fatal cases with insufficient data.

Allocation of a diagnostic category must follow strictly the definition provided. The categories used for the diagnosis of 'definite' and 'possible' acute myocardial infarction are not necessarily those that would be used by a clinician, but rigid definitions are essential for event analysis.

Definitions

(1) Definite acute myocardial infarction:

(a) Definite electrocardiogram; or
(b) Symptoms typical or atypical or inadequately described, together with probable electrocardiogram and abnormal enzymes; or
(c) Symptoms typical and abnormal enzymes with ischaemic or non-codable electrocardiogram or electrocardiogram not available; or
(d) Fatal cases, whether sudden or not, with naked-eye appearance of fresh myocardial infarction and/or recent coronary occlusion found at necropsy.

(2) Possible acute myocardial infarction or coronary death

(a) Living patients: with typical symptoms whose electrocardiogram and enzyme results do not place them in category (1) and in whom there is no good evidence for another diagnosis for the attack; or
(b) Fatal cases whether sudden or not (not in category (1)), where there is no good evidence for another cause of death, clinically or at autopsy:

(i) with symptoms typical or atypical or inadequately described; or
(ii) without typical or atypical or inadequately described symptoms but

with evidence of chronic coronary occlusion or stenosis or old myocardial scarring at necropsy; or

(iii) with a good history of chronic ischaemic heart disease such as definite or possible myocardial infarction, or coronary insufficiency or angina pectoris in the absence of significant valvular disease or cardiomyopathy.

NOTE: A strict watch should be kept over competing causes of death. Local rules should be standardized and a record kept of difficult decisions.

(3) Ischaemic cardiac arrest with successful resuscitation not fulfilling criteria for definite or possible myocardial infarction:

Spontaneous cardiac arrest not provoked by medical intervention, electrocution, drowning or other gross physical insults, from presumed primary ventricular fibrillation secondary to ischaemic heart disease, in the absence of significant valvular disease or cardiomyopathy.

(4) No acute myocardial infarction

(a) Living patients (not in category (1)):

(i) with combinations of symptoms and tests that do not qualify them for the definite category and who do not have typical symptoms that might place them in the possible category, or

(ii) where illness episode has been explained by another diagnosis;

(b) Fatal cases, whether sudden or not, not in category (1), where another diagnosis has been made (clinically or at autopsy).

NOTE: A strict watch should be kept over competing causes of death. Local rules should be standardized and a record kept of difficult decisions.

(5) Fatal cases with insufficient data:

Cases with no autopsy, no history of typical or atypical or inadequately described symptoms, no previous history of chronic ischaemic heart disease and no other diagnosis. Living patients should not be allocated to this category.

The MONICA Protocol gives detailed definitions for: "definite electrocardiogram", "probable electrocardiogram", "ischaemic electrocardiogram", and others, based on Minnesota coding of serial electrocardiogram records; typical (20 minutes of chest pain) and atypical symptoms; abnormal enzymes (above twice the normal limit without other possible explanations); and so on.

Exclusion Criteria

Since a previous myocardial infarction may have influenced the patient's blood pressure level or may have influenced the pattern of care given by the medical practitioner or may have resulted in increased detection of and/or treatment for hypertension, the cases for this study were confined to those which were suffering from their first acute myocardial infarction.

Eighteen (15 fatal and 3 non-fatal) cases of myocardial infarction whose hypertension status could not be ascertained were excluded from the analysis.

Validation of Previous History of Myocardial Infarction

History of previous heart attack was obtained by questioning the relatives of fatal cases, or the patient, as a part of the main MONICA interview schedule (Appendix A.9). This was confirmed by finding the old records in the seven public hospitals in the Lower Hunter Region and checking the discharge summary diagnoses. In addition, past history of patients admitted to hospital under the categories 410-428 according to the International Classification of Diseases - 9th Revision, (World Health Organization, 1975) during the period 1979-1986 were checked by using the record number of the patient in that hospital. For deaths outside hospital, attempts were made to find previous admissions in the Hunter Region for 1979-1986, using the address, date of birth and sex of the deceased as identifiers.

COMMUNITY CONTROLS

Selection of Community Controls

Inclusion Criteria

Five hundred and three subjects (219 men and 284 women) aged 35-69 years were taken from the respondents to a special population survey, which was conducted in the above region in 1986 and which involved a random sample from the electoral rolls of 965 men and women aged 18 and older. The corrected response rate (the percentage of the population which could have replied) was 89 percent. A detailed description of the methods employed in this population survey has been described earlier, in Chapter II. A comparison of the age and sex distribution of the respondents with that of the general population indicated that the sample was representative of the general population. In addition, a follow-up of a sub-sample of the non-respondents showed that almost half of those who had not replied had moved from their address and that the majority of true non-respondents was aged less than 35 years (see Chapter II). Thus, the response rates among subjects aged 35-69 years may have been higher than that for the total sample.

Exclusion Criteria

Twenty-six potential control subjects aged 35-69 years (5 percent of the total sample) were excluded from the analysis because of a history of a previous myocardial infarction.

DESCRIPTION OF STUDY VARIABLES

Blood Pressure Status

Three variables were used to measure the blood pressure status of myocardial infarction cases and community controls: awareness, treatment and control. The "awareness" of high blood pressure was determined by the subjects' answer to the question *"Have you ever been told that you have high blood pressure?"*. The "past treatment" status for aware hypertensive persons was determined by the subject's answer to the question

"Have you ever had treatment for high blood pressure?" and the "current treatment" status by the answer to the question *"Are you receiving treatment for high blood pressure at the present time?"*. "Control" status was determined to be only for treated hypertensive persons by checking their general practitioners' records. A treated hypertensive person was labelled as "controlled" if the last diastolic blood pressure measurement recorded before an acute myocardial infarction occurred, or the survey was taken, was less than 90mmHg.

Utilization of Medical Care Services

The subjects' responses to the questions *"When did you last visit a doctor before this present illness?"* and *"When was your blood pressure last measured before this present illness?"* were used as a measure of utilization of medical care services.

Smoking Habits

For cases and control subjects, smoking behaviour was classified as: current smoker, ex-smoker and non-smoker. A current smoker was defined as a person smoking at least one cigarette per day, an ex-smoker was defined as a person who had given up smoking for at least six months and a non-smoker was defined as a person who had never smoked regularly.

Alcohol Drinking Behaviour

The alcohol intake of individual subjects was measured by the frequency method using questions which assess the frequency of alcohol drinking (Question: *"How often do you usually drink alcohol?"*) and the quantity of alcohol consumed (Question: *"On a day when you drink alcohol, how many drinks do you usually have?"*). There are no internationally accepted criteria to provide a classification of alcohol consumption. However, in line with other studies, alcohol consumption was classified according to the distribution of drinking patterns in the sample of the general population. According to the number of drinks consumed per week (1 drink = approximately 8-10 grams of alcohol), subjects were classified into three alcohol consumption categories: non-drinkers (which consists of people who do not drink and ex-drinkers), light drinkers (less than 8 drinks

per week), and moderate or heavy drinkers (8 drinks or more per week).

Body Mass Index

The Quetelet body mass index, calculated as the weight (kg) divided by the square of the height (m) with one kilogram subtracted from the weight to allow for clothing, was used as a measure of obesity. The body mass index relates closely to body fat while being quite independent of height (Keys *et al.*, 1972; Roche *et al.*, 1981) and thus is a better measure of obesity than percentage body fat. In addition, the Quetelet index is in routine use in epidemiologic studies because of its strong correlation with body fatness, and unlike relative body weight, it can be related to a single set of easily memorized standards (Gray, 1989).

Subjects were classified into the four categories: underweight, of acceptable weight, overweight or obese, according to their Quetelet body mass index (Bray, 1978). Because of the physiological differences in the proportion of the fat fraction of the total body weight between men (15-18 percent of body weight is fat) and women (20-25 percent of body weight is fat), the Bray (1978) classifications of the body mass index uses separate cut-off points for males and females, as follows: underweight (for men <=19.499 and for women <=18.499); acceptable weight (for men 19.5 - 25.499 and for women 18.5 - 24.499); overweight (for men 25.5 - 30.499 and for women 24.5 - 29.499) and obese (for men >=30.5 and for women >=29.5).

Antihypertensive Medications

Information concerning the antihypertensive medications which were being taken by the patients on treatment for hypertension who developed myocardial infarction was obtained from the medical records of the patients' regular doctors. For both treated hypertensive cases and controls, the antihypertensive drugs which were being taken before the coronary event (or before the survey) were classified into four groups of major antihypertensive agents: diuretics, beta-blockers, calcium channel blockers and other antihypertensive agents (Appendix A.12).

Blood Pressure Levels

Letters were sent to the regular doctors of those myocardial infarction patients and control subjects who had answered that they were currently receiving treatment for high blood pressure. Doctors were requested to describe the type of antihypertensive medications that were being taken before the event or to provide the name/s of the antihypertensive medications taken. In addition, doctors were asked to complete a questionnaire that sought information on dates and levels of the most recent blood pressure recorded before the date of the myocardial event (last recorded blood pressure), the pre-treatment blood pressure (or highest blood pressure recorded if this one was not available) and to confirm that the antihypertensive medications were being given for the treatment of hypertension, and if not, what condition(s) they were being prescribed for - such as, giving beta-blocking agents to treat angina. Those doctors who did not reply within four weeks were sent a reminder letter which was followed by a telephone call. A thank-you letter was sent to all those doctors who replied. Samples of the letters and the questionnaires are shown in Appendices A.13 to A.22.

Twelve patients who were identified by their general practitioner as currently having been on treatment for angina rather than for hypertension before suffering their first myocardial infarction and seven patients for whom doctors did not have records were excluded from the analysis.

Validation of Hypertension Treatment Status

Since the hypertension treatment status of patients with acute myocardial infarction and the name/s of the antihypertensive agents which were being taken before the coronary event were obtained through personal interviews with heart attack patients (or close relatives of deceased patients), comparing the questionnaire data with that obtained from the patient's regular doctor's medical records ("the standard") provided an opportunity to evaluate the accuracy of this information (Feinstein and Horwitz, 1982). Data were available for 265 patients on treatment for hypertension who developed acute myocardial infarction. Of these, twelve patients were identified by their regular doctor as being currently on treatment for angina rather than hypertension (overall proportion of agreement on hypertension treatment status = 253/265 = 95 percent). While some

patients were found to be taking the medications (mainly beta-blockers) for medical conditions other than hypertension, those subjects who stated that they were currently on treatment for high blood pressure and actually named the antihypertensive medications which were being taken before the myocardial event were indeed on such therapy. The fairly acccurate recall of heart attack cases of antihypertensive medication use is consistent with the findings of other researchers (Paganini-Hill and Ross, 1982), and in view of similar findings among community hypertensive controls (Chapter II), there appears to be no evidence of myocardial infarction cases preferentially recalling more antihypertensive drug usage than controls (see Chapter II). In addition, the data suggest that subjects in this community can recall fairly accurately their medical and drug usage history, which should prove useful to other researchers concerned about accuracy of drug information obtained from subjects in the Australian population.

DATA MANAGEMENT AND STATISTICAL ANALYSIS

Training and Retraining of Nurse Interviewers

The Project Manager of the Newcastle MONICA Project conducted regular retraining sessions for the nurse interviewers during the study period.

The purpose of these retraining sessions was to explain to the nurses where their data collection fitted into the study, to emphasize the need for standardization of methods of data collection throughout the period of the study and to allow the nurse interviewers to discuss issues and/or problems relating to the study questionnaire with the Principal Investigator of this study (the author).

Coding and Checking of the Data Forms

Nurse interviewers with the study did most of the coding of the structured questionnaire during the interview. Detailed written coding instructions for the hypertension questionnaire (Appendix A.9) and the antihypertensive medication groups (Appendix A.12; Pages 1, 3, 4 and 5) were supplied to the interviewers. This would have ensured the consistency of the coding decisions and provided a permanent record of how these decisions were made for future reference. Nurses were directed not to deviate from

the format of the interview schedule and to postpone any "off the track" conversation until the form was completed. The interviewers were also instructed to avoid leading questions and, if the patient found a question difficult to answer, the answer which the patient felt was most correct was recorded.

All completed data forms were checked by scrutinizing the record forms for errors and omissions. Effort was made to ensure the completeness of the forms and that any deficiencies or suspicious values were checked and corrected before the data forms were sent for data entry.

Data Entry

Data entry structures were set up on temporary data files. To avoid additional data handling, and thus reducing the risk of loss and errors, a skilled keyboard operator was employed to type the information directly from the original data forms on to the data files using a microcomputer terminal in the study office. For the analysis, the data were transferred to a study account on the University's VAX Cluster at the Computer Centre of the University of Newcastle.

Computer Checking and Editing

Once the data had been entered into the computer, the frequency distributions of all variables were examined using the SAS statistical software package (SAS Institute Inc., 1985). A separate table was produced for each variable, showing how many individuals were assigned to each value of the variable or to each category. The information about the expected values and relationships among the data items was used to check for errors in the recorded values or in the data entry (Abramson, 1979; Marinez *et al.*, 1984). For data thought to be in error, the original data form was checked and the error was corrected in the data item. If examination of the original form failed to identify a mistake, a "missing" value was assigned to the data item. "Don't know" responses were also counted as missing data.

Data Analysis

All collected data were computerized and the SAS (SAS Institute Inc., 1985) and BMDP (Dixon *et al.*, 1985) statistical software packages were used for data management and statistical analysis. Univariate analyses were performed on all variables to assess their frequency and distribution among the myocardial infarction cases and the control subjects. Thus, baseline descriptive statistics were obtained on the prevalence of hypertension (awareness, treatment and control) among subjects in all age groups, as well as separately for men and women.

The association of each study variable with acute myocardial infarction was evaluated by the odds ratio, which is a close approximation to the relative risk (Cornfield, 1951). The odds ratios were calculated using the standard methods of odds ratio analysis (univariate and multivariate) employed in case-control studies (Breslow and Day, 1980, Chapter 4; Schlesselman, 1982, Chapter 7). These included stratified group-based analysis, "the Mantel-Haenszel technique", to adjust for age and sex (Mantel and Haenszel, 1959; Kuritz, Landis and Koch, 1988) with the 95 percent confidence intervals calculated by the method of Cornfield (Breslow and Day, 1980, Chapter 4) and logistic regression for unmatched analyses of case-control studies. Since with moderate sample size it is not feasible to simultaneously adjust for more than one or two confounders by stratification, logistic regression (Dixon *et al.*, 1985) was used to calculate the odds ratios, confidence intervals and the tests of significance, while adjustments were made for possible confounding variables (Schlesselman, 1982, Chapter 8).

Using multiple logistic regression, the case-control status was taken as the response variable, and the primary exposure variable "Hypertension" and potential confounding variables were entered as regressor variables. The multivariate model provides direct estimates of the odds ratios which were statistically adjusted for all other variables included in the particular regression analysis. Thus, logistic regression was considered an appropriate method for the analysis because it provides a direct estimate of the odds ratio and allows adjustment for several confounders without the need for extensive stratification of all confounders (Lee, 1986).

In accordance with recent recommendations, confidence intervals were used to

assess the statistical significance of the associations (Berry, 1986; Gardner and Altman, 1986; Braitman, 1988). If the 95 percent confidence interval did not include the value "one", the risk estimate was regarded as significant.

A case-control study can be used to estimate the proportion of all cases in the population which are attributable to the risk factor under study (the aetiologic fraction) if, as here, the control subjects are representative of the population (Walter, 1978; Whittmore, 1983). Thus, calculation of the aetiologic fraction allows us to estimate the potential reduction in acute myocardial infarction if the risk from hypertension were reduced substantially. The stratified group-based analysis method described by Schlesselman (1982, Pages 224-226) to adjust for confounding was used to calculate the aetiologic fractions and their 95 percent confidence intervals with adjustment for age and sex. Cases and controls were stratified into sub-groups on the basis of age and sex distributions and estimates were made of the proportion of myocardial infarction cases within each stratum which are attributable to exposure (hypertension). Then, by taking a weighted average of the fractions across the strata, a standardized estimate of the overall proportion of cases which are attributable to exposure was obtained.

Using the method described by Schlesselman (1982, Pages 224-6) to estimate the aetiologic fraction in an unmatched case-control study

Exposure	**Cases**	**Controls**	**Total**
Yes	a	b	m1
No	c	d	m2
Total	n1	n2	

the aetiologic fraction was calculated from the formula:

$$\text{the aetiologic fraction } (\lambda) = \frac{(a \times d) - (b \times c)}{n1 \times d}$$

and the 95 percent confidence intervals for the aetiologic fractions were calculated from

the formula:

$$\lambda L = 1 - (1 - \bar{\lambda}) \exp\left(+ Z_{\alpha} \sqrt{\bar{V}}\right)$$

$$\lambda U = 1 - (1 - \bar{\lambda}) \exp\left(- Z_{\alpha} \sqrt{\bar{V}}\right)$$

where $\bar{V} = \frac{a}{cn1} + \frac{b}{dn2}$

All available potential confounders such as age, sex, smoking status, amount of alcohol consumption and body mass index were added to the hypertension logistic regression model to determine whether they had a role in confounding the association between hypertension and the occurrence of acute myocardial infarction. This technique is in keeping with the approach recommended by Kleinbaum, Kupper and Morgenstern (1982) when applying the logistic regression model to case-control studies. The variables used in the logistic model, along with the method of measurement and coding allocation, are presented in Table 4.1.

Table 4.1. Method of coding of variables used in the logistic model of myocardial infarction cases and community controls: persons aged 35-69 years in the Hunter Region in 1986.

Variable	Coding
Age	35-49 years (reference)/50-59 years/60-69 years
Sex	0 = female/1 = male
Smoking status	non-smoker (reference)/ex-smoker/current smoker
Alcohol consumption	non-drinker (reference)/light drinker/ moderate-heavy drinker
Body mass index	Quintiles of Quetelet index (weight/height^2) underweight/ acceptable weight (reference)/ overweight/obese
Hypertension:	
Ever told	0 = no/1 = yes
Ever treated	0 = no/1 = yes
On current treatment	0 = no/1 = yes
Last visit to a doctor	0 = more than 3 months ago/ 1 = within the last 3 months
Last time blood pressure was measured	0 = more than 3 months ago/ 1 = within the last 3 months

RESULTS

Numbers of Myocardial Infarction Cases and Community Controls

A total of 781 first-time acute myocardial infarction patients (542 men and 239 women) in the age group 35-69 years were identified in the study population during the twelve months period from 27th August, 1985, to 26th August, 1986. Of these, 599 survived for at least 28 days and 182 died within 28 days after suffering their first myocardial event. Four hundred and ninety-one cases were definite acute myocardial infarction, 279 were possible acute myocardial infarction and 11 were ischaemic cardiac arrest.

Those who suffered their first myocardial event were compared with those with a prior history of myocardial infarction. Table 4.2 shows that there were no differences, in the proportions of subjects with a history of and/or treatment for hypertension, between those with a history of previous myocardial infarction and those with no such history. This is in contrast with the proportion of those who were current cigarette smokers, which was lower among those with previous myocardial infarction (28 percent) than among those suffering their first myocardial event (40 percent). Although this suggests that current smokers who suffered a heart attack received some intervention, there still remains room for a reduction in the prevalence of cigarette smoking (the prevalence of cigarette smoking among patients with previous myocardial infarction, i.e., 28 percent, is higher than among people in the community, i.e., 24 percent). Similar observations were reported from other Australian populations (Simons and Simons, 1987).

Given the knowledge that a myocardial event would influence the blood pressure level of patients, and in view of the finding that a previous heart attack would influence the care given by doctors, it was decided to confine the analysis to those suffering their first ever acute myocardial infarction.

Table 4.2. **Numbers and percentages of acute myocardial infarction (AMI) cases by history of previous myocardial infarction among persons aged 35-69 years in the Lower Hunter Region.**

Variable	History of previous myocardial infarction: Yes (Cases with previous AMI)	History of previous myocardial infarction: No (New AMI cases)
No. of subjects	356	781
Sex:		
Men	258 (73)*	542 (69)
Women	93 (27)	239 (31)
Hypertension status:		
Ever told	192 (54)	409 (52)
Ever treated	151 (42)	362 (46)
On current treatment	135 (38)	290 (37)
Cigarette smoking	100 (28)	313 (40)

* Percentages in parentheses

Prevalence of Hypertension Among Myocardial Infarction Cases and Community Controls

The age and sex distribution of myocardial infarction cases and community controls, together with the number of males and females who had a past history of hypertension (ever told), those who had a past history of treatment for hypertension (ever treated), those who were on current treatment for hypertension (on current treatment), or those who were current smokers, are shown in Table 4.3. Seven hundred and eighty one cases of first-time acute myocardial infarction (542 men and 239 women) were available for comparison with 477 community controls (205 men and 272 women) who had no previous history of heart attack.

Among cases of acute myocardial infarction, the proportion of subjects with hypertension (however it was defined) was greater than among the community controls. The pattern was consistent for both men and women and for younger (aged 35-59 years) and older (aged 60-69 years) age groups. Overall, 33 percent of the controls (29 percent of the men and 36 percent of the women) had a history of hypertension at the time of the interview compared with 53 percent of the myocardial infarction cases (49 percent of the men and 62 percent of the women). The comparative figures for those who were currently receiving treatment for hypertension are 21 percent (18 percent of the men and 22 percent of the women) and 37 percent (34 percent of men and 46 percent of women) for the community controls and the acute myocardial infarction cases respectively.

Seventy one percent of the myocardial infarction cases with a history of hypertension were currently receiving treatment compared with 60 percent of hypertensive control subjects. The proportion of women with hypertension (history of hypertension and current treatment) was higher than that in men; this pattern is similar to that reported in a 1983 Nationwide risk factor survey (National Heart Foundation of Australia, 1985).

Table 4.3. First acute myocardial infarction (AMI) cases and community controls classified by age, sex, hypertension and smoking status.

	First AMI cases			Community Controls		
Variable	**Men**	**Women**	**Total**	**Men**	**Women**	**Total**
No. of subjects	542	239	781	205	272	477
Age: (years)						
35-49	90(17)*	29(12)	119(15)	106(52)	124(46)	230(48)
50-59	179(33)	72(30)	251(32)	48(23)	84(31)	132(28)
60-69	273(50)	138(58)	411(53)	51(25)	64(24)	115(24)
Hypertension:						
Ever told	263(49)	146(61)	409(52)	68(33)	101(37)	169(35)
Ever treated	247(46)	115(48)	362(46)	48(23)	84(31)	132(28)
On current treatment	182(34)	108(45)	290(37)	38(19)	61(22)	99(21)
Smoking status:						
Current smoker	234(43)	79(33)	313(40)	61(30)	45(17)	106(22)
Ex-smoker	185(34)	37(15)	222(28)	66(32)	43(16)	109(23)

* Percentages in parentheses

Assessment of Risk of Myocardial Infarction in Relation to History of Hypertension (Stratified Analysis)

The relationship between hypertension and the risk of myocardial infarction, controlling for age and sex, is presented in Table 4.4. For men and women combined, a history of hypertension (odds ratio 2.2; 95 percent confidence interval 1.7 to 2.9; P <0.00001), a history of treatment for hypertension (odds ratio 2.3; 95 percent confidence interval 1.7 to 3.1; P <0.00001) and current treatment for hypertension (odds ratio 2.0; 95 percent confidence interval 1.5 to 2.8; P <0.00001) were all associated with an increased risk of acute myocardial infarction.

Current smoking appears to be a greater risk factor for myocardial infarction (odds ratio 2.8; 95 percent confidence interval 2.0 to 4.0; P <0.001) than does hypertension. The relationship between the occurrence of acute myocardial infarction and smoking was also stronger in women than in men, but this sex difference was not statistically significant (P >0.05).

Table 4.4. Risk of first acute myocardial infarction (AMI) associated with hypertension and smoking, controlling for age.

Variable	Men	Women	Both sexes*
Hypertension:			
Ever told	2.1 (1.4-3.2)**	2.3 (1.5-3.4)	2.2 (1.7-2.9)
Ever treated	2.3 (1.5-3.6)	2.2 (1.5-3.4)	2.3 (1.7-3.1)
On current treatment	2.0 (1.3-3.2)	2.0 (1.3-3.1)	2.0 (1.5-2.8)
Smoking status:			
Current smoker	2.4 (1.6-3.9)	3.1 (2.0-5.8)	2.8 (2.0-4.0)
Ex-smoker	1.1 (0.7-1.8)	1.7 (0.9-3.1)	1.3 (0.9-1.9)

* Also controlling for sex

** 95 percent confidence interval in parentheses

Utilization of Medical Services for Hypertension

Table 4.5 shows that the proportion of acute myocardial infarction cases who had visited a doctor within the last three months before the event (74 percent) was significantly higher ($P < 0.05$) than among community control subjects (61 percent). Seventy percent of the myocardial infarction cases had undergone a blood pressure measurement within the last three months before suffering their myocardial event compared with 49 percent of community controls ($P < 0.05$). Women (patients or controls) were more likely to have visited a doctor and to have had their blood pressure measured within the last three months before an event (or survey) than were men.

Table 4.5. Utilization of health services for hypertension among myocardial infarction cases and community controls, aged 35-69 years.

Variable	First AMI Cases			Community Controls		
	Men	Women	Total	Men	Women	Total
No. of subjects	509	230	739*	205	272	477
Last visit to a doctor:						
More than three months ago	148(29)**	44(19)	192(26)	84(41)	100(37)	184(39)
Within the last three months	361(71)	186(81)	547(74)	121(59)	172(63)	293(61)
Last blood pressure measurement:						
More than three months ago	132(26)	93(40)	225(30)	106(52)	139(51)	245(51)
Within the last three months	377(74)	137(60)	514(70)	99(48)	133(49)	232(49)

* Excluding 42 myocardial infarction cases (33 men and 9 women) for whom data were not available

** Percentages in parentheses

Multivariate Assessment of Risk of Acute Myocardial Infarction in Relation to History of Hypertension (Logistic Regression)

Table 4.6 shows that even with further adjustment for smoking status, amount of alcohol consumption and body mass index, hypertension (on current treatment) was still associated with an increased risk of myocardial infarction (odds ratio 2.3; 95 percent confidence interval 1.6 to 3.1). The results of the logistic regression are in broad agreement with the univariate analysis. Similar findings were obtained when the logistic regression was repeated using past history of hypertension rather than current treatment (odds ratio 2.6; 95 percent confidence interval 1.9 to 3.4). This emphasises the strength of the association between hypertension and the occurrence of myocardial infarction in the general population.

Older age (people aged 60-69 years) and male sex appeared to be the two most important risk factors for myocardial infarction. Current smokers, overweight subjects and heavy drinkers and non-drinkers were all at high risk.

Table 4.6. Multivariate assessment of risk of first-time acute myocardial infarction (AMI) in relation to hypertension.

Variable	No. (%) of AMI cases (n=781)	No. (%) of controls (n=477)	Odds ratio* of first AMI (95% confidence interval)
Age category:			
35-49 years	119 (15)	230 (48)	1.0**
50-59 years	251 (32)	132 (28)	3.8 (2.7-5.6)
60-69 years	411 (53)	115 (24)	7.5 (3.2-10.7)
Sex:			
Women	239 (31)	272 (57)	1.0**
Men	542 (69)	205 (43)	3.2 (2.3-4.5)
Smoking status:			
Non-smoker	246 (31)	262 (55)	1.0**
Ex-smoker	222 (28)	109 (23)	1.5 (1.0-2.1)
Current smoker	313 (40)	106 (22)	3.2 (2.3-4.6)
Alcohol consumption:			
Non-drinker	291 (37)	201 (42)	1.0**
Light	341 (44)	234 (49)	0.8 (0.6-1.1)
Moderate - heavy	149 (19)	42 (9)	1.5 (0.9-2.5)
Body Mass Index (kg/m^2):			
Underweight	43 (6)	22 (5)	1.1 (0.5-2.2)
Acceptable weight	359 (46)	264 (55)	1.0**
Overweight	283 (36)	146 (31)	1.3 (1.0-1.8)
Obese	96 (12)	45 (9)	1.6 (1.0-2.6)
Hypertension (on treatment)			
No	491 (63)	378 (79)	1.0**
Yes	290 (37)	99 (21)	2.3 (1.6-3.1)

* Odds ratios are adjusted for all other factors in table

** Reference category

Table 4.7 shows that restricting the multivariate logistic regression analysis to patients whose diagnosis was definite acute myocardial infarction did not affect the results. The adjusted odds ratios for those on treatment for hypertension was 1.8 (95 percent confidence interval 1.3 to 2.7) and the pattern of cardiovascular risk factor distributions among cases and controls was similar to that in the total population (Table 4.6).

Table 4.7. Multivariate assessment of risk of first-time definite acute myocardial infarction (AMI) in relation to hypertension (analysis restricted to those with definite AMI only).

Variable	No. (%) of AMI cases (n=491)	No. (%) of controls (n=477)	Odds ratio* of first AMI (95% confidence interval)
Age category:			
35-49 years	72 (15)	230 (48)	1.0**
50-59 years	138 (28)	132 (28)	4.0 (2.6-6.1)
60-69 years	281 (57)	115 (24)	8.7 (5.8-13.2)
Sex:			
Women	118 (24)	272 (57)	1.0**
Men	373 (76)	205 (43)	4.1 (2.8-5.9)
Smoking status:			
Non-smoker	135 (27)	262 (55)	1.0**
Ex-smoker	134 (27)	109 (23)	1.3 (0.9-2.1)
Current smoker	222 (45)	106 (22)	3.7 (2.5-5.5)
Alcohol consumption:			
Non-drinker	159 (32)	201 (42)	1.0**
Light	220 (45)	234 (49)	0.8 (0.5-1.1)
Moderate - heavy	112 (23)	42 (9)	1.8 (1.0-3.1)
Body Mass Index (kg/m^2):			
Underweight	35 (7)	22 (5)	1.2 (0.6-2.5)
Acceptable weight	228 (46)	264 (55)	1.0**
Overweight	180 (37)	146 (31)	1.3 (1.0-1.9)
Obese	48 (10)	45 (9)	1.4 (0.8-2.4)
Hypertension (on treatment)			
No	331 (67)	378 (79)	1.0**
Yes	160 (33)	99 (21)	1.8 (1.3-2.7)

* Odds ratios are adjusted for all other factors in table

** Reference category

The multivariate logistic regression analysis was repeated, separately, for those myocardial infarction patients who were alive at 28 days following their coronary events and those who died separately, in order to determine whether treatment for hypertension affected fatal and non-fatal myocardial infarction events differently. In accordance with the recommendations by Calle (1984), living controls were used in comparisons with the fatal cases since these will allow for less biased estimation of the relative risk than will the use of dead cases.

Table 4.8 shows that the prevalence of treatment for hypertension was lower among those myocardial infarction cases who died within 28 days of the event (30 percent; 95 percent confidence interval 23 to 37) than among those who survived (39 percent; 95 percent confidence interval 35 to 43). However, treatment for hypertension was more prevalent among myocardial infarction cases (fatal or non-fatal) than among people in the community (21 percent). The prevalence of current smokers was similar among fatal (42 percent; 95 percent confidence interval 35 to 49) and non-fatal (39 percent; 95 percent confidence interval 35 to 43) myocardial infarction cases but still significantly higher than in the community (22 percent; 95 percent confidence interval 18 to 26).

Table 4.8. Distribution of history of hypertension and cigarette smoking among fatal and non-fatal cases of acute myocardial infarction (AMI) and community controls, aged 35-69 years.

Variable	No. (%) of AMI Cases: Non-fatal cases alive at 28 days of event (n = 599)	No. (%) of AMI Cases: Fatal cases died within 28 days of event (n = 182)	No. (%) of community controls (n = 477)	Odds ratio* of first AMI (95% confidence interval): Non-fatal AMI	Odds ratio* of first AMI (95% confidence interval): Fatal AMI
Hypertension:# (On treatment)					
No	363 (61)	128 (70)	378 (79)	1.0**	1.0**
Yes	236 (39)	54 (30)	99 (21)	2.5 (1.7-3.3)	1.7 (1.0-2.5)
Smoking Status:##					
Non-smoker	193 (32)	53 (29)	262 (55)	1.0**	1.0**
Ex-smoker	170 (28)	52 (29)	109 (23)	1.5 (0.9-2.1)	1.4 (0.7-2.5)
Current smoker	236 (39)	77 (42)	106 (22)	3.3 (2.0-4.4)	2.5 (1.3-4.3)

* Odds ratios are adjusted for age, sex, alcohol consumption and body mass index

** Reference category

\# Odds ratio is also adjusted for smoking status

\#\# Odds ratio is also adjusted for hypertension treatment status

Estimation of the Aetiologic Fraction

An estimate was made of the proportion of first acute myocardial events which could be attributed in this population to the presence of hypertension and cigarette smoking. Table 4.9 shows that the estimated population attributable risk of myocardial infarction events associated with hypertension was greater among women (22 percent) than among men (13 percent), while cigarette smoking appears to be equally important among men (26 percent) and women (22 percent).

Overall, 16 percent of all cases could be attributed to the effect of hypertension (on current treatment) and 24 percent of all events could be attributed to the effect of current cigarette smoking, with an additional 10 percent of events being attributed to ex-smoking. Therefore, the total percentage of myocardial infarction cases attributable to cigarette smoking was 34 percent (adjusted for age and sex). Thus, half (34 percent + 16 percent) of all heart attacks in the community were attributable to cigarette smoking and hypertension.

Table 4.9. Estimated proportion of cases of first acute myocardial infarction (AMI) attributable to hypertension and smoking, by age, of men and women*.

Exposure	Age-specific Aetiologic Fractions 35-49	50-59	60-69	Age-adjusted Aetiologic Fractions (95% confidence interval)
Hypertension (on treatment):				
Men	0.196	0.113	0.126	0.133 (0.043 to 0.215)
Women	0.208	0.134	0.270	0.222 (0.113 to 0.318)
Both sexes	0.199	0.119	0.174	0.160** (0.098 to 0.217)
Smoking Status:				
Men:				
Current smoker	0.485	0.413	0.076	0.255 (0.078 to 0.398)
Ex-smoker	-0.024	0.077	0.148	0.096 (-0.119 to 0.264)
Women:				
Current smoker	0.402	0.489	0.045	0.221 (0.115 to 0.314)
Ex-smoker	0.129	0.136	0.069	0.094 (0.014 to 0.184)
Both sexes:				
Current smoker	0.464	0.434	0.066	0.244** (0.153 to 0.325)
Ex-smoker	0.013	0.093	0.121	0.095** (0.012 to 0.171)

* Estimates based on data in Table 4.3. For example, among men 35-49 years of age, an estimated 19.6 percent of cases of AMI are attributable to hypertension, and overall, an estimated 13.3 percent of cases of AMI among men aged 35-69 years are attributable to hypertension:

Age-adjusted aetiologic fraction for hypertension among men = [90(0.196) + 179(0.113) + 273(0.126)] / 542 = 0.133.

** Also adjusted for sex, by age, of men and women

Prevalence of Cardiovascular Risk Factors Among Treated Hypertensives

Table 4.10 shows that the proportion of current cigarette smokers was higher among treated hypertensives who developed myocardial infarction (28 percent) than among treated hypertensives in the community (16 percent); an adjusted odds ratio of 2.2 (95 percent confidence interval of 1.2 to 4.4). Although the proportions of heavy alcohol drinkers and obese subjects were higher among treated hypertensive subjects who developed myocardial infarction than among treated hypertensives in the community, the differences were not statistically significant.

Table 4.10. Prevalence of cardiovascular risk factors among treated hypertensives who developed acute myocardial infarction (AMI) and treated hypertensive subjects in the community, aged 35-69 years.

Variable	Treated hypertensive subjects		Odds ratio* of first AMI (95% confidence interval)
	No. (%) of AMI cases (n=290)	No. (%) of controls (n=99)	
Age category:			
35-49 years	32 (11)	22 (22)	1.0**
50-59 years	90 (31)	28 (28)	1.4 (0.7-3.0)
60-69 years	168 (58)	49 (49)	3.0 (1.5-6.0)
Sex:			
Women	108 (37)	61 (62)	1.0**
Men	182 (63)	38 (38)	2.4 (1.3-4.2)
Smoking status:			
Non-smoker	113 (39)	56 (55)	1.0**
Ex-smoker	96 (33)	27 (27)	1.4 (0.8-2.6)
Current smoker	81 (28)	16 (16)	2.2 (1.2-4.4)
Alcohol consumption:			
Non-drinker	126 (43)	49 (49)	1.0**
Light	113 (39)	45 (44)	0.7 (0.5-1.2)
Moderate - heavy	51 (18)	6 (6)	1.9 (0.7-5.1)
Body Mass Index (kg/m^2):			
Underweight	8 (3)	3 (3)	0.9 (0.2-4.2)
Acceptable weight	119 (41)	39 (39)	1.0**
Overweight	111 (38)	42 (42)	0.9 (0.5-1.5)
Obese	52 (18)	15 (15)	1.3 (0.6-2.6)

* Odds ratios are adjusted for all other factors in table

** Reference category

Blood Pressure Control of Myocardial Infarction Cases and Community Controls

Data were available for 253 hypertensive patients (155 men and 98 women) who developed their first myocardial event (a "response rate" of 91 percent) and 91 subjects (35 men and 56 women) on treatment for hypertension in the community with no previous medical history of myocardial infarction (a "response rate" of 92 percent).

Table 4.11 shows that the proportion of subjects with a pre-treated diastolic blood pressure of 95mmHg or more was similar for those hypertensive subjects who later developed acute myocardial infarction (82 percent) and subjects on treatment for hypertension in the community with no history of coronary events (84 percent), but the proportion of those with more severe forms of hypertension (pre-treated diastolic blood pressure of 115mmHg or more) was slightly higher among those who developed myocardial infarction (22 percent) than among the hypertensive control subjects (13 percent).

A similar pattern is seen for pre-treated systolic blood pressure; that is, Table 4.11 shows that the proportion of those with a pre-treated systolic blood pressure of 160mmHg or more was similar for cases (81 percent) and controls (80 percent). In addition, the proportion of those with more severe forms of hypertension (pre-treated systolic blood pressure of 200mmHg or more) was slightly higher among those who developed myocardial infarction (19 percent) than among hypertensive subjects (14 percent).

Table 4.11. A comparison of the pre-treated systolic and diastolic blood pressure levels of patients with hypertension who developed acute myocardial infarction (AMI) and of hypertensive subjects in the community, aged 35-69 years.

Characteristic	Hypertensive cases of AMI	Community Hypertensive Controls
No. of subjects	253	91
Pre-treated systolic blood pressure (mmHg):		
Less than 160	48 (19)*	18 (20)
160 - 179	88 (35)	40 (44)
180 - 199	68 (27)	20 (22)
200 or more	49 (19)	13 (14)
Pre-treated diastolic blood pressure (mmHg):		
Less than 95	46 (18)	15 (16)
95 - 104	84 (33)	30 (33)
105 - 114	68 (27)	34 (38)
115 or more	55 (22)	12 (13)

* Percentages in parentheses

Table 4.12 shows that the proportion of subjects poorly controlled (last measured treated diastolic blood pressure before event equal to or greater than 90mmHg) was higher among myocardial infarction cases (48 percent) than among community controls (27 percent), with a similar pattern seen for treated systolic blood pressure of 140mmHg or more (poorly controlled subjects) which was higher among myocardial infarction cases (67 percent) than among control subjects (51 percent).

Table 4.12. A comparison of treated systolic and diastolic blood pressure levels of patients with hypertension who developed acute myocardial infarction (AMI) and of hypertensive subjects in the community, aged 35-69 years.

Characteristic	Hypertensive cases of AMI	Community Hypertensive Controls
No. of subjects	253	91
Treated systolic blood pressure (mmHg)		
Less than 120	18 (7)*	4 (4)
120 - 139	65 (26)	41 (45)
140 - 159	97 (38)	33 (37)
160 or more	73 (29)	13 (14)
Treated diastolic blood pressure (mmHg):		
Less than 80	36 (14)	14 (15)
80 - 89	97 (38)	52 (58)
90 - 94	66 (41)	18 (20)
95 or more	54 (21)	7 (7)

* Percentages in parentheses

Table 4.13 shows that the mean blood pressure of those on treatment (systolic or diastolic) was higher among those who later developed a myocardial event than among those in the community sample despite similar pre-treatment blood pressure levels. This pattern was consistent across age and sex groups.

In addition, there were greater declines in both systolic and diastolic blood pressure levels in subjects on treatment for hypertension in the community than there were for those hypertensives who developed myocardial infarction - Table 4.13.

Table 4.13. A comparison of mean blood pressure levels of patients on treatment for hypertension who developed myocardial infarction and of subjects on treatment for hypertension in the community, aged 35-69 years (standard error in parentheses).

Characteristic	Hypertensive cases of AMI	Community Hypertensive Controls
No. of subjects	253	91
(a) Pre-treatment blood pressure:		
Systolic mmHg	175.5 (1.6)	172.8 (2.1)
Diastolic mmHg	104.9 (1.3)	103.7 (1.2)
(b) Last recorded blood pressure before event*:		
Systolic mmHg	144.7 (1.5)	137.0 (1.5)
Diastolic mmHg	87.0 (0.8)	82.4 (0.8)
Reduction in blood pressure: (a) - (b)		
Systolic mmHg	30.8 (1.6)	35.8 (2.3)
Diastolic mmHg	17.9 (0.9)	21.3 (1.3)
Percentage of reduction in blood pressure**:		
Systolic	17.5% (0.9%)	20.7% (1.1%)
Diastolic	17.0% (0.8%)	20.5% (1.1%)
Period on treatment for hypertension (months)	55.0 (3.7)	51.6 (5.7)

* Or before survey in community controls

** Percentage reduction in blood pressure $= \frac{(a) - (b)}{(a)} \times 100$

Sixty-six percent and 90 percent of the last recorded blood pressures of hypertensives who developed acute myocardial infarction were taken within the past month and the past three months, respectively, before the onset of the coronary event. The comparative figures for community hypertensive controls were 56 and 91 percent before survey.

Poorly controlled blood pressure was defined as treated diastolic blood pressure of equal to or greater than 90mmHg, in accordance with the definition of hypertension recently recommended by the 1984 and 1988 Reports of the Joint National Committee on Detection, Evaluation and Treatment of High Blood Pressure in the United States, the World Health Organization (Amery *et al.*, 1986) and the British Hypertension Society Working Party (Swales *et al.*, 1989).

Multivariate Assessment of Risk of Myocardial Infarction in Relation to Hypertension Control

The relationships between blood pressure control and the risk of acute myocardial infarction, adjusting for age, sex, smoking status, amount of alcohol consumption and body mass index, are presented in Table 4.14. Since the blood pressure increases markedly with age, adjustment has been made using age as a continuous variable, rather than having three age categories. Hypertensives with poorly controlled blood pressure (treated diastolic blood pressure of 90mmHg or more) were at higher risk of developing myocardial infarction (adjusted odds ratio 2.9; 95 percent confidence interval 1.6 to 5.3). Hypertensives with low treated diastolic blood pressure (less than 80mmHg) appear to be at increased risk also. However, the 95 percent confidence interval included one (no effect) (Table 4.14). Similar findings were obtained when the analysis was repeated using different criteria for poor control; that is, treated diastolic blood pressure of at least 95mmHg (adjusted odds ratio 5.1; 95 percent confidence interval 1.9 to 14.1) or 100mmHg (adjusted odds ratio 5.4; 95 percent confidence interval 1.8 to 16.7).

Repeating the analysis using systolic treated blood pressure levels revealed similar findings (Table 4.14), with hypertensives with treated systolic blood pressure of 140mmHg or more (poorly controlled hypertensives) having an adjusted odds ratio of 3.2 (95 percent confidence interval 1.5 to 6.5) for developing acute myocardial infarction.

Using different criteria for systolic blood pressure control did not change the findings but the risk increased with increasing the blood pressure cut point; that is, those with a systolic blood pressure of 160mmHg or more had an adjusted odds ratio of 3.1 (95 percent confidence interval 1.5 to 6.4) for developing myocardial infarction and those with a systolic blood pressure of 180mmHg or more had an adjusted odds ratio of 9.5 (95 percent confidence interval 1.2 to 27.3).

When the more stringent criteria for a well controlled blood pressure of values less than both 140mmHg systolic and 90mmHg diastolic were applied, those with treated blood pressure of 140/90mmHg or more were at even greater risk of developing myocardial infarction (adjusted odds ratio 3.6; 95 percent confidence interval 1.9 to 6.6). Further, adjusting for the proportion of hypertensive cases on beta- blockers and diuretics did not change the associations observed.

Table 4.14. Risk of first acute myocardial infarction (AMI) in relation to treated blood pressure level among subjects on treatment for hypertension in the Hunter Region, aged 35-69 years.

Variable	No. (%) of Hypertensive AMI Cases (n = 253)	No. (%) of Hypertensive Controls (n = 91)	Odds Ratio* of first AMI (95% confidence interval)
Last diastolic blood pressure:			
Less than 80mmHg	35 (14)	14 (15)	1.6 (0.7 - 3.4)
80 - 89mmHg	97 (38)	52 (57)	1.0**
90mmHg or more	121 (48)	25 (27)	2.9 (1.6 - 5.3)
Last systolic blood pressure:			
Less than 120mmHg	19 (8)	4 (4)	2.4 (0.8 - 7.4)
120 - 139mmHg	65 (26)	41 (45)	1.0**
140mmHg or more	169 (67)	46 (51)	3.2 (1.5 - 6.5)

* Odds ratios are adjusted for age, sex, smoking status, alcohol consumption and body mass index

** Reference category

Table 4.15 shows that the higher proportion of poorly controlled hypertensives (those with a treated blood pressure equal to or greater than 90mmHg diastolic) among treated hypertensives who later developed acute myocardial infarction than among treated hypertensive subjects in the community was consistent across age and sex groups.

Because of the differences in the age distribution between cases and controls, the statistical analysis was repeated employing matched sets (with a variable number of cases per control), that is, conditional logistic regression (Breslow and Day, 1980, Chapter 7). The sets were matched by sex and age (either the same year of birth or less than two years' difference). However, the increased risk of developing acute myocardial infarction among poorly controlled hypertensives (those with a treated blood pressure equal to or greater than 90mmHg diastolic) was observed in both matched and unmatched analyses, as shown in Table 4.16.

Table 4.15. Risk of first acute myocardial infarction (AMI) in relation to last recorded diastolic blood pressure reading before event, among age and sex groups.

Stratum (age in years)	No. (%) of Hypertensive AMI Cases	No. (%) of Hypertensive Community Controls	Odds Ratio of AMI (95% confidence interval)	Chi-square df = 1	P-value (two-sided test)
Men:					
35-59					
Less than 80mmHg	11 (14)	2 (11)	1.10 (0.15-9.76)	0.12	0.7300
80-89mmHg	25 (31)	5 (28)	1.0*		
90mmHg or more	44 (54)	11 (61)	0.80 (0.21-2.90)	0.01	0.9320
60-69					
Less than 80mmHg	12 (16)	1 (6)	5.42 (0.60-122.45)	1.79	0.1806
80-89mmHg	31 (41)	14 (82)	1.0*		
90mmHg or more	32 (43)	2 (12)	7.23 (1.35-50.35)	6.15	0.0131
Total					
Less than 80mmHg	23 (15)	3 (9)	2.46**(0.60-11.84)	1.21	0.2712
80-89mmHg	56 (36)	19 (54)	1.0*		
90mmHg or more	76 (49)	13 (37)	2.05**(0.84-4.86)	2.27	0.1322
Women:					
35-59					
Less than 80mmHg	6 (17)	5 (18)	1.75 (0.35-9.03)	0.17	0.6771
80-89mmHg	11 (31)	16 (57)	1.0*		
90mmHg or more	19 (53)	7 (28)	3.95 (1.08-14.99)	4.40	3.0360
60-69					
Less than 80mmHg	6 (10)	6 (21)	0.57 (0.13-2.41)	0.30	0.5857
80-89mmHg	30 (48)	17 (61)	1.0*		
90mmHg or more	26 (42)	5 (18)	2.95 (0.85-10.68)	2.78	0.0958
Total					
Less than 80mmHg	12 (12)	11 (20)	0.95**(0.33-2.72)	0.02	0.9014
80-89mmHg	41 (42)	33 (59)	1.0*		
90mmHg or more	45 (46)	12 (21)	3.38**(1.41-8.37)	7.93	0.0049

* Reference category

** Odds ratios are adjusted for age

Table 4.16. Odds ratio of first acute myocardial infarction (AMI) in relation to last recorded blood pressure measurement before event, using different methods of statistical analysis.

Treated Diastolic Blood Pressure Level	No. (%) of Hypertensive AMI Cases (n = 253)	No. (%) of Hypertensive Community Controls (n = 91)	Crude Odds Ratio	Odds Ratio Adjusted for Age and Sex Using Logistic Regression	
				Matched Analysis	Unmatched Analysis
Less than 80mmHg	35 (14)	14 (15)	1.3 (0.6-2.9)*	1.8 (0.7-4.6)	1.4 (0.6-3.1)
80-89mmHg	97 (38)	52 (57)	1.0**	1.0**	1.0**
90mmHg or more	121 (48)	25 (27)	2.6 (1.5-4.7)	3.8 (1.9-7.8)	2.7 (1.4-4.8)

* 95 percent confidence interval

** Reference category

In order to determine whether the degree of therapeutically induced blood pressure reduction might predict the decreasing risk of acute myocardial infarction, the multivariate logistic regression analysis was repeated using the difference between the pre-treatment and the last recorded blood pressures rather than the on-treatment pressures. The reduction was calculated as the difference between the pre-treatment blood pressure level and the last recorded blood presure level before the event or survey. Based on the decline in blood pressure level, both hypertensive cases and controls were stratified into three levels of systolic (declines less than 10mmHg; those of 10-29mmHg; and those of 30mmHg or more) and diastolic pressures (less than 5mmHg; 5-14mmHg; 15mmHg or more). By logistic regression analysis (adjusting for age, sex, smoking status, alcohol consumption and body mass index), it was found that those who had a decline in blood pressure of less than 5mmHg diastolic were at higher risk of acute myocardial infarction than those who achieved moderate declines (5-14mmHg diastolic) or large declines (15mmHg or more diastolic). Failure to achieve a 5mmHg diastolic decline was associated with the highest risk of myocardial infarction occurrence - Table 4.17. This may reflect the higher proportion of those with more severe forms of hypertension (pre-treated diastolic blood pressure of 115mmHg or more) among those who developed myocardial infarction (22 percent) than among the hypertensive subjects in the community (13 percent) - Table 4.11.

A similar result was obtained when the analysis was repeated using systolic blood pressure, with those who had a reduction of less than 10mmHg systolic being at highest risk of myocardial infarction (but the associations were not statistically significant for moderate reduction in systolic blood pressure; Table 4.17).

Table 4.17. Risk of developing acute myocardial infarction (AMI) in relation to blood pressure reduction among subjects on treatment for hypertension in the Hunter Region, aged 35-69 years.

Variable	No. (%) of Hypertensive AMI Cases (n = 253)	No. (%) of Hypertensive Controls (n = 91)	Odds Ratio* of first AMI (95% confidence interval)
Reduction# in diastolic blood pressure:			
Less than 5mmHg	49 (19)	8 (9)	2.2 (1.1 - 4.6)
5 - 14mmHg	62 (24)	27 (29)	1.9 (1.0 - 3.8)
15mmHg or more	142 (56)	56 (62)	1.0**
Reduction# in systolic blood pressure:			
Less than 10mmHg	43 (17)	12 (13)	2.3 (1.0 - 5.4)
10 - 29mmHg	69 (27)	14 (16)	1.2 (0.7 - 2.2)
30mmHg or more	141 (56)	65 (71)	1.0**

* Odds ratios are adjusted for age, sex, smoking status, alcohol consumption and body mass index

** Reference category

Reduction in blood pressure = (pre-treated blood pressure) - (last recorded blood pressure before event)

Fifty-three percent of treated hypertensive persons who developed first-time acute myocardial infarction were taking beta-blocking agents (singly or in combinations of agents) compared with 60 percent of hypertensive control subjects (adjusted odds ratio 0.8; 95 percent confidence interval 0.5 to 1.3). Forty-two percent of these cases were receiving diuretic agents (singly or in combinations of agents) compared with 43 percent of the control subjects (adjusted odds ratio 1.1; 95 percent confidence interval 0.6 to 1.9) - Table 4.18.

Table 4.18. Risk of acute myocardial infarction (AMI) in relation to type of antihypertensive medications previously used by treated hypertensive subjects in the Hunter Region, aged 35-69 years.

Antihypertensive medication (singly or in combination of agents	No. (%) of Hypertensive AMI Cases (n = 253)	No. (%) of Hypertensive Controls (n = 91)	Odds Ratio* of first AMI (95% confidence interval)
Beta-blockers:			
No	121 (48)	36 (40)	1.0**
Yes	132 (52)	55 (60)	0.8 (0.5 - 1.3)
Diuretics:			
No	144 (57)	52 (57)	1.0**
Yes	109 (43)	39 (43)	1.1 (0.6 - 1.9)
Other antihypertensive agents:			
No	96 (38)	45 (49)	1.0**
Yes	157 (62)	46 (51)	1.5 (0.9 - 2.5)

* Odds ratios are adjusted for age, sex, smoking status, alcohol consumption and body mass index

** Reference category

DISCUSSION

Case-Control Studies in Cardiovascular Disease: Control of Bias

Because of their logistic, ethical and economic advantages (described in detail by Schlesselman, 1982, Chapter 1), case-control studies have become an important research strategy in the investigation of disease aetiology (Cole, 1979). While the case-control (or case-referent) technique is widely employed in cancer epidemiology (Muir and Wagner, 1979), its use in the investigation of cardiovascular disease causation has remained relatively limited. This is largely because, unlike cancer registers, community-based registers of cardiovascular disease are not well established. This population-based case-control study, which examined the relationship between a history of hypertension and the way it was controlled and the development of acute myocardial infarction in persons aged 35-69 years in the Hunter Region, has demonstrated how the case-control research design can be used to good effect in the investigation of cardiovascular disease causation. Because the study included all acute myocardial infarction events in the community and control subjects who were representative of the same community, the findings could be generalized to the rest of the community. In addition, estimates of the proportion of all cases of first acute myocardial infarction attributable to the presence of hypertension (the aetiologic fraction) can be calculated. While case-control studies usually include only one case group and one control group, the study design could be expanded to include more than one case series (Cole, 1979). This departure from the customary situation in investigations of cardiovascular disease aetiology allows a case-case comparison as well as comparison with the control subjects. This technique could be used to good effect in the investigation of cardiovascular disease causation, as has been shown for studies of cancer aetiology (Linte and Brookmeyer, 1987; Smith, Pearce and Callas, 1988).

Although a thoughtfully designed, carefully executed case-control study can provide valuable clinical and epidemiological information, this study design is particularly susceptible to bias because both the exposure and disease have already occurred at the time the study participants enter the study. This requires that careful consideration in the study design must be made of the most likely sources from which bias may arise in the

particular investigation in order to minimize or, preferably, to avoid its occurrence (Sackett, 1979).

Selection bias arises in a case-control study when either the cases are not representative of the diseased population, or controls are not representative of the disease-free population. This is most likely to occur in hospital-based case-control studies. The design of this population-based case-control study, with all new cases of acute myocardial infarction which occurred in the study population within the twelve months' period of the study and with controls randomly selected from the Electoral Rolls, along with the high response rates (89 percent of community controls and all the cases in the study population), ensures that cases and controls were representative of their diseased and disease-free populations, respectively. Thus, selection bias is extremely unlikely to have occurred in this study.

Bias due to disease misclassification is also unlikely because well-defined internationally accepted criteria were used for diagnosing cases of acute myocardial infarction (see "Subjects and Methods - Ascertainment of Myocardial Infarction Cases"). In addition, community controls with a history of myocardial infarction were excluded from the analysis.

Of greater concern in this study is the possibility of recall bias - those with a recent history of myocardial infarction being more likely to remember that they had been told that they had hypertension. We have endeavoured in the study design to minimize the possible effect of recall and/or interviewer bias by collecting the questionnaire and the interview information according to a standard study protocol and not informing the subjects or the interviewers of the specific study hypothesis. In addition, the usual doctors of those myocardial infarction patients and control subjects who answered that they were currently receiving treatment for high blood pressure were contacted and the hypertension treatment status of both cases and controls was confirmed.

Reliance on a surviving spouse or close relative for information about exposure to the studied risk factors was unavoidable for a sizeable number of cases who had died within 28 days of the myocardial event (23 percent). It is difficult in this study to estimate the effect of differential sources of information. However, a validation study of the

information provided by relatives of deceased patients on the treatment for hypertension status and the name/s of antihypertensive medications which were being taken by the deceased patients indicated that the information provided was accurate. The study showed that 100 percent of deceased patients who were reported by their relatives to have been taking medications for hypertension were confirmed to have been doing so by a review of the medical records. This is consistent with the findings of many studies which validated the questionnaire responses provided by surviving spouses (Lerchen and Samet, 1986) or next-of-kin relatives (Herrman, 1985).

Confounding, which is strictly not a bias, but rather a property of the relationship between variables in the data set, may exist when a variable is related both to the disease and to another exposure variable. When present, confounding biases the estimates of the relative risk (the odds ratio) away from or towards unity. In this study, confounding was controlled by the use of multivariate techniques in data analysis.

Acute Myocardial Infarction in Relation to Hypertension and Other Selected Risk Factors

This population-based case-control study has quantified the strength of the association between hypertension and the occurrence of acute myocardial infarction in the Hunter Region population, an association that is consistent with the findings from studies in other populations (Kannel and Stokes III, 1985). The findings confirm the results of an earlier study that was conducted by the author (Al-Roomi *et al.*, 1986) in 1985 in the same area which compared the prevalence of a history of hypertension among patients with myocardial infarction identified from a heart attack register with that among respondents to a risk factor prevalence survey. The study (Al-Roomi *et al.*, 1986) showed that the proportion of subjects with a history of hypertension was higher among myocardial infarction patients than among people in the community.

An advantage of this present study, which examined all the acute myocardial infarction cases in the community and looked at control subjects who are representative of the same community, is that estimates of the proportion of all cases of acute myocardial infarction attributable to hypertension (the aetiologic fraction) can be calculated. Calculation of the aetiologic fraction provides the clinician with an estimate of the

potential reduction in acute myocardial infarction which might be achieved in the population if the risks from hypertension were reduced substantially and thus is of importance to public health authorities in the planning of intervention programmes for disease prevention (Miettinen, 1974).

Sixteen percent and twenty-four percent of the first acute myocardial infarction cases which occurred in the study population were attributable to hypertension and cigarette smoking, respectively. This indicated the important role of these risk factors in the aetiology of acute myocardial infarction in the Australian population. However, it is likely that the proportion of new acute myocardial infarction cases attributed to hypertension in the study population is an underestimate because the definition of hypertension included only those persons with hypertension who were on current treatment.

While cigarette smoking was found to be a stronger risk factor for acute myocardial infarction than was hypertension, its relative importance changed with age. Smoking was a strong contributor to coronary events in younger age groups (those aged 35-49 years and 50-59 years) but its importance decreased in older age groups (those aged 60-69 years). This is in contrast to hypertension, which remained a major contributor to acute myocardial infarction throughout the age range (Table 4.9). In addition, in both cases and controls, current smoking was significantly more prevalent, and treatment for hypertension less prevalent, in younger age groups (35-59 years) than in older age groups (60-69 years). These findings are consistent with the results from other studies (Doll and Peto, 1976; Kannel and Gordon, 1978) and suggests the need to control hypertension even in elderly patients, a conclusion which is supported by the recent results from the European Working Party on High Blood Pressure in the Elderly Trial (Amery *et al.*, 1985).

Both current smoking and ex-smoking were associated with an elevated risk of acute myocardial infarction, with ex-smokers having a risk of myocardial infarction intermediate between current smokers and non-smokers. The findings were consistent in both univariate and multivariate analyses. While current cigarette smoking is a well documented risk factor for ischaemic heart disease (Fielding, 1985), the findings concerning the degree of risk among ex-smokers have not been consistent. Some studies

have reported no increased risk of ischaemic heart disease in ex-smokers (Gordon *et al.*, 1974), while others have shown that ex-smokers have a higher risk of myocardial infarction than non-smokers (Rogot and Murray, 1980). The findings of this study are in accordance with the notion that smoking has a cumulative, non-transient effect and that the benefit of giving up cigarette smoking is gradual (Cook *et al.*, 1986).

Light to moderate drinkers appear to have a lower risk of developing acute myocardial infarction than both non-drinkers and heavy drinkers, even after adjustment is made for other factors (Table 4.6). While the findings are similar to those reported by other researchers (Marmot, 1984), the possible protective effect of moderate alcohol intake against ischaemic heart disease remains controversial (Castelli, 1979). On the one hand, alcohol consumption tends to increase the concentration of high density lipoprotein, which implies a decreased risk of ischaemic heart disease (Castelli *et al.*, 1977). On the other hand, alcohol consumption is associated with elevations of blood pressure (Klatsky *et al.*, 1977); that is, with an increased risk of cardiovascular disease. The concept of a "protective" effect of moderate alcohol drinking on mortality from cardiovascular disease has been recently challenged by Shaper, Wannamethee and Walker (1988), who demonstrated in data on alcohol intake obtained as part of the British Regional Heart Study that non-drinkers include people who gave up drinking because of ill health. Hence a higher risk of cardiovascular disease would not be surprising when using non-drinkers as a baseline against which to compare drinkers concerning the consequences on general health of drinking alcohol. However, this is unlikely to be the whole explanation for the observed U-shaped association between alcohol intake and the risk of acute myocardial infarction in this study, because of the small proportion of ex-drinkers among non-drinkers (9 percent of myocardial infarction cases and 5 percent of community controls). In fact, the beneficial effect of light to moderate alcohol drinking remained even when the multivariate analysis was repeated excluding those non-drinkers who used to be moderate to heavy drinkers (ex-drinkers). In addition, other studies have found that life-time abstainers have a higher mortality than current drinkers (Yano, Rhoads and Kagan, 1977; Rosenberg *et al.*, 1981), which does not support the findings by Wannemethee and Shaper (1988). Further, Marmot, Rose and Shipley (1981) compared two groups of middle-aged male civil servants in Britain, an "unhealthy group" of men defined as those with a history of diabetes, symptoms of cardiovascular or chronic respiratory disease, or taking any medication, and a healthy group of men (the

remainder). Marmot, Rose and Shipley (1981) found that in both the "healthy" and "unhealthy" groups mortality was higher in non-drinkers.

Obesity was found to be associated with a significantly increased risk of acute myocardial infarction (Table 4.6). While a number of established risk factors for ischaemic heart disease such as high blood pressure, elevated serum cholesterol level and diabetes are more common in overweight persons than in persons who are not overweight (Van Itallie, 1985), the association between obesity and ischaemic heart disease is not well established. In the Framingham Study (Gordon *et al.*, 1977), relative weight was not a significant univariate risk factor for men although it was for women. However, the association in women was not independent from other risk factors. In the Pooling Project Research Group Study (1978), relative weight was significantly related to risk of myocardial infarction and coronary mortality for those who were 40-49 years of age but not for older age groups. More recently, Keys (1980) reviewed the relationship between ischaemic heart disease and obesity in 15 published prospective studies from North America, Britain and Europe. Keys (1980) found that in only 2 out of 15 studies has there been a significant relationship between ischaemic heart disease and relative body weight. The possible explanations for these conflicting results have been recently reviewed by Kissebah, Freedman and Peiris (1989). While the distribution of other risk factors, particularly cigarette smoking, may differ between obese and non-obese persons, cigarette smoking is unlikely to explain the increased risk of acute myocardial infarction among obese subjects found in this study because the association persisted even after adjusting for cigarette smoking, a view which is supported by the findings of other researchers (Barrett-Connor, 1985). Whatever the plausible explanations for these inconsistent findings may be, there seems to be an agreement that methods used to define obesity in most epidemiological and clinical studies, though crude, are useful at extremes of distribution (Kissebah, Freedman and Peiris, 1989). Since obesity is common in adult Australians, affecting 42 percent of men and 35 percent of women aged 25-64 years (National Heart Foundation of Australia Risk Factor Prevalence Study No. 2, 1985), the results from this study suggest that, from the public health viewpoint, obesity may be an important risk factor for myocardial infarction and that people should be encouraged to achieve and maintain their ideal weight.

Relationship Between Blood Pressure Control and Acute Myocardial Infarction

In spite of the theoretical value of antihypertensive therapy in the reduction of mortality from acute myocardial infarction, most clinical trials (extensively reviewed by Cutler and Furberg, 1985; and MacMahon *et al.*, 1986) have failed to demonstrate a significant reduction in the incidence of acute myocardial infarction as a result of reducing blood pressure (an exception being the Hypertension Detection and Follow-up Programme Cooperative Group Trial, 1988). However, recent quantitative statistical overviews of treatment of mild to moderate hypertension (i.e., diastolic blood pressure between 90 and 114mmHg) have demonstrated a reduction in the incidence of coronary events in the order of 9-12 percent (Hennekens, Satterfield and Hebert, 1988). This indicates that the modification of blood pressure levels may be beneficial in reducing the risk of ischaemic heart disease.

In this study, an increased risk of developing myocardial infarction was found among both those with poorly controlled blood pressure (treated diastolic blood pressure equal to or greater than 90mmHg) and those with particularly low blood pressure on treatment (less than 80mmHg diastolic). This is unlikely to be due to failure to detect hypertension or to initiate treatment for hypertension when it is discovered, since the majority of subjects in the community had had a recent blood pressure measurement and the majority of those with a history of hypertension were on antihypertensive therapy. The above increased risk was consistent for both systolic and diastolic pressures and also in both matched and unmatched analyses. The possibility of a non-causal relationship between elevation of blood pressure and ischaemic heart disease, which might arise through dual association with another factor (i.e., a third factor may precipitate the myocardial event and raise the blood pressure) cannot be excluded. However, it is an unlikely explanation for the higher last recorded blood pressure measurements before the coronary event (or survey for controls) among those who developed acute myocardial infarction than among those in the community, since only 10 percent of the blood pressure readings were recorded in the week before the myocardial event.

The findings of this study on myocardial infarction are not consistent with the results of randomized controlled trials of treatment of mild to moderate hypertension

(Cutler and Furberg, 1985; MacMahon *et al.*, 1986). Unlike most trials of antihypertensive therapy, those patients with more severe forms of hypertension were not excluded (22 percent of those hypertensives who later developed acute myocardial infarction had a pre-treatment blood pressure of 115mmHg diastolic or higher). Such patients would be expected to benefit from the treatment of severe hypertension (Hennekens, Satterfield and Hebert, 1988). Examining a different spectrum of high blood pressure (Cruickshank, Thorp and Zacharias, 1987a), the increased risk among overtreated hypertensives, together with the adverse effects on blood lipids and serum sugar of antihypertensive drugs (Pollare, Lithell and Berne, 1989), could explain the failure of randomized controlled trials to demonstrate a reduction in acute myocardial infarction rates and may explain the discrepancy between the results of this observational study and the findings of randomized trials.

In this study, the mean blood pressure of persons on treatment was found to be higher among those who later developed myocardial infarction than among those in the community, while the pre-treatment blood pressure levels were similar. Thus, the risk of acute myocardial infarction was related to the on-treatment blood pressure level but not to the blood pressure before treatment. This is consistent with the hypothesis that blood pressure control does, after all, influence the risk of coronary events. These findings concur with reports from other studies which indicated that the risk of myocardial infarction in hypertensive patients was predicted by the blood pressure achieved during treatment but not by the blood pressure before treatment (Breckenridge, Dollery and Parry, 1970; Isles *et al.*, 1986; Samuelsson *et al.*, 1987; Bulpitt *et al.*, 1988).

The hypothesis that excessive reduction of blood pressure causes death from myocardial infarction was first proposed by Stewart (1979), who reported an alarming increase in the relative risk of ischaemic heart disease in hypertensive patients whose diastolic pressures were reduced to below 90mmHg. In a group of patients with no prior history of ischaemic heart disease, treated for moderate to severe hypertension (diastolic blood pressure 105-140mmHg), Stewart (1979) found a five-fold increase in risk of myocardial infarction in patients whose treated diastolic blood pressure was less than 90mmHg compared with those whose treated diastolic blood pressure was 100-109mmHg. While the observed excess risk among overtreated hypertensives (those with a treated

diastolic blood pressure below 80mmHg) in this study was not statistically significant (the confidence interval included unity), the findings are consistent with a number of other recent reports (summarized in Table 4.19).

Table 4.19. Studies of hypertension which showed a U-shaped relationship between treated diastolic blood pressure level and risk of myocardial infarction.

Trial	Design	No. of patients	Age Range (years)	Degree of hypertension	Treatment*	Length of follow-up (years)
Clatterbridge Hypertension Clinic Study[1]	Open	932 (585 men, 347 women)	17-77	Moderate to severe	D,B,O	10.2
Heart Attack Primary Prevention in Hypertension Trial[2]	Randomized controlled	6569 men	40-64	Mild to moderate	D,B	3.8
Goteberg Primary Prevention Trial[3]	Open	686 men	47-54	Mild to moderate	D,B,O	12
Glasgow Blood Pressure Clinic[4]	Open	3350 (1660 men, 1690 women)	25-84	Mild to severe	D,B,O	15
Department of Health and Social Security Hypertension Care Computing Group[5]	Open	2145 (1075 men, 1070 women)	13-89	Mild to severe	D,B,O	10.5
Hypertension in Elderly Patients in Primary Care[6]	Randomized	884 (273 men, 611 women)	60-79	Mild to moderate	D,B	10
European Working Party on High Blood Pressure in the Elderly[7]	Randomized	691 (206 men 485 women)	Mean, 72	Mild to moderate	D,O	4.7

* D = diuretics, B = beta-blockers, O = other antihypertensive agents

Source of information: (see over)

Source of information:

1 - Cruickshank, Thorp and Zacharias, 1987a; Cruickshank *et al.*, 1987.

2 - Wilhelmsen *et al.*, 1987.

3 - Samuelsson *et al.*, 1987.

4 - Waller *et al.*, 1988.

5 - Fletcher *et al.*, 1988.

6 - Coope and Warrender, 1986; Coope and Warrender, 1987.

7 - Staessen *et al.*, 1989.

J-shaped or U-shaped relationships between ischaemic heart disease mortality and diastolic blood pressure have also been described in population surveys where most individuals were not treated or not even hypertensive (Anderson, 1978; Aromaa, 1980; Lindholm *et al.*, 1985) and similar J curve have been reported in untreated control groups from randomized trials (Coope, 1987; Staessen *et al.*, 1989). Thus, the harm is most likely to have been caused by lowering the blood pressure too far rather than by the adverse effects of antihypertensive therapy. In both this study and the Glasgow Blood Pressure Clinic Study (Waller *et al.*, 1988), adjustment for antihypertensive medication did not change the U-shaped associations between treated blood pressure and acute myocardial infarction.

An alternative explanation is that the low diastolic blood pressure may be a result of (rather than a cause of) the myocardial event. However, since only 10 percent of the blood pressure readings of the low treated blood pressure group were recorded in the week before the coronary event, it seems unlikely that the low blood pressure is a result of the myocardial event. Coope (1987) suggested that the excess deaths from myocardial infarction in patients with a low diastolic blood pressure may reflect poor left ventricular function due to ischaemia, a suggestion disputed by Cruickshank, Thorp and Zacharias (1987b), who demonstrated that both survivors and dead in the low treated diastolic blood pressure group had similar mean cardiothoracic ratios (which is strongly correlated with mortality in patients with heart failure). Further, those with high treated diastolic blood pressures had similar mean cardiothoracic ratios to those with low treated pressures. In addition, Fletcher and fellow researchers (1988) found the J curve in relation to patients who had been treated but not in relation to those who had not. Thus, it seems unlikely that heart failure was responsible for the observed J curve phenomenon. Finally, Cruickshank (1988) suggested that the excess deaths occur only in patients with narrowed coronary arteries. However, the J curve was reported in respect to patients both with and without coronary ischaemia (Wilhelmsen *et al.*, 1987; Fletcher *et al.*, 1988; Waller *et al.*, 1988). A more plausible explanation for the J curve is that excessive reduction of blood pressure towards the low part of the normal range may endanger the nutritional blood flow to the myocardium, a concept discussed by Green (1982) and Strandgaard and Haunso (1987).

The data suggest that the presence of hypertension and its poor control by treatment

confers an increased risk of acute myocardial infarction occurring. An increased risk was also found in those whose blood pressure levels were controlled below 80mmHg diastolic or below 120mmHg systolic (overtreated hypertensives), a finding that is consistent with a number of other reports (Table 4.19). This effect, together with adverse effects on blood lipids of antihypertensive agents (Weinberger 1985), could explain the failure of randomized controlled trials to show a reduction in acute myocardial infarction rates. Thus it would seem advisable to endorse the recommendations of other researchers (Beevers, 1988) that clinicians should be made aware that overtreating hypertension may impart additional risks to the patient.

Utilization of Health Services for Hypertension

The higher proportion of subjects who had visited a doctor and had had their blood pressure measured within the three months before an event, among myocardial infarction cases than among people in the community, was consistent with the higher proportion of hypertension among cases than among controls. This was in keeping with the many studies which have documented that hypertension leads to increased utilization of health services, for example, Cypress (1979).

The overwhelming majority of treated hypertensive patients who developed myocardial events had visited doctors and had had their blood pressure levels checked within the last three months before suffering the myocardial infarction. Thus, it is unlikely that the observed increased risk of developing myocardial infarction among those subjects with poorly controlled blood pressure (treated diastolic blood pressure equal to or greater than 90mmHg) is due to discontinuation of hypertensive follow-up care (non-attendance). It appears that poor adherance to antihypertensive medication or inadequate therapy are more likely explanations for this less than ideal blood pressure control.

Type of Antihypertensive Medication and Risk of Myocardial Infarction

Information was obtained from both cases and controls during the same time period. This allowed a comparison of the types of antihypertensive medications among patients with hypertension who developed myocardial infarction and those patients on current

treatment for hypertension in the community.

In this study, there were fewer hypertensive cases than hypertensive community control subjects who were being treated with beta-blockers (Table 4.18). Recent reports have suggested that beta-blockers may prevent first events of myocardial infarction in patients with hypertension (Wikstrand *et al.*, 1988; Psaty *et al.*, 1989). Although the risk of myocardial infarction occurring was slightly lower among those hypertensives on beta-blocking agents (adjusted odds ratio 0.8; 95 percent confidence interval 0.5 to 1.3) than among those on other antihypertensive agents, the difference was not statistically significant. Thus the analysis does not provide any evidence to incriminate diuretic agents, nor does it suggest any advantage in the use of beta-adrenoceptor blocking agents as initial antihypertensive therapy over that of diuretic agents as far as the risk of myocardial infarction is concerned.

Risk Factors in Treated Hypertensive Patients

Studies which examined the prognostic factors in treated hypertensive patients have reported conflicting and contradictory conclusions. While some studies suggested that obesity may protect hypertensive patients against cardiovascular disease (Barrett-Connor and Khaw, 1985; Cambien *et al.*, 1985; The Hypertension Detection and Follow-up Program Cooperative Research Group, 1985), other researchers reported an increased risk among obese hypertensive patients (Bloom *et al.*, 1986). Some studies reported a negative relationship between serum cholesterol and mortality in hypertensive patients (Bulpitt *et al.*, 1979), while others found a positive relationship (Samuelsson *et al.*, 1987).

Cigarette smoking and impaired glucose tolerance are the only risk factors that were consistently shown to be associated with increased risk of developing acute myocardial infarction among treated hypertensive patients (Bulpitt *et al.*, 1979; The Management Committee of the Australian National Blood Pressure Study, 1984; Samuelsson *et al.*, 1985; Isles *et al.*, 1986). However, there are doubts about the influence of glucose tolerance on the occurrence of myocardial infarction (Bulpitt, 1985) because most patients on treatment for hypertension were also on diuretic medications (which raises blood sugar levels).

This present study provided further evidence incriminating cigarette smoking as an important risk factor among treated hypertensive patients (Table 4.10). Treated hypertensive smokers had twice the risk of developing myocardial infarction compared with patients on treatment for hypertension who are non-smokers, a pattern which is similar to that seen in the general population (Table 4.6). This is in agreement with the doubled mortality rate in treated hypertensive smokers observed in other studies (Bulpitt *et al.*, 1979; The Management Committee of the Australian National Blood Pressure Study, 1984). Furthermore, the findings are supported by recent reports indicating that cigarette smoking interferes with the treatment of hypertension, especially with the reduction of blood pressure by beta-blockers (propranolol) and thus cigarette smoking may offset the beneficial effect of blood pressure lowering (Greenberg, Thompson and Brennan, 1987; Materson *et al.*, 1988). In fact, in a recent study, the evidence to this effect was so overwhelming that the researchers suggested that the package containing propranolol should include a warning that the drug might not be as effective in smokers as in non-smokers (Materson *et al.*, 1988).

It is unfortunate that serum cholesterol levels could not be measured in this study. Not only would this have provided an interesting comparison of the relative importance of raised serum cholesterol in the aetiology of myocardial infarction compared with that of hypertension but also because the myocardial infarctions which occurred in poorly controlled hypertensive patients may, in fact, have been partly due to raised blood lipid levels.

Blood sugar levels were unavailable for this study. However, based on self-reports of treatment for diabetes mellitus, the small proportion of hypertensive subjects receiving treatment for diabetes (four percent of myocardial infarction cases and one percent of controls) shows that diabetes is unlikely to have accounted for the increased risk of developing myocardial infarction among hypertensive persons.

There is a need to improve the management of hypertension in the community. Close attention to non-compliance and the optimal use of medications appears a priority. In addition, since other major cardiovascular risk factors - for example, cigarette smoking - appear to be important among treated hypertensive patients, good blood pressure control alone is not sufficient to overcome the excess risk. Thus, assessment of the total

cardiovascular risk factor profile should become an integral part of any management plan concerning hypertension.

SUMMARY

The relationship of the control of hypertension to the development of acute myocardial infarction was examined in persons aged 35-69 years in the Hunter Region of New South Wales, Australia. Cases of first acute myocardial infarction were identified from a community-based heart attack register and compared with control subjects obtained from a random population sample from the same community.

In this study, 781 first myocardial infarction cases were compared with 477 community control subjects, adjusting for age, sex and several possible confounding variables. Twenty-one percent of community controls were on current treatment for hypertension compared with 37 percent of first myocardial infarction cases (adjusted odds ratio 2.3; 95 percent confidence interval 1.6 to 3.1). Forty percent of first myocardial infarction cases were current smokers compared with 22 percent of community controls (adjusted odds ratio 3.2; 95 percent confidence interval 2.3 to 4.5). Cigarette smoking appears to be a stronger contributor to acute myocardial infarction than hypertension. In addition, the estimated population attributable risk of first acute myocardial infarction associated with cigarette smoking (34 percent) was greater than that associated with hypertension (16 percent) in this population.

For those on treatment for hypertension, blood pressure levels were obtained from the records of relevant general practitioners. The mean blood pressure of those on treatment (systolic or diastolic) was higher among those who later developed a myocardial infarction than among those in the community sample, despite similar pre-treatment blood pressure levels. In addition, the proportion of poorly controlled subjects (treated diastolic blood pressure equal to or greater than 90mmHg) was higher among those who developed acute myocardial infarction (48 percent) than among community controls (27 percent); an adjusted odds ratio of 2.9 (95 percent confidence interval 1.6 to 5.3). The pattern was consistent across age and sex groups. These findings may reflect low compliance of hypertensive patients with their medication because most subjects in the community had had a recent blood pressure measurement and the majority of those with a history of hypertension were on therapy. Those with particularly low blood pressure on treatment (less than 80mmHg diastolic) appeared to be at higher risk of developing an

acute myocardial infarction than were those with a treated diastolic blood pressure of 80-89mmHg (adjusted odds ratio 1.6; 95 percent confidence interval 0.7 to 3.4).

The relationship between blood pressure control and the development of acute myocardial infarction appears to be U-shaped, with both those with high and those with low treated blood pressures being at increased risk. Although not statistically significant, the excess risk among overtreated hypertensives (those with a treated diastolic blood pressure less than 80mmHg) is consistent with other recent reports (Table 4.19). While larger clinical trials would be needed to provide additional evidence about the relationship of overtreated blood pressure to cardiovascular events, clinicians should be aware of the possible complications of too greatly lowering blood pressure.

CHAPTER V

HYPERTENSION AND THE RISK OF STROKE

INTRODUCTION

The relationship between blood pressure control and the occurrence of stroke in persons aged 35-69 years, normally resident in the Hunter Region of New South Wales, is investigated using a similar methodology to that described in Chapter IV for acute myocardial infarction. Cases of first ever stroke, identified from a community-based stroke register (specially developed for this study), are compared with a representative group of community controls from the same population (first described in Chapter II) using identical questions for both cases and controls. An estimation of the proportion of first stroke events which could be attributed to hypertension and smoking is then presented.

The information obtained in this study, apart from being of value in identifying the major risk factors for stroke in the Hunter Region, will contribute to our knowledge of the community control of hypertension in the Hunter Region (which could be extrapolated to other areas of New South Wales and the rest of Australia) and will provide an interesting comparison with the data obtained from the study of acute myocardial infarction (Chapter IV).

This study will also be of value in providing a picture of the patterns of stroke admissions to hospitals in the Hunter Region and will allow an examination of the characteristics of those people admitted with stroke, the type of stroke they have had and its natural history. Further, future studies might well be based upon the initial observations from this study.

Hypotheses

1. The proportion of subjects with a history of high blood pressure among patients with stroke is higher than among community controls.

2. The proportion of subjects on current treatment for hypertension among patients with stroke is higher than among community controls.

3. The percentage of hypertensives who are on current treatment for hypertension among the stroke cases is lower than among community hypertensive controls.

4. The percentage of poorly controlled hypertensives (treated diastolic blood pressure equal to or greater than 90mmHg) among stroke patients is higher than among community hypertensive controls.

Study Objectives

1. To identify all patients aged 35-69 years with a diagnosis of stroke admitted to each of the seven main public hospitals in the Lower Hunter Region during the period from 1st April, 1987, to 31st December, 1987.

2. To administer to these patients (or to their relatives if the patients are unable to communicate), or to the relatives of dead patients, a questionnaire seeking information on the history of their blood pressure measurements and the detection and treatment of their hypertension.

3. To obtain, in addition, information about cigarette smoking behaviour, alcohol consumption habits and demographic data.

4. To compare this information with similar data obtained from a random sample of people aged 35-69 years living in the same community (see Chapter II) and from patients admitted to hospital with a diagnosis of acute myocardial infarction in the same age group (see Chapter IV).

5. To contact the general practitioners of those stroke patients who answered that they were currently receiving treatment for high blood pressure to ask about the

date of the last blood pressure measurement before the event or survey and its level, the pre-treatment blood pressure level and the type of antihypertensive medications which were being taken before the stroke event.

6. To compare the information obtained from the general practitioners of patients who developed stroke with similar data obtained from patients on treatment for hypertension who developed myocardial infarction (Chapter IV) and people on treatment for hypertension in the community (Chapter II).

Subsidiary Objectives

1. To compare the utilization of medical services for hypertension by patients who developed stoke with that by subjects in the community.

2. To examine the role of treatable risk factors, other than hypertension, in the aetiology of stroke in the Hunter Region community.

3. To compare the prevalence of cardiovascular risk factors in hypertensives who have had a stroke event with that in hypertensives in the community.

SUBJECTS AND METHODS

THE STUDY POPULATION

For this project, the study population comprised all persons aged 35-69 years normally resident in the five urban local government areas in the Lower Hunter Region of New South Wales (Newcastle, Lake Macquarie, Cessnock, Maitland and Port Stephens); a population of 156,500 persons at the 1986 Census (75,400 men and 81,100 women). The age cut-off was chosen to allow comparability with the previous studies of the population (Chapter II) and of patients with acute myocardial infarction (Chapter IV).

CASES OF STROKE

Ascertainment of Stroke Cases

All residents of the study area aged 35-69 years presenting with acute stroke events to the seven general public hospitals in the Lower Hunter Region (Royal Newcastle Hospital, Mater Misericordiae Hospital, Belmont District Hospital, Wallsend District Hospital, Maitland Hospital, Cessnock Hospital and Kurri Kurri Hospital) or to the Lingard Private Hospital during the period from 1st April, 1987, to 31st December, 1987, were enrolled in this study. "Stroke" was defined according to the World Health Organization's definition (Aho *et al.*, 1980) as "rapidly developing signs of focal (or global) disturbance of cerebral function, leading to death or lasting longer than 24 hours, with no apparent cause other than vascular". The definition can be applied to patients presenting with clinical signs suggestive of subarachnoid haemorrhage, intracerebral haemorrhage or cerebral ischaemia but it does not include transient ischaemic attacks. Patients with a transient ischaemic episode (signs or symptoms lasting less than 24 hours) were excluded because of the difficulty of case ascertainment with limited resources.

The methods of case-finding included the routinely available sources of identifying patients admitted to hospital, such as systematic searches of daily hospital admissions and discharge lists, surveillance of hospital wards and casualty attendances, discussion with ward sisters and sighting of hospital discharge records. In addition, all death certificates and necropsy records (held at the local Registry Office of Births, Deaths and Marriages)

were checked at least once monthly and details of all deceased patients who might have had a stroke, either before or at the time of death, were reviewed (those death certificates with diagnoses fitting the International Classification of Diseases - 9th Revision codes 430-438, World Health Organization,1975). This yielded additional registered cases. In order to ensure that ascertainment of patients with first stroke over the study period was complete, hospital discharge diagnoses in all hospitals enrolled in the study were regularly checked to find cases with a cerebrovascular diagnosis. Evaluation of similar hospital admissions surveillance systems of cases of new stroke indicated that this method is efficient and sensitive (Barker, Feldt and Feibel, 1984).

All patients hospitalized with a provisional diagnosis of stroke were interviewed by a nurse with the study, using a structured questionnaire (Appendix A.23). Data similar to that collected from the myocardial infarction study (Chapter IV) and from subjects in the community (Chapter II) was obtained. The information obtained included: present and past medical history; present and past neurological history; demographic data; history of blood pressure measurement; detection of and treatment for hypertension; family history; and social and life-style characteristics. If the patient was unable to communicate because of severe disability with stroke, an appointment was made with a close relative or, if no relative could be found, a close friend to whom the same questions were directed. In addition, nurse interviewers extracted information on the results of radiological, haematological and biochemical investigations from patients' medical records, together with copies of relevant radiological (computed tomographic scan) and pathological investigations, the full report of the neurologists' assessment of the case, and the name and address of the regular general practitioner of the patient. Relatives of deceased cases of strokes identified from the death register were sent a postal questionnaire and similar data were obtained (Appendices A.24 to A.26).

Selection of Stroke Cases

Inclusion Criteria

All cases of first ever stroke (fatal or non-fatal) in the study population aged 35-69 years registered during the nine months' period from 1st April, 1987, to 31st December, 1987, were included in this study. In order to ensure that the diagnostic standards remained uniform, the study team (which included two consultant neurologists) met regularly, and newly registered cases were discussed. The diagnosis of stroke was made on the basis of neurological findings of sudden or rapid onset, persisting for more than 24 hours, and whose vascular origins were limited to thrombotic or embolic occlusion of a cerebral artery, resulting in infarction, or to rupture of a vessel, resulting in intracerebral haemorrhage. Thus, cases with occlusion or rupture due to traumatic, neoplastic or infectious process were excluded.

Diagnostic Classification of Stroke Cases

Clinical cases of stroke were classified into subcategories of stroke according to the classification recommended by the MONICA Stroke Advisory Group (Asplund *et al.*, 1988). The classification uses strict criteria based on the symptoms and/or the results of investigations (for example, necropsy, computed tomographic scan). These strict diagnostic criteria depend largely on the necropsy rates among fatal events and on the possibility of using computed tomographic scan among non-fatal events.

Subcategories of Stroke

The subcategories are as follows: (from Asplund *et al.*, 1988, Pages 33-35):

(1) Subarachnoid haemorrhage
(2) Intracerebral haemorrhage
(3) Brain infarction due to occlusion of precerebral arteries
(4) Brain infarction due to cerebral thrombosis
(5) Embolic brain infarction
(6) Unspecified stroke.

(1) Subarachnoid haemorrhage

Symptoms: Abrupt onset of severe headache or unconsciousness or both. Signs of meningeal irritation (stiff neck, Kernig and Brudzinski signs). Focal neurological deficits are usually not present.

Findings: At least one of the following must be present in addition to typical symptoms:

(1) Necropsy - recent subarachnoid haemorrhage and an aneurysm or arteriovenous malformation;

(2) Computer-aided computerized axial tomography - blood in the Fissura Sylvii or between the frontal lobes or in the basal cistern or in cerebral ventricles;

(3) Cerebrospinal fluid (liquor) bloody (>2,000 rbc per cmm), and an aneurysm or an arteriovenous malformation found on angiography;

(4) Cerebrospinal fluid (liquor) bloody (>2,000 rbc per cmm) and xanthochromic, and the possibility of intracerebral haemorrhage excluded by necropsy or computer-aided computerized axial tomography scan.

(2) Intracerebral haemorrhage

Symptoms: Usually sudden onset during activities. Often rapidly developing coma, but small haemorrhage presents no disturbance of consciousness.

Findings: Cerebrospinal fluid often, but not always, bloody or xanthochromic. Often severe hypertension present. Haemorrhage must be confirmed by necropsy or by computer-aided computerized axial tomography.

(3) Brain infarction due to occlusion of precerebral arteries

Symptoms: May vary.

Findings: The occlusion must be confirmed by angiography or ultrasound or necropsy.

(4) Brain infarction due to cerebral thrombosis

Symptoms: No severe headache, if at all. Onset acute, sometimes during sleep. Often gradual progression of focal neurologic deficits. Usually, no, or only slight, disturbance of consciousness. Often, transient ischaemic attack can be detected in the history, and often other symptoms of atherosclerosis (coronary heart disease, peripheral arterial disease) or underlying diseases (hypertension, diabetes).

Findings: Brain infarction in the necropsy or in the computer-aided computerized axial tomography scan *and* no evidence of an embolic origin.

(5) Embolic brain infarction

Symptoms: Abrupt onset, usually completion of the neurologic deficits within a few minutes. Disturbance of consciousness absent, or present only slighly at onset.

Findings: Brain infarction in the necropsy or in the computer-aided computerized axial tomography scan and the source of the embolus must be detectable. The most common origins are: (i) arrhythmia (atrial flutter and fibrillation); (ii) valvular heart disease (mitral); (iii) recent acute myocardial infarction (within previous three months).

(6) Unspecifed stroke

Those cases with a final clinical diagnosis of stroke for whom a pathological basis could not be ascertained either because the appropriate investigations were not performed or were unhelpful.

Exclusion Criteria

As for acute myocardial infarction cases (Chapter IV), cases were confined to those with a first stroke. Six cases who died within 28 days after suffering their stroke event were excluded because of a lack of information on their hypertension status, either

because the relatives of the deceased were unable to be contacted or because relatives refused to participate.

Selection of Controls

Community Controls

The random sample of the general population (described earlier in Chapter IV) which identified 503 subjects (219 men and 284 women) in the age group 35-69 years, was again used as the control group. Seven potential community control subjects had a prior history of stroke and were excluded from the case-control analysis.

Patients with a Diagnosis of Acute Myocardial Infarction

In addition to the case-control analysis, a case-case analysis was performed using patients with myocardial infarction aged 35-69 years (described in Chapter IV) as controls. The use of two groups of cases with different diseases allowed a case-case comparison to be made as well as a comparison with the community controls.

Description of Study Variables

Information was obtained from stroke patients (or relatives of deceased cases) on blood pressure treatment status, recent contacts with medical services for hypertension, smoking habits, alcohol drinking behaviour, height and weight and other demographic data using identical questions (Appendix A.23) to those employed in the myocardial infarction study (Appendix A.9). In addition, the same cut-off points which were used to define the study variables in the myocardial infarction study (Chapter IV, Subjects and Methods section) were also used in this stroke study. This would ensure comparability with the myocardial infarction study and would allow a case-case comparison to be made between the stroke cases and the myocardial infarction cases. A description of the variables used in the analysis, together with the definition of coding allocations of the variables, was presented earlier in Chapter IV, Table 4.1.

Blood Pressure Levels

A one-page questionnaire, together with an explanatory letter and a reply-paid envelope, were sent to the regular doctors of those patients with a diagnosis of stroke who had answered that they were currently receiving treatment for high blood pressure. The questionnaire sought information on dates and levels of the most recent blood pressure recordings made before the stroke occurred (last recorded blood pressure) and the pre-treatment blood pressure (or highest blood pressure recorded if this was not available). In addition, doctors were asked to confirm the blood pressure treatment status of these stroke patients, to provide the name(s) of the antihypertensive medications which were being taken before the stroke occurred, and to give details of any medical conditions (other than hypertension) which patients may have been suffering from, and/or taking treatment for, before the stroke occurred. Similar information has already been obtained from doctors of those myocardial infarction patients and community control subjects who answered that they were currently receiving treatment for hypertension (see Chapter IV), using similar methods to those described for the stroke patients. As suggested by Ogborne, Rush and Fondacaro (1986), those doctors who had not replied after four weeks were sent a reminder letter which included a copy of the questionnaire and another reply-paid envelope. This was followed by a telephone call. A thank-you letter was sent to all those doctors who replied. Personalized mailout packages were used as these have been demonstrated to increase response rates in physicians' mail surveys (Maheux, Legault and Lambert, 1989). Samples of the letters and the questionnaire form are shown in Appendices A.27 to A.34.

DATA MANAGEMENT AND STATISTICAL ANALYSIS

Coding of the Data Forms

Training sessions for the nurse interviewers were conducted both before and during the nine months' study period. Nurses were directed to adhere strictly to the interview schedule and to avoid asking leading questions. The same MONICA Study nurse interviewers who conducted the hospital interviews with the myocardial infarction patients (Chapter IV) were employed to conduct the interviews in this study. Apart from ensuring the internal consistency in reporting patients' responses in both the myocardial infarction and the stroke study, this had the additional advantage of nurses being already

trained in coding responses to the questions and details concerning the medications. Coding was carried out according to strict rules using a structured questionnaire (Appendix A.23). All the information obtained from stroke patients was coded by the nurse interviewers into boxes arranged down the right-hand side of the questionnaire form. This had the advantage of speeding up the data entry procedure. Although most of the coding was done by the nurse interviewers on the spot during the interview, some coding, such as information about medications, was done by the nurses at the study office. The antihypertensive medications were coded, using strict written coding instructions, into the antihypertensive medication groups: beta-blockers, diuretics, calcium channel blockers, and other antihypertensive agents (Appendix A.12, Pages 1, 3, 4 and 5).

Checking of the Data Forms

All completed data forms were checked by the author and the Project Manager of the MONICA Study. Any deficiencies or suspicious values were checked and corrected before the data forms were sent for data entry. Effort was made to ensure that the checking took place as soon as possible after data collection from each stroke patient in order to allow the maximum chance of any resulting queries being resolved. Checks were basically of two sorts, range checks and consistency checks. Range checks dealt with the occurrence of coding errors, while consistency checks detected impossible combinations of data.

In addition, in order to minimize errors occurring during the handling of data, the following measures were undertaken: copying of data from one form to another was avoided; all coding allocations were checked twice; and the data were entered directly from the original data forms on to the data files on the microcomputer terminal. Since on many computer systems and in many statistical software packages it is impossible to distinguish zero from a blank response (meaning no data), the use of code zero for blank responses was avoided. Instead code "8" for irrelevant responses and code "9" for unknown or missing data were used.

Data Entry

A computer operator was employed to type the data directly from the coded questionnaire into a data base on a microcomputer terminal in the study office. Back-up copies were kept on floppy discs at each entry session. After the data had been entered, a

text file was created from the data base file, and this was transferred to the study's account on the University of Newcastle VAX Cluster using the Kermit package. The SAS statistical package (SAS Institute Inc., 1985) was used to read the text file and convert the data into an SAS data set for subsequent analyses.

Computer Checking and Editing

Using the SAS statistical software package (SAS Institute Inc., 1985), a separate table and a frequency distribution were produced for each study variable, showing the number of individuals who fell into each value of the variable or into each category. This information about the expected values and relationships among the data items was used to check for errors in the precoded values or in data entry (Abramson, 1979). For data found to be in error, the original data form was checked and the error was corrected in the data item. If the examination of the original form failed to identify the mistake, a missing value was assigned to the data item.

Data Analysis

The data management and the statistical analysis were basically the same as those described in detail in the myocardial infarction study (see Chapter IV, Subjects and Methods section). In brief, all collected data were computerized and analysis was performed using the SAS (SAS Institute Inc., 1985) and BMDP (Dixon *et al.*, 1985) statistical software packages. Standard methods of case-control studies analysis were used, as described by Breslow and Day (1980) and Schlesselman (1982). Relative risks were estimated from odds ratios calculated using the Mantel-Haenszel technique to adjust for age and sex, with the 95 percent confidence intervals calculated by the method of Cornfield (Breslow and Day, 1980). The risk factors were assessed together multivariately by means of logistic regression (Schlesselman, 1982, Chapter 8). This method allowed the odds ratios, confidence intervals and tests of significance to be calculated, while adjustments were made for possible confounding variables (Schlesselman, 1982, Chapter 8). In addition, the aetiologic fractions were calculated adjusting for age and sex using the method described by Schlesselman (1982, Pages 224-226) as a measure of the importance of hypertension and smoking in the aetiology of stroke.

Validation of Stroke Questionnaire Data

Since the data were obtained from personal interviews, the quality of this data depends on the ability of the patients to recall information correctly. Accuracy of recall can be evaluated by measuring the agreement between questionnaire-derived data and that obtained from another, presumably more accurate, source, such as medical record information - a validation method which is widely employed in epidemiological research (Harlow and Linet, 1989).

Accuracy of recall of current treatment for high blood pressure (the factor which is most important to estimate accurately in the study) was assessed by comparing the information obtained from personal interviews with that acquired from the medical records of the patients' regular doctors, on hypertension treatment status and the name(s) of antihypertensive medications which were being taken before the stroke event occurred. Table 5.1 shows that there was 100 percent agreement between the two data sources and that patients' recall (or that of relatives of deceased cases) of the type of antihypertensive therapy which was being taken before the stroke occurred was fairly accurate (overall proportion of agreement was 96 percent). This suggests that there is no apparent bias due to preferential recall by persons with stroke, in line with similar findings which were reported earlier for community controls (Chapter II).

Table 5.1. Comparison of hypertension treatment status obtained from two data sources: questionnaire interviews and medical records, for 89 stroke patients who answered that they were currently receiving treatment for high blood pressure.

Characteristic	Questionnaire Interviews N	Medical Records N	Overall Proportion of Agreement (%)
On current treatment for hypertension	89	89	100
Type of antihypertensive medication* combination before the stroke event:			
B only	13	11	
D only	4	4	
O only	21	20	
B + D	10	11	
B + O	9	8	
D + O	23	23	
B + D + O	9	12	96

* B = beta blockers, D = diuretics, O = other anytihypertensive agents

RESULTS

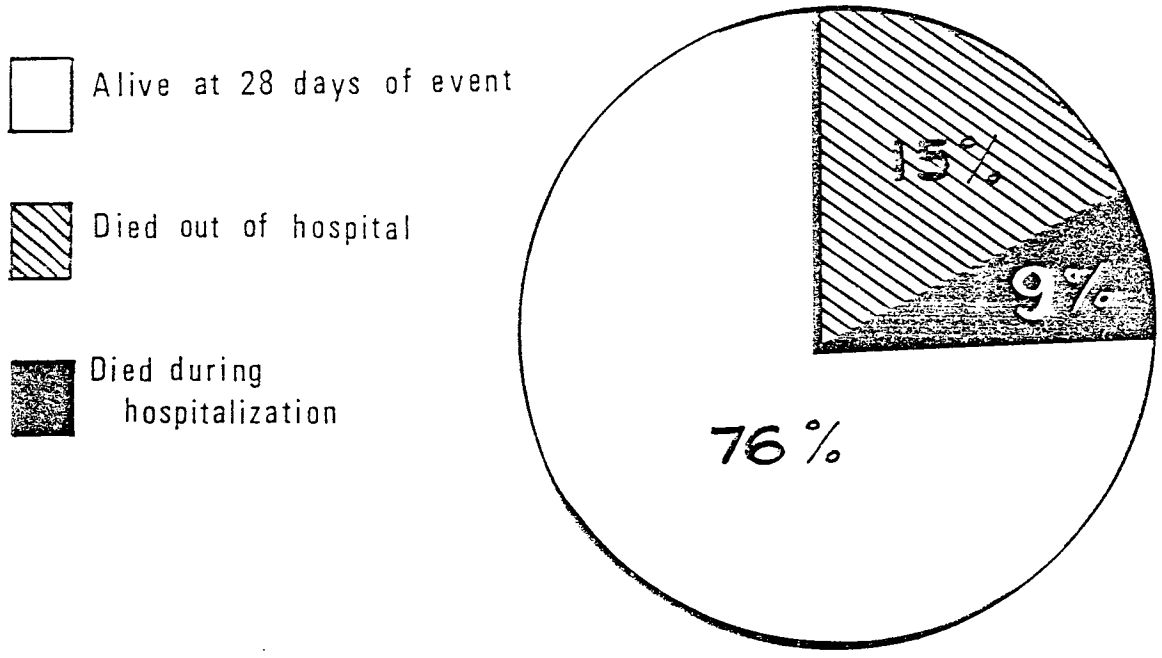
Age and Sex Distribution of First Stroke Cases

In this study, a total of 190 patients with first events of stroke (118 men and 72 women) were identified among persons aged 35-69 years normally resident in the Lower Hunter Region of New South Wales, during the period from 1st April, 1987, to 31st December, 1987. Seventy-nine cases (42 percent) of first stroke were aged 35-59 years and 111 cases (58 percent) were 60-69 years of age.

Of the registered cases, 161 patients (85 percent) with first events of stroke were admitted to hospital and 29 patients (15 percent) died out of hospital and were identified through regular surveillance of official death records. Of those patients admitted to hospital with first stroke, 81 percent had at least one computed axial tomographic scan, 16 percent had more than one computed axial tomographic scan, 11 percent had carotid angiography, 5 percent were investigated using doppler ultrasonography (common, external and internal carotid arteries) and 7 percent of patients had a lumbar puncture. Thirty-four percent of those patients who died out of hospital had a necropsy report. Clinical cases of stroke were classified into the pathological subcategories according to the results of the computed tomographic scan for those cases who were admitted to hospital, or the results of the necropsy findings for those stroke patients who died out of hospital.

Most deaths from stroke occurred before hospitalization (Figure 5.1). The pie chart shows that 45 patients with first stroke (24 percent) died within 28 days of suffering their cerebral event. Of those, 15 percent (29 patients) died out of hospital and 9 percent (16 patients) died during their hospitalization. This pattern is consistent with that reported from other community-based stroke registers in Australia (Ward, Jamrozik and Stewart-Wynne, 1988).

Figure 5.1. Distribution of fatal and non-fatal first stroke cases in persons aged 35-69 years in the Hunter Region of New South Wales.



Pathological Subcategories of First Stroke Cases

Of 190 consecutive cases of first stroke with a final clinical diagnosis of stroke, the pathological bases could not be ascertained for 29 percent of the cases (55 patients) either because the appropriate investigations were not performed or because they were unhelpful, or because they were fatal cases for whom a necropsy report was not available.

The greatest proportion of first stroke cases were thrombotic brain infarctions, accounting for 45 percent of registered cases of first stroke (85 patients). This compares with 7 percent of first stroke cases (13 patients) being due to embolic brain infarctions, 7 percent (14 patients) due to subarachnoid haemorrhage and 12 percent (23 patients) due to intracerebral haemorrhage - Table 5.2. Because of the small number of registered cases of first stroke, both cases of subarachnoid haemorrhage and intracerebral haemorrhage were combined in the statistical analysis.

The higher proportion of thrombotic brain infarctions to haemorrhagic infarctions is consistent with reported results from other stroke registers in Caucasian populations (Mohr *et al.*, 1978; Bamford *et al.*, 1988; Bogousslavsky, Van Melle and Regli, 1988).

Haemorrhagic stroke, although accounting for less than 20 percent of all registered stroke cases, was characterized by a high case fatality rate (the proportion of stroke patients who died within 28 days of the onset of stroke) and occurred in relatively younger people (those aged 35-59 years), particularly women, as shown in Table 5.2. This is consistent with our knowledge of the natural history of haemorrhagic stroke (Weinfeld, 1981). In fact, even if all the unspecified stroke cases were infarction strokes, leading to a case fatality rate at 28 days of event of 20 percent, it would still be much lower than the case fatality rate among patients with haemorrhagic stroke (41 percent).

Table 5.2. Pathological subcategories of first stroke cases aged 35-69 years by age, sex, hypertension and smoking status.

Variable	Infarction Stroke	Haemorrhagic Stroke	Unspecified Stroke	All Stroke Cases
No. of stroke cases	98 (100)	37 (100)	55 (100)	190 (100)
Age:				
35 - 49	9 (9)*	8 (22)	4 (7)	21 (11)
50 - 59	26 (27)	17 (46)	15 (27)	58 (31)
60 - 69	63 (64)	12 (32)	36 (65)	111 (58)
Sex:				
Men	69 (70)	15 (41)	34 (62)	118 (62)
Women	29 (30)	22 (59)	21 (38)	72 (38)
Hypertension:				
Ever told	73 (73)	24 (65)	35 (64)	132 (69)
Ever treated	62 (63)	22 (59)	31 (56)	115 (61)
On current treatment	55 (56)	17 (47)	25 (46)	97 (51)
Smoking Status:				
Current smoker	31 (32)	11 (30)	20 (37)	62 (33)
CFR# at 28 days	12% (6-18)**	41% (29-53)	33% (20-46)	24% (18-30)

* Percentage of number of stroke cases in parentheses

** 95 percent confidence interval

\# Case fatality rate

Prevalence of Hypertension Among Stroke Cases and Community Controls

One hundred and ninety cases of first events of stroke were available for comparison with 496 community control subjects who had no previous history of stroke. The age and sex distribution of stroke cases and community control subjects, together with the number of men and women who had a past history of hypertension (ever told), those who had a past history of treatment for hypertension (ever treated), those who were on current treatment for hypertension (on current treatment), or those who were current cigarette smokers, are presented in Table 5.3.

The majority of registered stroke cases (58 percent) occurred in older subjects (those aged 60-69 years). This indicates that stroke is strongly related to age. The proportion of subjects with hypertension (history of high blood pressure or current treatment for hypertension) was higher among cases of stroke than among community controls. The pattern was consistent throughout the age range and in both men and women. Amongst those who had ever been told they had hypertension, 73 percent of stroke cases were currently receiving treatment compared with 61 percent of hypertensive control subjects.

Not only was the proportion of stroke cases with a history of hypertension (69 percent) higher than that among people in the community (35 percent), but is was also higher than that among patients with myocardial infarction (52 percent - see Chapter IV, Table 4.3). This indicates the important role of hypertension in the aetiology of stroke in this community.

Table 5.3. First stroke cases and community controls classified by age, sex, hypertension and smoking status.

	First Stroke Cases			Community Controls		
Variable	**Men**	**Women**	**Total**	**Men**	**Women**	**Total**
No. of subjects	118	72	190	216	280	496
Age: (years)						
35-49	11 (9)*	10(14)	21(11)	106(52)	124(46)	230(46)
50-59	39(33)	19(26)	58(31)	56(26)	86(31)	142(29)
60-69	68(58)	43(60)	111(58)	54(25)	70(25)	124(25)
Hypertension:						
Ever told	78(66)	54(75)	132(69)	68(31)	105(38)	173(35)
Ever treated	68(58)	47(65)	115(61)	54(25)	87(31)	141(28)
On current treatment	59(50)	38(53)	97(51)	41(19)	65(23)	106(21)
Smoking status:						
Current smoker	43(36)	19(26)	62(33)	65(30)	46(16)	111(22)
Ex-smoker	38(33)	8(11)	46(26)	75(35)	44(16)	119(24)

* Percentages in parentheses

Assessment of Risk of Stroke in Relation to History of Hypertension (Stratified Analysis)

Table 5.4 shows that hypertension (defined as being on current treatment for hypertension) was associated with an increased risk of stroke in all age and sex groups. The risk (odds ratio) appears to be higher among younger age groups (those aged 35-49 years) than among older age groups (those aged 60-69 years).

Table 5.4. Risk of stroke associated with hypertension (HT)* among age and sex groups.

Stratum (age in years)	Stroke Cases	Community Controls	Odds Ratio of Stroke (95% confidence interval)	Chi-square df = 1	P-value (two-sided test)
Men:					
35-49					
HT	5	9			
Not HT	6	97			
Total	11	106	8.98 (1.91-43.54)	9.66	0.0019
50-59					
HT	18	15			
Not HT	21	41			
Total	39	56	2.34 (0.91-6.10)	3.00	0.0834
60-69					
HT	36	17			
Not HT	32	37			
Total	68	54	2.45 (1.09-5.54)	4.80	0.0284
Women:					
35-49					
HT	4	13			
Not HT	6	111			
Total	10	124	5.69 (1.18-27.41)	4.86	0.0275
50-59					
HT	10	24			
Not HT	9	62			
Total	19	86	2.87 (0.93-8.93)	3.29	0.0697
60-69					
HT	24	28			
Not HT	19	42			
Total	43	70	1.89 (0.82-4.40)	2.08	0.1490
All subjects:					
HT	97	106			
Not HT	93	390			
Total	190	496	3.84 (2.65-5.57)	56.67	0.0000

* Defined as being on current treatment for hypertension

The relationship between hypertension and the risk of stroke, controlling for age and sex, is presented in Table 5.5. For all stroke cases combined, a history of hypertension (odds ratio 4.0; 95 percent confidence interval 2.7 to 6.0; P <0.00001), a history of treatment for hypertension (odds ratio 3.3; 95 percent confidence interval 2.3 to 5.1; P <0.00001), and current treatment for hypertension (odds ratio 3.1; 95 percent confidence interval 2.2 to 4.8; P <0.00001), were all associated with an increased risk of stroke.

Current cigarette smoking was also associated with an increased risk of stroke (odds ratio 1.5; 95 percent confidence interval 0.9 to 2.4) but the association was not statistically significant (P = 0.07) - Table 5.5. Thus hypertension was a greater risk factor for stroke than was current cigarette smoking. The pattern was consistent in both men and women (Table 5.6), among younger age groups (those aged 35-59 years) and older age groups (those aged 60-69 years), irrespective of the pathological basis of the stroke case (Table 5.5).

Table 5.5. Risk of first stroke associated with hypertension and smoking among stroke subcategories, controlling for age and sex.

Variable	Infarction Stroke	Haemorrhagic Stroke	Unspecified Stroke	All Stroke Cases
No. of stroke cases	98	37	55	190
Hypertension:				
Ever told	3.8 (2.3 - 6.3)*	4.4 (2.1 - 10.2)	3.9 (1.8 - 8.9)	4.0 (2.7 - 6.0)
Ever treated	3.3 (2.0 - 5.5)	3.5 (1.8 - 8.1)	3.1 (1.5 - 6.9)	3.3 (2.3 - 5.1)
On current treatment	3.2 (2.0 - 5.6)	3.0 (1.5 - 6.8)	2.6 (1.3 - 5.7)	3.1 (2.2 - 4.8)
Smoking Status:				
Current smoker	1.6 (0.9 - 2.9)	1.4 (0.6 - 3.6)	1.0 (0.4 - 2.8)	1.5 (0.9 - 2.4)
Ex-smoker	0.9 (0.5 - 1.8)	1.3 (0.5 - 3.4)	0.8 (0.3 - 2.5)	0.9 (0.5 - 1.6)

* 95 percent confidence interval in parentheses

Table 5.6. **Risk of first stroke associated with hypertension and smoking, among men and women, controlling for age.**

Variable	Men	Women	Both sexes*
No. of stroke cases	118	72	190
No. of controls	216	280	496
Hypertension:			
Ever told	3.8 (2.3-6.6)**	4.3 (2.3-8.2)	4.0 (2.7-6.0)
Ever treated	3.5 (2.1-6.2)	3.2 (1.7-5.8)	3.3 (2.3-5.1)
On current treatment	3.4 (2.0-6.0)	2.8 (1.6-5.4)	3.1 (2.2-4.8)
Smoking status:			
Current smoker	1.4 (0.8-2.7)	1.5 (0.8-3.3)	1.5 (0.9-2.4)
Ex-smoker	0.9 (0.5-1.8)	1.0 (0.4-2.4)	0.9 (0.5-1.6)

* Also controlling for sex

** 95 percent confidence interval in parentheses

Utilization of Medical Services for Hypertension

Table 5.7 shows that the proportion of stroke patients who had visited a doctor within the last three months before the event (82 percent) was significantly higher ($P < 0.01$) than among community control subjects (61 percent). Seventy-seven percent of stroke patients had undergone a blood pressure measurement within the last three months before suffering their cerebral event, compared with 49 percent of community controls.

Table 5.7. **Utilization of health services for hypertension among stroke cases and community controls, aged 35-69 years.**

Variable	First Stroke Cases			Community Controls		
	Men	Women	Total	Men	Women	Total
No. of subjects	107	64	171*	216	280	496
Last visit to a doctor:						
More than three months ago	22(21)**	9(14)	31(18)	88(41)	106(38)	194(39)
Within the last three months	85(79)	55(86)	140(82)	128(59)	174(62)	302(61)
Last blood pressure measurement:						
More than three months ago	132(26)	93(40)	39(23)	111(51)	143(51)	254(51)
Within the last three months	377(74)	137(60)	132(77)	105(49)	137(49)	242(49)

* Excluding 19 stroke cases (11 men and 8 women) for whom data not available

** Percentages in parentheses

Multivariate Assessment of Risk of Stroke in Relation to History of Hypertension (Logistic Regression)

Table 5.8 shows that even with further adjustment for smoking status, alcohol consumption and body mass index, hypertension (on current treatment) was still associated with an increased risk of stroke (odds ratio 3.5; 95 percent confidence interval 2.3 to 5.4). The results of the logistic regression are in broad agreement with the univariate analysis.

When the logistic regression analysis was repeated using five-year age groups rather than three age categories, the results of the multivariate analysis were little changed.

Table 5.8. Multivariate assessment of risk of first ever stroke in relation to hypertension.

Variable	No. (%) of Stroke Cases (n=190)	No. (%) of Controls (n=496)	Odds Ratio* of First Stroke (95% confidence interval)
Age category:			
35-49 years	21 (11)	230 (46)	1.0**
50-59 years	58 (31)	142 (29)	5.9 (3.0-11.8)
60-69 years	111 (58)	124 (25)	10.5 (5.4-20.7)
Sex:			
Women	72 (38)	280 (56)	1.0**
Men	118 (62)	216 (44)	2.1 (1.3-3.5)
Smoking status:			
Non-smoker	82 (43)	266 (54)	1.0**
Ex-smoker	46 (24)	119 (24)	0.8 (0.5-1.5)
Current smoker	62 (33)	111 (22)	1.3 (0.8-2.2)
Alcohol consumption:			
Non-drinker	79 (47)	207 (42)	1.0**
Light	71 (37)	245 (49)	0.7 (0.4-1.2)
Moderate - heavy	40 (21)	44 (9)	2.2 (1.1-4.5)
Body Mass Index (kg/m^2):			
Underweight	17 (9)	22 (4)	2.4 (1.0-5.6)
Acceptable weight	89 (47)	272 (55)	1.0**
Overweight	61 (32)	156 (31)	1.0 (0.6-1.5)
Obese	23 (12)	46 (9)	1.3 (0.6-1.6)
Hypertension (on treatment):			
No	93 (49)	390 (79)	1.0**
Yes	97 (51)	106 (21)	3.5 (2.3-5.4)

* Odds ratios are adjusted for all other factors in table

** Reference category

Estimation of the Aetiologic Fraction

Estimates of the proportions of first events of stroke which could be attributed to the presence of hypertension and current cigarette smoking in this community are presented in Table 5.9.

Thirty percent of first stroke cases were attributed to hypertension (defined as being on current treatment) and 8 percent to current cigarette smoking.

Table 5.9. Estimated proportion of cases of first stroke attributable to hypertension and current smoking, by age, of men and women*.

Exposure	Age-specific Aetiologic Fractions			Age-adjusted Aetiologic Fractions (95% confidence interval)
	35-49	50-59	60-69	
Hypertension (on treatment):				
Men	0.484	0.264	0.313	0.305 (0.144 to 0.416)
Women	0.329	0.342	0.263	0.292 (0.095 to 0.453)
Both sexes	0.410	0.289	0.294	0.300** (0.179 to 0.380)
Current smoking:				
Men	0.273	0.198	-0.039	0.068 (-0.251 to 0.305)
Women	0.348	0.198	-0.002	0.099 (-0.123 to 0.277)
Both sexes	0.309	0.198	-0.025	0.080** (-0.102 to 0.232)

* Estimates based on data in Table 5.2. For example, among men 35-49 years of age, an estimated 40.3 percent of cases of stroke are attributable to hypertension, and overall, an estimated 29.3 percent of cases of stroke among men aged 35-69 years are attributable to hypertension:

Age-adjusted aetiologic fraction for hypertension among men = [11(0.484) + 39(0.264) + 68(0.313)] / 118 = 0.305.

** Also adjusted for sex

Prevalence of Cardiovascular Risk Factors Among Treated Hypertensives who Developed Stroke

Table 5.10 shows that the proportion of current cigarette smokers was higher among treated hypertensives who later developed stroke (30 percent) than among treated hypertensives in the community (17 percent); an adjusted odds ratio of 1.6 (95 percent confidence interval of 0.6 to 4.5), but this was not statistically significant. The proportion of heavy alcohol drinkers was also higher among treated hypertensive subjects who later developed stroke than among treated hypertensives in the community; however, the difference was not statistically significant. This may reflect the small number of hypertensive stroke cases in this study.

Table 5.10. Prevalence of cardiovascular risk factors among treated hypertensives who developed stroke and treated hypertensive subjects in the community, aged 35-69 years.

Variable	Treated hypertensive subjects		Odds ratio* of first stroke (95% confidence interval)
	No. (%) of Stroke cases (n=97)	No. (%) of controls (n=106)	
Sex:			
Women	38 (39)	65 (61)	1.0**
Men	59 (61)	41 (39)	2.3 (1.0-5.8)
Age category:			
35-49 years	9 (9)	23 (22)	1.0**
50-59 years	28 (29)	30 (28)	2.4 (1.2-4.8)
60-69 years	60 (62)	53 (50)	3.3 (1.4-7.6)
Smoking status:			
Non-smoker	43 (44)	58 (55)	1.0**
Ex-smoker	25 (26)	30 (28)	0.6 (0.2-1.7)
Current smoker	29 (30)	18 (17)	1.6 (0.6-4.5)
Alcohol consumption:			
Non-drinker	45 (46)	51 (48)	1.0**
Light	38 (39)	47 (44)	0.8 (0.3-2.1)
Moderate - heavy	14 (14)	8 (8)	1.0 (0.3-3.7)
Body Mass Index (kg/m^2):			
Underweight	6 (6)	3 (3)	1.5 (0.2-12.8)
Acceptable weight	45 (46)	41 (39)	1.0**
Overweight	32 (33)	44 (42)	1.1 (0.4-2.5)
Obese	14 (14)	18 (17)	1.1 (0.3-3.5)

* Odds ratios are adjusted for all other factors in table

** Reference category

Blood Pressure Control Among Stroke Cases and Community Controls

The regular doctors of 97 patients with a diagnosis of stroke, who had answered that they were currently receiving treatment for hypertension, were asked to provide their patients' blood pressure level recordings and the name(s) of the antihypertensive medications which were being taken before the stroke event. This information was obtained for 89 hypertensive patients (55 men and 34 women) who had later developed stroke (a "response rate" of 92 percent). Most doctors replied to the first mailing (68 patients, or 70 percent of the total number of patients) and information on a further 21 patients was obtained in response to a reminder letter and/or a telephone call. Similar data were obtained for 102 control subjects (39 men and 63 women) on current treatment for hypertension with no previous medical history of stroke (a "response rate" of 96 percent). The high general practitioners' response rates are consistent with results from other studies (Maheux, Legault and Lambert, 1989) which have implemented similar personalization techniques.

Table 5.11 shows that the proportion of subjects with a pre-treated diastolic blood pressure of 95mmHg or more was similar for subjects who later developed stroke (82 percent) and for those in the community with no history of stroke (84 percent), but the proportion of those with more severe forms of hypertension (pre-treated diastolic blood pressure of 105mmHg or more) was higher among those who developed stroke (60 percent) than among the hypertensive control subjects (50 percent).

A similar pattern is seen for pre-treated systolic blood pressure; that is, as Table 5.11 shows the proportion of those with a pre-treated systolic blood pressure of 160mmHg or more was similar for cases (87 percent) and controls (79 percent). In addition, the proportion of those with more severe forms of hypertension (pre-treated systolic blood pressure of 180mmHg or more) was higher among those who developed stroke (57 percent) than among hypertensive control subjects (36 percent).

Table 5.11. A comparison of the pre-treated systolic and diastolic blood pressure levels of patients on treatment for hypertension who developed stroke and of treated hypertensive subjects in the community, aged 35-69 years.

Characteristic	Hypertensive cases of Stroke	Community Hypertensive Controls
No. of subjects	89	102
Pre-treated systolic blood pressure (mmHg):		
Less than 160	12 (13)*	21 (21)
160 - 179	26 (29)	45 (44)
180 - 199	25 (28)	21 (21)
200 or more	26 (29)	15 (15)
Pre-treated diastolic blood pressure (mmHg):		
Less than 95	16 (18)	16 (16)
95 - 104	20 (22)	35 (34)
105 - 114	39 (44)	38 (37)
115 or more	14 (16)	13 (13)

* Percentages in parentheses

The proportion of poorly controlled subjects (last measured treated diastolic blood pressure before the stroke event or survey equal to or greater than 90mmHg) was higher among stroke cases (64 percent) than among community control subjects (28 percent), as shown in Table 5.12.

A similar pattern is seen for treated systolic blood pressure of 140mmHg or more (poorly controlled subjects) which was higher among stroke cases (66 percent) than among community control subjects (49 percent) - Table 5.12.

Table 5.12. A comparison of treated systolic and diastolic blood pressure levels of patients with hypertension who developed stroke and of hypertensive subjects in the community, aged 35-69 years.

Characteristic	Hypertensive cases of Stroke	Community Hypertensive Controls
No. of subjects	89	102
Treated systolic blood pressure (mmHg):		
Less than 120	4 (4)*	5 (5)
120 - 139	27 (30)	47 (46)
140 - 159	29 (33)	38 (37)
160 or more	29 (33)	12 (12)
Treated diastolic blood pressure (mmHg):		
Less than 80	11 (12)	15 (15)
80 - 89	21 (24)	59 (58)
90 - 94	34 (38)	21 (21)
95 or more	23 (26)	7 (7)

* Percentages in parentheses

Table 5.13 shows that the last recorded mean blood pressure of those on treatment (both systolic and diastolic pressures) was higher among those who later developed first stroke than among those treated hypertensive subjects in the community sample, despite similar pre-treatment blood pressure levels. The pattern was consistent among younger (those aged 35-59 years) and older age groups (60-69 years old) (Figure 5.2), in both men and women (Figure 5.3). Figures 5.2 and 5.3 show that the degree of control of hypertension among hypertensives who developed a first stroke was worse than both that among hypertensives who developed first myocardial infarction (see Chapter IV) and that in the general population.

Ninety-one percent of the last recorded blood pressure readings of those hypertensives who later developed stroke were taken within the three months prior to the onset of the stroke event.

Table 5.13. A comparison of mean blood pressure levels of patients on treatment for hypertension who developed stroke and of subjects on treatment for hypertension in the community, aged 35-69 years (standard error in parentheses).

Characteristic	Hypertensive cases of Stroke	Community Hypertensive Controls
No. of subjects	89	102
(a) Pre-treatment blood pressure:		
Systolic mmHg	175.0 (2.9)	171.8 (2.0)
Diastolic mmHg	105.8 (1.7)	103.4 (1.1)
(b) Last recorded blood pressure before event*:		
Systolic mmHg	148.0 (2.3)	137.4 (1.4)
Diastolic mmHg	88.9 (1.4)	82.7 (0.7)
Reduction in blood pressure: (a) - (b)		
Systolic mmHg	27.0 (3.1)	34.4 (2.1)
Diastolic mmHg	16.9 (2.1)	20.7 (1.1)
Percentage of reduction in blood pressure**:		
Systolic	15.4% (1.6%)	20.0% (1.0%)
Diastolic	15.1% (1.6%)	20.0% (1.0%)
Period on treatment for hypertension (months)	54.2 (6.0)	52.1 (5.1)

* Or before survey in community controls

** Percentage reduction in blood pressure $= \frac{(a) - (b)}{(a)} \times 100$

Figure 5.2. Percentages of poorly controlled treated hypertensives (treated diastolic blood pressure of 90mmHg or more) among younger (35-59 years) and older (60-69 years) age groups in the Hunter Region.

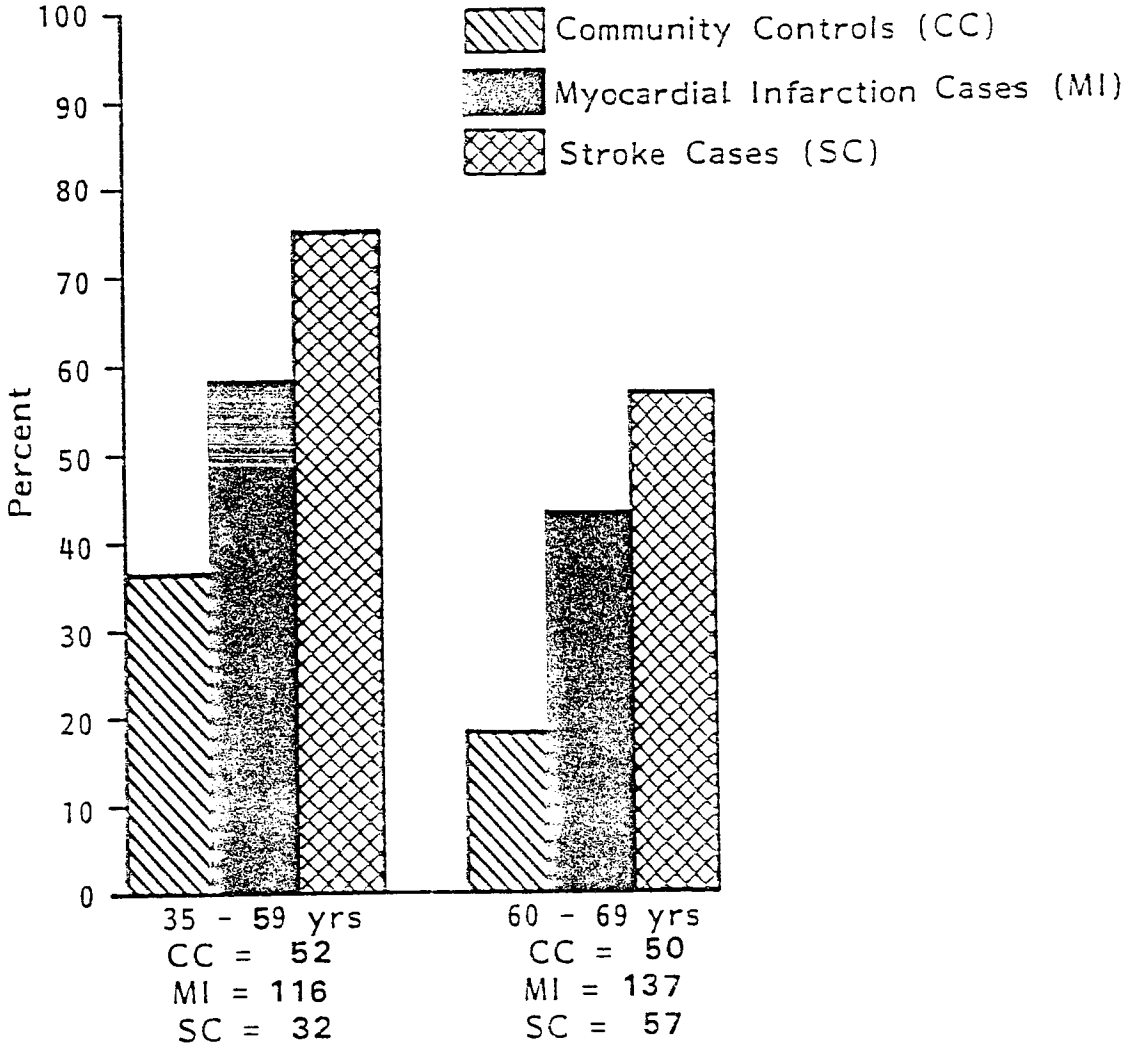
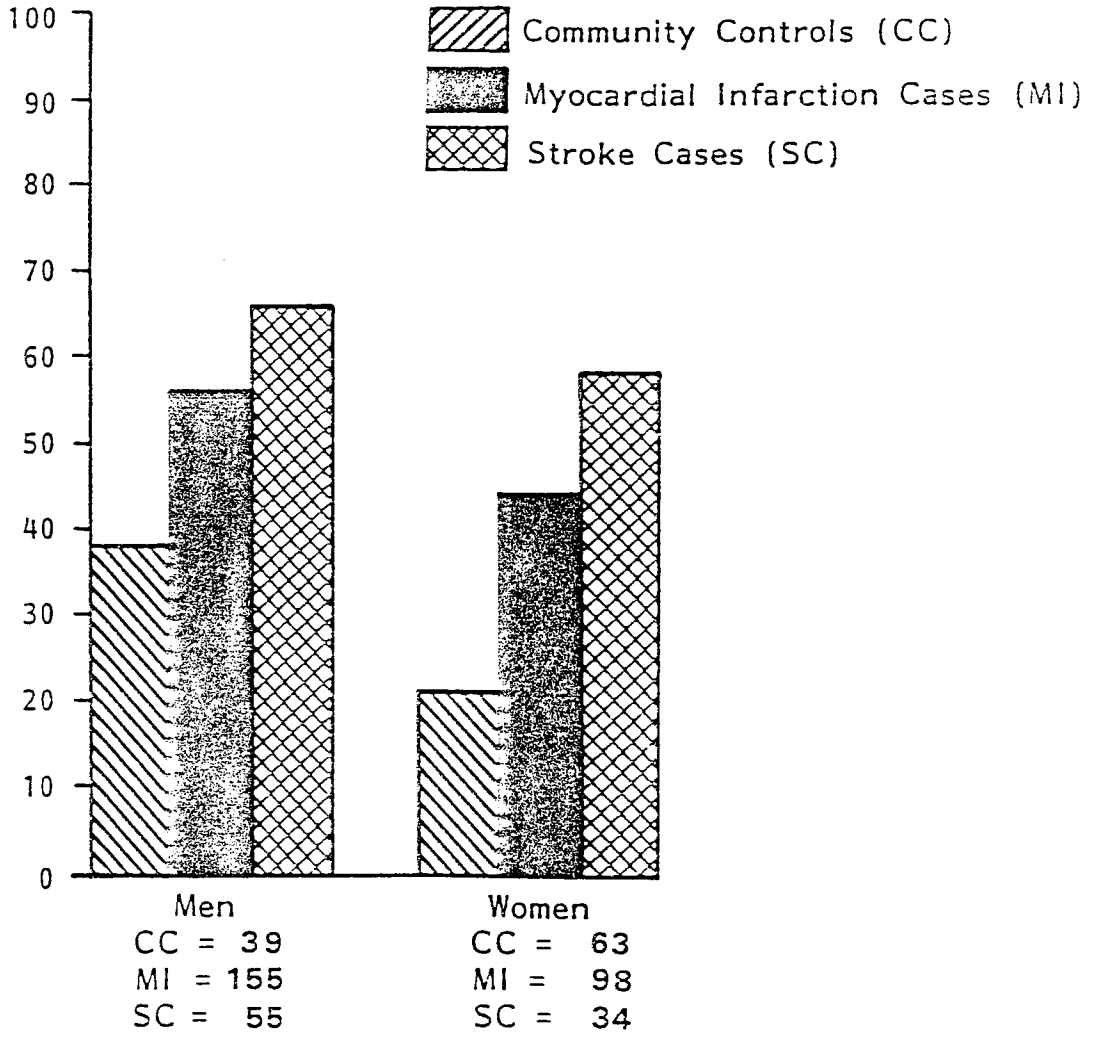


Figure 5.3. Percentages of poorly controlled treated hypertensives (treated diastolic blood pressure of 90mmHg or more) among men and women in the Hunter Region.



Multivariate Assessment of Risk of Stroke in Relation to Hypertension Control

The relationship between blood pressure control and the risk of stroke, adjusting for age, sex, smoking status, alcohol consumption and body mass index, is presented in Table 5.14. Since blood pressure increases markedly with age, adjustment has been made using age as a continuous variable rather than having, as previously, three age categories. Hypertensives with poorly controlled blood pressure (treated diastolic blood pressure of 90mmHg or more) were at higher risk of developing stroke (adjusted odds ratio 5.8; 95 percent confidence interval 2.5 to 13.8) than those with a diastolic blood pressure of 80-89mmHg. Repeating the analysis using different criteria for poor blood pressure control did not change the associations observed, that is, those with a treated diastolic blood pressure of at least 95mmHg were at higher risk of stroke occurring (adjusted odds ratio of 4.5; 95 percent confidence interval 1.4 to 6.2) than those with a diastolic blood pressure of 80-94mmHg.

Repeating the analysis, but looking at systolic treated blood pressure levels, revealed similar findings (Table 5.14), with hypertensives with treated systolic blood pressures of 140mmHg or more (poorly controlled hypertensives) having an adjusted odds ratio of 2.2 (95 percent confidence interval 1.1 to 4.8) for developing stroke. Using different criteria for systolic blood pressure control did not change the findings, that is, those with a systolic blood pressure of 160mmHg or more had an adjusted odds ratio of 2.9 (95 percent confidence interval 1.2 to 6.7) for developing stroke.

Table 5.15 shows that the increased risk of developing stroke among poorly controlled hypertensive subjects (those with a treated diastolic blood pressure equal to or greater than 90mmHg) was consistent in both men and women and also across age groups.

Table 5.14. Risk of first stroke in relation to treated blood pressure level among subjects on treatment for hypertension in the Hunter Region, aged 35-69 years.

Variable	No. (%) of Hypertensive Stroke Cases (n = 89)	No. (%) of Hypertensive Controls (n = 102)	Odds Ratio* of first Stroke(95% confidence interval)
Last diastolic blood pressure:			
Less than 80mmHg	11 (12)	15 (15)	1.3 (0.4- 4.4)
80 - 89mmHg	21 (24)	59 (58)	1.0**
90mmHg or more	57 (64)	28 (28)	5.8 (2.5 - 13.8)
Last systolic blood pressure:			
Less than 120mmHg	4 (4)	5 (5)	1.6 (0.6 - 4.0)
120 - 139mmHg	27 (30)	47 (46)	1.0**
140mmHg or more	58 (65)	50 (49)	2.2 (1.1 - 4.8)

* Odds ratios are adjusted for age, sex, smoking status, alcohol consumption and body mass index

** Reference category

Table 5.15. Risk of first stroke in relation to last recorded diastolic blood pressure reading before event, among age and sex groups.

Stratum (age in years)	No. (%) of Hypertensive Stroke Cases	No. (%) of Hypertensive Community Controls	Odds Ratio of AMI (95% confidence interval)	Chi-square df = 1	P-value (two-sided test)
Men:					
35-59					
Less than 80mmHg	1 (5)	2 (11)	0.60 (0.02-14.00)	0.08	0.7779
80-89mmHg	5 (24)	6 (32)	1.0*		
90mmHg or more	15 (71)	11 (58)	1.64 (0.32-8.53)	0.10	0.7476
60-69					
Less than 80mmHg	6 (18)	2 (10)	5.33 (0.71-49.12)	2.31	0.1284
80-89mmHg	9 (26)	16 (80)	1.0*		
90mmHg or more	19 (56)	2 (10)	16.89 (2.65-135.44)	12.02	0.0005
Total					
Less than 80mmHg	7 (13)	4 (10)	2.65**(0.57-14.02)	1.15	0.2842
80-89mmHg	14 (25)	22 (56)	1.0*		
90mmHg or more	34 (62)	13 (33)	4.81**(1.71-16.59)	9.34	0.0022
Women:					
35-59					
Less than 80mmHg	1 (9)	5 (15)	1.90 (0.07-38.83)	0.06	0.8061
80-89mmHg	2 (18)	19 (58)	1.0*		
90mmHg or more	8 (73)	9 (27)	8.44 (1.21-73.16)	5.03	0.0249
60-69					
Less than 80mmHg	3 (13)	6 (20)	1.80 (0.25-13.35)	0.05	0.8204
80-89mmHg	5 (22)	18 (60)	1.0*		
90mmHg or more	15 (65)	6 (20)	9.00 (1.90-46.37)	9.02	0.0027
Total					
Less than 80mmHg	4 (12)	11 (17)	1.83**(0.35-9.28)	0.20	0.6575
80-89mmHg	7 (21)	37 (59)	1.0*		
90mmHg or more	23 (68)	15 (24)	8.77**(2.67-30.33)	15.45	0.0001
All subjects					
Less than 80mmHg	11 (12)	15 (15)	2.23# (0.75-6.75)	1.82	1.7779
80-89mmHg	21 (24)	59 (58)	1.0*		
90mmHg or more	57 (64)	28 (27)	6.32# (3.04-15.22)	26.01	0.0000

* Reference category

** Odds ratios are adjusted for age

\# Odds ratios are adjusted for age and sex

In order to determine whether the degree of therapeutically induced blood pressure reduction might predict a decreasing risk of stroke, the logistic regression analysis was repeated using the difference between the pre-treatment and the last recorded blood pressures, rather than using the on-treatment pressures.

Table 5.16 shows that those who had a reduction in blood pressure of less than 5mmHg diastolic were at higher risk of developing stroke than both those who achieved a reduction of 5-14mmHg diastolic and those who achieved a reduction greater than 15mmHg diastolic pressure.

Repeating the analysis using systolic blood pressure revealed similar findings, with those who had a reduction of less than 10mmHg systolic being at highest risk of developing stroke - Table 5.16.

Table 5.16. Risk of developing stroke in relation to blood pressure reduction among subjects on treatment for hypertension in the Hunter Region, aged 35-69 years.

Variable	No. (%) of Hypertensive Stroke Cases (n = 89)	No. (%) of Hypertensive Controls (n = 102)	Odds Ratio* of first Stroke (95% confidence interval)
Reduction# in diastolic blood pressure:			
Less than 5mmHg	21 (24)	13 (13)	3.0 (1.2 - 7.5)
5 - 14mmHg	15 (15)	16 (16)	1.2 (0.4 - 3.2)
15mmHg or more	53 (61)	73 (72)	1.0**
Reduction# in systolic blood pressure:			
Less than 10mmHg	24 (27)	9 (9)	5.0 (1.8 - 13.9)
10 - 29mmHg	21 (24)	30 (29)	1.5 (0.9 - 3.6)
30mmHg or more	44 (49)	63 (62)	1.0**

* Odds ratios are adjusted for age, sex, smoking status, amount of alcohol consumption and body mass index

** Reference category

Reduction in blood pressure = (pre-treated blood pressure) - (last recorded blood pressure before event)

Table 5.17 shows that 47 percent of treated hypertensive subjects who developed first events of stroke were taking beta-blocking agents (singly or in combination with other agents) and 56 percent of stroke cases were taking diuretic agents (singly or in combination with other agents). This compares with 61 percent and 43 percent of hypertensives in the community taking beta-blocking agents (singly or in combination with other agents) and diuretics (singly or in combination with other agents), respectively.

Table 5.17. Risk of stroke in relation to type of antihypertensive medications previously used by treated hypertensive subjects in the Hunter Region, aged 35-69 years.

Antihypertensive medication (singly or in combination with other agents)	No. (%) of Hypertensive Stroke Cases (n = 89)	No. (%) of Hypertensive Controls (n = 102)	Odds Ratio* of first Stroke (95% confidence interval)
Beta-blockers:			
No	47 (53)	40 (39)	1.0**
Yes	42 (47)	62 (61)	0.9 (0.4 - 1.9)
Diuretics:			
No	39 (44)	58 (57)	1.0**
Yes	50 (56)	44 (43)	1.7 (0.4 - 3.9)
Other antihypertensive agents:			
No	26 (29)	51 (50)	1.0**
Yes	63 (71)	51 (50)	1.9 (0.9 - 3.9)

* Odds ratios are adjusted for age, sex, smoking status, alcohol consumption and body mass index

** Reference category

A transient rise in blood pressure commonly accompanies acute cerebral events (Wallace and Levy, 1981; Britton, Carlsson and De Faire, 1986). Examination of the blood pressure course of patients admitted to hospital with an acute stroke in this study (Table 5.18) shows that although 68 percent of stroke patients had high blood pressure (had a diastolic blood pressure reading of 90mmHg or more) at the time of their admission, most stroke patients (86 percent) had a diastolic blood pressure less than 90mmHg at the time of their discharge (were normotensive).

Table 5.18. Blood pressure readings of 161 consecutive patients admitted with an acute stroke to hospitals in the Hunter Region in 1987, grouped according to patients' blood pressure status.

	On Current Treatment for Hypertension	With History but are not on Treatment	Not Hyper-tensive	All Stroke Patients
Number of patients	86	32	43	161
Mean diastolic blood pressure:				
On admission (Day 1)	98.3 (1.8)*	96.1 (3.2)	89.0 (2.4)	95.7 (1.4)
Day 3	83.3 (1.4)	81.5 (2.4)	80.0 (1.8)	82.3 (1.0)
On discharge	78.6 (1.3)	77.4 (1.9)	75.4 (1.8)	77.6 (0.9)
Proportion with a diastolic blood pressure equal to or greater than 90mmHg:				
On admission (Day 1)	77%	64%	54%	68%
Day 3	41%	36%	23%	35%
On discharge	18%	17%	4%	14%
Proportions receiving antihypertensive medications during hospitalization	91%	42%	30%	63%

* Standard error in parentheses

DISCUSSION

Assessment of Completeness of Stroke Registration

Unlike acute myocardial infarction, the epidemiological surveillance of stroke is complicated by the fact that a sizeable proportion of persons with stroke who were treated or died outside hospital are not identified, a proportion estimated from other studies to be approximately 25 to 30 percent (Gibson, 1974; Wade and Langton Hewer, 1985; Bonita, Anderson and North, 1987). However, this is likely to be an over-estimate of the proportion of missed stroke events in the present study because all fatal cases of cerebrovascular disease in the study population were included, having been identified through regular surveillance of the official death records. In addition, the study included relatively young patients (aged between 35 and 69 years) who are twice as likely to be admitted to hospital than older stroke patients in the community (those over the age of 69 years) (Bonita and Beaglehole, 1988).

Two recent studies examined the incidence of stroke in the Australian cities of Brisbane, in 1984 (Shah and Bain, 1989), and Perth, in 1986 (Ward, Jamrozik and Stewart-Wynne, 1988). Comparisons between the findings of these studies and our study are made in the relevant parts of the text. It was found that 11 and 15 percent of persons with stroke in the Brisbane and Perth studies, respectively, were never hospitalized, that is, they were managed entirely at home or in nursing homes.

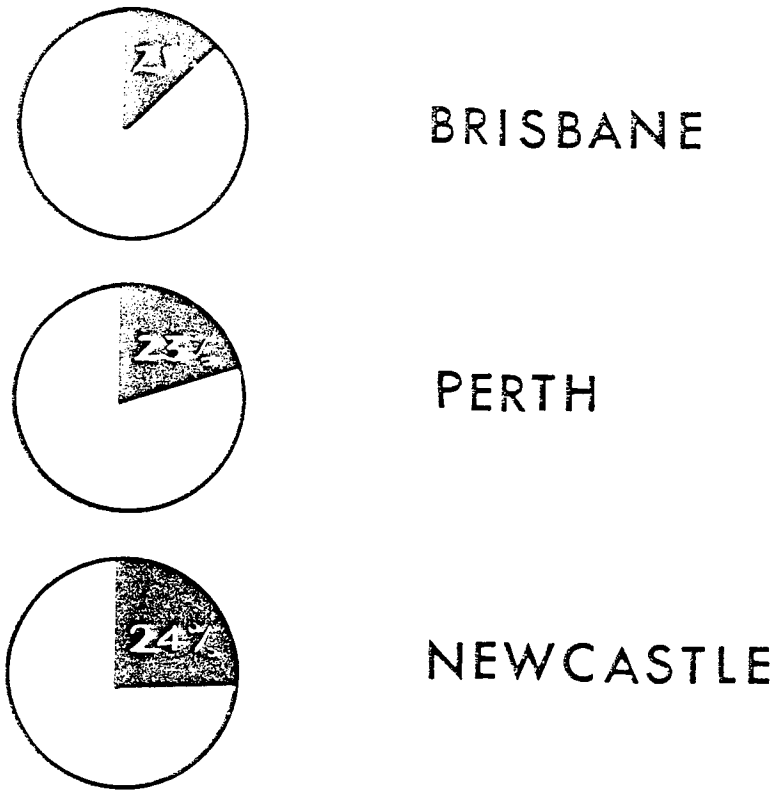
In order to provide an estimate of the proportion of non-fatal stroke which may have been missed in this study, the distribution of fatal and non-fatal stroke cases in this study was compared with that reported from the two other Australian stroke registration studies (Ward, Jamrozik and Stewart-Wynne, 1988; Shah and Bain, 1989). The between-registers variation in case-fatality in stroke events (the proportion of persons with stroke who died within 28 days of the event) provides a crude estimate of the completeness of stroke registration (Asplund *et al.*, 1988).

Figure 5.4 shows the distribution of fatal and non-fatal stroke cases in three community-based stroke registers which were compiled in the Australian cities of Brisbane (Shah and Bain, 1989), Perth (Ward, Jamrozik and Stewart-Wynne, 1988)

and Newcastle (this study). The case-fatality rates in stroke events at 28 days were 21, 23 and 24 percent for Brisbane, Perth and Newcastle, respectively.

While the comparison of the case-fatality rates at 28 days between the three Australian centres is subject to differences in population structures and hospital admission policies, the higher case-fatality rate in Newcastle (this study) than in the two other Australian studies is consistent with an under-reporting of non-fatal stroke cases in this study.

Figure 5.4. Distribution of fatal and non-fatal stroke cases in three Australian registers: Brisbane, Perth and Newcastle during the period 1984 to 1987.



The Role of Hypertension and Other Selected Risk Factors in the Aetiology of Stroke in the Hunter Region

Hypertension was found to be by far the most important factor which predisposes people aged 35-69 years to stroke (of whatever type) in the Hunter community, a finding that is consistent with results reported from studies in other populations (Ostfeld, 1980). The strong association found in this study between hypertension and stroke (adjusted odds ratio 3.5; 95 percent confidence interval 2.3 to 5.4) is in agreement with the threefold increased risk of stroke in patients with hypertension reported from studies in other western populations (Bonita, 1986; Henrich and Horwitz, 1989). In addition, the proportion of first stroke cases in the study population which were attributed to hypertension (30 percent) is consistent with estimates made in other studies (Bonita, 1986). This indicates an important direction for stroke prevention in the future.

In contrast to hypertension, there is no agreement among published studies on the significance of cigarette smoking in the aetiology of stroke (Shinton and Beevers, 1989). Furthermore, even reported results from the same data base have not been conisistent. Earlier reports from the Framingham Heart Study found no significant relationship between current cigarette smoking and stroke incidence (Dawber, 1980, Chapter 11). However, more recent publications from the Framingham Study (Wolf *et al.*, 1988) have indicated that cigarette smoking carries a definite risk of stroke. This may be due to an inadequate sample size in the earlier reports or to possible incaccuracies in distinguishing between infarction and haemorrhagic strokes before computed tomographic scanning became widely available (Anonymous, 1984). In this study, in line with recent reports (Abbott *et al.*, 1986; Golditz *et al.*, 1988) an increased risk of stroke was found among current cigarette smokers (odds ratio 1.5; 95 percent confidence interval 0.9 to 2.4), but the association was not statistically significant ($p = 0.07$).

A recent case-control study which was conducted in Melbourne, Australia, (Donnan *et al.*, 1989) and involved a large number of first stroke cases (422 patients with first stroke) reported a relative risk of 5.7 (95 percent confidence interval 2.8 to 12.0) from current cigarette smoking. While the prevalence of cigarette smoking found in the present study (33 percent) is similar to that found in the Melbourne study (32 percent), a statistically significant association between cigarette smoking and stroke could not be demonstrated in this study. This may reflect the small number of stroke patients in this

study (190 patients). Further, it has recently been suggested that cigarette smoking may be important in the aetiology of cerebral infarction but not in the aetiology of cerebral haemorrhage (Shinton and Beevers, 1989). This case-control analysis does not provide support for such an assumption, with similar odds ratios for cerebral infarction (1.6; 95 percent confidence interval 0.9 to 2.9) and cerebral haemorrhage (1.4; 95 percent confidence interval 0.6 to 3.6).

Although the association between current cigarette smoking and stroke found in this study is weak by epidemiological standards (odds ratio 1.5), the 50 percent excess risk (compared with non-smokers) is in agreement with that calculated in a recently published meta-analysis (Shinton and Beevers, 1989) which pooled the results of 32 studies on the relationship between cigarette smoking and stroke (odds ratio 1.5; 95 percent confidence interval 1.4 to 1.6). The proportion of stroke cases attributed to current cigarette smoking (the aetiologic fraction) was higher among younger age groups (those below the age of 50) than among older age groups (those aged 50 years or older). This is consistent with the reported decreasing relative risk of stroke with increasing age in the meta-analysis study of stroke and cigarette smoking (Shinton and Beevers, 1989).

Heavy alcohol consumption is not an established risk factor for stroke (Ostfeld, 1980). Recent studies which investigated the possible role of high alcohol intake in the aetiology of stroke have reported conflicting results. Some publications have suggested that it carries a definite risk (Gill *et al.*, 1986), while others found no marked risk of stroke (Herman *et al.*, 1983). A possible explanation for these contradictory results may be that high alcohol intake is important in the aetiology of haemorrhagic stroke (Dohahue *et al.*, 1986) but probably not in the aetiology of infarction stroke (Henrich and Horwitz, 1989). A twofold increased risk for stroke was demonstrated in the present study in moderate or heavy alcohol drinkers (odds ratio 2.2; 95 percent confidence interval 1.1 to 4.5) compared with non-drinkers. The proportion of heavy alcohol drinkers was higher among both infarction stroke (26 percent) and haemorrhagic stroke (27 percent) cases than among people in the community (9 percent). Thus, the study provides further evidence incriminating high alcohol intake in the aetiology of stroke.

The relative importance of hypertension and cigarette smoking appears to be quite different in the cerebral and coronary circulations. While hypertension was associated with increased risks for both acute myocardial infarction and stroke, the relationship

between hypertension and stroke was stronger than that with myocardial infarction (Chapter IV). In addition, cigarette smoking was found to be a major determinant in the aetiology of myocardial infarction (accounting for 24 percent of the first myocardial events in this community, Table 4.9) but not in the aetiology of cerebrovascular events (8 percent of the first stroke events were attributed to smoking, Table 5.9). Thirty percent and 8 percent of first stroke events could be attributed to hypertension and cigarette smoking respectively. The implications, in terms of prevention, are clear.

Management of Hypertension and the Risk of Stroke in the Hunter Community

Despite the knowledge that stroke can be prevented by the treatment of hypertension (Cutler and Furberg, 1985), and even though 51 percent of patients with first stroke events were on current treatment for hypertension in the present study (compared with 21 percent of people in the community currently receiving treatment for hypertension), these patients still suffered a stroke. Examination of the blood pressure measurements recorded before the stroke events revealed that almost two-thirds (64 percent) of treated hypertensive patients who developed a stroke were poorly controlled (i.e., they had a diastolic blood pressure equal to or greater than 90mmHg). This is consistent with the recent results from the Oxfordshire Community Stroke Project (Sandercock *et al.*, 1989) which found the presence of elevated blood pressure readings (having a recording of both systolic pressure greater than 160mmHg and diastolic pressure greater than 90mmHg) in 57 percent of first stroke patients before suffering the cerebral event.

Not only were those treated hypertensives with inadequate blood pressure control (those with a blood pressure equal to or greater than 90mmHg diastolic) at increased risk of developing stroke events (Table 5.14), but the risk was also related to the reduction in blood pressure achieved during treatment. Those treated hypertensives who had a reduction in blood pressure of less than 5mmHg diastolic were at higher risk of stroke occurrence than both those who achieved a reduction of 5-14mmHg diastolic and those who achieved a reduction greater than 15mmHg diastolic pressure (Table 5.16). The findings suggest that poor blood pressure control may explain the failure of treatment for hypertension to prevent stroke in this population. This conclusion is not only consistent with reports from observational studies, which have shown that improvements in control of hypertension in the community is associated with a reduction in stroke deaths

(Tuomilehto *et al.*, 1985; Cartmel *et al.*, 1987; Garraway and Whisnant, 1987), but also with results from clinical trials which have demonstrated that the reduction of blood pressure reduced the risk of stroke (reviewed by Cutler and Furberg, 1985).

Although not statistically significant, the observed 30 percent excess risk of stroke among the over-treated hypertensives in this study (those with a treated diastolic pressure below 80mmHg or systolic pressure below 120mmHg) is consistent with other reports (reviewed by Jansen, Schulte and Gribnau, 1987) which have suggested that "overtreatment" of hypertension may actually cause strokes, possibly due to a reduction of cerebral blood flow. Whilst the benefits of effective control of hypertension are beyond doubt, clinicians should be alerted to the possible complications of lowering the blood pressure too far.

Since the overwhelming majority of treated hypertensives who developed stroke (90 percent) had visited their regular doctors and had had their blood pressure levels checked within the three months before suffering a stroke, the apparent poor blood pressure control among treated hypertensives who developed stroke is unlikely to be due to discontinuation of hypertensive follow-up care (non-attendance) but is consistent with low compliance with antihypertensive medication.

In conclusion, the presence of hypertension and of poor control of hypertension in this community engenders an increased risk of stroke occurrence. This is unlikely to be due to a failure to detect hypertension, to initiate treatment or to provide adequate follow-up care, since the majority of subjects in this community had had a recent blood pressure measurement taken and the majority of those with a history of hypertension were on therapy and reported a recent visit to a doctor. It is possible that poor compliance with antihypertensive medication is related to the development of stroke and it is hoped that future studies will explore this issue as part of the effort to reduce the community burden of cerebrovascular disease.

SUMMARY

In order to determine the importance of the presence of hypertension and its control on the development of stroke in persons aged between 35 and 69 years in the Lower Hunter Region community, a population-based case-control study was performed. Cases of first stroke were identified from a community-based stroke register and compared with community-control subjects obtained from a random sample from the same population.

In this study, 190 first stroke patients were compared with 496 community control subjects, adjusting for age, sex and other possible confounding factors. Although 51 percent of first stroke patients were currently on treatment for hypertension (compared with 21 percent of community controls), this did not prevent them from suffering stroke (adjusted odds ratio 3.5; 95 percent confidence interval 2.3 to 5.4). Amongst those who had been told at some stage that they had hypertension, 73 percent of stroke cases and 62 percent of control subjects were currently receiving treatment. In contrast with the case with acute myocardial infarction, hypertension was a greater contributor to the aetiology of stroke than was current cigarette smoking. Thirty percent of first stroke cases were attributed to hypertension (defined as being on current treatment) and 8 percent to current cigarette smoking.

In those patients who were on current treatment for hypertension, blood pressure measurements taken before the stroke events were obtained from their general practitioner's records. The proportion of treated hypertensive subjects with a diastolic blood pressure of 90mmHg or more (poorly controlled) was higher among stroke cases than among community controls (adjusted odds ratio 2.9; 95 percent confidence interval 1.6 to 5.3). The pattern was consistent across age and sex groups. Ninety percent of stroke patients and 91 percent of control subjects on current treatment for hypertension had had their blood pressure recorded in the three months before the event (or survey, for controls).

In this population, both the presence of hypertension and the poor control of hypertension were found to generate an increased risk of stroke. The findings are consistent with the results of randomized controlled trials of antihypertensive therapy which have demonstrated a reduction in rates of stroke in response to a reduction in blood

pressure. This less than ideal control of hypertension is unlikely to be due to a failure to detect hypertension, to start treatment or to provide adequate follow-up care on treatment, but is consistent with low compliance with antihypertensive medication.

CHAPTER VI

CONTROL OF HYPERTENSION IN A SAMPLE OF DOCTORS' SURGERIES

INTRODUCTION

As part of an attempt to identify reasons for the continuing high prevalence of hypertension in the community, a register of patients currently receiving treatment for hypertension was established to examine the degree of control of hypertension and the patterns of treatment among all the doctors' general practice in the Port Stephens area of the Hunter Region.

This chapter describes the degree of blood pressure control for treated patients on this hypertension register and the methods by which they are being treated, and investigates ways to achieve further improvements in the control of hypertension in the community.

Hypothesis:

The majority of treated hypertensive patients under general practitioners' care have well controlled blood pressure (a treated diastolic blood pressure of less than 90mmHg).

Objectives:

1. To develop a simple registration system of people in the Lower Hunter Region who have hypertension (i.e., who are currently receiving treatment for hypertension or who have had high blood pressure recorded).

2. To pilot this simple registration system in a small, geographically confined area of the

Hunter Region (the Port Stephens area).

3. To detect the levels of blood pressure control for patients on this hypertension register.

4. To compare the control of hypertension and the antihypertensive prescription patterns among participating practices.

METHODS

A simple system of registration was developed, in the form of a hypertension registration card (Appendix A.35) to be filled out by the general practitioners, for all patients in their practices with hypertension (those who are on current treatment for hypertension and those who have high blood pressure recorded).

The Port Stephens area of the Hunter Region (see the Preliminaries, Pages xxiii to xxvi), a small, geographically confined area with 10 general practices consisting of 21 general practitioners, serving a total population of approximately 25,000 people, was chosen to pilot the registration system over an 18 months' trial period, commencing in July, 1986.

Before the project was implemented, all the general practitioners in the Port Stephens area of the Hunter Region were individually approached and up to an hour was spent with each practitioner and the practice nurse to explain the aim and the purpose of this project. Nine of 10 eligible practices in the area agreed to participate and seven proceeded to register patients.

Since it was hoped to register all subjects who were considered by their general practitioners to be suffering from high blood pressure, doctors were asked to register all patients with hypertension under their care, including those who were managed without the use of drugs (under close supervision, dietary advice or other forms of non-pharmacological treatment). Further, the diagnostic criteria for hypertension were not defined by the research team. Patients currently receiving treatment for hypertension were entered on to the hypertension register by their general practitioner when they attended the clinic for treatment (or repeat prescription). In addition, in order to encourage case-finding in general practice, doctors were asked to check the blood pressure of all patients aged 25 years or older who attended the practice for whatever reasons and to enter on the hypertension register those subjects whom they considered to be hypertensive. In order to avoid registering patients more than once, the medical record of each patient entered on to the register was marked with a coloured sticker at the right upper corner of the patient's notes.

The hypertension registration form sought information about each patient's name

and address, date of birth, sex, occupation, the date of diagnosis of hypertension, the pre-treatment blood pressure level, the most recent blood pressure measurement taken and the type of antihypertensive therapy currently being administered.

The author visited each of the seven participating practices on a three-monthly basis and collected completed registration forms from each practice. The data were checked, coded and then entered on to a data box on a microcomputer. Back-up copies were kept on floppy discs at each entry session. A text file was then created from the data box file and this was transferred to a study account on the University of Newcastle VAX Cluster using the Kermit package. At the end of the 18 months' trial period of registration, the data were analysed using the SAS statistical package (SAS Institute Inc., 1985). All registration cards which had been entered on the computer were returned to the relevant practice so that those general practitioners interested in the subject of the study could continue to maintain the register and record follow-up blood pressure measurements.

Each of the participating practices was notified every three months about the total number of patients with hypertension registered in that practice and how that compared with the average percentage registration for all the general practitioners taking part in the study. This was hoped to encourage those general practitioners with low registration rates to find and register more hypertensive patients.

In order to obtain the age/sex-specific registration rates in each of the participating practices, it was necessary to determine the age/sex distributions of patients on the active practice list (denominator) in each practice. One of the major difficulties in this study was that none of the participating practices had an age/sex register and most were not aware of the number of patients on their active practice list (or even the number of patients' records in their filing cabinet). Permission was obtained from each of the participating practitioners to get access to their medical records. A part-time nurse employed with the study visited each of the seven practices and reviewed a systematic random sample of one in ten patients' notes, so that the number of patients aged 25 years and over on the active practice list could be established. The examination of the medical records was performed in the evening (after normal working hours) in order to avoid any disruption to the running of the practices. The registration rate for patients with hypertension in each practice was then calculated as a percentage of patients aged 25 years or older on the practices' active lists.

RESULTS

Age Distribution of Patients on the Register

At the end of the 18 months' trial period of registration (the period from July, 1986 to December, 1987), the combined register of the seven participating practices held a total of 839 patients with hypertension (318 men and 521 women) (4.3 percent of people aged 25 years or over living in the Port Stephens area). Of these, 41 patients (4.9 percent) were excluded from the analysis because they were not currently receiving medications for hypertension (managed without drugs or under observation) and a further 13 patients (1.5 percent) were excluded because the pre-treatment blood pressure measurements were unavailable. The remaining 785 patients (93.6 percent) were receiving current drug therapy for hypertension (other than sedatives) and those patients formed the basis of the analysis.

The number of patients with hypertension registered in each of the seven participating practices varied from 28 to 202. Consequently, the individual practice registration rates ranged from 26 patients with hypertension per 1,000 patients on the practice list to 138 per 1,000. This wide variation in the hypertension registration rates may reflect differences in the treatment rates between participating practices or, more likely, differences in the completeness of the registration process.

Table 6.1 shows the age distribution of treated hypertensive subjects entered on to the register. Eleven percent of the registered patients were under the age of 45, 35 percent were aged 45-64 years, and 54 percent were aged over 64. There were more women registered (482; 61 percent) than men (303; 39 percent). The higher proportion of treated hypertensive patients among older (those aged 65 years or older) than younger age groups (those under the age of 65) and among women than among men are both consistent with the reported distribution of the prevalence of treatment for hypertension in the Australian community (National Heart Foundation of Australia Risk Factor Prevalence Study No. 2, 1985). Similar observations have also been reported from other hypertension registers (Penfold, Styles and Bulpitt, 1983; Stern, 1986).

Table 6.1. Age distribution of treated hypertensive patients on the hypertension register.

Age (Years)	Number	Percentage
25 - 34	35	4.5
35 - 44	52	6.6
45 - 54	85	10.8
55 - 64	192	24.5
65 - 74	322	41.0
75 or older	99	12.6
Total	785	100.0

Blood Pressure Control in General Practice

Tables 6.2 and 6.3 show that while only 3.3 percent of patients on the register aged between 25 and 64 years and 0.5 percent of patients aged 65 years or older had a pre-treatment diastolic pressure of less than 90mmHg, good blood pressure control in terms of restoring the blood pressure levels to the normotensive levels was achieved in most patients. The majority of both younger treated patients (those aged 25-64 years) and older patients (those aged 65 years or older) had achieved adequate blood pressure control, with 67 percent of younger (25-64 years) and 58 percent of older (65 or older) patients achieving a treated diastolic blood pressure of less than 90mmHg.

Table 6.2. **Blood pressure levels recorded before and during treatment of patients on the hypertension register, aged 25-64 years (number = 364).**

Blood Pressure Level	Number of Patients	Percentage
Diastolic Blood Pressure less than 90mmHg:		
Pre-treatment	12	3.3*
On treatment	245	67.3
Systolic Blood Pressure less than 140mmHg:		
Pre-treatment	7	1.9
On treatment	223	61.2

* Calculated as a percentage of the total number of registered patients aged 25-64 years.

Table 6.3. **Blood pressure levels recorded before and during treatment of patients on the hypertension register, aged 65 years or older (number = 421).**

Blood Pressure Level	Number of Patients	Percentage
Diastolic Blood Pressure less than 90mmHg:		
Pre-treatment	2	0.5*
On treatment	243	57.7
Systolic Blood Pressure less than 140mmHg:		
Pre-treatment	5	1.1
On treatment	169	40.1

* Calculated as a percentage of the total number of registered patients aged 65 years or older.

Comparison of Management of Hypertension between Practices

A comparison of treatment patterns and blood pressure control between five of the participating practices (two practices were excluded because of the small number of registered patients) is presented in Table 6.4. Because none of the selected practices had an age/sex register of their practice population, age- and sex-specific treatment rates could not be calculated. Table 6.4 shows that in spite of the differences in the age and sex structures of the practice populations, the majority of treated hypertensive patients had been controlled effectively (had a diastolic pressure of less than 90mmHg).

The comparison of the types of antihypertensive medications prescribed in the selected practices shows that beta-blockers and diuretics remain the main first-line antihypertensive drugs in spite of the new generations of antihypertensive medications which have been introduced on to the Australian market over the past 10 years.

Table 6.4. Comparison of treatment for hypertension in five general practices which registered patients. All data refer to patients aged 25 years and over.*

Variable	Practice No.				
	1	2	3	4	5
Number of registered treated hypertensive patients	**202**	**195**	**81**	**161**	**89**
Registration rate** per 100 patients in the active practice list	13.8	10.2	7.9	8.9	9.2
Percentage of registered patients aged 65 years or older	61.9	55.4	34.6	58.3	54.0
Percentage of registered male patients	34.2	51.3	19.8	37.9	42.7
Percentage of treated patients with a diastolic blood pressure less than 90mmHg	61.3	63.1	60.0	64.0	57.3
Type of antihypertensive medications#: (percentages)					
B	29.7	28.1	25.4	8.7	21.0
D	6.8	9.2	-	17.3	12.4
O	21.9	14.6	8.5	20.4	9.9
B + D	14.1	18.9	37.3	22.1	30.9
B + O	11.0	9.7	3.4	7.9	1.2
D + O	8.9	12.4	13.6	16.5	18.5
B + D + O	7.8	7.0	11.9	7.0	6.2

* Two practices were excluded because of the small numbers of registered patients.

** Calculated as a percentage of the total number of patients on the active practice list.

B = beta-blockers, D = diuretics, O = other antihypertensive medications.

DISCUSSION

Blood Pressure Control in General Practice

General practitioners are in a position to make contact with a large proportion of the general population. The importance of their role in the early detection of hypertension has recently been emphasized by the findings of a population survey which was undertaken in 1986 in the Hunter Region (Al-Roomi and Heller, 1987). The survey stated that 90 percent of adults in the Hunter Region had visited a doctor in the previous year and that 79 percent had undergone a blood pressure measurement in that year (earlier described in Chapter II).

Because age/sex registers of the practice populations were not available, age- and sex-specific hypertension treatment rates could not be established for participating practices. This is unlike other hypertension registers, for example, in the United Kingdom where the age and sex distributions of the practice populations can be obtained from the Family Practitioners Committee (Penfold, Styles and Bulpitt, 1983). Even though a high proportion of hypertensive patients had their condition well-managed, 38 percent had a diastolic pressure equal to or greater than 90mmHg (i.e., they had inadequate blood pressure control). Thus, it is vital to explore the reasons for the poor control of hypertension in these patients. In these circumstances, a hypertension register is a useful tool for comparing the characteristics of those patients whose hypertension is adequately controlled and those for whom it is not properly controlled. If modifiable causes of poor hypertension control could be identified, such as patients' poor compliance with medication or inadequate therapy, and measures taken to correct them, then further improvements in the control of hypertension in the community could be achieved. In Newcastle, it is intended to continue maintaining the hypertension registers and including further blood pressure follow-up recordings along with information on patients' cardiovascular risk factor levels (such as smoking and obesity).

The small proportion of hypertensive patients (5 percent) managed without drugs is disappointing in view of the recent studies which have indicated that non-pharmacological measures for the control of mild elevations in blood pressure, such as weight reduction, moderation of alcohol intake, dietary sodium restriction, potassium supplementation and physical activity, may be substituted for drugs in a substantial

proportion of patients (evidence reviewed by Beilin, 1988). Since mild hypertension (blood pressures between 90mmHg and 104mmHg diastolic) accounts for almost half of the cases of hypertension in the community, there would appear to be great scope for managing a larger proportion of hypertensive patients without resorting to drugs.. In this context, a greater role for practice nurses in the management of hypertensive patients might be worth considering. While research should continue to examine the efficacy of non-pharmacological approaches to blood pressure control, methods for implementing such approaches in medical practice need also to be researched thoroughly.

SUMMARY

A register of patients with hypertension was established to examine the degree of control of hypertension and patterns of treatment in the general practices in the Port Stephens area of the Lower Hunter Region. This is a small, geographically confined area with 10 general practices. From July, 1986, until December, 1987, general practitioners were asked to register all hypertensive patients over the age of 25. An examination of the records in each practice provided an estimate of the number of patients on the active practice list (denominator). Nine of the 10 eligible practices agreed to participate and seven proceeded to register patients.

At the end of the first 18 months of registration, 839 patients with hypertension (318 men and 521 women) had been registered. Individual practice registration rates ranged from 2.6 percent to 13.8 percent. Ninety-four percent of registered patients were currently receiving pharmacological treatment, the majority of whom (62 percent) had a diastolic pressure less than 90mmHg (properly controlled). Eleven percent of registered patients were under the age of 45, 35 percent were aged 45-64 years, and 54 percent were aged over 64. The wide variation in hypertension registration rates between participating practices may reflect differences in completeness of registration or true differences in treatment rates.

Only five percent of patients entered on the hypertension register were managed without drugs (close observation or dietary advice) and there would appear to be a potential for managing a greater proportion of hypertensive patients with a non-pharmacological approach. While most of the treated hypertensive patients had their condition well-controlled, 38 percent had a blood pressure equal to or greater than 90mmHg diastolic (poorly controlled). Attention to control of hypertension in the community remains an important goal for health practitioners.

CHAPTER VII

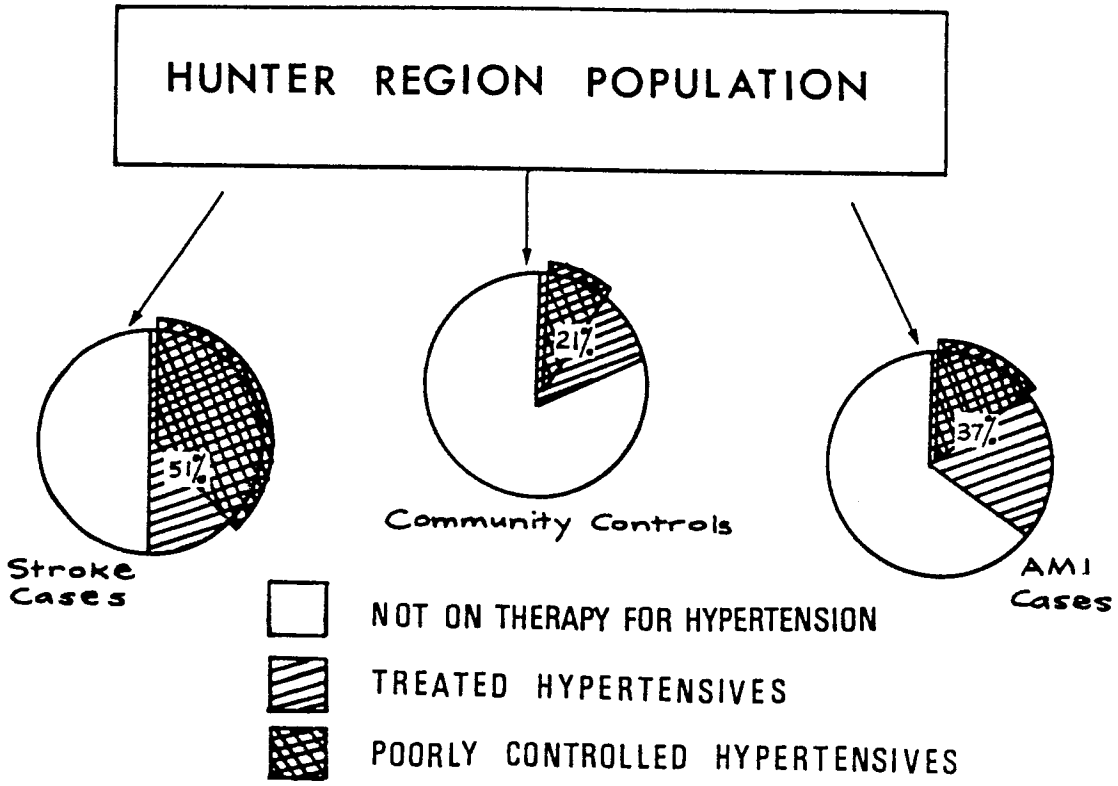
CONCLUSIONS

Blood Pressure Control in the Community

The series of studies was designed to examine the contribution that a history of hypertension and the way it has been controlled might make to the aetiology of myocardial infarction and stroke in the community in the Hunter Region of New South Wales, Australia. The results obtained suggest that the presence of hypertension and its poor control during treatment may be important aetiologically both for stroke and myocardial infarction since the prevalence of hypertension was greater and the blood pressure during treatment was less well-controlled among both acute myocardial infarction and stroke cases than among community controls (Figure 7.1). This is unlikely to be due to a failure to detect hypertension since most members of this community (89 percent) had undergone a blood pressure measurement in the past three years, as the blood pressure population survey has demonstrated (Chapter II). Failure of doctors to initiate treatment for hypertension when it is discovered is also unlikely since most subjects with a history of hypertension in the community are currently receiving therapy for hypertension.

Since the overwhelming majority of treated hypertensives who developed myocardial or stroke events had visited their doctors and had had their blood pressure levels checked within three months before suffering the myocardial infarction or stroke, it is unlikely that the apparent poor blood pressure control is due to failure of doctors to provide adequate follow-up care.

Figure 7.1. Flow chart of the prevalence of hypertension, among acute myocardial infarction (AMI) and stroke patients, and community control subjects.



While the findings for stroke are consistent with the results of randomized controlled trials of antihypertensive therapy, the data for acute myocardial infarction are in conflict with the results of individual clinical trials which do not demonstrate a significant reduction in the incidence of acute myocardial infarction (the exception being the findings of the Hypertension Detection and Follow-up Program Cooperative Group, 1988). However, quantitative statistical overviews have demonstrated a reduction in the incidence of acute myocardial infarction in the order of 9-12 percent, by pharmacological treatment of mild-to-moderate hypertension, which was of borderline statistical significance (Hennekens, Satterfield and Hebert, 1988). This indicates that the modification of blood pressure levels may be beneficial in reducing the risk of acute myocardial infarction.

An increased risk of acute myocardial infarction was seen in those patients whose blood pressure levels were controlled below 80mmHg diastolic or below 120mmHg systolic (overtreated hypertensives). This effect, together with adverse effects of antihypertensive agents on blood lipid and glucose levels (Weinberger, 1985; Pollare, Lithell and Berne, 1989), could explain the failure of randomized controlled trials to show a reduction in acute myocardial infarction rates and may explain the discrepancy between the findings of this case-control study and the results of clinical trials. In addition, unlike most trials of treatment of hypertension, those patients with more severe forms of hypertension were not excluded from this case-control study (22 percent of those hypertensives who later developed acute myocardial infarction had a pre-treatment blood pressure of 115mmHg diastolic or higher). Such patients would be expected to benefit from the treatment of severe hypertension (Cruickshank, Thorp and Zacharias, 1987a).

The use of two groups of cases with different diseases allows a case-case comparison as well as a comparison with population controls. In this work, it was shown that while hypertension was associated with an increased risk of both stroke and myocardial infarction, the relationship between hypertension and stroke was found to be stronger than that with myocardial infarction. Thirty percent of first stroke cases and 16 percent of first acute myocardial infarction cases were attributable (the aetiologic fraction) to hypertension (defined as being on current treatment). This indicates the important role of hypertension in the aetiology of acute myocardial infarction and stroke in this population.

In contrast to hypertension, the association between current cigarette smoking and stroke (8 percent of first stroke cases were attributed to current cigarette smoking) was weaker than that with acute myocardial infarction (24 percent of first myocardial infarction cases were attributed to current cigarette smoking). Heavy alcohol consumption was associated with an increased risk of both myocardial infarction and stroke. While the contribution of current cigarette smoking and high alcohol intake to the occurrence of acute myocardial infarction is well established, the impact of these risk factors on the aetiology of stroke is less clear. Thus the findings of this study provide evidence incriminating high alcohol intake and current cigarette smoking in the aetiology of stroke.

The distributions by age, sex and marital status of the study population were similar to those for Australia as a whole (see the Preliminaries, Pages xxiii to xxx); for apart from a lower immigrant population and relatively fewer people in professional and administrative occupations (and more in skilled and semi-skilled occupations, especially mining) than elsewhere in Australia, the Hunter population is representative of the Australian community as a whole. While the differences outlined above, along with possible variations in response from areas with different populations, should be considered before generalizing the findings of this series of studies to the rest of Australia, it is reasonable to expect that the results of this work can be generalized to other parts of Australia.

This series of studies, which examined the management of hypertension in the Hunter community, has shown that the presence of hypertension in the community and its poor control despite treatment has led to an increased occurrence of stroke and myocardial infarction. This is unlikely to be due to a failure to detect hypertension, to start treatment or to provide adequate follow-up care on treatment, but is consistent with poor compliance with antihypertensive medications. It is possible that low compliance with antihypertensive medication is related to the development of both stroke and myocardial infarction, and it is hoped that future studies will explore this issue as part of the effort to reduce the community burden of these diseases.

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APPENDIX

DOCUMENTATION: Questionnaires, coding instructions and letters covering all aspects of the thesis

Random sample of the adult population on the Electoral Rolls (A.1 - A.4)

A.1 Initial letter

A.2 First reminder letter

A.3 Second reminder letter

A.4 Blood pressure questionnaire

Subsequent questionnaire to respondents aged 35-69 years (A.5 - A.8)

A.5 Initial letter

A.6 First reminder letter

A.7 Second reminder letter

A.8 Questionnaire

Myocardial infarction patients aged 35-69 years (A.9 - A.12)

A.9 Interview schedule to hospitalized cases

A.10 Autopsy form

A.11 Death certificate form

A.12 Medication coding instructions form

Questionnaire to doctors of treated hypertensive subjects in the community sample aged 35-69 years (A.13 - A.15)

A.13 Initial letter to doctors

A.14 Reminder letter to doctors

A.15 Questionnaire to doctors

Questionnaire to doctors of treated hypertensive subjects who developed myocardial infarction aged 35-69 years (A.16 - A.22)

A.16 - A17 Initial letter to doctors

A.18 Reminder letter

A.19 Thank-you letter

A.20 - A.22 Questionnaires to doctors

Stroke patients aged 35-69 years (A.23 - A.26)

A.23 Interview schedule to hospitalized cases

A.24 Initial letter to relatives of deceased cases

A.25 Reminder letter to relatives

A.26 Thank-you letter to relatives

Questionnaire to doctors of treated hypertensives who deveoloped stroke aged 35-69 years (A.27 - A.34)

A.27 - A.28 Initial letter to doctors

A.29 Reminder letter to doctors

A.30 Thank-you letter to doctors

A.31 - A.34 Questionnaires to doctors

General practice study (A.35)

A.35 Hypertension registration card

HUNTER REGION HEART DISEASE PREVENTION PROGRAMME
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(049) 685648.

Professor Stephen Leeder
Project Director

Mrs Hilary Alexander
Project Manager

As part of ongoing research into heart disease in the Hunter Region we are investigating some questions about high blood pressure. For us to do this 1200 people from the Newcastle, Lake Macquarie, Port Stephens, Maitland, Cessnock and Kurri Kurri areas have been selected at random from the electoral roll.

As you are one of those selected, we are writing to ask your cooperation in answering a few questions. Please complete the attached form and return it to us in the reply paid envelope provided. It is important for our research purposes that the answers you give are about your own health and not that of anyone else.

We assure you that any information you give us will be absolutely confidential.

If you have any queries please do not hesitate to contact us on the above phone number.

Thanking you in anticipation of your help.

Yours sincerely,

K.A. AL-ROOMI
Medical Researcher

R.F. HELLER
A/Professor of Clinical Epidemiology

S.R. LEEDER
Professor of Community Medicine

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Professor Stephen Leeder
Project Director

Mrs Helen Alexander
Project Manager

Recently we wrote to you asking if you would be kind enough to answer a few questions to assist us in our research into heart disease in the Hunter Region.

As it is very important for our project to get a response from everyone, and as we haven't received a reply from you yet, we are sending you this reminder letter.

In case the original questionnaire did not reach you we are enclosing another copy of it and a copy of the original letter.

Please complete the form and return it to us in the reply paid envelope.

If you have any queries do not hesitate to contact us on the above phone number.

Many thanks.

Yours sincerely,

K.A. AL-ROOMI
Medical Researcher

R.F. HELLER
A/Professor of Clinical Epidemiology

S.R. LEEDER
Professor of Community Medicine

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Professor Stephen Leeder
Project Director

Mrs Hilary Alexander
Project Manager

We hope you received our earlier letters asking you to answer a few questions to assist us in our research into heart disease in the Hunter Region.

We are taking this opportunity to explain to you why **it is so important for us to get a reply from you.** Your name was one of 1200 selected at random from the electoral roll. We need a reply from everyone to learn how frequently high blood pressure occurs in the community - we are interested in you even if you have normal blood pressure or have never had it measured.

Please take a few minutes to complete the enclosed questionnaire and return it in the pre-paid envelope.

Many thanks.

Yours sincerely,

K Al-Roomi

K.A. AL-ROOMI
Medical Researcher

Dr R Heller

R.F. HELLER
A/Professor of Clinical Epidemiology

Stephen Leeder

S.R. LEEDER
Professor of Community Medicine

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Professor Stephen Leeder
Project Director

Mrs Hilary Alexander
Project Manager

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ease tick the appropriate box

Sex: Male ☐ Female ☐ ☐

Date of birth: ..... ☐☐ ☐☐ ☐☐

When did you last visit a doctor? Tick one box only.

- In the last 3 months ☐
- In the last 6 months ☐
- In the last year ☐ ☐
- In the last three years ☐
- More than three years ago ☐

Was your blood pressure measured then?

Yes ☐ ☐
No ☐

When was your blood pressure last measured? Tick one box only.

- In the last 3 months ☐
- In the last 6 months ☐
- In the last year ☐ ☐
- In the last three years ☐
- More than three years ago ☐
- Never measured ☐

Have you ever been told you have high blood pressure?

Yes ☐ ☐
No ☐

Have you ever had treatment for high blood pressure?

Yes ☐ ☐
No ☐

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Are you receiving treatment for high blood pressure at the present time:

Yes ☐

No ☐ ☐

If Yes, please write down the name/s of these blood pressure medications in the space provided:

.....

.....

☐☐☐☐☐☐

PLEASE PLACE IN THE ENVELOPE PROVIDED AND RETURN TO US.

THANK YOU VERY MUCH FOR FILLING OUT THIS FORM.

HUNTER REGION HEART DISEASE PREVENTION PROGRAMME
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Telephone (all hours):
(049) 685648.

Associate Professor Annette Dobson
Project Director

Mrs Hilary Alexander
Project Manager

Thank you for completing the questionnaire on blood pressure which we sent to you some time ago.

From the 1200 people we approached initially, we have selected a sample aged between 35-69 years. This is the age range of particular interest in our study of heart disease.

We are sorry to trouble you again but we would appreciate it if you would complete another questionnaire. For us to complete our research work satisfactorily, it is vital that we get this information. When you have filled in this questionnaire we will not approach you again.

Please take the few minutes necessary to complete the enclosed questionnaire and return it in the pre-paid envelope.

If you have any queries please do not hesitate to contact us on the above phone number.

Yours sincerely,

K'Laldoomy

K.A. AL-ROOMI
Medical Researcher

R.F. HELLER
Professor of Community Medicine

Annette J. Dobson

A.J. DOBSON
Director
Professor of Biostatistics

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Professor Annette Dobson
Project Director

Mrs Hilary Alexander
Project Manager

Recently we wrote to you asking if you would be kind enough to answer a few more questions to assist us in our research into heart disease in the Hunter Region.

As it is very important for our project that we obtain a reponse from everyone approached, and as we haven't as yet received a reply from you, we are sending you this reminder letter.

In case the original questionnaire did not reach you we are enclosing another copy of it together with a copy of our original letter. We would be most grateful if you would complete the form as soon as possible and return it in the enclosed pre-paid envelope.

Please remember that all information you give us will be treated in the strictest confidence and used only as combined results, never on an individual basis. Once we have received your completed questionnaire, it will not be necessary for us to trouble you again.

Thank you in anticipation of your assistance. If you have any questions, please do not hesitate to phone us on 685648.

Yours sincerely,

K.A. AL-ROOMI
Medical Researcher

R.F. HELLER
Professor of Community Medicine

A.J. DOBSON
Director
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Associate Professor Annette Dobson
Project Director

Mrs Hilary Alexander
Project Manager

We hope you received our earlier letters asking you to answer a few questions to assist us in our research into heart disease in the Hunter Region.

We are taking this opportunity to explain to you why it is so important for us to get a reply from you. You were one of those people selected in the age range 35-69 years of the original sample of people we approached. We need a reply from everyone to learn how frequently high blood pressure occurs in the community - we are interested in you even if you have normal blood pressure or have never had it measured.

When you have completed the questionnaire you will not be approached again.

Please take a few minutes to complete the enclosed questionnaire and return it in the pre-paid envelope. If you have any queries, please do not hesitate to phone us on 685 648.

Many thanks.

Yours sincerely,

K.A. AL-ROOMI
Medical Researcher

R.F. HELLER
Professor of Community Medicine

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Associate Professor Annette Dobson
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Mrs Hilary Alexander
Project Manager

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Please tick the appropriate box

1. Sex: Male ☐ Female ☐

2. Date of birth: .....

3. Have you ever been told that you have high blood pressure?
   Yes ☐ No ☐

4. Have you ever been told you have had a heart attack?
   Yes ☐ No ☐

5. Have you ever been told you have had a stroke?
   Yes ☐ No ☐

6. Have you ever had treatment for high blood pressure?
   Yes ☐ No ☐

7. Are you receiving treatment for high blood pressure at the present time?
   Yes ☐ No ☐

If Yes, please write down the name/s of these blood pressure medications.

Names of medications: .....

8. Have any of your close relatives (parents, brothers or sisters) had any of the following?

High blood pressure	Yes ☐	☐
	No ☐	
A heart attack	Yes ☐	☐
	No ☐	
A stroke	Yes ☐	☐
	No ☐	

9. Please tell us your approximate height ..... ☐☐☐

10. Please tell us your approximate weight ..... ☐☐☐

11. Have you ever smoked cigarettes, cigars or pipe regularly?

Yes ☐ ☐
No ☐

if the answer is no, please go to Question 14.

12. How old were you when you started smoking regularly? ..... ☐☐

13. Have you given up smoking permanently?

Yes ☐ ☐
No ☐

If yes, when did you give up smoking? Tick one box only.

1 - 5 months ago	☐
6 - 11 months ago	☐
1 - 3 years ago	☐
4 - 6 years ago	☐ ☐
7 - 9 years ago	☐
10 - 12 years ago	☐
More than 23 years ago	☐

14. How often do you usually drink alcohol? Tick one box only

- Every day ☐
- On 5 or 6 days a week ☐
- On 3 or 4 days a week ☐
- On 1 or 2 days a week ☐
- Less than once a week ☐
- Rarely or never ☐
- Used to be moderate to heavy drinker ☐

15. On a day when you drink alcohol, how many drinks do you usually have? Tick one box only.

- More than 20 drinks ☐
- 13 to 20 drinks ☐
- 9 to 12 drinks ☐
- 5 to 8 drinks ☐
- 3 to 4 drinks ☐
- 1 to 2 drinks ☐

<u>For people who are on treatment for high blood pressure please read Question 16 carefully.</u>

16. We would like to get further details of your blood pressure treatment by approaching your doctor. If you are happy for us to do so, please write your doctor's name and address below.

Name of doctor .....

Address of doctor .....

We are very grateful for your assistance in this heart disease research study.

PLEASE PLACE IN THE ENVELOPE PROVIDED AND RETURN TO US.

THANK YOU VERY MUCH FOR FILLING OUT THIS FORM.

IN CONFIDENCE

HUNTER REGION HEART DISEASE PREVENTION PROGRAMME

INTERVIEW SCHEDULE

Good morning/hello _____

My name is _____ and I'm working with a research team from the Faculty of Medicine at the University of Newcastle. Among other things we are studying heart disease and its prevention in the Hunter Region.

This study is part of a research project being coordinated by the World Health Organization in 42 centres around the world. It is supported by the National Heart Foundation of Australia, the National Health & Medical Research Council and the Federal Department of Health.

Would you mind answering a few questions which will help us in our research. This will take approximately 30-40 minutes. You will receive a follow-up letter from the study team in 12 months time and you may be approached for a second interview within the next few days.

Naturally, your answers will be treated in the strictest confidence and used only for research purposes.

(Wait for the patient to answer or ask you questions .....)

Thank you for agreeing to help us.

The first thing we'd like you to do is sign and date our consent form. So that you know what's involved, I'll read out this statement for you.

CONSENT

The purpose of this study has been explained to me and I give my consent for information regarding my health to be used for this research. I understand that I will receive a follow-up letter from the study team in twelve months time and that I may be approached for a second interview.

SIGNATURE: _____

DATE: _____

N.B. Combined results for the whole study will be used for research purposes only, and reported in scientific journals.
Strict confidentiality will be maintained.

FULL NAME: _____

ADDRESS & POSTCODE: _____

_____

_____

PHONE NUMBER: _____

DATE OF BIRTH: _____

HOSPITAL: _____

U.R. NUMBER: _____

HOSPITAL DOCTOR(S): _____

_____

GENERAL PRACTITIONER: _____

NURSE/INTERVIEWER: _____

DATE OF REGISTRATION: _____

NEXT-OF-KIN: _____

ADDRESS & POSTCODE: _____

_____

PHONE NUMBER: _____

RELATIONSHIP: _____

1. Study Number:

2. L.G.A. of residence:

Newcastle	1
Lake Macquarie	2
Cessnock	3
Maitland	4
Port Stephens	5

☐

3. Date of birth:

☐☐ ☐☐ ☐☐
day month year

4. Hospital:

Royal Newcastle	01
Mater	02
Wallsend	03
Belmont	04
Maitland	05
Cessnock	06
Kurri Kurri	07

☐☐

5. U.R. Number: ☐☐☐☐☐☐

6. Nurse/Interviewer: ☐

7. Date of Registration:

☐☐ ☐☐ ☐☐
day month year

8. Sex:

Male	1
Female	2

☐

First I'd like to ask you a few important background questions.

9. Have you been interviewed before by a member of the Hunter Valley Heart Attack study team (in 1979) or by a member of our study team (since the beginning of 1984) ?

1979 study	1
1984-86 study	2

(Code 9 if not known; 8 if not relevant) ☐

10. Where were you born ?

_____ ☐☐

Place of Birth

(Code 99 if not known; code 01 for all states and territories in Australia)

(For those born outside Australia ask Q11)

11. From this card, please tell me how many years you have lived in Australia altogether ?

CARD 1

Less than 1 year	0
1 - 9 years	1
10 - 19 years	2
20 - 29 years	3
30 - 39 years	4
40 years or more	5

☐

(Calculate total years. Code 9 for not known; 8 for not relevant, i.e. the patient was born in Australia.)

12. From the list on this card, which ONE term best describes your PRESENT marital state ?

CARD 2

Now married	1
Never married	2
Separated but not divorced	3
Divorced	4
Widowed	5

☐

I now want to ask you some questions about your PRESENT illness.

13. What was the main sign or symptom you noticed that made you realize you needed medical help?

Please select the MAIN one from this list.

CARD 3

Chest pain	01
Pain in arm/jaw/neck	02
Pain in back	03
Blackout/Collapse	04
Shortness of breath	05
Uncomfortable beating of heart	06
Profuse sweating	07
Feeling unwell	08
Feeling of tiredness	09
None of these, but some other sign of illness	10
No sign of illness was noticed	11

(Code 99 if not known)

14. On what date did the .....
(main symptom) start?

CARD 4

day mth year

(Code 777777 for gradual onset; 999999 for not known. This date should be the date of the onset of symptoms that led to this hospitalization.)

(If chest pain was the main symptom in Q.13, there is no need to ask Q.15 in full. Just clarify the answer with the patient and code 1 in the code box for Q.15. For those with a main symptom other than chest pain ask Q.15 in full.)

15. Did you have any chest pain?

Yes	1
No	2

(Code 9 if not known)

(Q.16 is only for patients with chest pain. For those with no chest pain code 8's in the code boxes for Q.16, 17 & 18 and go to Q.19.)

16. Was the chest pain continuous (that is, without a break) or intermittent (with periods free of pain)?

Continuous	1	☐
Intermittent	2	

(Code 9 if not known; 8 if not relevant; 7 for gradual onset.)

(If the chest pain was continuous, ask Q.17; if intermittent go to Q.18 and code 8's in the code boxes for Q.17; if gradual onset go to Q.19 and code 7's in the code boxes for Q.17 & 18.)

(Q.17 only for those with continuous pain.)

17. For how long did your chest pain continue?

☐☐☐☐
hrs mins

(Code 6666 for pain described as lasting for 20 minutes or more but for which no exact time can be nominated by the patient (record precise words used by patient); 7777 for gradual onset; 8888 for not relevant; 9999 for not known.)

(Q.18 only for those with intermittent pain.)

18. What was the length of time of the longest bout or period of chest pain?

☐☐☐☐
hrs mins

(Code 6666 for pain described as lasting for 20 minutes or more but for which no exact time can be nominated by the patient (record precise words used by patient); 7777 for gradual onset; 8888 for not relevant; 9999 for not known.)

(Q.19 - 22 are for all patients.)

19. Who was the first medical person to attend you after you noticed the ..... (main symptom) on ..... (onset date)?

CARD 5

General practitioner	1
Medical specialist	2
Ambulance staff	3
Hospital staff	4
Other medical person (please specify _____)	5

(Code 9 if not known)

20. How long was it between the time you noticed the ..... (main symptom) on .....(onset date) and when you received medical care (either from the general practitioner, the medical specialist, the ambulance staff or another medical person) outside hospital?

CARD 6

Probably less than 5 minutes	1
6 - 59 minutes	2
1 - 4 hours	3
5 - 10 hours	4
11 - 23 hours	5
24 hours or more	6

(Code 9 if not known; 8 if patient didn't receive initial care from any of these people, i.e. they went straight to hospital)

21. How long was it between the time you noticed the .....(main symptom) on ..... (onset date) and the time you were attended by a medical person in the hospital?

CARD 6

Probably less than 5 minutes	1
6 - 59 minutes	2
1 - 4 hours	3
5 - 10 hours	4
11 - 23 hours	5
24 hours or more	6

(Code 9 if not known)

22. How did you get to the hospital?

CARD 7

Car	1
Intensive Care Ambulance	2
Ambulance	3
Taxi	4
Public Transport (eg: bus, train, etc.)	5
Walked	6
Helicopter	7

(Check pink transport sheet in medical records about nature of ambulance. Intensive Care Ambulance (2) takes precedence over ordinary Ambulance (3). Code 9 if not known; 8 if patient was already in hospital.)

(Check the answers to Q.13 - 22 before moving on.)

I'd like to ask you some questions about your health before this illness.

23. Have you ever been admitted to hospital for a heart attack ?

If so, when did this happen and which hospital did you go to? (Start with the most recent attack.)

Year .....

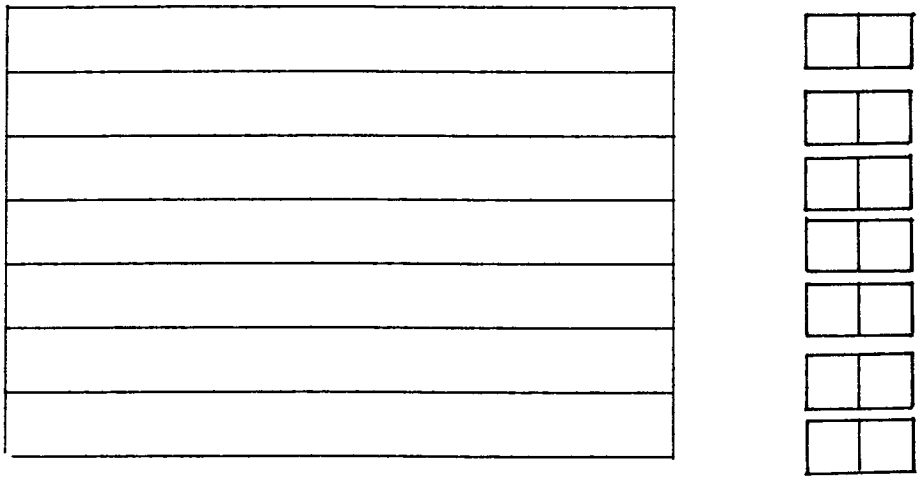
Hospital .....

(Check the old medical records of the patient if she/he went to a study hospital. Code in the code box according to the following:

Reply	Code	Explanation
NO	1	Has not had a previous heart attack at all
YES	2	Did not go to a study hospital but there is evidence in the current medical notes of a previous heart attack
	3	Did not go to a study hospital and there is no evidence in the current medical notes of a previous heart attack (i.e. unconfirmed)
	4	Did go to a study hospital and had a confirmed heart attack
	5	Did go to a study hospital but had a non-heart disease diagnosis given. State diagnosis .....
	6	Did go to a study hospital but had a heart disease diagnosis given other than heart attack. State diagnosis .....
DON'T KNOW	9	Not known

Note: Confirmed heart attack takes precedence over other diagnosis or unconfirmed heart attack.)

24. In the month before you were admitted to hospital for this illness, what medicines have you taken ? These may have been prescribed by your doctor or bought "off-the-shelf" or "over-the counter".



(Code 88 if no drugs taken or to complete the remaining code boxes; 99 if not known. Check medical records as well.)

25. Have you ever had cardiac catheterization performed on you? That is, a tube was placed in your groin or elbow, dye was injected into the tube and then the doctor took x-rays of your heart.

YES	1	☐
NO	2	

(Code 9 if not known. Note: this procedure must have been done outside Newcastle - usually in Sydney.)

26. Have you ever had coronary artery by-pass surgery?

YES	1	☐
NO	2	

(Code 9 if not known. Note: this procedure must have been done outside Newcastle - usually in Sydney.)

27. When did you last visit a doctor before this present illness?

In the last 3 months	1
3-6 months ago	2
6-12 months ago	3
1-3 years ago	4
More than 3 years ago	5
Never visited a doctor	6

(Code 9 if not known)

28. Was your blood pressure measured then?

Yes	1
No	2

(Code 9 if not known)

29. When was your blood pressure last measured?

In the last 3 months	1
3-6 months ago	2
6-12 months ago	3
1-3 years ago	4
More than 3 years ago	5
Never measured	6

(Code 9 if not known)

30. Have you ever been told you have had high blood pressure?

Yes	1
No	2

(Code 9 if not known)

(If Yes to Q.30, ask Q.31. If No to Q.30 code 88 in the code boxes and go to Q.32.)

31. In what year were you told for the first time that you had high blood pressure?

(Code 99 if not known; 88 if not relevant)
Record approximate year.

☐☐ year

32. Have you ever had treatment for high blood pressure?

Yes	1
No	2

(Code 9 if not known)

☐

33. Are you receiving treatment for high blood pressure at the present time?

Yes	1
No	2

(Code 9 if not known)

☐

34. Have you ever been told by a doctor or other medical person that you had ANY of the following conditions ?

CARD 8

High blood pressure	☐
Angina	☐
Stroke	☐
High cholesterol	☐
High triglycerides	☐
Diabetes	☐
Obesity/overweight	☐

(Yes 1, No 2, Code 9 if not known)

35. How tall are you ? ☐☐☐ cms

36. How much do you weigh ? ☐☐☐ kgs

(Code 999 for not known. Check medical records. Approximations are acceptable.)

37. What was the HIGHEST level of education you completed ?

CARD 9

Never attended school	1
Primary School	2
Some High School	3
Completed High School	4
Technical College	5
University or C.A.E.	6

☐

(Code 9 for not known)

38. Which of these terms best describes your employment status immediately before your present illness ?

CARD 10

Permanently unable to work/ill	1
Retired	2
Employed full-time	3
Full-time student	4
Employed part-time	5
Part-time student	6
Home duties	7
Unemployed	8

(Patients may pick ONE item only. Code 9 if not known.)

39. What is/was your main occupation ?

_____

(Make sure you have a full description of the job so that you can code easily, e.g. ask in what industry the person works/worked, as well as what the job is/was. Code 99 if not known.)

40. What is/was your spouse/partner's main occupation?

_____

(Make sure you have a full description of the job so that you can code easily, e.g. ask in what industry the person works/worked, as well as what the job is/was. Code 99 if not known.)

And now some questions of a different nature.

41. Have you EVER smoked cigarettes, cigars or a pipe regularly?

YES 1 ☐

NO 2

(Code 9 if not known. If the patient says No, go straight to Q44 and code 8's in the code boxes for Q42-43: if Yes, please ask the next questions.)

42. How old were you when you started smoking regularly? ☐☐

(Code 99 if not known; code 88 if not relevant, i.e. patient hasn't smoked regularly)

43. Had you given up smoking permanently BEFORE this recent illness started and you were admitted to hospital?

(If so, ask how long ago this happened.)

CARD 14

1 - 5 months ago	1
6 - 11 months ago	2
1 - 3 years ago	3
4 - 6 years ago	4
7 - 9 years ago	5
10 - 12 years ago	6
More than 23 years ago	7

☐

(Code 9 if not known; code 8 if not relevant, i.e. patient hasn't given up before this recent illness.)

44. How often do you usually drink alcohol?

CARD 16

Every day	1
On 5 or 6 days a week	2
On 3 or 4 days a week	3
On 1 or 2 days a week	4
Less than once a week	5

☐

(Code 9 if not known; code 8 if patient doesn't drink any alcohol at all and code 8 in the code box for Q45. "Heavy" drinkers are coded as 1. People who never or rarely drink are coded as 6)

45. On a day when you drink alcohol, how many drinks do you usually have?

CARD 17

More than 20 drinks	1
13 to 20 drinks	2
9 to 12 drinks	3
5 to 8 drinks	4
3 to 4 drinks	5
1 to 2 drinks	6

☐

(Code 9 if not known; 8 if patient doesn't drink any alcohol at all. "Heavy" drinkers are coded as 1. People who never or rarely drink are coded as 6. Note: 1 drink = 10 grams.)

That brings us to the end of the interview.

Thank you very much for being so helpful.

Medical Record Information (at 28 days)

(Code highest set only over 28 day period)

(a) What are the patient's enzyme levels ?

(i) AST (SGOT) _____

CPK _____

LDH _____

Date of analysis _____

Were tests done within 72 hours of onset of symptoms or admission ?

Yes 1

No 2

(Code 9 if not known)

(ii) AST (SGOT) _____

CPK _____

LDH _____

Date of analysis _____

Were tests done within 72 hours of onset of symptoms or admission ?

Yes 1

No 2

(Code 9 if not known)

(iii) AST (SGOT) _____

CPK _____

LDH _____

Date of analysis _____

Were tests done within 72 hours of onset of symptoms or admission ?

Yes 1

No 2

(Code 9 if not known)

(iv) AST (SGOT) _____

CPK _____

LDH _____

Date of analysis _____

Were tests done within 72 hours of onset of symptoms or admission ?

Yes 1

No 2

(Code 9 if not known)

(b) Xerox four copies of each of the patient's ECG's. Include on each ECG - the date, time of ECG, hospital number/U.R. number, study number, and the number of the ECG (1,2,3,4...)

ECG's to be selected:

1. The first available, codable ECG in the index attack (or one recorded within 28 days before the attack.)

2. The next two codable ECG's on dates different from the first and each other.

3. The last codable ECG in the record file for the admission.

ECG number (1,2,3,4..)	Date performed	Time performed (24 hr clock)	4 copies (✓ if Yes)

How many ECG's in total were performed on this patient during this event ? _____

(c) Was cardio pulmonary resuscitation attempted outside hospital?

1 Yes
2 No
8 No cardiac arrest occurred outside hospital
9 Not known

☐

(d) Does the patient have or has the patient had any of the following:

Yes 1
No 2

(Code 9 if not known)

(i) liver disease ☐

(ii) recent major infection ☐

(iii) surgery (requiring anaesthesia) within past 3 days (please specify what sort of surgery it was: ☐

_____

(iv) other ☐

(v) recent intra-muscular injection ☐

(vi) intravascular manipulation such as angiography, angioplasty or intra-arterial thrombolytic treatment within past 3 days. ☐

(vii) defibrillation ☐

(Refer to definitions of the above items in the manual.) ☐☐

MONICA AUTOPSY FORM

GENERAL INFORMATION

Name: _____

Address: _____ Post Code: _____

Hospital Unit Record Number: _____ | | | | | | |

Type of Autopsy: (Please circle appropriate number)

Hospital 1

Forensic 2 | |

Date of Death: ../ ../ 19 ..
day mth year | | | | | | |

Age at Death: _____ years

HEART EXAMINATION (Please circle appropriate number)

Coronary Arteries:	Total Occlusion:	Thrombus	Yes 1 No 2	
		Atheroma	Yes 1 No 2	
	Stenosis:		Severe: >75% 1 Moderate: 50-75% 2 Nil/<50% 3	
Myocardium:	Fresh Myocardial Infarction (macro):		Definite 1 Suspicious 2 Absent 3	
	Rupture (all kinds):		Present 1 Absent 2	
	Old Infarct (>0.5cm on (transverse section):		Present 1 Absent 2	

P.M. CONCLUSION

Other Primary Cause of Death:
(if not Ischaemic Heart Disease)
(Please circle appropriate number) Yes 1
No 2

STATE MAJOR CAUSE OF DEATH:

_____ | | | | |

_____ | | | | |

_____ | | | | |

MONICA CRITERIA FOR INCLUSION IN THE PROJECT

Persons aged 25-69 years who are usually resident in the Lower Hunter Local Government Areas (Newcastle, Lake Macquarie, Cessnock, Maitland and Port Stephens).

EXPLANATION OF PROCEDURE

1. CORONARY ARTERIES:

Method: Cross sections of:

Left anterior descending Left circumflex and Right coronary	Make cuts commencing 1 cm from origin at 1 cm intervals for distance of 6 cm at least

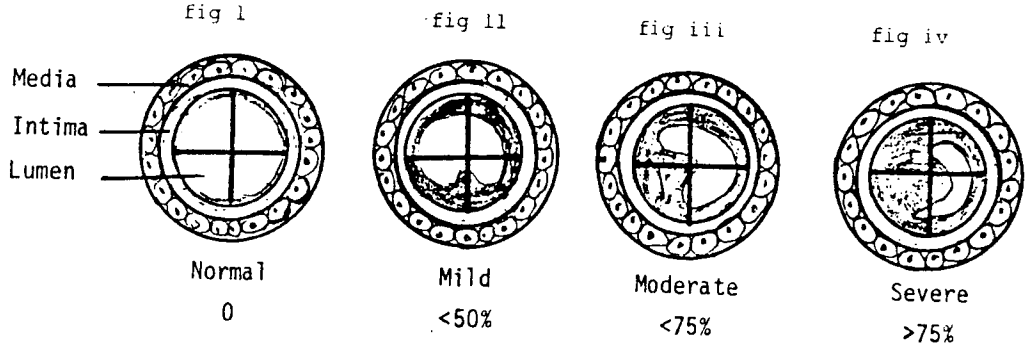
Extent of Narrowing: (figs i - iv)

Estimate extent of luminal narrowing as follows:

Mild (fig ii) = <50% i.e. 2 quandrants occluded

Moderate (fig iii) = 50 - 75% i.e. up to 3 quadrants occluded

Severe (fig iv) = >75% i.e. more than 3 quadrants occluded



2. MYOCARDIUM:

Extent of: 1) Necrosis
2) Old infarction i.e. scarring (must be confluent)

Method: Make 4 transverse slices of whole heart 1 cm thick, commencing 3 cm distal to origin of L. anterior descending artery.

Note calibre of arteries (for 1) and evidence of recent, established or old infarct.

Old infarct: scar with or without thinning of myocardium.

DEATH CERTIFICATE FORM

1. Study Number: [ ][ ][ ][ ][ ][ ]

2. Death Registration Number: [ ][ ][ ][ ][ ][ ]

3. Name: _____

4. Usual Residence: _____

_____ Post Code [ ][ ][ ][ ]

5. Unit Record Number (if available): [ ][ ][ ][ ][ ][ ]

6. Sex: Male 1
Female 2 [ ]

7. Place of birth (country) [ ][ ]

8. How long lived in Australia, if not born here (years): [ ][ ]

9. Age at death: [ ][ ]

10 Marital status: Married 1
Single 2
Divorced 3
Widowed 4 [ ]

11. Date of death: [ ][ ][ ][ ][ ][ ]
day mth year

12. Place of death:
Study hospital name _____ [ ][ ][ ][ ]
Other hospital name _____
Nursing home 7777
Out of hospital 8888
Not known 9999

13. Was autopsy performed:
Yes - in hospital 1
Yes - forensic 2
No 4
Not known 9 [ ]

14. Apparent survival time in attack:
Less than 1 hour 1
1 - 24 hours 2
24 hours or more 3
probably < 24 hours 4
probably > 24 hours 5
not known 9 [ ]

15. Cause of death: [ ][ ][ ][ ]

_____ [ ][ ][ ][ ]

_____ [ ][ ][ ][ ]

_____

_____

16. Date of registration: [ ][ ][ ][ ][ ][ ]
day mth year

17. Certifying Doctor (not coded):

_____

_____

18. Name and address of next of kin (not coded):

_____

_____

Phone number: _____

Relationship: _____

19. Occupation: _____

HUNTER REGION HEART DISEASE PREVENTION PROGRAMME
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HUNTER REGION MONICA MEDICATION CODING: REVISION 1.4

1. Attached is the current version of the medications coding system used in the Hunter Region MONICA project since 27th August 1985 (the beginning of the second year of data collection). While there have been small amendments since that date, the revisions are upwardly compatible.

2. The current MONICA medication coding groups can be derived from the Hunter Region coding system as follows:

MONICA Group (is equivalent to)	Hunter Region Scheme
anti-arrhythmic ANTAR	Group 1 plus atropine (64)
anticoagulant ANTCO	Group 4
anti-platelet ANTPL	Group 5
beta blockers BBLOK	Group 2 plus labetolol (56)
calcium channel blockers CABLO	Group 8
diuretics DIUR	Group 7
antihypertensives HYPOT	Group 10 (52-55) less labetolol (56)
nitrates NITRO	Group 9
inotropes INO	Group 11 plus Group 3
thrombolytic drugs STREP	Group 6

3. The more detailed coding system used for the Hunter Region MONICA project reflects a desire to use medications or combinations of medications as indicators of clinical situations, in addition to analysis of asociations with outcomes. Thus, for example, cardiotonic glycosides are distinct from vasoconstrictors, nitroprusside from other antihypertensive agents, and atropine from other anti-arrhythmics.

4. Drugs available in the Hunter Region which do not appear in the MONICA Memo 57 lists of medications are indicated by an asterisk (*). Medications in the Memo 57 lists which are not available in Australia, or not recognised for the purpose given (piperazine), have been omitted.

HUNTER REGION MONICA MEDICATION CODING: REVISION 1.4

GROUP 1: ANTI-ARRHYTHMICS OTHER THAN BETA BLOCKERS

(1) lignocaine (Xylocard)	01
(2) mexiletine (Mexitil)	02
(3) quinidine (Kinidin, Quinidex)	03
(4) bretyllium (Bretylate, Critifib)	04
(5) IV magnesium sulphate (*)	05
(6) disopyramide (Rhythmodan, Norpace)	06
(7) procainamide (Pronestyl)	07
(8) amiodarone (Cordarone)	08
(9) flecainide (Tambocor)	09
(10) IV Digoxin (Lanoxin) (*)	10
(11) IV verapamil (Isoptin, Cordilox) (*)	11
(12) phenytoin - usually IV (Dilantin)	12
(13) tocainide (Tonocard)	13
(14) spare	14

MIMS 1986 Section 2(b) plus.

GROUP 2: BETA BLOCKERS

(1) NON-SELECTIVE 15

propanolol (Inderal, Cardinol)
alprenolol (Aptin, Betacard)
timolol (Blocadren)
oxprenolol (Trasicor, Captol)
pindolol (Visken, Barbloc)
sotalol (Sotacor)
other

(2) CARDIO-SELECTIVE 16

metoprolol (Betaloc, Lopressor)
practolol (Eraldin)
atenolol (Tenormin)
other

(3) Spare 17

(4) Spare 18

MIMS 1986 Section 2(d)

GROUP 3: INOTROPIC DRUGS

(1) adrenalin	19
(2) dopamine or dobutamine	20
(3) isoprenaline (Isuprel, Saventrine)	21
(4) metaraminol (*) or angiotensin (*)	22
(5) noradrenalin (Levophed)	23
(6) other: phenylephrine IV	24
(7) Spare	25

GROUP 4: ANTICOAGULANTS

(1) warfarin and similar agents warfarin (Coumadin, Marevan) phenindione (Dindevan)	26
(2) heparin IV (therapeutic doses)	27
(3) heparin S/C (subcutaneous) (Calcihep)	28
(4) Spare	29

Part of MIMS 1986 Section 3(b)

GROUP 5: ANTIPLATELET DRUGS

(1) aspirin (alone and in compounds)	30
(2) dipyridamole (Persantin, Dipramol)	31
(3) other: sulphinpyrazone (Anturan)	32
(4) Spare (Local use only: Subject in ISIS-2 or other blinded trial of cardiovascular drug.)	33

GROUP 6: FIBRINOLYTIC (THROMBOLYTIC) DRUGS

(1) streptokinase or urokinase (given peripherally)	34
(2) streptokinase or urokinase (intra-cardiac administration)	35
(3) other: tissue plasminogen activator (TPA)	36

(Note: Enter a code 99 initially if subject is in ISIS-2)

GROUP 7: DIURETICS

(1) POTASSIUM SPARING 37

spironolactone (Aldactone)
amiloride (Midamor)
triamterene (Dytac)
other

(2) POTASSIUM LOSING: LOOP TYPE 38

bumetanide (Burinex)
frusemide (Lasix, Uremide)
ethacrynic acid (Edecril)
other

(3) POTASSIUM LOSING: THIAZIDES AND ANALOGUES 39

mefruside (Baycaron)
hydrochlorothiazide (Dichlotride)
bendrofluazide (Aprinox, Benzide)
quinethazone (Aquamox)
chlorothiazide (Chlotride, Azide)
clopamide (Brinaldix)
metolazone (Diulo)
methylclothiazide (Enduron)
chlorthalidone (Hygroton)
cyclopenthiazide (Navidrex)
chlorexalone (Nefrolan)
quinethazone

(4) OTHER POTASSIUM LOSING DIURETICS 40

acetazolamide (Diamox)
indapamide (Natrilix)

(5) OTHER DIURETIC AGENTS 41

mannitol IV

Note: Combination diuretics: code to both

eg Moduretic (amiloride + hydrochlorothiazide) = 37 + 39
Dyazide (triamterene + hydrochlorothiazide) = 37 + 39

(6) Spare 42

MIMS 1986 Section 7(b) (except vasopressin, desmopressin, lysopressin)

GROUP 8: CALCIUM CHANNEL BLOCKERS

(1) nifedipine (Adalat) 43

(2) verapamil (Isoptin, Cordilox) 44

(3) diltiazem (Cardizem) 45

(4) other: perhexiline (Pexid) 46

GROUP 9: NITRATES

(1) short-acting (sublingual PRN use) 47

glyceryl trinitrate S/L (Anginine)
isisorbide dinitrate S/L (Isordil)

(2) long-acting (oral or topical, regular use) 48

isosorbide dinitrate (Isordil 10mg)
topical glyceryl trinitrate

Nitrobid
Nitrolate
Nitradisc
Transiderm-Nitro

(3) intravenous 49

glyceryl trinitrate (Tridil)

(4) nitrate analogues and other 50

pentaerythritol tetranitrate (Peritrate)
amyl nitrite (inhaled)

(5) Spare 51

GROUP 10: OTHER ANTIHYPERTENSIVE AGENTS

(1) VASODILATORS: CENTRAL ACTION 52

methyldopa (Aldomet)
clonidine (Catapres)
reserpine (Serpasil)

(2) VASODILATORS: PERIPHERAL ACTION 53

hydralazine (Apresoline)
guanethidine (Ismelin, Antipres)
debrisoquine (Declinax)
diazoxide (Hyperstat)
prazosin (Minipress)
minoxidil (Loniten)
rauwolfia (Raudixin)

(3) ACE INHIBITORS 54

captopril (Capoten)
enalopril (Renitec) (*)
other

(4) nitroprusside IV (Nipride) 55

(5) labetolol (Trandate) 56

(6) spare 57

(7) spare 58

GROUP 11: CARDIOTONIC GLYCOSIDES

(1) digoxin - oral (Lanoxin) 59

(2) other: 60

digitoxin (restricted use)
ouabain (restricted use)
proscillaridin (Talusin) (*)
Miroton (compound of white squill, convallaria leaf, oleander leaf and adonis herb) (*)

(3) spare 61

GROUP 12: HYPOLIPIDAEMIC AGENTS

(1) cholesterol and/or triglyceride-lowering 62

clofibrate (Atromid-S)
colestipol
cholestyramine

(2) spare 63

GROUP 13: OTHER CARDIOVASCULAR

(1) atropine 64

(2) spare 65

(3) all other cardiovascular 66

GROUP 14: OTHER MEDICATIONS

(1) steroids - any route except inhaled and topical (skin) 67

hydrocortisone
dexamethasone
betamethasone
cortisone acetate
prednisone/prednisolone
methylprednisolone

(2) insulin 68

(3) oral hypoglycaemic agents 69

MIMS 1986 Section 6(e)

(4) anti-gout/urate lowering 70

allopurinol (Zyloprim)
colchicine (Colgout)
probenecid (Benemid)
sulphinpyrazone (Anturan) - code as both 32 and 70.

(5) other musculoskeletal 71

non-steroidal anti-inflammatory agents
other MIMS 1986 Section 5 drugs

(6) antacids 72

magnesium compounds
aluminium compounds
other

(7) anti-emetic agents 73

metoclopramide (Maxolon)
prochlorperazine (Stemetil)
promethazine (Avomine)
thiethylperazine (Torecan)
other

(8) Histamine type 2 blocking drugs 74

cimetidine (Tagamet)
ranitidine (Zantac)
other

(9) other peptic ulcer therapy (other than 72 and 74 drugs) 75

carbenoxolone (Biogastrone)
misoprostol (Cytotec)
bismuth (De-Nol)
sucralfate (Ulsanic)

(10) other gastrointestinal 76

(all other MIMS 1986 Section 1 drugs other than 72-75 above)

(11) analgesics: opiates IM or IV and other S8 drugs 77

morphine
papaveretum (Omnopon)
pethidine
methadone (Physeptone)
oxycodone (Percodan)

(12) analgesics - other (oral) 78

all other MIMS 1986 Section 4(a) oral analgesics

(13) minor tranquillers/antianxiety agents 79

MIMS Section 4(c)
diazepam (Valium)
oxazepam (Serepax)
other

(14) major tranquillisers/antipsychotic agents 80

MIMS Section 4(d) except lithium

(15) hypnotic agents 81

MIMS Section 4(b)

(16) antidepressant agents 82

MIMS Section 4(e)
lithium

(17) antibiotic agent - parenteral (IM/IV) 83

MIMS Section 8 (parenteral)

(18) antibiotic agent - oral or topical (but not primarily for skin) 84

MIMS Section 8

(19) antineoplastic agents 85

MIMS Section 9

(20) respiratory - bronchodilator 86

salbutamol (Ventolin)
theophylline (Theodur, Brondecon)
aminophylline
adrenalin (inhaled)
fenoterol (Berotec)
isoprenaline (Medihaler)
orciprenaline (Alupent)
terbutaline (Bricanyl)
ipratropium bromide (Atrovent)
inhaled steroids: Aldecin
Becotide
sodium cromoglycate (Intal)
other

(21) respiratory: all other 87

acetylcysteine (Mucomyst)
MIMS Section 11(a)
other

(22) eye/ear/nose/throat/skin 89

MIMS 1986 Sections 13, 14, 15
unless included elsewhere

(23) immune system/anti-allergy 90

MIMS Section 12
antihistamines

(24) other blood/haemopoietic 91

MIMS Section 3 except those
covered above

(25) hormones - contraceptive 92

MIMS Section 18

(26) hormones and endocrine system - all other 93

MIMS Section 6 not coded above

(27) renal/urinary tract/genital tract 94

MIMS Section 7 not coded above

(28) potassium supplements 95

potassium chloride (Slow K,
Span-K, Kayciel)

(29) magnesium supplements 96

magnesium aspartate (Magmin)
magnesium-containing antacids - code as 72 and 96.

Mucaine
Mylanta
Aludrox
Gastrogel etc

(30) other nutritional and metabolism 97

MIMS Section 10 not coded above
vitamins
minerals

(31) other central nervous system 98

other MIMS Section 4:
anticonvulsants
antiparkinsonian
anti-migraine (MIMS Section 2(i))
other

(32) all drugs not included elsewhere 00

****

No medication 88

unknown medication 99

Code combination medications to the codes of each component.

Drugs which potentially fall into two classes should be coded into only one category unless specified above. Choose the most specific action - e.g. code verapamil as calcium blocker before antihypertensive.

For drugs with different codes for oral, IV or topical routes of administration, code as oral when there is no information regarding route of administration.

EXCLUSION RULES TO APPLY WHEN LIST OF MEDICATIONS IS TOO LONG TO BE CODED:

1. These rules apply only to the coding of medication lists for which there are insufficient coding boxes on the form. Otherwise code all medications.

2. Note however that (a) a particular medication should be coded only once on a list;

(b) intravenous fluids without additives are not coded.

3. When medications have to be excluded using these rules, please list the excluded medication(s) in the left hand margin of the form.

4. Do not code heparinised saline flushes of IV lines (with heparin in saline solution, 10 Units/ml).

Rule 1: Delete duplicate entries (e.g when a drug appears under both its generic and trade names). NOT if different routes of administration for medications having these coded differently.

Rule 2: Include only one code from each of the following groups:

73 anti-emetic agents

83 antibiotics IM/IV

84 antibiotics oral

77 opiate analgesics

85 anti-neoplastic agents

92 contraceptive agents

87 respiratory other

76 other GIT

71 other musculoskeletal

89 eye/ear/nose/throat/skin

91 other blood/haemopoietic

94 renal/urinary tract

98 other CNS

Rule 3: Delete all 00 (not included elsewhere) codes

Rule 4: Consult for further advice.

The rules should be applied in the order given above.

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Project Director

Mrs Hilary Alexander
Project Manager

[Date]

[Name]
[Street & Number]
[Town & Postcode]

Dear [Name]

We are currently undertaking a study in the Hunter Region investigating the relationship between the degree of control of high blood pressure and the risk of developing a heart attack and/or stroke. We are identifying cases through the MONICA Project (MONItoring trends and determinants of CArdiovascular disease), a World Health Organization sponsored project, and comparing the degree of blood pressure control among these cases with community controls identified from a random sample from the electoral rolls of people living in the Hunter Region.

Through our contact with your patient [Patient's Name] [he/she] has indicated that [he/she] is taking the medications on the attached sheet. We would oe very grateful if you could confirm whether these medications are being taken currently. Would you also provide us with the pre-treatment and the latest blood pressure readings for the patient, and return the attached form to us in the pre-paid envelope provided.

Naturally all information is treated in the strictest confidence.

Please do not hesitate to contact us oy phone (685648) if you have any queries.

Thanking you in anticipation of your assistance.

Yours sincerely,

DR. K.A. AL-ROOMI
Medical Researcher

PROF. R.F. HELLER
Professor of Community Medicine

HUNTER REGION HEART DISEASE PREVENTION PROGRAMME
WHO COLLABORATING CENTRE FOR THE EPIDEMIOLOGY OF CARDIOVASCULAR DISEASES
Faculties of Medicine and Mathematics, University of Newcastle

fice:
edical Sciences Building,
iiversity of Newcastle,
S.W. 2308

lephone (all hours):
49) 685648.

Associate Professor Annette Dobson
Project Director

Mrs Hilary Alexander
Project Manager

[date]

[name]
[street & number]
[town & postcode]

Dear Dr. [name],

We wrote to you recently asking for some information on medication and blood pressure readings for your patient(s) [name(s) of patient(s)].

This information is required for the WHO sponsored MONICA cardiovascular disease project. We would appreciate it if you would complete the attached sheets and return them to us in the pre-paid envelope provided.

Naturally all information is treated in the strictest confidence.

Please do not hesitate to contact us by phone (685648) if you have any queries.

Thanking you in anticipation of your assistance.

Yours sincerely,

DR. K.A. AL-ROOMI
Medical Researcher

PROF. R.F. HELLER
Professor of Community Medicine

STRICTLY CONFIDENTIAL

Patient's name:

1. Please confirm (by ticking the appropriate space) if this patient is currently taking these antihypertensive medications.

   _____ Yes ( ) No ( )

   _____ Yes ( ) No ( )

   _____ Yes ( ) No ( )

   _____ Yes ( ) No ( )

2. Please indicate any recent changes to this patient's antihypertensive medications.

   _____

   _____

3. Pre treatment blood pressure (or if not available highest recorded blood pressure reading)

   Systolic _____ Diastolic _____

   Date _____ Month _____ Year _____

4. Last recorded blood pressure reading.

   Systolic _____ Diastolic _____

   Date _____ Month _____ Year _____

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/ 2308

none (all hours):
685648

Professor Annette Dobson
Project Director

Mrs Hilary Alexander
Project Manager

[date]

[Name]
[Street & Number]
[Town & Postcode]

Dear [Name]

As part of the the MONICA Project (MONItoring trends and determinants in CArdiovascular disease), a World Health Organization co-ordinated study of which Newcastle is one of two centres in Australia taking part, we are currently identifying cases of heart attack and ischaemic heart disease deaths. We are particularly interested in the relationship between blood pressure and the risk of developing a heart attack.

Through our contact with your patient [Patient's Name], who suffered a heart attack in [month and year], [he/she] indicated that at that time [he/she] was taking the medications on the attached sheet. We would be very grateful if you could confirm whether these medications were being taken by [patient's name] at that time. Would you also provide us with the blood pressure readings for [patient's name] as indicated on the attached sheet and return the sheet to us in the pre-paid envelope provided.

Naturally all information is treated in the strictest confidence.

Please do not hesitate to contact us by phone (685648) if you have any queries.

Thanking you in anticipation of your assistance.

Yours sincerely,

DR. K.A. AL-ROOMI
Medical Researcher

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) 685648

Professor Annette Dobson
Project Director

Mrs Hilary Alexander
Project Manager

[date]

[Name]
[Street & Number]
[Town & Postcode]

Dear [Name]

As part of the MONICA Project (MONItoring trends and determinants in CArdiovascular disease), a World Health Organization co-ordinated study of which Newcastle is one of two centres in Australia taking part, we are currently identifying cases of heart attack and ischaemic heart disease deaths. We are particularly interested in the relationship between blood pressure and the risk of developing a heart attack.

Through our contact with [the wife, etc.] of your patient [Patient's Name], who died in [month and year], [he/she] indicated that at that time [his/her wife, etc.] was taking the medications on the attached sheet. We would be very grateful if you could confirm whether these medications were being taken by [patient's name] at that time. Would you also provide us with the blood pressure readings for [patient's name] as indicated on the attached sheet and return the sheet to us in the pre-paid envelope provided.

Naturally all information is treated in the strictest confidence.

Please do not hesitate to contact us by phone (685648) if you have any queries.

Thanking you in anticipation of your assistance.

Yours sincerely,

DR. K.A. AL-ROOMI
Medical Researcher

PROF. R.F. HELLER
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ıone (all hours):
685648

Professor Annette Dobson
Project Director

Mrs Hilary Alexander
Project Manager

MON4/16

[date]

[name]
[street & number]
[town & postcode]

Dear Dr. [name],

We wrote to you recently asking for some information on medication and blood pressure readings for your patient [name of patient].

This information is required for the WHO sponsored MONICA cardiovascular disease project, which aims to monitor all suspected heart attacks and IHD deaths over 10 years in the Hunter Region and to identify possible risk factors.

Even if your patient's [hospitalization/death] was not due to a heart attack, we would appreciate it if you would complete the attached sheet and return it to us in the pre-paid envelope provided.

Naturally all information is treated in the strictest confidence.

Please do not hesitate to contact us by phone (685648) if you have any queries.

Thanking you in anticipation of your assistance.

Yours sincerely,

DR. K.A. AL-ROOMI
Medical Researcher

PROF. R.F. HELLER
Professor of Community Medicine

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rsity of Newcastle,
2308

none (all hours):
685648

Professor Annette Dobson
Project Director

Mrs Hilary Alexander
Project Manager

MON4/14

[date]

[name]
[street]
[town]

Dear Dr. [Name of Doctor],

I am writing to thank you for completing and returning the questionnaire we sent you recently in relation to [patient's name].

The information collected from you and other doctors whom we have approached will assist greatly in our research into cardiovascular disease in the Hunter Region. All information is treated in the strictest confidence and used only as combined results, **never** on an individual basis.

Once again, thank you for your co-operation, it is greatly appreciated.

Yours sincerely,

DR. K.A. AL-ROOMI
Medical Researcher

PROF. R.F. HELLER
Professor of Community Medicine

h/a

STRICTLY CONFIDENTIAL

Patient's Name: _____

1. Please confirm (by ticking the appropriate space) if this patient was taking these antihypertensive medications before his/her admission to hospital on / / .

_____	Yes ( )	No ( )
_____	Yes ( )	No ( )
_____	Yes ( )	No ( )
_____	Yes ( )	No ( )

2. Blood pressure reading **before** treatment for high blood pressure commenced (or if not available highest recorded blood pressure reading)

	Systolic	Diastolic
Date / Month / Year		

3. Last recorded blood pressure reading before the patient was admitted to hospital on / / .

	Systolic	Diastolic
Date / Month / Year		

A.21

h/a

STRICTLY CONFIDENTIAL

Patient's Name: _____

1. Please advise which antihypertensive medication(s) this patient was taking before his/her admission to hospital on / / .

_____

_____

_____

_____

2. Blood pressure reading **before** treatment for high blood pressure commenced (or if not available highest recorded blood pressure reading)

Systolic Diastolic

_____ _____ _____

Date Month Year

3. Last recorded blood pressure reading before the patient was admitted to hospital on / / .

Systolic Diastolic

_____ _____ _____

Date Month Year

A.22

h/a

STRICTLY CONFIDENTIAL

Patient's Name: _____

1. Please advise which antihypertensive medication(s) this patient was taking before his/her death on / / .

_____

_____

_____

_____

2. Blood pressure reading **before** treatment for high blood pressure commenced (or if not available highest recorded blood pressure reading)

Systolic Diastolic

_____ _____ _____
Date Month Year

3. Last recorded blood pressure reading before the patient died on / / .

Systolic Diastolic

_____ _____ _____
Date Month Year

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)hone (all hours):
) 685648

Professor Annette Dobson
Project Director

Mrs Hilary Alexander
Project Manager

INTERVIEW SCHEDULE

Good morning/Hello _____

My name is _____ and I'm working with a research team from the Faculty of Medicine at the University of Newcastle. We are currently investigating the relationship between stroke and high blood pressure in the Hunter Region.

Would you mind answering a few questions which will help us in our research. This will take approximately 5-10 minutes.

Naturally, your answers will be treated in the strictest confidence and used **only** for research purposes.

(Wait for the patient to answer or ask you questions .....)

Thank you for agreeing to help us.

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9) 685648

Professor Annette Dobson
Project Director

Mrs Hilary Alexander
Project Manager

RELATIVE INTERVIEW SCHEDULE

Good morning/Hello _____

My name is _____ and I'm working with a research team from the Faculty of Medicine at the University of Newcastle. We are currently investigating the relationship between stroke and high blood pressure in the Hunter Region.

As the present condition of your _____ Mr./Mrs./Miss _____ does not allow him/her to answer questions, we would be grateful if you would assist us in obtaining the information we require. This will take approximately 5-10 minutes.

Naturally, your answers will be treated in the strictest confidence and used only for research purposes.

(Wait for the relative to answer or ask you questions .....)

Thank you for agreeing to help us.

FULL NAME: _____

ADDRESS & POSTCODE: _____

_____

_____

PHONE NUMBER: _____

DATE OF BIRTH: _____

HOSPITAL: _____

U.R. NUMBER: _____

HOSPITAL DOCTOR(S): _____

_____

GENERAL PRACTITIONER: _____

NURSE/INTERVIEWER: _____

DATE OF ADMISSION: _____

NEXT-OF-KIN: _____

ADDRESS & POSTCODE: _____

_____

PHONE NUMBER: _____

RELATIONSHIP: _____

1. Study Number:

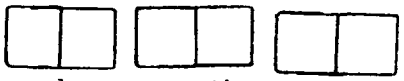


2. L.G.A. of residence:

Newcastle	1
Lake Macquarie	2
Cessnock	3
Maitland	4
Port Stephens	5

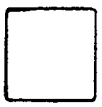


3. Date of birth:

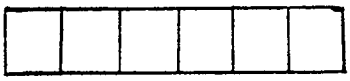


4. Hospital:

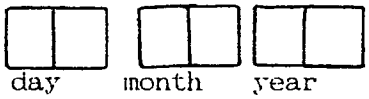
Royal Newcastle	01
Mater	02
Wallsend	03
Belmont	04
Maitland	05
Cessnock	06
Kurri Kurri	07



5. U.R. Number:

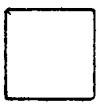


6. Date of Admission:



7. Sex:

Male	1
Female	2



8. I'd like to ask you some questions about your present illness, i.e. in the last few days prior to your admission to hospital.

I'd like to ask you some questions about your _____'s illness i.e. in the last few days prior to his/her illness.

What were the main signs or symptoms you had which made you or your relatives realise you needed medical attention to be admitted to hospital in this present illness?

What were the main signs or symptoms your _____ had which made him/her realize that or the relative realise that he/she needed to be admitted to hospital in this present illness?

_____

_____

_____

_____

_____

Memory impairment
Confusion
Disorientation
Agitation
Convulsions or seizures
Vomiting or nausea
Headache
Difficulty in speech
Difficulty in swallowing
Weakness (paresis or paralysis) affecting one side of extremities
Weakness (paresis or paralysis) affecting the face
Coma

(Check medical records)

Date of onset _____

How long did the weakness last for?

_____ hours _____ days

I'd like to ask you some questions about your health before this illness.

(For relatives) I'd like to ask you some questions about your _____'s health before this illness.

9. When did you last visit a doctor before this present illness?

(For relatives) when did your _____ last visit a doctor before this present illness?

In the last 3 months	1
3-6 months ago	2
6-12 months ago	3
1-3 years ago	4
More than 3 years ago	5
Never visited a doctor	6

(Code 9 if not known)

Was your blood pressure measured then?

Yes	1
No	2

(Code 9 if not known)

10. When was your blood pressure last measured?

(For relatives) Do you know when your_____ had his/her blood pressure measured before this present illness?

In the last 3 months	1
3-6 months ago	2
6-12 months ago	3
1-3 years ago	4
More than 3 years ago	5
Never measured	6

(Code 9 if not known)

11. Have you ever been told you have had high blood pressure?

(For relatives) had your _____ ever been told he/she had high blood pressure?

Yes 1

No 2

(Code 9 if not known)

In what year were you told for the first time that you had high blood pressure?

(For relatives) Do you know what year your _____ was told for the first time that he/she had high blood pressure?

(Code 99 if not known; 88 if not relevant)
Record approximate year.

12. Have you ever had treatment for high blood pressure?

(For relatives) Do you know if your _____ ever had treatment for high blood pressure?

Yes 1

No 2

(Code 9 if not known)

13. Are you receiving treatment for high blood pressure at the present time?

(For relatives) Was your _____ receiving treatment for high blood pressure before this present illness?

Yes 1

No 2

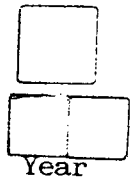
(Code 9 if not known)

14. Have you ever been told you have had a stroke which lasted more than 24 hours before this present illness?

(For relatives) Has your _____ ever had a previous stroke attack which lasted more than 24 hours before this?

Yes 1

No 2



If yes, when did this happen?

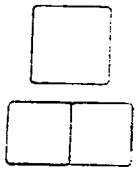
Year

15. Have you ever been admitted to hospital for a heart attack

(For relatives) Had your _____ ever been admitted to hospital for a heart attack?

Yes 1

No 2



If yes, when did this happen?

Year

16. In the month before you were admitted to hospital for this illness, what medications have you been taking?

(For relatives) In the month before your _____ was admitted to hospital for this illness, what medication had he/she been taking?

_____

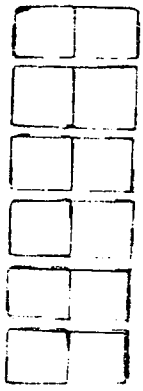
_____

_____

_____

_____

_____



(Code 88 if no drugs taken or to complete the remaining code boxes; 99 if not known. Check medical records as well)

And now for some questions of a different nature.

17. How tall are you? ☐☐☐ cm

(For relatives) How tall is your _____

18. How much do you weigh? ☐☐☐ kg

(For relatives) How much does your _____ weigh?

(Code 999 for not known. Check medical records. Approximates are acceptable).

19. Have any of your close relatives (parents, brothers or sisters had any of the following?

(For relatives) Did any of the close relatives (parents, brothers or sisters) of your _____ have any of the following?

High blood pressure	Yes	1	☐
	No	2	
A heart attack	Yes	1	☐
	No	2	
A stroke	Yes	1	☐
	No	2	

20. Have you EVER smoked cigarettes, cigars or a pipe regularly?

(For relatives) Has your _____ ever smoked cigarettes, cigars or a pipe regularly?

Yes 1

No 2 ☐

(Code 9 if not known. If the patient says No, go straight to Q 23 and code 8's in the code boxes for Q 21-22: if Yes, please ask the next questions)

21. How old were you when you started smoking regularly? ☐☐

(For relatives) How old was he/she when he/she started smoking regularly?

(Code 99 if not known; code 88 if not relevant, i.e. patient hasn't smoked regularly)

22. Had you given up smoking permanently BEFORE this recent illness started and you were admitted to hospital?

(For relatives) Had your _____ given up smoking prior to his/her recent illness?

(If so, ask how long ago this happened)

1 - 5 months ago	1
6 - 11 months ago	2
1 - 3 years ago	3
4 - 6 years ago	4
7 - 9 years ago	5
10 - 12 years ago	6
More than 23 years ago	7

(Code 9 if not known; code 8 if not relevant, i.e. patient hasn't given up before this recent illness).

23. How often do you usually drink alcohol?

(For relative) How often does he/she drink alcohol before being admitted to hospital?

Every day	1
On 5 or 6 days a week	2
On 3 or 4 days a week	3
On 1 or 2 days a week	4
Less than once a week	5
Rarely or never	6
Use to be a moderate to heavy drinker	7

(Code 9 if not known; code 8 if patient doesn't drink any alcohol at all and code 8 in the code box for Q 24. Heavy" drinkers are coded as 1. People who never or rarely drink are coded as 6)

24. On a day when you drink or used to drink alcohol, how many drinks did you usually have?

(For relatives) On a day when he/she drinks or used to drink alcohol, how many drinks does/did he/she have?

More than 20 drinks	1
13 to 20 drinks	2
9 to 12 drinks	3
5 to 8 drinks	4
3 to 4 drinks	5
1 to 2 drinks	6

(Code 9 if not known; 8 if patient
doesn't drink any alcohol at all.
"Heavy" drinkers are coded as 1.
People who never or rarely drink are
coded as 6. Note: 1 drink = 10 grams)

That brings us to the end of the interview.

Thank you very much for being so helpful.

Diagnostic Procedures:

1. Blood Pressure

1st reading (on admission)

Date _____

Systolic ☐☐☐ mmHg

Diastolic ☐☐☐ mmHg

2nd reading (after 48 hours of admission)

Date _____

Systolic ☐☐☐ mmHg

Diastolic ☐☐☐ mmHg

3rd reading (last reading before discharge or death)

Date _____

Systolic ☐☐☐ mmHg

Diastolic ☐☐☐ mmHg

2. C.T. Scanning (1st)

Done 1

Not Done 2 ☐

If done, What was the result?

Infarction	1
Intracerebral Haemorrhage	2
Subachnoid haemorrhage	3
Multiple Infarctions	4
Others	6
Irrelevant, normal	8
Not known	9

☐

Date of C.T. scanning _____

3. C.T. Scanning (2nd)

Done 1

Not Done 2 ☐

If done, What was the result?

Infarction	1
Intracerebral Haemorrhage	2
Subachnoid haemorrhage	3
Multiple Infarctions	4
Others	6
Irrelevant, normal	8
Not known	9

☐

Date of C.T. scanning _____

4. Angiography:

Done 1

Not Done 2

If done, what was the result?

Stenosis	1
Aneurysm	2
Arteriovenous malformation	3
Others	6
Irrelevant, normal	8
Not known	9

Date of Angiography _____

5. Lumbar puncture - fluid

Done 1

Not Done 2

If done, what was the result?

Clear, colourless	1
Bloody	2
Xauthochromic	3
Others	6
Irrelevant	8
Not known	9

Date of lumbar puncture _____

6. (Check the medical records)

Did the weakness persist for more than 24 hours?

Yes 1

No 2

(Code 9 if not known)

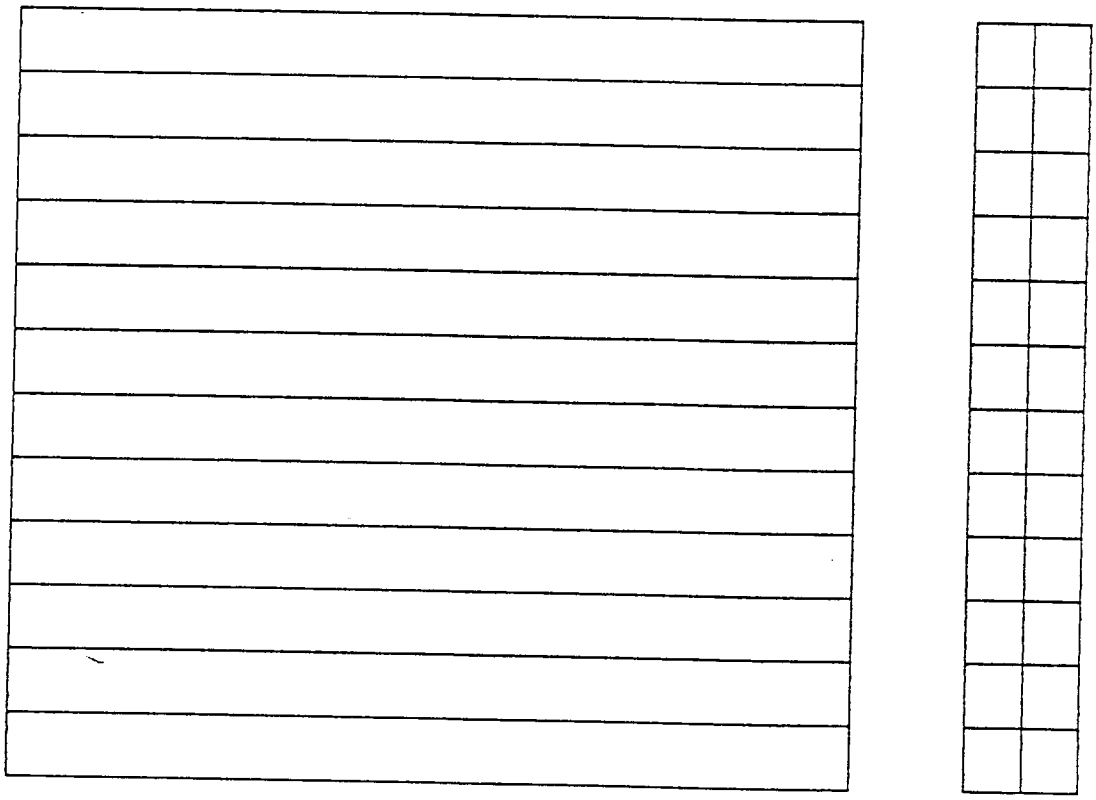
25. Did the patient have the following procedures during this admission?

Yes 1
No 2
Not known 9

(i)	Carotid endartectomy	
(ii)	Extracranial/intracranial bypass surgery	
(iii)	Surgical evacuation of cerebellar haemorrhage or clot	
(iv)	Others (please specify)	
(v)		
(vi)		

26. What medication (of all types) did the patient take while <u>in hospital</u>? (Code 99 if not known.)

27. What medications (of all types) was the patient given or prescribed upon discharge?



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N.S.W. 2308

Telephone (all hours):
(049) 685648.

Associate Professor Annette Dobson
Project Director

Mrs Hilary Alexander
Project Manager

MON4/03

[date]

[name]
[street]
[town]

Dear [name]

We are currently involved in some important research which is attempting to find out more about the causes of stroke, a leading cause of death in Australia.

We depend very much on the relatives of people who have had or might have had a stroke to give us more information. We realize that you may feel that this is an intrusion upon you, but we are aiming to collect information about all stroke sufferers, so that others may be helped in the future.

As part of the study it has recently come to our attention that your [relationship of deceased] died from a stroke. We hope you will be prepared to answer a few short questions in the enclosed questionnaire. Please read the directions carefully, complete the form and return it to us in the enclosed pre-paid envelope. If you would prefer to answer the questions over the telephone please phone us during office hours (9 am - 5 pm).

Thank you in anticipation of your assistance. If you have any questions please do not hesitate to phone us on 685648.

Yours sincerely,

K.A. AL-ROOMI
Medical Researcher

R.F. HELLER
Professor of Community Medicine

J.T. HOLLAND
Consultant Neurologist
Clinical Associate Professor in Medicine

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Associate Professor Annette Dobsor
Project Director

Mrs Hilary Alexander
Project Manager

MON4/10

[Date]

[Name]
[Street & Number]
[Suburb & Postcode]

Dear [Name]

We hope you received the letter we wrote to you several weeks ago as part of our study into stroke. We are attempting to find out more about the causes of this disease which is a leading cause of death in Australia.

In cases where death from stroke has occurred we depend very much on relatives or those who were closely associated with the deceased, to give us more information.

We realize you may feel this is an intrusion upon you, but for this research to produce worthwhile findings which may help in future prevention of stroke we need replies from everyone we've written to.

Please take a few minutes to answer the questions on the enclosed form and return it to us in the pre-paid envelope.

Thank you in anticipation of your assistance. If you have any questions please do not hesitate to phone us on 685648.

Yours sincerely,

DR. K.A. AL-ROOMI
Medical Researcher

PROF. R.F. HELLER
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HUNTER REGION HEART DISEASE PREVENTION PROGRAMME
WHO COLLABORATING CENTRE FOR THE EPIDEMIOLOGY OF CARDIOVASCULAR DISEASES
Faculties of Medicine and Mathematics, University of Newcastle

Office:
Medical Sciences Building,
University of Newcastle,
N.S.W. 2308

Telephone (all hours):
(049) 685648.

Associate Professor Annette Dobson
Project Director

Mrs Hilary Alexander
Project Manager

MON4/09

[date]

[name]
[street]
[town]

Dear [name]

I am writing to thank you for completing and returning the questionnaire we recently sent you in relation to your late [relationship of deceased]'s death. We very much appreciate the help you have given us.

The information collected from you and others who have lost someone near to them will assist greatly in our research into strokes. All information is treated in the strictest confidence and used only as combined results, **never** on an individual basis.

Once again, our sincere thanks for your assistance.

Yours sincerely,

DR. K.A. AL-ROOMI
Medical Researcher

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Associate Professor Annette Dobsor
Project Director

Mrs Hilary Alexander
Project Manager

[date]

MON4/19

[Name]
[Street & Number]
[Town & Postcode]

Dear [Name]

As part of the MONICA Project (MONItoring trends and determinants in CArdiovascular disease), a World Health Organization co-ordinated study of which Newcastle is one of two centres in Australia taking part, we are currently identifying cases of stroke. We are particularly interested in the relationship between blood pressure and the risk of developing a stroke.

Through our contact with your patient [Patient's Name], who suffered a stroke in [month and year], [he/she] indicated that at that time [he/she] was taking the medications on the attached sheet. We would be very grateful if you could confirm whether these medications were being taken by [patient's name] at that time. Would you also provide us with the blood pressure readings for [patient's name] as indicated on the attached sheet and return the sheet to us in the pre-paid envelope provided.

Naturally all information is treated in the strictest confidence.

Please do not hesitate to contact us by phone (685648) if you have any queries.

Thanking you in anticipation of your assistance.

Yours sincerely,

DR. K.A. AL-ROOMI
Medical Researcher

J.T. HOLLAND
Consultant Neurologist
Clinical Associate Professor
in Medicine

PROF. R.F. HELLER
Professor of Community Medicine

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Associate Professor Annette Dobson
Project Director

Mrs Hilary Alexander
Project Manager

[date]

MON4/18

[Name]
[Street & Number]
[Town & Postcode]

Dear [Name]

As part of the MONICA Project (MONItoring trends and determinants in CArdiovascular disease), a World Health Organization co-ordinated study of which Newcastle is one of two centres in Australia taking part, we are currently identifying cases of stroke. We are particularly interested in the relationship between blood pressure and the risk of developing a stroke.

Through our contact with [the wife, etc.] of your patient [Patient's Name], who died in [month and year], [he/she] indicated that at that time [his/her wife, etc.] was taking the medications on the attached sheet. We would be very grateful if you could confirm whether these medications were being taken by [patient's name] at that time. Would you also provide us with the blood pressure readings for [patient's name] as indicated on the attached sheet and return the sheet to us in the pre-paid envelope provided.

Naturally all information is treated in the strictest confidence.

Please do not hesitate to contact us by phone (685648) if you have any queries.

Thanking you in anticipation of your assistance.

Yours sincerely,

DR. K.A. AL-ROOMI
Medical Researcher

J.T. HOLLAND
Consultant Neurologist
Clinical Associate Professor
in Medicine

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iversity of Newcastle.
S.W. 2308

ephone (all hours):
(9) 685648

Professor Annette Dobson
Project Director

Mrs Hilary Alexander
Project Manager

MON4/16

[date]

[name]
[street & number]
[town & postcode]

Dear Dr. [name],

We wrote to you recently asking for some information on medication and blood pressure readings for your patients [names of patients].

This information is required for the WHO sponsored MONICA cardiovascular disease project in which we are currently identifying cases of stroke as well as acute myocardial infarction.

Even if your patients' [hospitalization was/deaths were] not due to a stroke, we would appreciate it if you would complete the attached sheets and return them to us in the pre-paid envelope provided.

Naturally all information is treated in the strictest confidence.

Please do not hesitate to contact us by phone (685648) if you have any queries.

Thanking you in anticipation of your assistance.

Yours sincerely,

DR. K.A. AL-ROOMI
Medical Researcher

PROF. R.F. HELLER
Professor of Community Medicine

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Telephone (all hours):
(049) 685648.

Associate Professor Annette Dobson
Project Director

Mrs Hilary Alexander
Project Manager

[date]

[name]
[street]
[town]

Dear Dr. [Name of Doctor],

I am writing to thank you for completing and returning the questionnaire we sent you recently in relation to [patient's name].

The information collected from you and other doctors whom we have approached will assist greatly in our research into cardiovascular disease in the Hunter Region. All information is treated in the strictest confidence and used only as combined results, never on an individual basis.

Once again, thank you for your co-operation, it is greatly appreciated.

Yours sincerely,

DR. K.A. AL-ROOMI
Medical Researcher

PROF. R.F. HELLER
Professor of Community Medicine

stroke ☐☐☐☐☐☐

☐

☐☐

STRICTLY CONFIDENTIAL

Patient's Name: _____

1. Please confirm (by ticking the appropriate space) if this patient was taking these antihypertensive medications before his/her admission to hospital on / / .

_____	Yes ( )	No ( )
_____	Yes ( )	No ( )
_____	Yes ( )	No ( )
_____	Yes ( )	No ( )

2. Blood pressure reading **before** treatment for high blood pressure commenced (or if not available highest recorded blood pressure reading)

Systolic _____ Diastolic _____

Date ____ Month ____ Year ____

3. Last recorded blood pressure reading before the patient was admitted to hospital on / / .

Systolic _____ Diastolic _____

Date ____ Month ____ Year ____

stroke ☐☐☐☐☐☐

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☐☐

STRICTLY CONFIDENTIAL

Patient's Name: _____

1. Please confirm (by ticking the appropriate space) if this patient was taking these antihypertensive medications before his/her death on / / .

_____	Yes ( )	No ( )
_____	Yes ( )	No ( )
_____	Yes ( )	No ( )
_____	Yes ( )	No ( )

2. Blood pressure reading **before** treatment for high blood pressure commenced (or if not available highest recorded blood pressure reading)

Systolic _____ Diastolic _____

Date _____ Month _____ Year _____

3. Last recorded blood pressure reading before the patient died on / / .

Systolic _____ Diastolic _____

Date _____ Month _____ Year _____

stroke ☐☐☐☐☐☐ A.3

☐

☐☐

STRICTLY CONFIDENTIAL

Patient's Name: _____

1. Please advise which antihypertensive medication(s) this patient was taking before his/her admission to hospital on / / .

_____

_____

_____

_____

2. Blood pressure reading **before** treatment for high blood pressure commenced (or if not available highest recorded blood pressure reading)

Systolic Diastolic

_____ _____ _____

Date Month Year

3. Last recorded blood pressure reading before the patient was admitted to hospital on / / .

Systolic Diastolic

_____ _____ _____

Date Month Year

stroke | | | | | | |

| |

| | |

STRICTLY CONFIDENTIAL

Patient's Name: _____

1. Please advise which antihypertensive medication(s) this patient was taking before his/her death on / / .

_____

_____

_____

_____

2. Blood pressure reading **before** treatment for high blood pressure commenced (or if not available highest recorded blood pressure reading)

Systolic Diastolic

_____ _____ _____

Date Month Year

3. Last recorded blood pressure reading before the patient died on / / .

Systolic Diastolic

_____ _____ _____

Date Month Year

HYPERTENSION REGISTRATION CARD

(Side one)

SURNAME _____ FIRST NAME OR INITIALS _____

Address and postcode: _____

_____

Telephone: _____

(Side two)

HYPERTENSION REGISTPATION CARD

UNIVERSITY OF NEWCASTLE
FACULTY OF MEDICINE

FOR ALL PATIENTS WITH HYPERTENSION

EVEN IF NOT ON TREATMENT

Sex: MALE ☐ FEMALE ☐

Date of birth: ☐☐ ☐☐ ☐☐ 2-7
day month year

Last recorded Blood Pressure: S. ☐☐☐ D. ☐☐☐ 8-13

Highest recorded Blood Pressure: S. ☐☐☐ D. ☐☐☐ 14-19

Medication name	Dosage per day

☐☐☐☐☐☐ 20-25
☐☐☐☐☐☐ 26-31
☐☐☐☐☐☐ 32-37
☐☐☐☐☐☐ 38-43
☐☐☐☐☐☐ 44-49

Serial Number: ☐☐☐☐☐☐ 50-55