USING ELECTRONIC DATA FROM PRIMARY CARE TO INFORM DECISION MAKING FOR HYPERTENSION IN THE ELDERLY

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For Elizabeth

I think she would have been pleased

1957 – 1994

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List of figures and tables

Author's declaration

I declare the contents of this thesis to be my own work except where mentioned in the Acknowledgements.

Publications

The following publications have been prepared from the methods and material contained in this thesis:

Mitchell, E. Sullivan, F. Grimshaw, J.M. Donnan, P.T. & Watt, G. (2005) Improving management of hypertension in general practice: a randomised controlled trial of feedback derived from electronic patient data. *British Journal of General* Practice, **55**: 94–101.

Macleod, U. & Mitchell, E. (2005) Co-morbidity in general practice. *The Practitioner,* **249**: 282-284.

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Mitchell, E. (2003) Invited commentary: patient derived data, so why not patient determined access? *The Journal on Information Technology in Healthcare*, **1**: 46-48.

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Using electronic patient records to determine the extent of co-morbidity in general practice (Distinction). 31st Annual Scientific Meeting of the Society for Academic Primary Care, Birmingham, July 2002

HYPER Trial Turning electronic patient data into useful knowledge (Poster). 31st Annual Scientific Meeting of the Society for Academic Primary Care, Birmingham, July 2002

Use of electronic patient records to inform management of elderly hypertensive patients. WONCA Europe, London, June 2002

Sick to death? The relevance of co-morbidity to persisting inequalities in health. The Scottish School of Primary Care conference: Breaking New Ground, Crieff, April 2002

Predicting risk based on 'routine' general practice data (Invited). ScHARR Spring Symposium: Risk, Sheffield, April 2002

The relevance of co-morbidity to deprivation (Invited). University of Glasgow symposium: Narrowing the inequalities in health gap: what difference can primary care make, Glasgow, April 2002

Use of 'routine' GP data to inform practice (Invited). Annual conference of the Scottish Departments of General Practice, Stirling, January 2002

The state of the science in primary care informatics. American Medical Informatics Association conference, Washington DC, Washington, US November 2001

Sick to death: the relevance of co-morbidity to persisting inequalities in health (Poster). Public Health Institute of Scotland conference, Turnberry, November 2001

The current status of general practice computing systems (Invited). Consumer Health Informatics Network Scotland conference, Glasgow, October 2001

What can "routine" practice data tell us about hypertension in the elderly – the HYPER trial? RCGP Research Symposium, London, June 2001

HYPER Trial: Turning Data into Knowledge. The Scottish School of Primary Care conference: Primary Care Research in Scotland, Stirling, March 2001

The case of the disappearing patient? GP records and memory (Invited: with Graham Smith). Annual conference of the Scottish Departments of General Practice, Stirling, January 2001

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Glossary

The following abbreviations are used throughout this thesis:

ANOVA	Analysis of Variance
ASCII	American Standard Code for Information Interchange
BNF	British National Formulary
BP	Blood Pressure
CVD	Cardiovascular Disease
CHD	Coronary Heart Disease
CHI	Community Health Index
CMR	Continuous Morbidity Recording project
DBP	Diastolic Blood Pressure
DOS	Disc Operating System
ECG	Electrocardiography
EQ	Electronic Questionnaire
GEE	General Estimating Equation
GMS	General Medical Services
GP(s)	General Practitioner(s)
GPASS	General Practice Administration System for Scotland
HDL	High-Density Lipoprotein
ICC	Intra-cluster Correlation Coefficient
ICD	International Classification of Disease
ICHPPC	International Classification of Health Problems in Primary Care
ID	Identifier
ISD	Information and Statistics Division, NHS Scotland
LDL	Low-Density Lipoprotein
LHCC	Local Health Care Co-operative

LREC	Local Research Ethics Committee
LVH	Left Ventricular Hypertrophy
MI	Myocardial Infarction
mm Hg	millimetres of mercury
MONICA	Monitoring Trends and Determinants of Cardiovascular Disease
MRC	Medical Research Council
MREC	Multi-centre Research Ethics Committee
NNT	Number Needed to Treat
NHS	National Health Service
PCCIU	Primary Care Clinical Informatics Unit, Aberdeen University
PCT	Primary Care Trust
ROC	Receiver Operating Characteristic curve
RCGP	Royal College of General Practitioners
SBP	Systolic Blood Pressure
SCIMP	Scottish Clinical Information Management in Primary Care
SEHD	Scottish Executive Health Department
SIGN	Scottish Intercollegiate Guidelines Network
UK	United Kingdom
US	United States
WHO	World Health Organisation
WONCA	World Organisation of National Colleges and Academies of General Practitioners/Family Physicians

Summary

Hypertension is a major risk factor for cardiovascular disease and the main risk factor for stroke. Previous research has demonstrated that treatment of hypertension significantly reduces cardiovascular risk and the incidence of cardiovascular events. Since the prevalence of hypertension increases with age, so the absolute reduction in risk associated with treatment and its resultant benefits are greater in the elderly population. Despite this, a situation known as the rule of halves has been shown to exist. This indicates that half of the hypertensive population are not known, half of those known are not treated and half of those treated are not controlled. Addressing this anomaly requires information on all potentially at risk patients and accessing the large amounts of data held in general practice computer systems is one of the best ways of generating such information. However, whilst practitioners can access the information required to inform management of individual patients, the data required to inform strategic decision making are not as readily available.

The research described in this thesis evaluates the provision of different levels of feedback, developed from computerised data, on identification, treatment and control of hypertension in the elderly. This was done by means of a randomised controlled trial. Fifty two Scottish general practices were recruited and randomised to three groups. A Control group which received no intervention, an Audit group which received feedback of audit data and a Strategic group which received audit feedback plus data prioritising patients by absolute risk of death from stroke. Electronic data on demography, morbidity and prescribing were extracted from practice computer systems annually from 1999–2001 and used to develop feedback. Participants represented both urban and rural practice and a range of practice size, list size and deprivation level.

The data presented demonstrate that over the period of study, the proportion of 65–79 years olds with a blood pressure recorded increased, with the largest improvement seen in the Audit group. At the outset, 30–40% of the patients whose blood pressure was ≥160 / ≥90 mm Hg had been identified as being hypertensive. This improved in all three groups, the improvement made in the Audit and Control groups being two to three times that made in the Strategic

group. The majority of diagnosed hypertensives were initially receiving treatment and this increased to more than 90% in all three groups. The greatest improvement was seen in the Strategic group. Around 40% of treated patients in each group had controlled high blood pressure at the outset of the study and this rose by around 10%. The lowest mean systolic blood pressure was found in the Strategic group, whilst the greatest proportions of controlled hypertensive patients were found in the Strategic and Control groups. However, after adjusting for clustering, patient and practice effects, there was a significant difference in the level of control in the Strategic group compared with the other two groups. Absolute risk was reduced for between 10-20% of patients in each group, with the largest reduction found in the Strategic group. More than 80% of the patients in that group had their blood pressure record updated compared with only half of the patients in the Audit and Control groups. In addition, twice as many patients in the Strategic group had their record changed to reflect that they did not smoke and fewer patients in that group were newly recorded as smokers. There was no significant difference in the numbers of patients in each group who had a stroke during the study period.

Improvements were demonstrated in all aspects of the rule of halves, a finding supported by other studies in this area. Whilst 60% of all hypertensive patients and 40% of treated hypertensives were still not controlled at the end of the study, the results suggest that providing practices with patient specific, strategic feedback can impact on identification and management of hypertension in the elderly, producing a consequent increase in blood pressure control. The study also demonstrates the utility of electronic primary care data and highlights the importance of practice organisation in the management of chronic disease.

Chapter 1

INTRODUCTION

1.1 Chapter overview

This thesis describes a randomised controlled trial designed to evaluate the impact of two different types of feedback, developed from electronic patient records, on management of hypertension in the elderly. This chapter describes the background issues, summarising the basis for the study undertaken. First of all, the burden of hypertension and its role as a risk factor for cardiovascular disease is described, with particular reference to age and the benefits of treating hypertension in older people. This is followed by a summary of record keeping in primary care, including the uptake of computerisation and electronic records, as a means of contextualising the extent and accessibility of electronic clinical data. A description of existing systems of decision support used in hypertension management is then provided, followed by a summary of the use of audit and feedback as an intervention. The chapter ends with the aims and objectives of the study.

1.2 Hypertension as a risk factor

There is a vast worldwide literature on hypertension, its risk factors and its management. The following section draws on a sample of some influential work to illustrate the disease burden created by hypertension, the implications for mortality in older people, the benefits of treatment and finally the current situation as regards hypertension management in primary care.

1.2.1 The burden of hypertension

> *"Hypertension can be defined in terms of a blood pressure level above which investigation and treatment do more good than harm"* (Evans & Rose 1971)

Hypertension is a major global health issue. It affects approximately one billion individuals worldwide and has been estimated to be the third leading cause of the global burden of disease, accounting for 4.4% of ill health (Ezzati et al. 2002). A recent study by Wolf-Maier et al. compared the prevalence of hypertension, taken from the health surveys of The United States, Canada and six European countries, including England (Wolf-Maier et al. 2003a). They found that the prevalence of hypertension in Europe, as denoted by a blood pressure of ≥140/≥90 mm Hg, is 60% higher than in North America (44% *v* 28%). The most recent health surveys in England, Wales (Department of Health 1999) and Scotland (Scottish Executive Health Department 2000) have shown that at this threshold, around 30% of the population of the United Kingdom (UK) is hypertensive. Even if a higher threshold of ≥160/≥95 mm Hg is used, at least 18% have hypertension.

Hypertension is a major risk factor for cardiovascular disease (CVD), the most common cause of death worldwide, (Murray & Lopez 1997). Indeed, the relationship of blood pressure to CVD and CVD related mortality is one which has been found to be continuous and independent of other risk factors (Glynn et al. 1995). Thus, as the level of blood pressure increases, so too does the risk of CVD (Selmer 1992) (Prospective Studies Collaboration 2002).

In the majority of cases, high blood pressure has no significant symptoms and as such, individuals do not usually present seeking care specifically for this condition. Whilst opportunistic screening when a patient attends for symptoms of other conditions often detects hypertension, identification at a population rather than individual level requires more proactive activity on the part of health care providers.

1.2.2 Hypertension and age

As age increases, so too does the level of an individual's blood pressure and consequently, the prevalence of hypertension. The recent Scottish and English health surveys showed that the prevalence of high blood pressure increased from 14–20% for individuals aged 45–54 to 27–40% for those aged 55–64 and to 43–58% for those aged 65–74. Previous work by Staessen et al. showed that the prevalence of systolic hypertension increased from an average of 8% amongst individuals in their 60s to over 25% amongst those in their 80s (Staessen, Amery, & Fagard 1990). Similar age related increases have been shown for diastolic blood pressure (Selmer 1992). As a consequence of this age related prevalence, older patients with hypertension are more at risk of CVD than younger patients (Kannel et al. 1981).

1.2.3. Hypertension and stroke

The Global Burden of Disease Study was initiated by the World Bank in 1992 and carried out over a five year period in collaboration with the World Health Organisation (WHO), with the aim of developing estimates of prevalence, incidence, disability and mortality by age, sex and geographic region (Murray & Lopez 1997). It found that in 1990, cerebrovascular accident, or stroke, was the cause of 4.4 million deaths worldwide, second only to ischaemic heart disease (6.3 million deaths). Another surveillance study, the WHO MONICA project (World Health Organization Monitoring Trends and Determinants in Cardiovascular Disease), was established in the 1980s to register the occurrence of myocardial infarction and stroke as a means of analysing changes in risk factors over time. This work has shown that there is great variation in stroke incidence rates amongst the 16 European and two Asian countries participating (Thorvaldson et al. 1995). In their recent study in Europe and North America,

Wolf-Maier et al. showed that the average mortality rate for stroke in Europe was 41.2 per 100,000 (Wolf-Maier et al. 2003a). In Scotland, whilst the rate has been falling over the last decade, it is still higher than the European average, at almost 50 deaths per 100,000 (Information and Statistics Division (ISD) website; www.isdscotland.org). The stroke mortality rate in Scotland is also higher than in the rest of UK (Registrar General for Scotland 2000), with rates having been shown to be similar for both men and women (Hart, Hole, & Davey-Smith 1999) (Isles et al. 1992).

Whilst hypertension is a risk factor for cardiovascular disease in general, it is the main risk factor for stroke (Kannel et al. 1970) (MacMahon et al. 1990) (Hart, Hole, & Davey-Smith 1999) (Psaty et al. 2001) (Prospective Studies Collaboration 2002) and has been estimated as being responsible for almost three quarters of all strokes (Dunbabin & Sandercock 1990). Furthermore, the incidence of stroke increases with increasing age. Research on the stroke incidence in Auckland, New Zealand showed that the rate increased dramatically, from three strokes per 10,000 individuals aged 30–40, to 300 per 10,000 individuals aged 80–90 (Bonita, Beaglehole, & North 1984). The same researchers also showed that 88% of strokes occurred in those aged over 65 (Bonita 1992). A recent meta-analysis of data relating to one million individuals from 61 observational studies from around the world showed that for those aged 40–69 years, each increase of 20 mm Hg in systolic blood pressure (SBP) or 10 mm Hg in diastolic blood pressure (DBP) doubles the risk of stroke death (Prospective Studies Collaboration 2002). Whilst these data are based on first occurrence of stroke, additional research demonstrates that survivors of a previous stroke have a 15-fold increase of a recurrence compared with the general population (Burn et al. 1994), equivalent to a risk of 8% per year (Lees, Bath, & Naylor 2000).

The majority of strokes are not fatal, but are rather the cause of chronic disability (Wade 1994). Indeed, stroke is the single largest cause of disability in the UK and in 1998 the Stroke Association estimated that there were around 250,000 disabled stroke survivors (The Stroke Association 1998). As such, stroke is a major source of expenditure in the NHS, estimated at around £2.3 billion per year (Department

of Health 1996). Identifying effective strategies for stroke prevention is of major importance.

1.2.4 Benefits of treating hypertension in older people

Several major randomised trials have demonstrated that treating high blood pressure in older individuals has a substantial impact on morbidity and mortality related to stroke.

In the late 1970s, two general practitioners (GPs), Coope and Warrender (Coope & Warrender 1986), conducted a trial with 884 men and women aged 60–79 (mean age 69) who were recruited from 13 general practices in England and Wales. Mean blood pressure on entry to the trial was 196/99 mm Hg. Participants were randomised to active treatment or to a control group and were followed up for an average of 4.4 years. At the end of the study, average blood pressure in the treatment group was 18/11 mm Hg lower than in the control group. Cardiovascular deaths were reduced by 22% in the treatment group compared with the control group and strokes by 42% (12.5 *v* 21.4 per 1000 patient years; $p<0.03$).

The European Working Party on High Blood Pressure in the Elderly conducted a trial in ten European countries involving 840 participants aged 60 or over (mean age 72) who were randomised to receive active treatment or placebo (Amery et al. 1985). All had both systolic and diastolic hypertension, with an average blood pressure of 182/101 mm Hg on entry to the study. Participants were followed up for an average of 4.7 years after which there was an average difference in blood pressure between the two groups of 22/10 mm Hg. Cardiovascular deaths were reduced by 27% in the treatment group and stroke mortality by 32% (11 *v* 16 per 1000 patient years; $p=0.16$). The same group later conducted a trial looking at isolated systolic hypertension, the Syst-Eur trial (Staessen et al. 1997), which involved 4,695 patients aged 60 or over (mean age 70) followed up for an average of two years. Again, participants were randomised to either active treatment or placebo and mean blood pressure at the outset of the trial was 174/85 mm Hg. At the end of the study period, blood pressure in the treatment group was 10.1/4.5 mm Hg lower than in the placebo group and the occurrence of stroke was reduced by 42% (7.9 *v* 13.7 per 1000 patient years; $p=0.003$).

In 1991, the Systolic Hypertension in the Elderly Program (SHEP) Cooperative Research Group reported findings from a trial conducted in the United States (US) involving 4,736 men and women aged 60 years or older (mean age 72) (SHEP Cooperative Research Group 1991). All of the participants had systolic hypertension with a baseline average pressure of 170/77 mm Hg. They were followed up for a period of 60 months, half receiving active treatment and half receiving placebo. At the study end, there was an average difference in blood pressure of 11.1/3.4 mm Hg between the treatment and control groups, in favour of the treatment group, and a significant reduction in stroke risk. Cardiovascular disease was reduced by 32% and strokes by 36% (5.2 *v* 8.2 per 100 subjects; p=<0.000). Subsequent analyses by the group showed that treatment reduced the incidence of both haemorrhagic and ischaemic stroke (Perry et al. 2000).

Around the same time, the Medical Research Council (MRC) conducted a trial involving 4,396 men and women aged 65–74 (mean age 70) (MRC Working Party 1992). They were recruited from 226 practices from Scotland, England and Wales which were part of the MRC General Practice Research Framework, established in the late 1970s. All participants had either isolated systolic hypertension or combined systolic and diastolic hypertension. On entry to the study, participants had a mean blood pressure of 185/91 mm Hg and were randomised to receive a diuretic, beta-blocker or placebo. They were then followed up for an average of 5.8 years. Both treatments reduced blood pressure below the level in the placebo group, the average reduction was 6.3/5.9 mm Hg. Patients in the active groups had a 17% reduction in cardiovascular events and a 25% reduction in strokes compared with the placebo group (8.1 *v* 10.8 per 1000 patient years; p=0.04).

In a study from Sweden, Dahlof and colleagues sought to determine the benefits of treatment on patients aged over 75 (Dahlof et al. 1991). They recruited 1,627 patients aged 70–84 years (mean age 76) from 116 health centres and randomised them to active treatment or placebo. All participants had either diastolic hypertension or combined systolic and diastolic hypertension and were followed up for an average of 25 months. At the outset of the study, participants had a mean blood pressure of 195/102 mm Hg. At the study end, there was an average difference in blood pressure between the two groups of 27/10 mm Hg.

Cardiovascular events were reduced by 40% in the treatment group and strokes by 46% (16.8 *v* 31.3 per 1000 patient years; p=0.008).

Similar results have been shown in trials conducted with elderly patients from Australia (The Management Committee 1981), China (Liu et al. 1998) and Japan (Kuramoto et al. 1981) and in smaller studies, such as the CASTEL study in Italy (Casiglia et al. 1994) and the study by Sprackling et al. in the UK (Sprackling et al. 1981).

In recent years, several meta-analyses have combined the results from these and other studies to give an overall quantification of the effect of treating hypertension in the elderly. Additional analyses have combined the results of the trials in elderly patients with those of trials involving both younger and older individuals, such as the Hypertension Optimum Treatment HOT study (Hansson et al. 1998) and the Heart Outcomes Prevention Evaluation (HOPE) trial (Heart Outcomes Prevention Evaluation Study Investigators 2000). All demonstrate that antihypertensive drug treatment reduces stroke by at least 20% and perhaps by as much as 42% (Blood Pressure Lowering Treatment Trialists' Collaboration 2000) (Staessen et al. 2000) (Insua et al. 1994) (Collins et al. 1990). A meta-analysis conducted by Gueyffier et al. analysed the results of five of the major trials by patient sex and found that the reductions in risk were consistent for both men and women (Gueyffier et al. 1997).

In a review published in Journal of the American Medical Association, Mulrow et al. combined the results from 13 trials involving patients aged 60 or over with 12 trials involving younger and middle aged patients to compare the benefits of treatment in the elderly with the benefits found in younger people (Mulrow et al. 1994). They showed that the number needed to treat (NNT) that is, the number of individuals who need to be treated with antihypertensive medication for five years in order to prevent one adverse cardiovascular outcome, is considerably lower for the elderly than for younger patients. For all outcomes except cardiac mortality, two to four times as many younger patients needed to be treated. Preventing one stroke required treatment of 46 elderly patients compared with 168 younger patients.

Thus, there is considerable research evidence to demonstrate that reducing blood pressure in older patients impacts on the incidence of stroke and other cardiovascular events. The majority of trials in this area were designed to determine the effectiveness of particular active treatments in reducing blood pressure. They did not consider effective ways of identifying the patients who would benefit most from receiving those treatments.

1.2.5 Hypertension identification, treatment and control

In 1968, Julian Tudor Hart carried out blood pressure screening on 100% of the men and 98% of the women in his practice in Glyncorrwg in Wales (Hart 1970). In 1970, Joseph Wilber and Gordon Barrow conducted a study involving 6,000 individuals aged 15 or over from a community of 23,000 adults in Atlanta, Georgia (Wilber & Barrow 1972). Their aim was to determine whether widespread community methods could improve control of hypertension and women from the target or adjacent neighbourhoods were trained to carry out screening. What these and other community surveys demonstrated was that half of those with high blood pressure were not know, half of known were not treated and half of those treated were not controlled. This situation became known as the 'rule of halves'. Subsequent studies in the UK have shown that although improved, the rule of halves still exists.

Smith et al. used data from the Scottish heart health study on 450 men and women aged 40–59 to audit the detection, treatment and control of adults in Scotland (Smith et al. 1990). They found that hypertension was undetected in 53% of men and 46% of women, detected but untreated in 42% of men and 33% of women and treated but uncontrolled in 50% of men and 40% of women. Data from the Scottish MONICA surveys were used to revisit the rule and showed that whilst improvements have been made, the rule still applies. In 1995, only 33% of treated hypertensives were controlled (Chen et al. 2003). In the British family heart study, carried out in 26 general practices around Scotland, England and Wales, the study group found that one third of men and one sixth of women with previously undetected high blood pressure had a diastolic reading of ≥90 mm Hg (Family Heart Study Group 1994). Only 24% of those with reported high blood pressure

were taking medication and almost two thirds of those who were diagnosed (64%) were not adequately controlled.

Fahey and Lancaster analysed the case records of 2,428 patients aged 65 or more registered with 27 practices in Northamptonshire, England (Fahey & Lancaster 1995). They found that whilst the majority of patients had a blood pressure recorded (86%), 49% of those with a blood pressure of ≥160/≥90 mm Hg were untreated and only 42% of those diagnosed were adequately controlled. Cranney et al. audited the case records of 6,139 patients aged 65 or more recruited 76 general practices in Merseyside, England, (Cranney, Barton, & Walley 1998). Almost half of the patients were identified as hypertensive (43%), 64% were receiving antihypertensive medication, but only 37% of those being treated were controlled.

In a recent study by Hooker et al., the computer systems of 22 general practices in London were used as a means of determining the rule of halves (Hooker et al. 1999). Even using less rigorous assessment criteria, based on the expected prevalence of hypertension in the elderly (identification), presence of an electronic blood pressure recording (treated) and mean SBP and DBP over a one year period (control), the researchers still found that only 74% of hypertensives were identified, 67% were treated and 61% were controlled. Duggan et al. reviewed the records of 6,986 patients from 51 practices in the former Northern Region of England (Duggan et al. 2001). Blood pressure status was undetermined in 30% of patients, whilst 70% of those diagnosed as hypertensive were treated and only 30% of those were controlled. In all, only 14% of elderly hypertensive patients were identified, treated and controlled.

Work elsewhere has demonstrated that the rule of halves also applies to other populations. In a study using the Northern Sweden MONICA cohorts, Weinehall et al. showed that 27% of those with hypertension were treated and only 29% of those were controlled (Weinehall et al. 2002). A study on trends in detection, treatment and control in the adult population of Belgium showed that whilst all phases improved between 1980 and 1992, 53% of male and 26% female hypertensives were still untreated and only 35% and 16% respectively were controlled (De Henauw et al. 1998). In the Unites States, work has shown that

there have been significant improvements since the first National Health and Nutrition Examination Survey in 1960 (Burt et al. 1995) (Chobanian et al. 2003). The proportion of treated hypertensives was 59% in 2000, an increase of around 30%. However, even with an increase of 25% on the 1960 total, the proportion of controlled hypertensives was still only 34%. A recent comparison of treatment and control in five European countries, Canada and the US, showed that control of hypertension in the European population is on average 37% less than in the US and 20% less than in Canada (Wolf-Maier et al. 2003b). The rule of halves has also been shown to be relevant to the hypertensive populations in Spain (Compan et al. 1998), India (Deepa et al. 2003) and in Afro-Caribbean countries (Cruickshank et al. 2001).

Thus, despite the benefits arising from the treatment of hypertension at any age, but particularly in elderly patients, the rule of halves remains an ongoing problem worldwide.

1.2.6 Absolute or relative risk?

Studies considering hypertension and the risk of stroke often vary in their description of risk. The majority report evidence in terms of relative risk, despite the fact that in clinical practice, absolute risk is as, if not more, relevant.

Absolute risk relates to the probability of an event happening in the population under study, that is, the incidence of the event in that population. For example, the absolute risk of death associated with coronary angiography is 0.1% or one death per 1000 individuals. Relative risk on the other hand is the ratio of two absolute risks, such as the risk of death in a population with a specific disease compared with the risk of death in a population without that disease.

Whilst the relative risk of death associated with raised blood pressure is greater in younger people, since the average blood pressure in that group is lower and high pressures less common, there is a higher level of absolute risk of death associated with age. In a commentary in the British Medical Journal in 1981, Geoffrey Rose presented age and blood pressure related mortality data for four groups of men based on both relative and absolute risk (Rose 1981). He demonstrates that the relative risk of death does increase as blood pressure increases, regardless of age,

but that the incline lessens as age advances. This is likely due to the fact that blood pressure increases with age and as such, a systolic pressure of 160 mm Hg is not as uncommon in older people. However, when the same data are presented for absolute risk, whilst there is still an increase in risk as blood pressure increases, the increase is most pronounced in the older age groups. So, there are twelve deaths per 1000 in men aged 30–39 with an SBP of 160 mm Hg, compared with 83 deaths per 1000 in men aged 60–69. In an article published ten years later (Rose 1991), Geoffrey Rose reiterates a point made in his earlier piece when he writes,

> *"All policy decisions should be based on absolute measures of risk; relative risk is strictly for researchers only"*

Since the risk of hypertension related death is greater in elderly patients than in younger patients, the risk reductions achieved through treatment and control of high blood pressure are also greater in this group. In view of this, the study reported in this thesis focused on patients' absolute risk. A summary of available risk prediction tools and the method used in this study are described in chapter 5.

1.3 Record keeping in primary care

1.3.1 The origins of record keeping

> *"The traditional medical record ..... is a vital part of the picture that he [the general practitioner] builds up of his patient to be able to recall with what frequency the patient consults him, whether a child has had measles, how many pregnancies a woman has had, and what was the outcome..." (Working Party of the Royal College of General Practitioners 1972)*

An influential report on quality assessment in general practice, states that primary care records are *"more than an aide-memoire to the doctor or nurse"*. Good quality record keeping is regarded as an *"essential aspect of care"* (Roland, Holden, & Campbell 1998) and it has been suggested that poor, incomplete record keeping may hide poor practice.

The records used in general practice in the UK today originate from the 1911 National Insurance Act, which obliged GPs, *"to keep such medical records as might be required of them under their conditions of service"*. As part of pay negotiations the following year, the then Prime Minister, Lloyd George, maintained that record keeping was one of the duties of a GP. However, the system introduced to facilitate this, day sheets which covered six square feet of table space, were cumbersome and failed to meet the needs of both clinical practice and preventive medicine (Honigsbaum 1979). Eight years later the Rolleston Committee was established to look at the form that these records might take and the Lloyd George envelope and record card emerged as the standard format. This provided the first method of continuously recording patients' attendance, diagnosis and treatment.

In 1921, regional medical officers were introduced in England to inspect the new records and ensure that they were kept. In contrast, the Board of Health in Scotland took a different approach and tried to promote record keeping through its research programme, beginning in 1930 (Honigsbaum 1979). Whilst record keeping was widely practised, the records themselves were often incomplete.

Clinical notes tended to be made only for more serious conditions, such as those that required certification off work, referral or operations (Digby 1999).

From 1950 onwards, there were proposals to improve the format of patient records, although none were widely adopted and the Lloyd George envelope continued to be extensively used. In 1967, the Department of Health supported a trial of A4 records and a year later the Scottish Council of the Royal College of General Practitioners (RCGP) began a major study of the A4 record scheme. This was put forward as a replacement for the Lloyd George envelope in both 1974 and 1977, but there were still conflicting views as to its merits and plans to introduce it as the standard throughout the UK were never fulfilled. In 1983, however, it was offered to any practice in Scotland that wanted to use it.

1.3.2 The advent of electronic records in the UK

Electronic record keeping emerged in parallel with manual systems and first came into the UK health service in the 1950s. Early development of computers focussed on their use for collecting and administering what was already being called 'routine patient data'.

Some of the earliest work was carried out as part of the Oxford Record Linkage Study and sought to demonstrate whether it was practical or indeed beneficial to collate patient health data. Records which had previously been held by various health professionals were pulled together into one centralised record (Acheson 1964) (Acheson & Forbes 1968) (Perry 1972). Systems for complete health centres also became operational around this time, with the purpose of allowing GPs and other health professionals to enter and access information during consultations (Abrams et al. 1968) (Abrams 1972).

By the end of the 1960s, a minority of innovative GPs were not only using systems for administrative activities, but were also using them for activities more related to patient care, such as running screening and immunisation programmes (Hodes 1968) or recording morbidity data (Dinwoodie 1969). In Livingston, which was at the forefront of primary care computerisation in Scotland, the impact of an electronic records system on health centre personnel was also being

tested (Gruer & Heasman 1970). Even at that time, the research team reported that the most,

> *"effective, practical assistance so far provided by the computer is in the preventive field of the practitioner's work"*,

and that one of the essential requirements in the development of the system was,

> *"...provision of adequate methods of population surveillance..."*

This early work had all depended on remote batch processing of patient data, where data from individual patients encounters was collected, but collectively entered in a single session, usually out with surgery hours. In 1970, the first real time data systems began to emerge (Preece et al. 1970) (Lippman & Preece 1971), allowing practitioners to access and enter data when required, using microcomputers situated in practice. Many aspects of the electronic medical records used today originate from this system, including patient history, repeat medication and recall for immunisations.

1.3.3 Implementation of electronic records

The Royal College of General Practitioners has been in favour of electronic patient records since the late 1970s, when its Computer Working Party [established in 1978] published a report considering,

> *".... the desirability and practicability of the use of computers for general practice clinical records...."* (Royal College of General Practitioners 1980)

However, it was another decade before computer use became widespread. The government's 'Micros for GPs' scheme, launched by the Department of Trade and Industry in 1982 as part of Information Technology Year, was the first real step towards universal general practice computerisation. Under the scheme, 150 practices in Britain received 50% of the cost of installing a particular computer system, either CAP (UK) or British Medical Data Systems. These systems were designed for patient registration, repeat prescribing and screening and recall and

in return practices agreed to participate in an evaluation of their use over a three year period. Although the scheme attracted criticism at the time, mainly over the lack of choice of available computer systems, more than 1000 practices applied to participate (Project Evaluation Group 1985).

In 1987, VAMP (now InPractice Systems) and AAH Meditel, two of the largest computer suppliers in the country, introduced no-cost computer schemes whereby practices were offered free multi-user computer systems in return for anonymous patient data on morbidity and repeat prescribing. As a result, 19% of practices in England and Wales had become computerised by 1988 rising to 28% by 1989 (Department of Health 1993). The situation in Scotland, however, was somewhat different.

1.3.4 The situation in Scotland

When the Micros for GPs scheme ended, the 16 participating Scottish practices were concerned that the progress and enthusiasm for computerisation that had been created would wane. To prevent this, David Ferguson, a Glasgow GP, offered a software package that he had designed in 1984, originally as a repeat prescribing system, and the General Practice Administration System for Scotland project (GPASS) was established. Development of the system has been financially supported by the Scottish Executive Health Department (SEHD) since 1984 and offered free to any practice with compatible hardware. Encouraged both by the success of the system and by the SEHD incentive, the number of computerised practices in Scotland had risen to 27% by 1988 and to 36% by 1989, covering more than one third of the total patient population (Ryan 1989).

1.3.5 Impact of the 1990 contract

Undoubtedly, the greatest catalyst in the drive towards electronic records in the UK came in the shape of the 1990 General Medical Services contract for general practice. The contract placed greater emphasis on health promotion, identification of at risk groups and disease prevention. As a means of ensuring that practices fulfilled these requirements, remuneration was linked to targets. To receive maximum payment for activity, practices had to identify all relevant patients. Not only did they need to identify groups of patients by age and sex, they now also

had to identify them by disease. Categorising and identifying patients in this way is quicker and easier on a computer than with paper records. As part of the contract, the Department of Health offered 50% reimbursement on the acquisition and running costs of computer systems. These factors led to an increase in the number of computerised practices from 28% in 1989 to 47% following the introduction of the contract and to 63% in the following year (Department of Health 1998).

1.3.6 The classification of electronic data

With the emergence of technology to store patient data electronically, came the need to categorise those data in a useful and meaning way.

Attempts to classify disease began in the early 1700s and by the beginning of the 19th century, the most widely used system was the *Synopsis Nosologiae Methodicae*, published in 1785 by William Cullen (1710–1790) (World Health Organisation 1993). When the General Register Office of England and Wales was established in 1837, William Farr (1807–1883), the first medical statistician, set about improving the Cullen classification. The system continued to develop, and with support from various individuals, including Florence Nightingale, it was expanded to include diseases resulting in measurable morbidity. Ultimately, the classification evolved into the *International Classification of Diseases* (ICD) which has been in routine use since 1945.

The prime function of ICD was to classify causes of mortality and the reasons for going to hospital and as such, it was considered biased towards secondary care and not suited to general practice. Consequently, various community oriented classifications were produced in several countries, including the RCGP's own system (College of General Practitioners 1959). In 1972, a WONCA working party (World Organisation of National Colleges and Academies of General Practitioners/Family Physicians) began developing a common system, the *International Classification of Health Problems in Primary Care* (ICHPPC), which was accepted by all countries during the sixth World Conference on General Practice in 1974 (WONCA Working Party 1976).

When planning the third UK National Morbidity Survey in 1981, the RCGP discovered that the updated ICHPPC-2 (WONCA 1979) now contained fewer codes than had been used in their 1971 survey. Since one of the objectives was to compare the data over time, a method of integrating ICHPPC-2 with ICD was developed to provide the missing information. Following the survey, the RCGP began to formalise this new system, eventually resulting in the *Classification and Analysis of General Practice Data*, the first classification specifically designed for use with electronic records (Royal College of General Practitioners 1986).

By the late 1980s, when levels of primary care computerisation were increasing, several methods of classifying electronic clinical data were available. In 1987, the Joint Computing Group of the RCGP and the General Medical Services Committee of the British Medical Association were given the remit of considering the various systems, with a view to use of a single system. They recommended that the *Read Clinical Classification*, be adopted as the standard general practice morbidity coding system in the UK (GMSC-RCGP joint computing group technical working party 1988). This is now the most commonly used coding system in UK general practice. Each piece of patient data is stored as an alphanumeric code, allowing rapid data access and retrieval. The Read Clinical Classification is discussed in detail in chapter 4.

1.3.7 Use and extent of electronic records

Patient records serve a variety of functions, which vary between general practices both in level and degree of use. The most common uses include documenting the patient's history, prescribing, screening and administration (Richards et al. 1998). Computerisation of records has provided the ability to collate and sort patient data and 'flag' patient files to highlight particular issues or act as a reminder to perform a particular task. In addition, these records can be used to audit current practice or for research purposes. They also form the basis of a medico-legal document for litigation.

In its most recent surveys on computerisation in primary care in England and Wales, the Department of Health found that the majority of responding general practices used electronic records for patient registration (98%), repeat prescribing (94%) and for maintaining clinical records (90%). Two thirds of the practices

entered clinical data during consultations (66%), whilst 63% used them to flag records for follow up tasks (Department of Health 1993). Similar figures were reported in a recent Scottish survey (Morris et al. 2003). The majority of respondents used electronic records for repeat prescribing (84%), whilst 63% recorded clinical information. Almost three quarters (72%) used their records for chronic disease management.

The Department of Health survey also showed that receptionists (92%) and secretaries (65%) are two of the largest users of electronic records, unsurprising given the high proportion of practices using records for patient registration data and recall. Doctors (80%) and practice nurses (76%) were also high users, but use among attached nurses (8%) and health visitors (11%) was uncommon. However, findings from the survey by Morris et al (2003) show that use amongst the practitioner groups has increased, particularly nurses. Almost all GPs used computerised records (94%), 91% of them whilst in the consulting room. Eighty five percent of practices nurses were frequent or occasional users, as were just over half of community nurses (55%) and health visitors (56%).

Thus, electronic records are widely used by members of primary care teams. Their use both during and out with consultations has resulted in datasets containing a wealth of data relating to patient demographics, morbidity and prescribing.

1.4 Use of computers for disease management

The widespread adoption of electronic patient records in primary care and the consequent application of computers to the consultation enabled the use of information technology to move beyond the administrative and towards facilitating improvements in the management of disease. Previous research has shown that use of computers and electronic patient data can lead to improvements in the organisation and outcome of care. A previous systematic review, conducted by the author as an update to her previous review (Sullivan & Mitchell 1995), assessed the impact of computers on primary care practitioner performance and on patient outcomes (Mitchell & Sullivan 2001). The majority of identified studies focussed on immunisation or preventive tasks and demonstrated that practitioner performance of these activities increased by as much as 34% (Rosser et al. 1992) (McDonald, Hui, & Tierney 1992) (Singh et al. 1992) (Chambers et al. 1991) and 47% (McDonald et al. 1984) (Tierney, Hui, & McDonald 1986) (Harris et al. 1990) (Burack et al. 1996) (Garr et al. 1993) respectively when a computer was used. Many of the studies on preventive activities involved the use of electronic reminder systems, where the greatest increases occurred when the practitioner was prompted as part of the consultation. However, some studies found that rates fell to pre-intervention levels (Chambers et al. 1991) or to levels similar to that of control practices (McDowell, Newell, & Rosser 1990) when the reminders were stopped.

Studies on prescribing showed that computer use increased prescribing of generic rather than proprietary drugs (Gehlbach et al. 1984), led to reductions in prescribing costs (Donald 1989) (Jones et al. 1996), led to time savings (Roland et al. 1985) and facilitated improved management through decision support to prevent drug interactions (Davidson, Kahn, & Price 1987).

Computers have also been found to have positive effects on disease management, primarily through the use of decision support systems incorporating electronic protocols, algorithms, electronic alerts and reminders, although improvements could also result in increased consultation length. These various methods have led to differing levels of improvement in standards of care for diabetes (Mazzuca et al. 1990) (Lobach & Hammond 1994) (Lobach 1996) (Mitchell, McConnachie,

& Sullivan 2003), in management for patients with HIV (Safran et al. 1996), in compliance with management plans for childhood illnesses (Margolis et al. 1992) and in the management of anticoagulation therapy (Fitzmaurice et al. 1996). Other studies have highlighted the difficulties involved in examining computer use by practitioners. In one study of decision support for lipid management, no real differences were demonstrated and in addition, system usage was less than expected (Hobbs et al. 1996). In another, the introduction of a computer algorithm for paediatrics did increase recording and compliance with management plans, but physicians found it 'too tedious to use during routine care' and the study was abandoned after five weeks (Margolis et al. 1992).

As part of the review, the methodological adequacy of included studies was assessed using a scoring technique which had been used in two earlier reviews of computerised clinical decision support systems (Johnston et al. 1994) (Hunt et al. 1998). The majority of studies received a relatively high overall rating (median 6/10; inter-quartile range 4-8), due in the main to their use of a rigorous trial methodology and attempts to minimise between group differences. However, more than three quarters of these studies were open to possible bias as a result of the unit of allocation used. Whilst the computer interventions studied were applied at the level of practitioner, study outcomes were generally measured at a patient level. Indeed, more than half of the studies randomised by patient, while a further quarter randomised by individual practitioner. By not allocating complete clusters such as practices, these studies may have created the potential for crossover contamination between groups, as practitioners either treated both intervention and control patients or acted as their own controls. In addition, they may have underestimated the statistical power required to demonstrate meaningful differences. Consequently, the true effect of the interventions is difficult to determine.

Nonetheless, it does appear that positive effects on practitioner performance have been demonstrated, particularly in relation to preventive care, prescribing and disease management. In their review, Hunt et al. concluded that 66% of the systems studied had improved patient care (Hunt et al. 1998) and more recent studies have continued to demonstrate varied levels of success. Improvements have been shown for cancer screening (Burack et al. 2003), provision of

preventive care to communities living in remote areas (Bailie et al. 2003), management of diabetes (Meigs et al. 2003) (Montori et al. 2002), prescribing (Tamblyn et al. 2003) and prevention of drug related morbidity (Morris et al. 2004). Other studies, however, showed no significant improvements when computers were used, for example in the management of asthma (McCowan et al. 2001), asthma and angina (Eccles et al. 2002) and heart disease (Tierney et al. 2003).

A recent update of the review by Hunt and colleagues, which incorporated a further 37 articles, again found that more than 60% of the systems studied had improved practitioner performance (Garg et al. 2005). The authors also demonstrated that the methodological quality of studies has improved over time; 36% of trials published before the year 2000 used cluster randomisation, compared with 67% after 2000. In addition, they reiterated the findings of previous work (Sullivan & Mitchell 1995) (Hunt et al. 1998) (Mitchell & Sullivan 2001) by concluding that the effects of computer use on patient outcomes remains understudied. Those studies which did examine patient health often had inadequate statistical power to detect clinically significant differences and consequently few have demonstrated any patient benefits.

1.4.1 Decision support in the management of hypertension

Several studies have also determined the impact of the use of electronic decision support as a means of improving management of hypertension.

Electronic protocols have been shown to increase recording of blood pressure and other cardiovascular risk factors. In Sheffield, England, use of a protocol which prompted for entry of data relating to new events, physical examination, including blood pressure, and decisions regarding care was evaluated for use during consultations for chronic hypertension (Brownbridge et al. 1986). Whilst use of the protocol led to a statistically significant increase in the number of physical examinations conducted, practitioners found it time consuming and average consultation length increased by a third. The researchers concluded that the verbal examination required to elicit relevant information from patients was too detailed and potentially inappropriate for use in routine consultations. In London, use of an electronic protocol by health promotion nurses and GPs led to a 20%

increase in blood pressure recording over a five year period compared with the control group (93% *v* 73%, p<0.001) and an increase of 28% in recording for diagnosed hypertensive patients (97% *v* 69%, p<0.001) (Robson et al. 1989). There was also a significant increase in recording of smoking status (73% *v* 57%, p<0.001).

Studies evaluating the use of electronic reminders have shown improvements in blood pressure recording and follow up. McDowell et al. compared the use of passive reminders (electronic reminder to practitioner at time of appointment) with active reminders (computer generated letter and telephone list) in a trial involving 8,298 patients from practices in Ottawa, Canada (McDowell, Newell, & Rosser 1989a). They found that the computer generated letter had the greatest effect and increased recording by 15% more than in the control group, compared with 10% for the practitioner reminder and 3% for the telephone reminder (p<0.001). In addition, a greater number of elevated blood pressure readings were detected in the practitioner and letter reminder groups compared with the telephone and control groups. In Boston, Massachusetts, Barnett et al. (Barnett et al. 1983) compared automated surveillance utilising the electronic medical records system to generate a practitioner reminder designed to improve follow up of newly diagnosed hypertensive patients. At 12 months, follow up was attempted or achieved for 84% of patients in the experimental group compared with 25% in the control group (p<0.01) and 98% compared with 46% after 24 months (p<0.01). There was also a significant difference in the proportion of patients who either had a diastolic blood pressure of <100 mm Hg or were on treatment (70% *v* 52%, p<0.01).

Previous work has also shown benefits in providing computer generated feedback as a means of improving care. In the main, this has been based on general practitioners completing a data collection form after each patient visit. The forms are then sent to a remote centre where the data are entered into a computer which generates feedback. In a study in Toronto, Canada, McAlister et al. found that although not statistically significant, mean DBP of patients with moderate hypertension (DBP >104 mm Hg) in the intervention practices fell below the goal of 90 mm Hg, but this was not the case in the control practices (88.5 mm Hg *v* 93.3 mm Hg) (McAlister et al. 1986). There was also a greater mean reduction in

DBP in the intervention group (21.7 mm Hg *v* 16.7 m Hg, p<0.06). In addition, fewer of the patients whose practitioners had been given feedback had dropped out of follow up treatment after three months (37.5% *v* 42.1%, p<0.03). In a study in the Netherlands, van den Hoogen and colleagues found that 31% more hypertensive patients were under permanent surveillance in the intervention group compared with the control group (76% *v* 45%) (van den Hoogen & van Ree 1990). They also found that the target diastolic pressure of 95 mm Hg was achieved in 14% more patients in the intervention group (70% *v* 56%). Dickinson et al. evaluated the impact of computer generated feedback against and with a practitioner education programme (Dickinson et al. 1981). The average number of appointments for patients in the feedback group was twice that found in the control group (4.2 v 2.2, p<0.05), suggesting that feedback led to greater scheduling of appointments. However, there was no statistically significant difference between the groups in relation to change in blood pressure levels or the proportion of patients controlled.

Finally, several studies have determined the benefits of computerised decision support for hypertension management, but have reported conflicting results. In the late 1970s in Chicago, US, a computerised algorithm was used to generate treatment recommendations for patients attending hypertension clinics. This was compared with standard treatment by physicians (Coe, Norton, & Oparil 1977). The researchers found no significant difference between the groups in relation to average reductions in blood pressure (SBP 19.5 mm Hg *v* 18.3 mm Hg; DBP 13.4 mm Hg *v* 14.5 mm Hg) or in prescribing patterns. In the Netherlands, van der Lei et al. compared an integrated decision support system to audit GP management of hypertension, 'HyperCritic', with review by a panel of physicians (van der Lei et al. 1991). The reviewers agreed with 260 of 468 (56%) management comments that had been made by practitioners; the system agreed with 118 (25%) of these. The main reasons for the discrepancy related to insufficient data in electronic medical records and omissions in the HyperCritic database. In Norway, an external computer programme, which was accessible from the main records system and guided practitioners in diagnosis, history and examination, was compared with usual care (Hetlevik, Holmen, & Kruger 1999). Use of the system resulted in a small but significant difference in diastolic pressure in favour of the intervention group (1 mm Hg, 95% CI 0.17, 1.89). In addition, a significant

difference in baseline systolic pressure which had been in favour of the control group was reduced from 2.7 mm Hg to 1.2 mm Hg. More recently, Montgomery at al. investigated the effect of a decision support system and risk chart, based on the New Zealand guidelines for hypertension management (Jackson 2000), on absolute cardiovascular risk for diagnosed patients in practices in Avon, England (Montgomery et al. 2000b). They found that patients in the decision support group were no more likely to have their risk reduced below 10% than patients in the chart only or control group (11% *v* 15% *v* 12%). Nor did they have greater reductions in mean blood pressure levels. The only significant difference was that the chart only group had a lower mean SBP when compared with the control group (4.6 mm Hg, p=0.02).

1.4.2 Strategic versus individual clinical decision support

Systems for decision support can either be 'passive', providing information on demand, or 'active', presenting recommendations for a particular course of action or preventing further action unless mandatory stages in a process have already been completed. Both types of system are already being used in practice. These include the electronic British National Formulary (BNF), which provides information on the clinical use of medicines, PRODIGY (Prescribing RatiOnally with Decision support In General practice studY (University of Newcastle 2000), a system designed to provide scenario based clinical knowledge about common conditions and symptoms seen in primary care, and electronic referral letters such as those used in the Scotland wide Electronic Clinical Communications Implementation programme (Pagliari, Gilmour, & Sullivan 2004).

However, with few exceptions, the decision support systems that have been used in the management of hypertension have concentrated on the provision of individual clinical decision support. That is, systems which aid decisions made about individual patients at the time of their consultation. That being the case, they are reliant on patients attending for treatment, or at least on the GP accessing the patient's record for some reason. Additionally, such systems often involve software programmes external to the practice records system, requiring manual entry of patient data which is already held elsewhere. Thus, existing systems are unlikely to provide comprehensive support in situations such as the rule of halves

since they do not readily facilitate care for those who have not yet been identified or who may have been lost to follow up.

Conversely, strategic decision support is based out with the individual patient consultation. This approach involves using information to review existing care or assist in the delivery of care at a population level rather than at an individual patient level. It is a method of targeting care to those who need it most, such as high risk groups. It is therefore a method which requires information relating to all those in need of care, not just those who are already diagnosed with a condition or attending for treatment. General practice computing systems were not designed with the clinical effectiveness agenda in mind, but rather the administration and collection of data relevant to individual patient care. Hence, the information required to facilitate a population based approach to decision making is not readily accessible to the practice team, although it is likely to be stored in the practice system.

Query programmes have been developed for use in the National Health Service (NHS) to allow interrogation of practice databases as a means of facilitating improvements in practice profiles and disease registers. The MIQUEST (Morbidity QUery Information Export SynTax) project enables extraction of data from different types of computer system using a common query language (Neal, Heywood, & Morley 1996). The NHS Information Authority is responsible for the software, which is compatible with most of the major commercial computer suppliers. Using local facilitators who liaise and work with practices, the system allows improvement of chronic disease registration and identification of under recording at a practice level and comparative analysis of practice activity at a Primary Care Trust (PCT) level. In Scotland, the majority of practices use the national computer system, GPASS, rather than commercial systems. The Primary Care Clinical Informatics Unit (PCCIU; formerly the GPASS Data Evaluation Project) at the University of Aberdeen developed software similar to MIQUEST for use with GPASS. The Electronic Questionnaire (EQ) extracts data held on the practice system; these are then analysed to produce practice specific reports on disease prevalence and prescribing. The PCCIU team also initiated the Continuous Morbidity Recording project (CMR), in which volunteer practices

return monthly EQ data. This project is now maintained by ISD Scotland as the CMR System for Scotland (www.isdscotland.org).

These interrogation programmes provide an opportunity to utilise existing primary care data for strategic purposes. By incorporating additional methods, such as data linkage and risk factor scores, it is possible to use these data to generate information which may assist practices in targeting and managing high risk groups, such as elderly hypertensive patients.

1.5 Feedback as an intervention

Research on interventions to enhance management of hypertension has shown that even when generated remotely, feedback can provide benefits related to improved care. This is described in more detail in section 1.4.1. Previous studies have demonstrated reductions in diastolic blood pressure, improved rates of follow up, and reduced drop out rates (McAlister et al. 1986) (van den Hoogen & van Ree 1990) (Dickinson et al. 1981).

The provision of feedback generated from audit is a commonly used method of impacting on clinical practice. It is also one which has met with varying degrees of success. The most comprehensive evidence comes from systematic reviews of the area.

Mugford et al. carried out a review of 36 studies to determine the impact of feedback of information on clinical practice (Mugford, Banfield, & O'Hanlon 1991). They differentiated between 'passive' feedback (the unsolicited provision of feedback with no stated requirement for action) and 'active' feedback (where the practitioner's interest in a particular aspect of practice has been engaged). They reported that passive feedback, such as presentations at medical conferences or mailed drug brochures, tended to have little effect. Conversely, active feedback, such as feedback of cost information or information relating to specific preventive care recommendations, whilst changes were small, did lead to some improvements. The authors' conclusion was that feedback has the potential to influence practice if it is part of an overall strategy and targets those who have already agreed to review their practice.

A subsequent review by Davis et al. synthesised 99 studies on the effects of continuing medical education strategies on physician performance (Davis et al. 1995). The review incorporated 24 studies on audit with feedback and the authors found that ten of these demonstrated a positive impact on behaviour, whilst 14 demonstrated a negative impact. In another review published that year, these same authors reported that the effectiveness of feedback across different types of clinical behaviour ranged from nil to moderate (Oxman et al. 1995). However, they also concluded that,

"There are no 'magic bullets' for improving the quality of health care, but there are a wide range of interventions available that, if used appropriately, could lead to important improvements in professional practice and patient outcomes"

Balas et al. conducted a meta-analysis combining trials that evaluated peer comparison feedback, which they defined as 'physician profiling' (Balas et al. 1996). They found that ten of the twelve studies included showed positive effects related to the provision of feedback. The results of the meta-analysis showed a statistically significant, but modest, effect of peer comparison feedback on various clinical procedures, including, screening, prescribing and test ordering.

In a recent update to a previous overview of systematic reviews related to changing provider behaviour (Bero et al. 1998), Grimshaw et al. demonstrated that passive feedback, such as the distribution of guidelines, is generally ineffective, regardless of the importance of the topic (Grimshaw et al. 2001). Interventions involving audit and feedback alone were found to be of variable effectiveness. However, they found that multifaceted interventions, such as a combination of audit and feedback with reminders, were consistently effective at promoting changes in practice. Oxman et al. (Oxman et al. 1995) have previously defined a reminder as,

"any intervention that prompts the health care provider to perform a clinical action. Examples include concurrent or inter-visit reminders to professionals about desired actions such as screening or other preventive services..."

Grimshaw and colleagues have recently published an additional review on the effectiveness and efficiency of guideline dissemination and implementation strategies (Grimshaw et al. 2004). In this review, unlike many of the previously published reviews, the authors have attempted to account for methodological weaknesses in the primary studies included, in order to provide a more accurate indication of the true effects of the various strategies designed to change provider behaviour. Of the 235 studies included in the review, 10 evaluated audit and feedback as a single intervention, whilst a further 57 studies evaluated it as part of a multifaceted intervention. Many of these studies had unit of analysis errors, and

whilst Grimshaw et al. concluded that the evidence related to audit and feedback was less robust than the evidence for other interventions, they also stated that audit and feedback, whether used alone or in conjunction with other interventions, did appear to result in modest effects. In addition, and in contrast to the findings of their previous review, they concluded that multifaceted interventions were effective, but did not appear to be more effective than single interventions, nor did the effects of multifaceted interventions increase incrementally with the number of components.

In 1998, Thomson et al. published the results of a Cochrane review comparing audit and feedback with alternative strategies to impact on practice (Thomson et al. 1998). Their conclusion was that audit and feedback might be effective. However, they also reported that few trials had altered the way in which audit and feedback could be done, including the source of the information, the recipient (individual or group), the format or the content. This review has since been updated and the authors report that audit and feedback can be effective in improving professional practice (Jamtvedt et al. 2004). The size of that effect varies greatly from apparently negative effects to very large positive effects. However, despite the update containing 85 studies, only two of those compared feedback of differing content. Like Grimshaw et al., the authors did not find evidence of a larger effect for multifaceted interventions compared with audit and feedback alone.

Thus, whilst previous work has demonstrated a positive impact from providing feedback for the management of hypertension, evidence relating to the type of feedback which has the greatest effect on practice is still relatively scarce. However, it would appear that providing multifaceted feedback, containing more than routine audit data, is likely to be of value, although not necessarily more effective than audit and feedback alone. Furthermore, linking feedback to the analysis of electronic patient data, which is not always accessible to practitioners, would appear to be a feasible method with which to impact on decision making related to identification, treatment and control of hypertension in the elderly. Indeed, the authors of a paper on the role of electronic records in primary care suggest that process monitoring and ongoing performance feedback, or 'quality improvement', can encourage compliance with guidelines (Elson & Connelly

1995). Thus, the study reported in this thesis sought to apply such a method to compare two different types of feedback, one containing audit data only, the other containing audit data plus strategic data on individual patient risk.

1.6 Aims of the research

The review in this chapter has demonstrated that hypertension in all age groups is a major risk factor for cardiovascular disease, and for stroke in particular (Kannel et al. 1970) (MacMahon et al. 1990). As systolic and diastolic pressure increase with age, so too does the prevalence of these disorders (Kannel et al. 1981). Research has shown that treatment of hypertension produces significant reductions in risk (SHEP Cooperative Research Group 1991) (MRC Working Party 1992) and the absolute reductions provided by treatment are greater in elderly patients (Dahlof et al. 1991). As a consequence, the numbers of elderly hypertensive patients who need to be treated for one year in order to prevent a cardiovascular event is considerably lower than for the younger age group (Mulrow et al. 1994).

The literature suggests that half of the hypertensive population are not known, half of those known are not treated and half of those treated are not controlled (Wilber & Barrow 1972), a situation known as the rule of halves. Despite the benefits that can be achieved through treating older patients at lower levels of blood pressure, the rule of halves also applies to this group.

The last two decades have seen a major increase in primary care computerisation in the UK (Department of Health 1993) (Department of Health 1998). Yet despite this, computers are still primarily used for routine functions such as preventive tasks and prescribing (Mitchell & Sullivan 2001). Various members of the primary care team use desktop computers to access and enter data during consultations and this has provided practices with a large central database of patient information. If general practices are to address the rule of halves for elderly hypertensive patients, or indeed, other long term health problems, one of the most effective policies is likely to be through the adoption of a strategic approach to decision making. In this way effort and resources can be targeted at high risk groups, who are most likely to benefit from treatment and control. This requires information on all patients at high risk, not just those already diagnosed or attending the surgery. It includes those lost to the system who may require screening, assessment, intervention or follow up. Whilst the data needed to allow

this are generally held in general practice computer systems, they are not readily available.

Practitioners can access the information required to inform the management of individual patients attending for treatment. However, extracting richer data, such as that required for strategic decision making, is complex and time consuming. Consequently, much of the information which should be available to the practice remains 'hidden' in the computer.

The research described in this thesis sought to address these issues in the context of the need to improve identification, treatment and control of hypertension in the elderly and the availability but inaccessibility of the electronic patient data which would facilitate this.

The aim of the study described was therefore,

> *To evaluate, by means of a randomised controlled trial, whether it was possible to improve identification, treatment and control of elderly hypertensive patients by providing practices with feedback developed from electronic patient data.*

In this study, two different levels of feedback were used as a means of determining whether a multifaceted intervention providing information at a strategic level had any greater impact than more traditional audit and feedback.

Chapter 2 provides a synopsis of the methods used to carry out this study.

Chapter 2

METHODS

2.1 Introduction

The purpose of this study was to determine whether feedback had any impact on identification, treatment and control of elderly hypertensive patients. The intervention was delivered at a practice level, since practitioners detect and provide ongoing care for patients with hypertension. Analysis was conducted at a patient level, since that is the best means of determining whether the treatment provided impacts on control of blood pressure. This study involved conducting a cluster randomised controlled trial.

Practice feedback was developed from data contained in electronic patient records and two intervention groups provided with different levels of feedback were compared to a control group. Questionnaires surveys were used to determine the organisational structure and levels of computerisation available in participating practices. A casenote review was conducted as a means of validating the data extracted from electronic patient records.

The following chapter details the rationale for the study design, outlines the process of practice recruitment and randomisation and describes the methods used in each aspect of the study. The chapter also outlines the procedures developed for collection and processing of electronic data and the statistical measures employed in analysis.

2.2 Use of cluster randomisation

The intervention used in this study was the provision of feedback based on data extracted from the electronic records of elderly patients with hypertension. Whilst it would have been possible to randomise individual practitioners to receive feedback, or to have provided feedback for only a random sample of hypertensive patients within a practice, it was considered that this would result in a flawed methodology for three main reasons.

Firstly, patients with hypertension may consult with and be managed by more than one GP in their practice. As such, it would be extremely difficult to determine whether any changes in blood pressure control were due to the actions of the practitioner receiving feedback or to interventions made by other members of the practice team. Asking individual patients to consult with a single GP and asking GPs to consult with only particular patients for the duration of the study would not have been feasible, nor is it likely to have been acceptable to practices. Secondly, whilst individual GPs would be provided with feedback, it would be difficult, if not impossible, to ensure that they did not discuss that feedback, management decisions or the study in general with their colleagues who were not receiving feedback. This might raise awareness of hypertension control within the practice as a whole, and create a situation whereby those not randomised to receive feedback might also be influenced to improve management. As a consequence, it would be difficult to interpret the results of the study, since there might be similar changes for patients in both the intervention and control groups. Finally, if feedback was based only on particular patients within a practice, it would be extremely difficult, and indeed unlikely, for professionals receiving the feedback not to apply knowledge gained through this to the management of all of their patients, not just those on whom feedback was based. Intervention and control patients might therefore be subject to the same treatment and as such, results might be similar for both. Thus, in order to avoid the potential contamination which might arise from randomising by individual, the unit of allocation used in this study was the practice.

Randomising by practice is a form of cluster randomisation, that is, where clusters or groups rather than individuals are randomised. In individually randomised

trials, it can be assumed that outcomes for the individual are independent of outcomes for other participants. However, when using cluster randomisation, it is no longer possible to make that assumption. Patients in the same practice may be more similar to each other than to patients from other practices, either because of sociodemographic differences, or because they are exposed to the same health care providers, practice culture, or methods of implementing care etc. As such, patients in the same practice may respond in similar ways, and may have similar outcomes. Thus, it cannot be taken for granted that the outcome for each patient is independent of that for any other patient. This had two major implications for the design and analysis of the study. Firstly, this lack of independence, or clustering, reduces the statistical power of the study compared with trials which randomise individuals. Therefore, standard sample size estimates had to be inflated to account for the cluster design. This is described in more detail in section 2.4.6. Secondly, whilst randomisation was by practice, analysis was conducted at a patient level and it was therefore necessary to account for the clustered nature of the data when analysing the main study outcomes. Failure to do so would have increased the likelihood of generating falsely significant findings. The additional statistical techniques applied are described in section 2.11.3.

2.3 Ethical considerations

This project was designed as a Scotland wide study covering the twelve mainland health board areas. As such, ethical approval had to be obtained from the Multi-Centre Research Ethics Committee (MREC) for Scotland before any of the Local Research Ethics Committees (LRECs) could be approached. An application was submitted to MREC in April 1998 and approval granted at the end of July 1998. Applications were then made to the twelve LRECs. All were successful and approval was received from the last of these in November 1998.

2.4 Sampling strategy

2.4.1 Sampling frame

The GPASS electronic record keeping system was designed in the early 1980s, by a general practitioner in Glasgow, as a repeat prescribing system. The Scottish Executive Health Department financially supported its subsequent development and it has been offered free to any practice with compatible hardware since 1984. Scotland is unique within British general practice in that more than 80% of practices use this national computer system (personal correspondence, GPASS).

The target population consisted of all general practices using the GPASS record system which were located in the twelve mainland health board areas namely, Argyll and Clyde, Ayrshire and Arran, Borders, Dumfries and Galloway, Fife, Forth Valley, Grampian, Greater Glasgow, Highland, Lanarkshire, Lothian and Tayside. At the time of study, a total of 744 GPASS practices were situated in these areas (Table 2.1).

2.4.2 Sampling criteria

This study was designed to evaluate the impact of providing practices with decision support, in the form of electronically derived feedback, on identification and management of elderly hypertensive patients. The way in which a practice will respond to such information and indeed the format of the feedback itself may be influenced by various factors. It was therefore necessary to account for the most important of these when recruiting practices.

Level of practice computerisation may determine the sorts of data collected electronically and therefore influence the information that can be derived from those data as well as the application of that information. Likewise, the health board area in which a practice is located may influence practice policy on utilisation of information and the activities conducted by the primary care team. However, it was considered that one of the most important determinants of practice response relates to personnel, in terms of the availability of members of the primary care team to respond to feedback.

Although there are routine data available on reimbursements made to practices for employing staff based on the practice profile, it is not possible to determine how these monies are actually allocated by a practice. Consequently, it is not possible to ascertain whether a practice nurse, practice manager, receptionist or other member of the primary care team is available to a practice without asking the practice directly. Therefore, the decision was made to use practice size, represented by number of partners, as the first stratification variable.

A further significant factor in determining response to strategic feedback is that of existing patient need. Previous research illustrates that socioeconomic deprivation has a significant impact on patient morbidity and mortality (Black 1980) (Acheson 1998) (Shaw et al. 1999). Thus, the health care needs of a patient population and the ability of a practice to meet those needs will vary according to sociodemographic characteristics. Without direct access to person specific data, it is not possible to accurately determine an individual's social or medical circumstances, nor is it possible to infer levels of practice workload based on patient need. Various deprivation indices exist, which aim to classify socioeconomic status either on the basis on single markers, such as employment status, or on an aggregate score based on multiple indicators. However, the majority of these indices attempt to categorise levels of disadvantage or otherwise for individuals living in geographical areas. Although these markers provide an accurate description of socioeconomic circumstances across a postal sector, they may not accurately represent each individual within that area. Nor will they accurately describe the needs of those individuals in relation to health care or its provision.

The Jarman Underprivileged Area index is a multivariate census based measure, designed to account for geographic variations in the demand for primary care services. It is used as an indicator of general practice workload. The index was derived from a questionnaire survey in which one in ten of all Britain's GPs were asked to rate the service and sociodemographic factors affecting their workload most. Service factors were omitted from the final score as they were thought to be sensitive to changes in local and national policy and NHS management. Other variables, including the proportion of over 65s and transport difficulties in visiting patients were also excluded, since they were incorporated in the existing GP

remuneration scheme. The UPA8 score is the most commonly used variant of the index and it comprises unemployment, overcrowding, lone parents, children under 5, elderly living alone, ethnicity, low social class and mobility (Jarman 1983). This measure, like most deprivation indices, has evoked criticism, primarily because the inclusion of overcrowding and ethnicity under represents rural deprivation. Nevertheless, it is used by the Department of Health as the marker against which to provide additional payments to general practitioners for the provision of services to patients from deprived areas. In England the index was originally calculated at ward level, while Scotland used Enumeration Districts. Here the low social class variable was omitted, as the data were not considered robust enough to be included. Levels of payment derived from this Scottish formula were used as the second stratification variable.

2.4.3 Identification of practices

Lists of practices using the GPASS system were obtained from the Primary Care Directorates of the twelve mainland Scottish health boards between June and September 1998. The lists contained demographic details of each practice, including practice size.

Data relating to practice deprivation payments were obtained from ISD Scotland in October 1998. At the time of study, there were three levels of payment, calculated at ward level, representing marginal deprivation, medium deprivation and high deprivation. The data obtained included the proportion of patients from each practice in each of these payment bands. Data were based on payments made to practices as at 1 April 1998.

2.4.4 Stratification of practices

All 744 general practices in the sampling frame were stratified according to size and deprivation payment level. Number of partners was derived from the health board lists and practices were categorised as belonging to one of three groups; 1 to 2 partners, 3 to 4 partners or 5 or more partners. A single level of deprivation payment was obtained by combining the proportions of patients in each of the three payment bands [marginal, medium, high] to give an overall figure for each practice (Table 2.2).

2.4.5 Data linkage

The two sets of data, practice details and deprivation payments, were manually entered into separate tables in a Microsoft Access database and were linked using practice code, a numeric identifier unique to each practice. The majority of health board lists did not contain these identifiers and health boards had to be re-contacted and the codes obtained before the two datasets could be linked.

The dataset contained several marginal practices, that is, practices which bordered two health board areas and as such, were included on the practice list for each board. However, these practices were only noted as being a GPASS user under one health board area and were therefore included in the sampling frame for that board only.

Deprivation payments were based on numbers of patients in each practice as at 1 April 1998. Difficulties arose over practices which had either formed, converged or split after this date. Such practices had been allocated new practice codes by the health boards and these did not correspond to the codes held by ISD. It was therefore not possible to identify deprivation data for these practices. Five practices were excluded from the sampling frame for this reason.

A small number of Scottish practices have no registered patients and therefore no data on deprivation payments. These are restricted GPs who are, for example, attached to a hospice or a practice for the homeless and confined to treating members of that 'institution'. One practice was excluded from the sampling frame for this reason.

After these exclusions, the remaining eligible practices (n=738) were divided into nine strata according to size [1–2 GPs; 3–4 GPs; ≥5 GPs] and deprivation payment level. As a means of verifying practice size, numbers of partners provided on the GPASS lists were compared with the numbers given on the full health board lists. In one health board, there was disagreement between the figures for eight practices. The health board was contacted for clarification, and as a result three practices had to be moved to a different recruitment stratum. Discontinuous deprivation categories were used to avoid overlap between the payment strata and accentuate inter-practice differences. Practices with

deprivation payment levels of between 1 to 4% (n=120) and 16 to 19% (n=33) were therefore excluded (Table 2.3). The 585 remaining practices were categorised as having low deprivation [received payment for 0% of patients], medium deprivation [payment for 5 to 15% of patients] or high deprivation [payment for 20% of patients or more].

2.4.6 Sample size

Since randomisation was by practice rather than by patient, possible variations in patient outcomes between and within practices were accounted for by the inclusion of an inflationary factor in the sample size calculation based on the intra-cluster correlation (ICC). The sample size was calculated to detect a 15% improvement in the number of controlled elderly hypertensives from 30% to 45%. If individual patients were randomised, a sample size of 324 patients would have 80% power to detect this change at a 5% significance level. Fahey and Peters (Fahey & Peters 1996) found an ICC for the proportion of controlled hypertensives in UK practices to be of the order of 0.06. The calculation for this study assumed a worse case intra-practice correlation of 0.1. This suggested that we required data on 40 patients from each of 60 practices.

The numbers of eligible GPASS practices in each of the nine sampling strata were determined. Then, the number of study practices required from each stratum was calculated to reflect the corresponding proportion of the total number of eligible practices (Table 2.4).

2.5 Practice recruitment

Practices were randomly selected from each stratum. The first batch of recruitment letters was sent in February 1999 and the last in September 1999. In total, 179 practices were contacted and after eight iterations of the recruitment process, 54 agreed to participate. These are located in eleven of the twelve mainland health boards and cover a range of practice sizes [1 to 11 GPs], list sizes [744 to 17647] and deprivation payment levels [0 to 54%] (Figure 2a).

2.6 Practice randomisation

2.6.1 Statistical method

Randomisation to study arm was carried out by an independent statistician using a list of sixty random numbers generated by the S-Plus statistical programme (version 4.5). Block randomisation was used, with five sets each containing 12 allocations. Each set of allocations consisted of four allocations to each of the three study arms. These were ordered independently of each other. The sets were then combined to make a full sequence, so that after every 12 allocations, distribution was balanced between study groups.

2.6.2 Study groups

Recruited practices were randomised to three groups as follows:

Control group [n=19] – which received no feedback on performance during the period under study. Practices allocated to this group, like those in the intervention groups, had access to existing guidelines, as well as to those published during the study period, such as the Scottish Intercollegiate Guideline Network (SIGN) guideline for hypertension in the elderly (Scottish Intercollegiate Guideline Network 2001).

Audit group [n=17] – which received rule of halves feedback on numbers of registered patients aged 65–79 who may require a) screening i.e. have no blood pressure measurement recorded b) assessment i.e. have no diagnosis of hypertension but a blood pressure ≥160 / ≥90 or c) treatment i.e. have a diagnosis of hypertension, with a blood pressure ≥160 / ≥90.

Strategic group [n=18] – which received the rule of halves feedback plus a list prioritising those patients most at risk of death from stroke in the next ten years.

2.7 Development of a risk formula

Absolute risk of death from stroke was derived by an equation developed using data from the Midspan study (Hawthorne et al. 1995). Unlike other risk predictors, this formula does not include cholesterol, since it was not thought likely that cholesterol levels would be recorded for every patient, nor was it possible to collect cholesterol readings electronically. The equation allocates a score based on the patient's age, systolic blood pressure, antihypertensive drug treatment, smoking status, stroke history and diabetes status. A detailed description of the equation and its development is provided in chapter 5.

2.8 Electronic data collection

Electronic data were collected from practice computer systems using the Electronic Questionnaire (EQ), a data extraction tool that pulls out demographic, morbidity and prescribing data, developed by the Primary Care Clinical Informatics Unit at Aberdeen University. At the outset of the study, it was anticipated that data would be extracted from practice systems on a quarterly basis for a period of 24 months, with feedback being returned to practices within four weeks of the download. However, the full process of distributing the EQ to practices, attempting to ensure complete returns, processing data and analysing and formatting it for feedback took months rather than the anticipated weeks. As a result only three batches of data were extracted during the study (Figure 2b). Issues related to data extraction and processing are discussed later (chapters 3 and 4).

Raw GPASS data, extracted by practice managers, were sent to PCCIU and returned to me as a Microsoft Access database consisting of nine different tables; 'Practice List', 'Clinicians', 'Encounters', 'Generates', 'Patients', 'Measurements', 'Clinical Events', 'Prescriptions' and 'Referrals'. Five of the tables were not utilised in the data analysis process. 'Practice list' and 'Generates' contain administrative data relating to data extraction. 'Clinicians' and 'Encounters' contain data relating to system identifiers for individual GPs and consultations. 'Referrals' contains data relating to referral specialty and location, but were not required for this study. The remaining tables, containing information relating to patient registration status and demographics, process measures of care, symptoms and diagnoses and prescribing were then utilised to produce practice feedback.

In each table, each patient is distinguished by a unique numeric identifier (ID), a combination of practice ID and an individual GPASS patient ID that remains constant to that patient. In a process lasting five months, a complex succession of more than 30 queries was developed to automate the process of linking each item of individual patient data using this identifier, thereby allowing more rapid generation of relevant information. Once the appropriate items of individual patient data were collated, the risk formula was applied, giving each patient a

score for ten year stroke mortality. Data output was transferred to a Feedback Report Template held in Microsoft Word and the relevant feedback was returned to practices.

Practices were recruited to the study over a 10 month period, between February and November 1999. Fifty two practices had been recruited by September 1999; one was recruited in October 1999 and one in November 1999. Distribution of the first Electronic Questionnaire (Baseline) began in October 1999 and data were returned by practices over the next five months, from October 1999 to February 2000 (Figure 2b). Following batch processing and analysis of data, the first feedback report was sent to practices at the end of June 2000, four months after data collection.

The second Electronic Questionnaire (Year 1) was sent to practices in September 2000, approximately one year after the baseline EQ and three months after the first feedback report. Data were returned by practices over the next six months, from September 2000 to February 2001 (Figure 2b). Feedback was sent to practices in September 2001, seven months after data collection.

The third and final Electronic Questionnaire (Year 2) was sent to practices in December 2001, again, approximately one year after the previous EQ and three months after feedback. Data were returned by practices over the next five months, from December 2001 to April 2002 (Figure 2b). Feedback was sent to practices in November 2002, seven months after data collection. No further extraction of electronic data took place.

2.9 Feedback intervention

The intervention in both the *Audit* and *Strategic* groups was the provision of a feedback report. Practices in both groups received audit feedback, which was essentially a rule of halves report, on all patients aged 65–79 and on patients aged 65–79 with diagnosed hypertension. This contained the numbers of patients with blood pressure recorded, with no blood pressure recorded, with normal blood pressure, with high blood pressure, receiving or not receiving antihypertensive drug treatment and with the additional risk factors of smoking, diabetes or previous stroke (Appendix 1). In addition, the feedback included average results for each of these categories for all practices in the relevant group. It did not contain data at an individual patient level. Patients were regarded as having a recorded blood pressure if a measurement of systolic and diastolic blood pressure was recorded in their electronic record. The threshold for high blood pressure was taken as ≥160 / ≥90 mm Hg, as indicated for treatment by the then current British Hypertension Society guideline (Sever et al. 1993). At the study outset, the versions of GPASS in use by participating practices did not record multiple blood pressure readings and each new entry replaced the previous entry in a patient's record. Feedback was therefore based on the most recent blood pressure reading only. No time limit was applied. The presence of one or more hypertension related Read codes in a patient's electronic record was taken as denoting a diagnosis of hypertension. Further information on Read codes is provided in chapter 4.

In addition, practices in the *Strategic* group received a patient specific colour coded list ranking individual patients according to their level of absolute risk of death from stroke; red denoted a stroke risk of greater than 25%, orange 20–25%, yellow 15–20% and green 10–15% (Appendix 2). This contained date of last blood pressure, systolic and diastolic reading, record of diagnosis, treatment and diabetes status and stroke history. Patients without a blood pressure record were excluded from this list. Patients without a record of smoking status were given two absolute risk scores; one based on being a smoker, the other on being a non-smoker. Each practice also received a computer disk containing a re-identification programme to link Patient ID as shown on the feedback report with the relevant patient contact details. In order to avoid overloading practices,

feedback was provided only for patients most at risk, that is, those with a 10% or higher chance of death from stroke in the next 10 years. Practices were told that they could have information on all patients if desired.

2.10 Questionnaire surveys

2.10.1 Practice organisation and structure

The availability of resources that would allow practices to respond to the feedback, such as surgery hours, consultation length, staff availability, clinics held and recall procedures was determined using a Practice Structure Questionnaire (Appendix 3). This questionnaire was sent to the liaison person in the practice, usually the practice manager, at the study outset and then bi-annually for a period of 24 months. The questionnaire was based on a similar questionnaire developed by the author for use in a previous study (Mitchell, McConnachie, & Sullivan 2003). This was then piloted with colleagues in General Practice and Primary Care, University of Glasgow and refined before use.

2.10.2 Practice computerisation

Information relating to levels of computerisation and extent of computer use in participating practices was collected using a questionnaire (Appendix 4). This incorporated questions to determine, among other things, the availability of computers in the consulting room, to members of the practice team, responsibilities in terms of data entry, use of computer systems and types of data collected. This questionnaire was sent to the liaison person in the practice, mid-way through the study. A draft questionnaire was developed based on the questionnaire used in the Department of Health's original survey of computing in primary care (Department of Health 1993). This was piloted with colleagues and a subsequent nominal group style meeting was held in General Practice and Primary Care, University of Glasgow, to further refine the tool.

2.10.3 Casenote review

To assess the accuracy and validity of the electronic data, the written records of a random sample of patients in a subset of practices were examined retrospectively. The review covered a 12 month period prior to the practice's most recent data extraction. Data were collected to allow comparison with those data collected electronically and used to determine the patient's risk and also to provide

information relating to the patient's utilisation of health services. Data therefore included age, sex, visits to primary and secondary care, blood pressure readings, hypertensive status, treatment and co-morbid conditions (Appendix 5). It was anticipated that 40 patients from each practice would be recruited and over sampling was used to account for refusals, non responders and attrition. Patients were sampled by level of risk; those 40 patients at highest risk of stroke mortality along with 40 randomly allocated from the remainder. In practices with less than 80 at risk patients, all patients were contacted.

2.11 Statistical considerations

The main purpose of the analyses of data extracted from the GP clinical record keeping systems and the questionnaire phases of this study was to compare identification, treatment and management of elderly patients with hypertension in the three study groups – Control, Audit and Strategic – accounting for practice characteristics. Data were analysed using SPSS v9.0 and SAS v8.2 and the following statistical methods were used in analysis of the data.

2.11.1 Chi-squared test

The chi-squared test is used to analyse categorical data. It compares proportions relating to different unmatched groups of subjects, for example, the proportions of patients aged 65–79 whose blood pressure is controlled. The simplest test compares the proportions of subjects falling into two descriptive categories, for example yes/no; however, the test can also be used on variables which have more than two categories. Data are arranged in a contingency table and the actual frequencies observed are compared with the frequencies expected, namely, the proportion of the total sample that would be expected to fall into each of the categories if the null hypothesis were true and there were no differences between the groups. The larger the gap between the observed and expected frequencies, the less likely it is that the null hypothesis is true.

2.11.2 Analysis of variance

Analysis of variance (ANOVA) is used to compare the means of three or more independent groups. It determines whether observed values might belong to the same population regardless of the groups, or whether the observations in at least one of the groups seems to come from a different population. In order to do this, the variability of values within the groups is compared with the variability of values between the groups. If there is a real difference in population means, that is, the null hypothesis is false, the between group estimate of variance is much larger than the variance within the groups.

2.11.3 Adjusting for the effects of clustering

The unit of randomisation in this study was the practice, not individual patients. As such, patients in one practice, or cluster, may be more similar to each other than to patients from other practices and respond in similar ways, since they are exposed to the same health care providers, practice culture, locality etc. As such, it cannot be taken for granted that they act independently. Analyses were therefore conducted to account for intra practice clustering (Donner 1998).

Due to the complexity of this type of analysis, a programme for SAS was written and the data analysed by Dr Peter Donnan, Senior Lecturer in Medical Statistics, Tayside Centre for General Practice. This technique was used for the main study outcomes, namely a) final systolic blood pressure adjusting for initial reading and b) final level of blood pressure control (yes / no) adjusting for initial level. Final SBP was analysed using a mixed model with the study arm treated as a fixed effect and practice as a random effect. The practice level factors of training status, practice nurse, hypertension register and recall system were adjusted for. The patient level factors adjusted for were initial systolic blood pressure, sex, smoking status (current, non, ex and unknown) and Carstairs deprivation category (1–7) (Carstairs & Morris 1988). Final control of hypertension was analysed in a logistic model using the Generalized Estimating Equation (GEE) approach. The practice and patient level factors outlined above were entered into the model along with a binary indicator of initial hypertension control.

2.12 Summary

Application of the methods used in this study facilitated the collection of data to allow comparison of identification, treatment and control of elderly hypertensives in the Control, Audit and Strategic groups. Subsequent chapters present more detail relating to development issues (chapter 3) and to the methods used to handle the vast amounts of electronic patient data returned by participating practices (chapter 4). The method used to predict patient risk is also described more fully (chapter 5).

Table 2.1 – Sampling frame: GPASS practices by health board area

HEALTH BOARD	TOTAL PRACTICES	GPASS	HB COVERAGE %
Ayrshire & Arran	62	52	83.9
Argyll & Clyde	103	91	88.3
Borders	23	23	100.0
Dumfries & Galloway *	36	27	75.0
Fife	66	32	48.5
Forth Valley	56	50	89.3
Grampian	97	33	34.0
Greater Glasgow	220	183	83.2
Highland	79	46	58.2
Lanarkshire	97	63	64.9
Lothian	126	98	77.8
Tayside	92	46	50.0
TOTALS	**1057**	**744**	--

Table 2.2 – Proportion of eligible GPASS practices by size and total deprivation payment

TOTAL DEPRIVATION PAYMENT (%)	1-2 GPs (n=257) (%)	3-4 GPs (n=268) (%)	≥ 5 GPs (n=213) (%)
0 (none)	68 (26.5)	43 (16.0)	24 (11.3)
1 – 5	33 (12.8)	49 (18.3)	68 (31.9)
6 – 10	43 (16.7)	52 (19.4)	51 (23.9)
11 – 15	20 (7.8)	45 (16.8)	31 (14.6)
16 – 20	11 (4.3)	19 (7.1)	13 (6.1)
21 – 25	18 (7.0)	18 (6.7)	11 (5.2)
26 – 30	16 (6.2)	7 (2.6)	5 (2.3)
31 – 35	4 (1.6)	7 (2.6)	4 (1.9)
36 – 40	17 (6.6)	15 (5.6)	4 (1.9)
41 – 45	15 (5.8)	7 (2.6)	--
46 – 50	4 (1.6)	2 (0.7)	--
≥ 50	8 (3.2)	4 (1.4)	2 (1.0)

Table 2.3 – GPASS practices excluded from sampling frame by deprivation payment

DEPRIVATION PAYMENT	NUMBER OF PRACTICES
1%	42
2%	25
3%	30
4%	23
Percentage of all GPASS	**16.3%**
16%	13
17%	6
18%	6
19%	8
Percentage of all GPASS	**4.5%**

Table 2.4 – Recruitment strata: practices required by size and deprivation payment level

DEPRIVATION PAYMENT LEVEL	PRACTICE SIZE					
	1-2 GPs †	*HYPER ‡*	3-4 GPs	HYPER	≥ 5 GPs	HYPER
0% (low)	68 (11.6%)	7 (11.6%)	43 (7.4%)	4	24 (4.1%)	2
5-15% (medium)	66 (11.3%)	7	108 (18.5%)	11	98 (16.8%)	10
≥ 20% (high)	86 (14.7%)	9	64 (10.9%)	7	28 (4.8%)	3

† Number (percentage) of eligible GPASS practices in the three deprivation bands [total = 585]

‡ Number of practices to be recruited from each stratum – calculated to reflect the corresponding proportion of the total number of eligible practices in the stratum [total = 60]

Figure 2a – Map showing location of participating practices

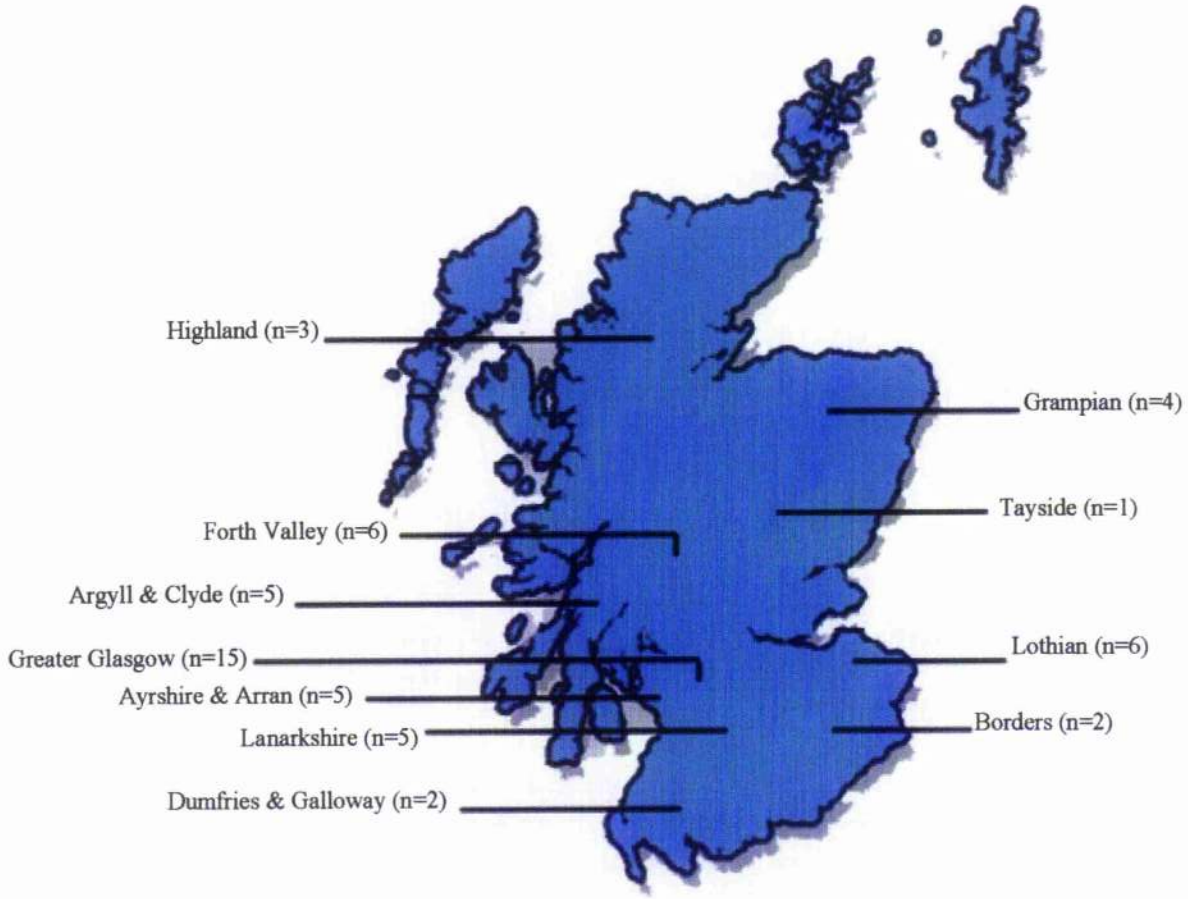
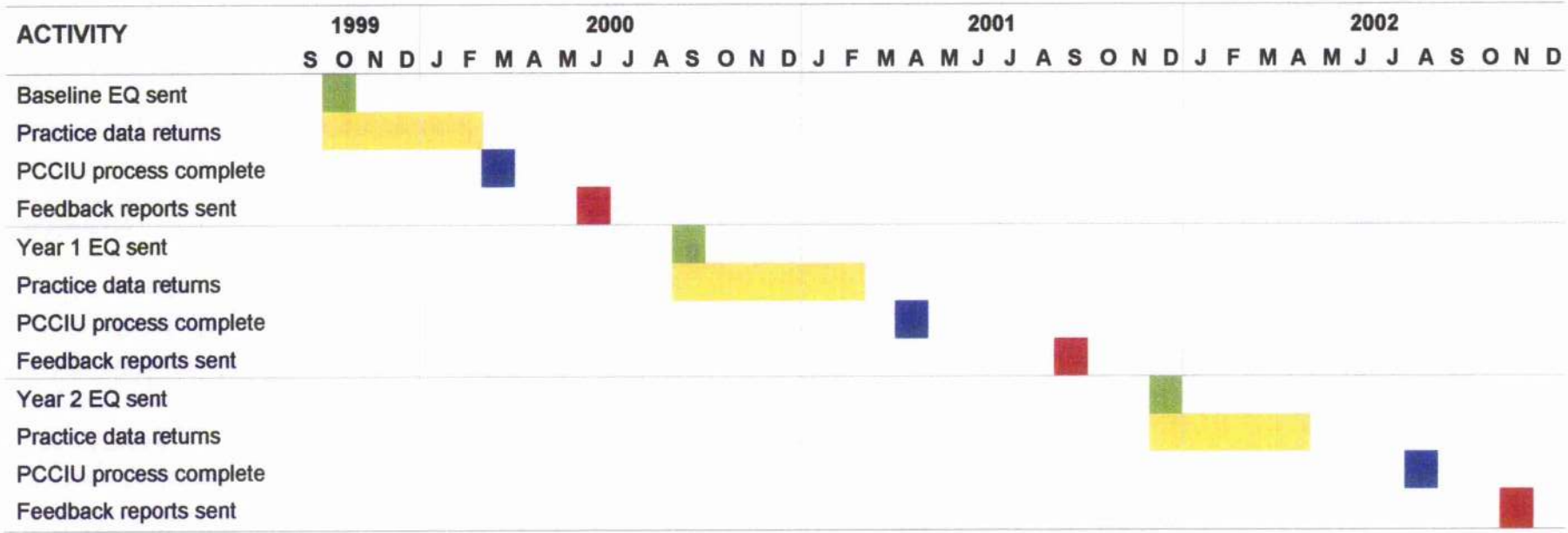


Figure 2b – Timeline of data extraction, processing and feedback



Chapter 3

PROJECT DEVELOPMENT ISSUES

3.1 Introduction

This study centred on the extraction of electronic patient data from the computer systems of participating general practices. As such, much of the study related to development work, dealing with the initial difficulties involved in establishing a new method of providing practices with feedback. Whilst the nature and complexity of the study meant that many of these problems were to be expected, others were unforeseen. This chapter details the difficulties that were encountered during the development process, both at a practice and a project level, and describes the approaches used to overcome these.

3.2 The GPASS computer system

In 1989, when SEHD undertook its first review of GPASS and subsequently assumed direct responsibility for its development and maintenance, almost 400 of the 1100 general practices in Scotland at that time were already using this single terminal, office based system. The number of users rose rapidly after the introduction of the 1990 Contract and continued to rise during the early 1990s. At the same time, the system progressed to include a multi terminal, consultation based version and by 1994 the system was being used by over 800 practices. GPASS maintained its position as the most widely used general practice computer system in Scotland and when this study began in 1998, 80% were users (Figure 3a).

The system was originally only available as a single-user system on the DOS (Disk Operating System) platform and then also as a multi-user system on the UNIX operating platform ('Old' GPASS). However, GP users were of the view that developments in the system lagged behind those available in other commercially available systems, in particular the lack of a graphical interface. After SEHD commissioned an independent review of GPASS, the decision was made to transfer the system to Windows™ ('New' GPASS). This process began in 1995 and between 1997 and 1999, when the transfer to the new technical platform was completed, and when this study was undertaken, four major versions of New GPASS were released.

3.3 Patient identification

In the early 1970s, Tayside health board developed a system of unique numeric identifiers for each patient in the health board area, known as the Master Patient Index System. By the end of the decade it had also been taken up by Argyll and Clyde health board and became known as the Community Health Index (CHI). The system was subsequently implemented across Scotland and since the early 1990s every patient registered with a GP has been issued with a CHI number. The CHI is a ten digit identifier comprising the six digits of the patient's date of birth, a further two digits denoting sex and an additional two digits allocated at random. It is widely available in electronic general practice records as a patient identifier, but since it contains data enabling identification of the patient, it does not meet the requirements of the Data Protection Act, which states that consent is required for the use of any identifiable data relating to a person's physical or mental health (1998). That being the case, it was not possible to extract CHI numbers for this project.

Instead, the only identifier extracted from electronic records to denote each individual patient was a unique GPASS number. Consequently, this was the only identifier that could be used for practice feedback. The study was based on the premise that practices in the Strategic group would be able to identify and target those patients listed in the at risk feedback report. In addition, patients from all three groups had to be identified for recruitment to casenote review. At the outset of the study, we were aware of the need for anonymity in data extraction. However, it later emerged that the ID number allocated to each patient was a system number only and as such, was not available to practices as a searchable field. Practices therefore had no means of identifying relevant patients.

The problem was discussed with PCCIU, who agreed to develop an additional software programme to enable re-identification. When run, this programme extracted relevant patient contact details from the GPASS system and linked these, in a separate report, to the identifier and if relevant, to the patient's risk score. Before it could be implemented for the study, the programme was site tested in two practices to ensure that it operated correctly with both Old and New GPASS. The process, from discussion of requirements until availability of the

software, lasted nine months. This delay lengthened the interval between practices submitting data and receiving initial feedback. In addition, running this programme was the only way that practices could identify patients. It was an extra, unanticipated task, which practices had not agreed to when they consented to take part in the study, and it may have had a detrimental effect both on rates of electronic data return and on utilisation of feedback.

Even after the software had been developed, there was a subsequent problem related specifically to practices operating Old GPASS. The re-identification programme could not extract addresses from the DOS or UNIX system. Although patients' names and dates of birth were pulled out, practices had to manually append addresses to the report. Again, this created additional workload for practices and resulted in direct consequences for recruitment of patients to the casenote review.

3.4 System changes

The migration of GPASS to Windows™, which was still ongoing when the study began, occurred in stages, with each succeeding generation of the software incorporating further developments. In addition, individual general practices develop and respond to innovations at different rates. These factors combined meant that versions of both Old and New GPASS were in use among participating practices at the outset of the study. As such, the variation existed not only in the system itself, but also in the way in which it was employed in practice, since some participants were still using single-user office based versions.

Prior to the initial EQ disks being distributed to practices in October 1999, 29 of the 52 participating practices were using Old GPASS, four were running the software on DOS and 25 on UNIX. The remainder were using one of the four releases of New GPASS available at that time. Practices upgraded their systems at various stages throughout the study and by the end all were using some version of New GPASS. However, the cycle of practice upgrades resulted in various challenges for the project.

3.4.1 Software incompatibility

The simplest, most easily remedied problem related to practices which upgraded from Old to New GPASS during the study period. The EQ software required to extract data from the DOS and UNIX versions of the system was different to that required for Windows™ based versions. Consequently, any practice which had upgraded between data extractions had to be re-sent the correct software. This extended the extraction period and generally meant additional work for practices.

3.4.2 Unique identifiers

Several practices upgraded to a newer version of GPASS in the period between extracting initial data from their system and being sent their re-identification disk. It was noted at that time, that the ID numbers as shown on the feedback report did not tally with those generated by the re-identification programme. It then emerged that for those practices which had upgraded from Old to New GPASS,

part of the upgrade process involved removing the unique identifiers of all patients in the system and sequentially re-allocating these in order to eradicate unused identifiers, i.e. numbers left behind when people were deleted from the practice list. Thus, initial and succeeding identifiers did not match, making data linkage for patients in these practices extremely difficult (chapter 4). This problem affected eighteen practices in all. It meant that eight practices in the Strategic group could not accurately re-identify those patients detailed in their first feedback report. In addition, patients in the remaining ten practices who had been randomised for participation in casenote review were not the patients for whom contact details were extracted (see section 3.5).

3.4.3 GPASS Release 4

Shortly after the study began, a further generation of the new GPASS software, Version 4, was released. One of the participating practices had upgraded to this latest version between consenting to take part in the study and being sent the EQ. At that stage, PCCIU was not able to extract data from Release 4 as they had not received accreditation from GPASS for the use of third party software with this version. Although this problem had been resolved by the time of the second data extraction, it was not possible to collect a complete set of data from that particular practice.

3.5 Patient recruitment

At the outset of the study, it was anticipated that the casenote review would be conducted for a random sample of patients in each of the participating practices. Thus, although only practices in the Strategic group required the identification of patients for possible assessment and/or treatment, all practices required identification of those patients randomly allocated to be invited to take part in the casenote review. The problem of the method of re-identification had been resolved, but it continued to create difficulties for patient recruitment.

Firstly, if a practice did not run the EQ and extract data, it was not possible to recruit patients from that practice. Eight of the 52 participating practices did not return electronic data at any time during the study. Secondly, if a practice returned data but did not run the re-identification programme, it was not possible to identify patients from that practice. Due to the problems already outlined, the project had been significantly delayed and it was crucial that patients were identified from the first data extraction in order to ensure completion of the review within the remaining timescale. Thirty seven practices returned data in the initial extraction, but despite rigorous follow up, fifteen did not run the re-identification programme. It was therefore not possible to recruit from these practices.

Twelve of the remaining 22 practices, which ran the programme, had extracted the data from Old GPASS but had upgraded to new GPASS before they received their feedback. Although they had identified the patients for contact, there was no method of ensuring that the contact details produced were for the correct patients, since it was likely that ID numbers had been deleted and the remainder reassigned as part of the upgrade.

As a result of these difficulties, casenote review could only be conducted for patients from ten practices.

3.6 Practice specific difficulties

In addition to the generic problems affecting the development of the study as a whole, there were issues relating to specific practices, which hindered the advancement of the project.

Organisation within the practices varied greatly, and this produced associated problems. Four practices (two groups of two) shared two practice managers, which meant that those practice managers had twice as much study related work as other participants. In addition, the practices in one of these groups shared the same GPASS system, thereby creating difficulties in relation to identifying patients from each individual practice for feedback and recruitment. Before extracting the data, the practice manager for this group had to append a code to each doctor from each practice, so that patients could then be differentiated using this. Perhaps unsurprisingly, three of the four practices did not return data.

One practice shared a server with two other practices in their health centre, which were not participating in the study. In this instance, the EQ could only be run by someone from the health board. The practice required additional instructions, and due to their reliance on health board personnel, returned each set of data after an average delay of 4 months.

One practice had a branch surgery which lay across the health board boundary. As a result, they had an additional GPASS system at that site. The practice manager had to be given two copies of the EQ, and asked to run one in each location. However, data from the two systems then had to be collated during processing and analysis since the practice required combined feedback.

3.7 Technical difficulties

Other problems were simply a result of the technological nature of the study.

Practice managers would often forget to sign and return the data release form, sent with each EQ, which allowed access to their data (Appendix 6). This required rigorous follow up since without the release form, the data could not be processed and used in the study.

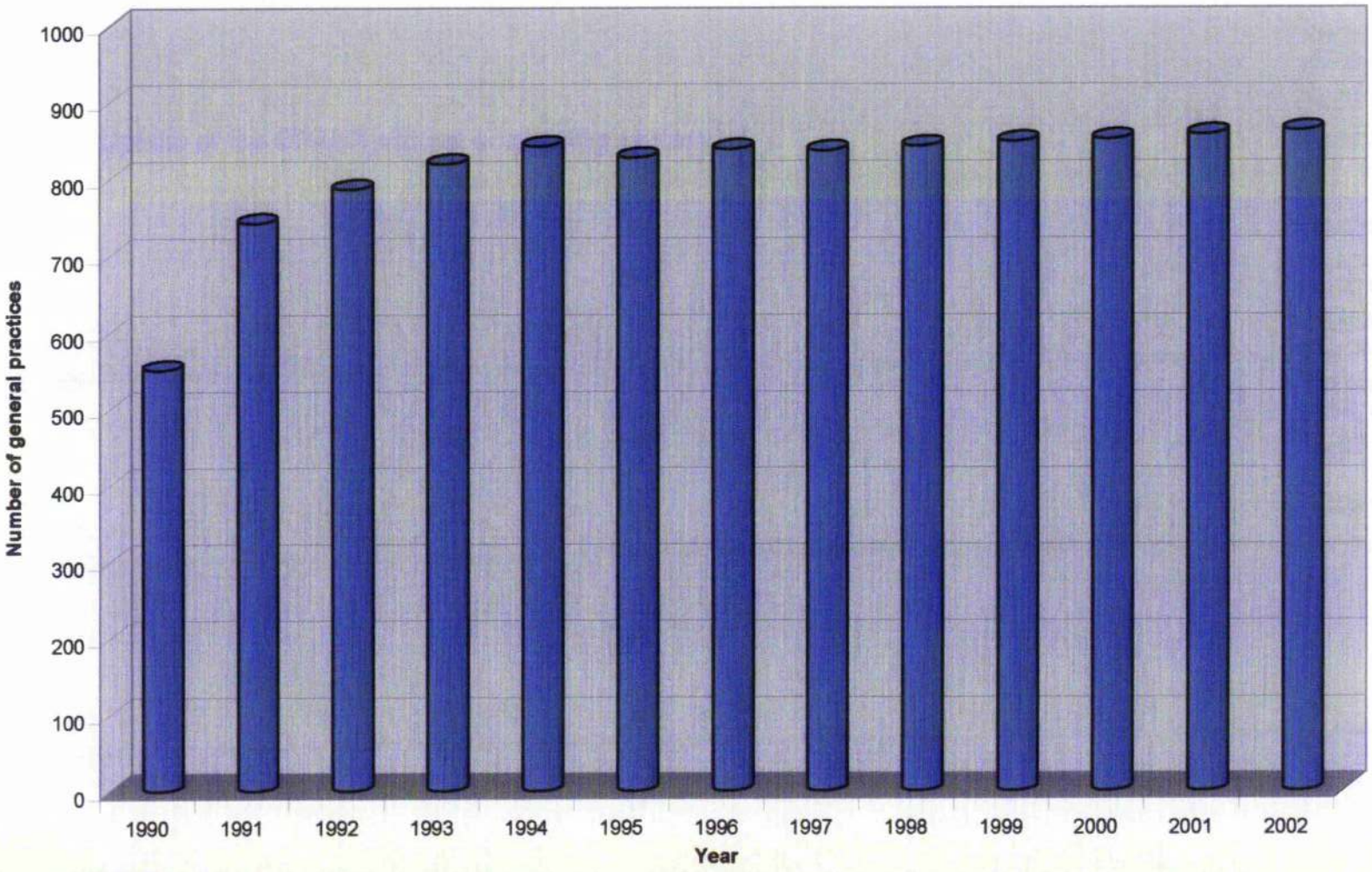
When the EQ is used, data are extracted from the practice system and stored on the same disk as the electronic questionnaire itself. However, a few of the practices held extremely large patient databases, too large to be stored on this single disk. This often meant that only partial data were extracted. Practices then had to be sent another EQ along with a batch of blank disk and asked to run the EQ again.

There were also some general system problems. The system in one practice did not have enough available memory to enable the extraction of data to the disk. There were also regular difficulties with EQ disks being corrupt or practices returning disks that did not contain any data. In these instances, practices had to be asked to run the EQ again, contributing to additional work on their part and adding further delay to the extraction period.

3.8 Summary

The developmental nature of this study generated problems related to the methods used to extract electronic patient data from primary care computing systems. These difficulties were not insurmountable and whilst they required thought and remedial action, they were resolved. As a result, participating practices generated vast quantities of data on several occasions. The methods used to handle and analyse those data are described in the following chapter.

Figure 3a – Uptake of the GPASS clinical computing system



Chapter 4

DATA HANDLING

4.1 Introduction

Extracting data from the computer systems of participating practices was the first stage in the feedback development process. Large quantities of electronic data were extracted, not all of which were relevant to this study. Data were subsequently processed, analysed and used to generate a risk score for individual patients before reports were sent to practices. This chapter describes the format of the data themselves and the systems used to automate the process of selecting only the most recent and relevant data for feedback. The chapter also outlines the method used to validate the automated process as a means of ensuring that only appropriate data were selected.

4.2 Classification of electronic data

The Read Clinical Classification (Read codes) was originally developed in the early 1980s by James Read, a GP in Loughborough, Leicestershire, as a means of allowing GPs to describe relevant clinical summary and administrative data. Following the Joint Computing Working Group's recommendation, the NHS Executive purchased the Read codes in 1990 and established the NHS Centre for Coding and Classification to maintain and develop the system for use across the NHS (Chisholm 1990).

The original version of the Read codes contained a hierarchy of around 40,000 codes, each consisting of four alphanumeric characters. The version launched following the Department of Health's purchase of the codes in 1990 (Version 2) had been adapted for use in hospitals as well as in general practice and restructured into a five level hierarchy to allow more detail. The Clinical Terms Projects, jointly undertaken by the NHS Executive and the clinical and nursing professions, established 55 representative working groups from the specialties with the remit of selecting terms which met their requirements. As a result, a new version of the Read codes (Clinical Terms Version 3) was developed and released in 1994 (NHS Information Authority 2000), although there has not been widespread uptake of this version.

There are around 125,000 different clinical terms in 30 groupings, incorporating not only diseases, but all clinical aspects of management including history and symptoms, examinations and findings, diagnostic and laboratory procedures, preventive, operative and therapeutic procedures, administrative procedures, occupation and social information. Thus, each doctor-patient encounter can be recorded as a single code or combination of codes. Each of the five characters in a code is linked to a specific category for which it is an alternative term. The first character denotes the grouping and the remaining characters branch out within that grouping until the required detail is reached (Figure 4a). The NHS Information Authority distributes the Read codes on behalf of the Department of Health and these are updated at six monthly intervals.

Although use of Read codes is not mandatory, it is the most commonly used system in the UK and is currently available in around 80% of general practices (NHS Information Authority Website 2004). In Scotland, Read codes are recommended by the NHS Executive as the primary system for coding clinical data. They are universally used in GPASS practices. In 1998 when this study began, GPASS used a partial implementation of Read Version 2 (Scottish Advisory Group on Read 1997). Upgrade to the full Read Version 2 was part of the redevelopment to New GPASS (described in chapter 3).

4.3 Data extracted from practice systems

4.3.1 Format of electronic data

The EQ extracted electronic data from the GPASS systems of participating practices in ASCII format (American Standard Code for Information Interchange). This is a widely used encoding system, developed as a means of exchanging information between computers manufactured by different companies. A string of seven bits (binary digits 1 and 0) are used to represent each character with a numeric code ranging from 0 to 127. The first thirty two ASCII codes are used to represent control characters, that is, codes which do not carry information but control devices such as printers and keyboards. Codes 33 to 126 represent printable characters such as letters, digits and punctuation marks. The last code, 127, represents delete (Table 4.1).

For each batch of data extracted, practices sent their encoded files directly to PCCIU either on disk or by email. There, the data were processed and imported into a Microsoft Access database configured as nine separate tables. Four of these tables were used to produce feedback. Further detail on the tables excluded is provided in chapter 2.

4.3.2 Content of data tables

The four relevant tables contained various pieces of patient information.

The *Patients* table contained information relating to patient registration and demographics: Practice ID, Patient ID (combine to make a unique patient identifier); date of birth; age; age-band (in five year bands from 000_004 to 100+); sex (M–male; F–female); postcode (truncated to sector level); deprivation category (based on Carstairs and Morris: 1–7); Clinician ID (number denoting registered doctor); registration status (L–live, D–dead, T–temporary); date registered; date deregistered; is deleted (electronic record has been deleted: F–false, T–true).

The *Measurements* table contained information relating to the process of care: Practice ID; Patient ID; measurement date; systolic blood pressure (BP); diastolic BP; height; weight; parity; gravida; Encounter ID.

The *Clinical events* table contained information relating to patients' symptoms and diagnoses: Practice ID; Patient ID; Read code; Number code (numeric representation of Read code); Read code type (D–dated; U–undated); Diagnosis date; Modifier (CMR practices only: First, Recurrent, Persistent); Encounter ID.

The *Prescriptions* table contained information relating to drugs prescribed: Practice ID: Patient ID; drug name; dosage; BNF code; start date; end date; script type (A–acute, R–repeat); Encounter ID.

4.4 Automated selection of data for feedback

4.4.1 Data required for feedback

Each of the three batches of data extracted provided several million pieces of information. Therefore, a process of automating data selection was developed in order to ensure rapid identification of those data required for the generation of feedback.

- *Practice ID* and *Patient ID* were selected from each of the four tables since they were the only means of linking data for each patient.
- Feedback was provided only for those patients aged 65–79, therefore *age* was selected. However, no data were allocated to this field in the first batch of data. Thus, *age-band* was used instead. Only those patients with an entry of between '045–049' and '075–079' in the *age-band* field were selected (45–64 year olds were selected for comparison only; these data were not provided to practices).
- *Sex* was selected.
- *Deprivation category* was selected as a marker of patients' socioeconomic status.
- *Registration status* was selected in order to ensure that feedback was provided for currently registered patients only. Only those patients with an entry of 'L' were selected. De-registered and temporary patients were excluded.
- *Measurement date* was selected in order to determine patients' most recently recorded blood pressure.
- *Systolic BP* was selected.
- *Diastolic BP* was selected.
- *Read code* was selected as a means of determining those patient who were diagnosed with hypertension. In addition, it was used to identify patients with additional risk factors and relevant morbidities required for the risk calculation, namely smoking status, diabetes and previous stroke.
- *Diagnosis date* was selected.
- *Drug name* was selected in order to identify those patients who had been prescribed antihypertensive medications. Data on *dosage* and *BNF code* were

not always present in patients' prescribing records and therefore could not be relied upon.

4.4.2 Methods of data selection

Microsoft Access is a powerful database management program in which all data are stored in tables. As such, procedures are either carried out on a single table, between tables or produce a table as the result. Tables are linked by establishing a 'join' between common fields, which tells the database how the data in each table are related. Records are then included or excluded depending on the type of join. In this study, the common data were Practice ID and Patient ID and these were used to link the four individual tables (Patients, Measurements, Clinical events, Prescriptions).

All of the procedures are carried out using queries, which question the data held in the tables, produce the records that are required and display these in a specified order. There are several types of query, which can be used to view, change and analyse data in various ways. The following queries were used to select data for feedback.

1. *Select* queries, which retrieve data from one or more tables and simply display the results. A select query can also be used to group records and calculate sums, counts, averages and other types of totals.
2. *Crosstab* queries, which calculate a sum, average, count or other type of total for grouped data.
3. *Action* queries, which make changes to or move multiple records in one operation. Three types of action query were used: *Delete* (deletes records from one or more tables), *Append* (adds records from one table to the end of another table), *Make-table* (creates a new table from all or part of the data in one or more tables).
4. *Find duplicates* queries, which determine if there are duplicate records in a table.

4.4.3 Criteria for data selection

Limits were placed on the queries to ensure that they identified and selected only those records that were relevant for feedback. All data selected related to currently registered patients aged between 45 and 79 years.

Measurement data

Data on Systolic BP, Diastolic BP and Read code were sorted and selected to ensure that only the most recent entry was retrieved. Data with a corresponding date were given priority over those without a date if both were available for a patient. However, if the only available data were undated, these were selected. No time limits were applied to the data – the most recent entry was selected, regardless of when it had been recorded.

The threshold for high blood pressure was taken as a systolic pressure of ≥160 or a diastolic pressure or ≥90. Those with a null entry or an entry of '0' or '-1' were labelled as 'Missing', those with an entry of <160/90 were labelled as 'Normal BP' and those with an entry of ≥160/≥90 were labelled as 'Possible HTN'. Data for patients labelled 'Missing' were included in the rule of halves feedback but not in the prioritised list. Data for patients labelled 'Normal BP' were included in rule of halves feedback and were included in prioritised list only if they had diagnosed hypertension. Data for patients labelled 'Possible HTN' were included in both the rule of halves feedback and the prioritised list since they were potential hypertensive patients.

Read coded data

At the time of study, there was no standardisation of the Read codes used by general practices to denote particular conditions. As such, no single code or small group of codes were routinely used to indicate hypertension, diabetes or stroke. It was therefore necessary to include every possible code which might be used by individual practices. Codes from the relevant sections of the Read hierarchy were chosen and the inclusions and exclusions were then verified by members of the project steering group and by other GP colleagues in General Practice and Primary Care, University of Glasgow.

All codes contained in the G2 hierarchy (*Hypertensive disease*) were included with the exception of G24z1: 'Hypertension secondary to drug'. In addition, the code representing 'History of hypertension' and several hypertension related codes from the 'Chronic disease monitoring' section of *Preventive procedures* and from the *Other therapeutic procedures* and *Administration* hierarchies were included. In total, 67 codes were used. Patients were considered to have diagnosed hypertension if they had an entry of one of these codes in the Read code field of their electronic record (Appendix 7).

All of the codes contained in the C10 hierarchy (*Diabetes mellitus*) were included. In addition, the codes representing 'History of diabetes', 'History of insulin therapy' and 'Diabetic diet' were used. Several diabetes related codes from the *Nervous system/sensory organ disease*, *Circulatory system diseases*, *Genitourinary system diseases*, *Skin/subcutaneous tissue diseases* and *Musculoskeletal/connective tissue* hierarchies were included, as were relevant codes from *Examinations/signs*, *Laboratory procedures*, *Preventive procedures*, *Other therapeutic procedures* and *Administration*. Codes relating to diabetes and pregnancy were excluded. Given the age of women in the target group, pregnancy was unlikely to have been recent and as such, it would not be possible to determine whether diabetes had been confined to pregnancy. If it had not, this should be picked up by the other diabetes codes. In total, 189 codes were used. Patients were considered to have diagnosed diabetes if they had an entry of one of these codes in the Read code field of their electronic record (Appendix 8).

More than half of the codes in the G6 hierarchy (Cerebrovascular disease) were included to determine patients with previous stroke. In addition, the codes representing 'History of CVA/stroke' and 'History of stroke in last year' were included as were relevant codes from the *Preventive procedures* hierarchy. A total of 65 codes were used. Patients were considered to have had a previous stroke if they had an entry of one of these codes in the Read code field of their electronic record (Appendix 9).

Smoking related Read codes were selected from the *History/symptoms* hierarchy, from the *Mental disorders* hierarchy – where several codes relating to tobacco dependence are located – and from the 'Prevention/screening admin' section of

the *Administration* hierarchy. The codes used encompassed current smokers, never smokers and ex smokers. A total of 52 codes were included. Patients were considered to have data on smoking status if they had an entry of one of these codes in the Read code field of their electronic record (Appendix 10).

Prescribing data

Section 2 (*Cardiovascular system)* of the then current British National Formulary, BNF 36, was searched for antihypertensive drugs. Given the large number of possible inclusions, GP colleagues from General Practice and Primary Care were provided with the list and asked to indicate those drugs which they considered unlikely to be prescribed for hypertension. They were also asked to suggest drugs which were not listed, but which would be prescribed. A total of 167 drug names were used (Appendix 11). The list was updated in 2000 following validation against BNF 39.

4.4.4 Query design

Queries to select relevant data were developed using a bottom up approach whereby each was added to the analytic database as it was required. Each new query was built on the previous one, producing a series of individual operations which, when run in succession, ultimately produced a single record for each patient. This record incorporated all relevant data items from each of the four original tables (Appendix 12).

The initial query selected each unique Read coded entry in the *Clinical events* table for each currently registered patient aged 45 79 and added this to a new table called *Morbidity master.* Subsequent queries selected the most recent blood pressure measurement for each patient (patients who had no blood pressure recorded were also included), identified all registered patients aged 45–79 with a hypertension related Read code and linked the two sets of data to produce a list of hypertensive patients and their most recent BP reading (*Hypertensives*). Additional queries identified all registered patients aged 45–79 with a diabetes related Read code (*Morbidity diabetes*), with a stroke related Read code (*Morbidity stroke*) or with a smoking related Read code (*Morbidity smoking*). A further query was developed to identify potential hypertensive patients, that is, those with a blood pressure measurement of ≥160 / ≥90 who did not have a

hypertension related Read code (*Possible hypertensives*). Due to the vast number of items of prescribing data, five separate queries were developed to identify patients receiving antihypertensive medication. These were then combined and the most recent entry for each patient selected (*Drug therapy*).

The final stage in the selection process involved linking the results of the various queries, *Hypertensives, Possible Hypertensives, Morbidity diabetes, Morbidity stroke, Morbidity smoking and Drug therapy*. This query, which took three hours to run, produced one single list containing all of the relevant data items for diagnosed and potential hypertensives namely, Practice ID, Patient ID, age-band, sex, last systolic BP, last diastolic BP, measurement date, hypertension status (diagnosed/undiagnosed), smoking status, stroke status (yes/no), diabetes status (yes/no) and antihypertensive medication (yes/no). Additional crosstab queries provided information by practice on age and sex, BP recording and BP levels.

4.4.5 Quality assurance

In total, 32 individual queries, which ran in succession, were developed to automate the process of data selection. The original development was carried out using the first batch of data extracted from participating practices. Saving the queries in this way made it possible to simply link each subsequent batch of data to the analytic database; the queries would then operate on those new data to identify and select the relevant items for feedback. Given that, it was essential that each query was accurate in relation to the data it selected. Testing and validation of query results was an integral part of the development process and was conducted throughout. Essentially, the process involved copying data from the original table or tables to Microsoft Excel. Records for those patients who were out with the target age bands and not currently registered were deleted as were data relating to irrelevant Read codes or drugs. The remaining data were then sorted chronologically and all but the most recent entries for each patient were excluded. The results of the manual tests were then compared with the results generated by the relevant query. Each query was developed and individually tested in a process lasting five months.

4.5 Summary

Whilst the process of automating the generation of feedback data was time consuming and complex, it undoubtedly led to time savings over the course of the study. It also enabled only relevant data to be extracted from patients' records, those data which were required to populate the risk equation. The risk equation used was developed as part of the study reported here and details of its derivation and content are provided in chapter 5.

Figure 4a – Read code hierarchy

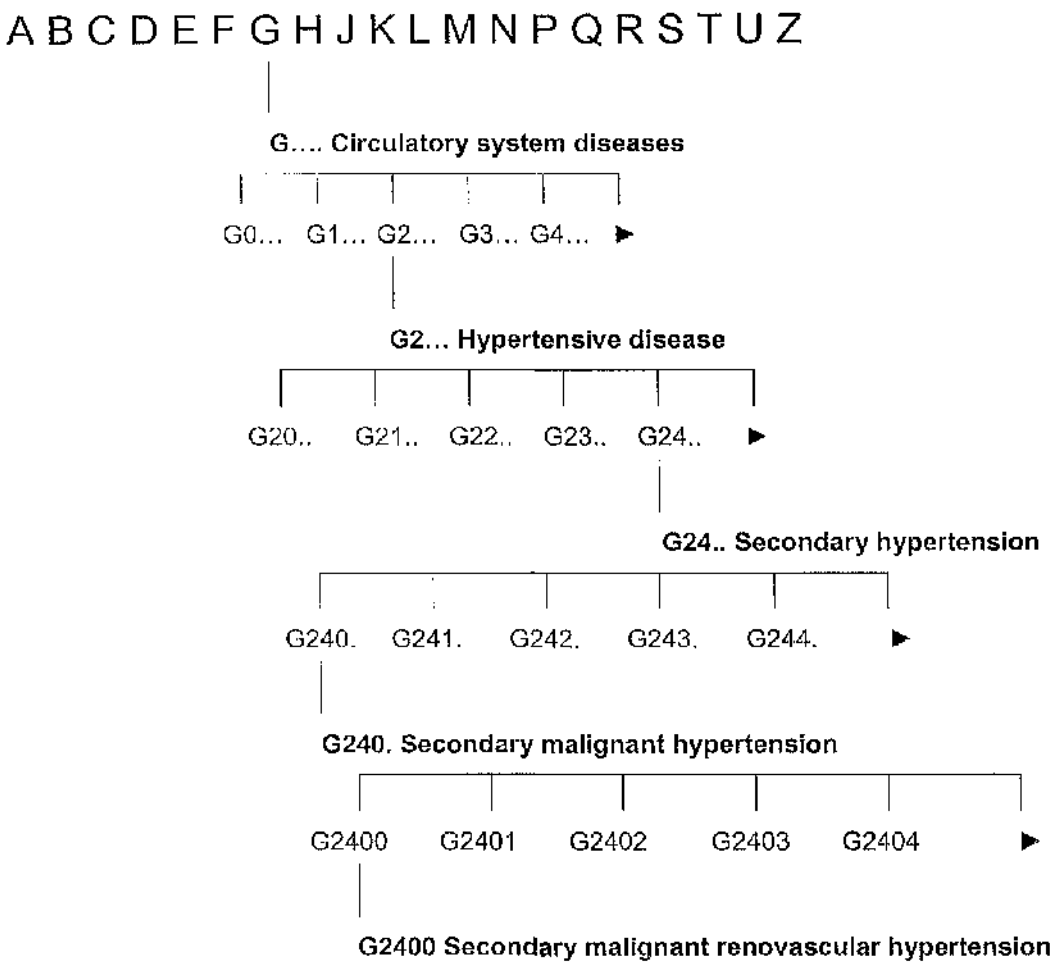


Table 4.1 – ASCII 7-bit codes

BINARY CODE	DECIMAL	CHARACTER	DESCRIPTOR
0000000–0011111	0 - 31		Control characters
100000	32		Space
100001	33	!	Exclamation mark
100010	34	"	Quotation mark
100011	35	#	Hash
100100	36	$	Dollar sign
100101	37	%	Percent sign
100110	38	&	Ampersand
100111	39	'	Apostrophe or right quote
101000	40	(	Left parenthesis
101001	41	)	Right parenthesis
101010	42	*	Asterisk
101011	43	+	Plus sign
101100	44	,	Comma
101101	45	-	Hyphen
101110	46	.	Full stop
101111	47	/	Forward slash
0110000–0111001	48 – 57	0 – 9	Numbers 0 – 9 (in order)
111010	58	:	Colon
111011	59	;	Semi-colon
111100	60	<	Less than
111101	61	=	Equals
111110	62	>	Greater than
111111	63	?	Question mark
1000000	64	@	Commercial at
1000001–1011010	65 – 90	A – Z	Capital letters A – Z (in order)
1011011	91	[	Left square bracket
1011100	92	\	Back slash
1011101	93	]	Right square bracket
1011110	94	^	Caret
1011111	95	_	Underline
1100000	96	`	Back apostrophe or left quote
1100001–1111010	97 – 122	a – z	Lower case letters a – z (in order)
1111011	123	{	Left curly bracket
1111100	124	|	Vertical bar
1111101	125	}	Right curly bracket
1111110	126	~	Tilde
1111111	127		Delete or rubout

Chapter 5

THE ISSUE OF RISK

5.1 Introduction

This study made use of a new equation to predict absolute risk of death from stroke in elderly hypertensive patients. This chapter describes the most commonly used scoring systems designed to predict risk of cardiovascular disease and outlines the reasons why these were unsuitable for use in this study. The method used to derive and validate the equation used is described, as is the result of its comparison with one of the most widely used systems, the Joint British guidelines. The chapter also outlines the patient groups included in the absolute risk feedback.

5.2 Risk factors for cardiovascular disease

In response to an increase in the prevalence of cardiovascular disease in the 1930s, the United States Public Health Service established a project to determine the biologic and environmental factors contributing to the rapid rise in cardiovascular death and disability. In 1948, the town of Framingham, Massachusetts, was selected as the study site and 5,209 healthy residents aged between 30 and 60 years, both men and women, were enrolled as the first cohort of participants. In 1971, the study recruited 5,124 children (and their spouses) of the original cohort for a second study, the 'Offspring Study'. The Framingham Heart Study has been one of the most influential community based epidemiological studies to date, and the first to determine that it was possible to identify and modify the risk factors associated with cardiovascular disease (Kannel, Dawber, & McNamara 1966).

Independent risk factors for cardiovascular disease are older age, elevated blood pressure, elevated blood cholesterol, smoking and diabetes mellitus. Other predisposing risk factors include obesity, physical inactivity, family history of cardiovascular disease, ethnicity and psychosocial characteristics. In the years following the establishment of Framingham, cardiovascular prevention focused primarily on the management of individual risk factors, in particular elevated blood pressure and cholesterol. However, longitudinal data from Framingham and other subsequent trials have helped demonstrate the relationship that exists between risk factors. The major risk factors are cumulative in effect and as such, total risk can be predicted by summing the risk from each of the individual factors. Consequently, there has been a shift away from preventive care based on relative risk towards care based on absolute risk.

High blood pressure is no longer viewed as an isolated risk factor and assessment of absolute risk is now regarded as the most accurate way of judging the benefits or otherwise of antihypertensive treatment (Ramsay et al. 1999) (Wood et al. 1998b). This approach allows identification of high risk patients and appropriate targeting of risk reduction therapies to those most in need. As such, patients at highest risk can be treated as a priority.

5.3 Predictors of cardiovascular risk

Numerous methods to calculate individuals' absolute risk of cardiovascular disease have been developed (Table 5.1). Many of these are based on data from the Framingham Heart Study and several were available at the outset of this study.

5.3.1 The Framingham equations

The first predictors of absolute risk were derived from data on 5,573 cardiovascular disease free subjects aged 30–74 in the Framingham Heart Study. Several equations were developed and they were designed to predict the risk of several cardiovascular endpoints – myocardial infarction (MI), coronary heart disease (CHD), death from CHD, stroke, cardiovascular disease and death from cardiovascular disease. The equations predict ten year risk based on the aggregate of age, sex, systolic and diastolic blood pressure, total serum cholesterol, high density lipoprotein (HDL) cholesterol, smoking, diabetes and left ventricular hypertrophy as measured by electrocardiography (ECG-LVH) (Anderson et al. 1991).

5.3.2 Dundee coronary risk disk

The Dundee coronary risk disk was developed from data on 5,203 men aged 40–59 from the United Kingdom heart disease prevention project. As such, it has not been validated for use with women. The system estimates five year modifiable risk of MI and death from CHD for 35–64 year olds and is based on smoking, systolic and diastolic blood pressure and blood cholesterol. The disk, a solid two sided calculator, provides an age-sex related ranking for each patient, from 1 (high risk, priority action) to 100 (low risk, general advice) (Tunstall-Pedoe 1991).

5.3.3 The PROCAM risk function

The Prospective Cardiovascular Münster study was a workplace study established in Münster, Germany in 1979 to examine cardiovascular risk factors, events and mortality in the employees of 52 companies. Recruitment ended in 1985, after data had been collected for 13,737 men and 5,961 women. The PROCAM risk function was developed from eight year follow up data from a cohort of men aged

35–65. As such, it has not been validated for use with women. The score estimates the ten year risk of MI or CHD death in those who do not have existing cardiovascular disease. It is based on age, systolic blood pressure, low density lipoprotein (LDL) cholesterol, HDL cholesterol, triglycerides, smoking, diabetes and family history of MI (Assmann 1993).

5.3.4 The Joint European guidelines

The Joint European guidelines are founded on the recommendations of the European Society of Cardiology, European Atherosclerosis Society and European Society of Hypertension. The risk prediction is based on the Framingham equation and estimates the ten year risk of non fatal CHD or coronary death in those aged 30–70 who have not yet developed symptomatic CHD or other atherosclerosis. The estimate is based on age, sex, systolic blood pressure, total cholesterol and smoking (Wood et al. 1998a).

5.3.5 The Sheffield table

The Sheffield table is based on the Framingham risk equation and can be used with people aged 52–70, who are currently free of cardiovascular disease, as a means of identifying those whose risk of a coronary death is 1.5% or more per year. Estimation of risk is based on age, sex, hypertension (based on dichotomised systolic blood pressure where blood pressure controlled to 160 mm Hg is 'yes' and to 139 mm Hg is 'no'), cholesterol (based on population mean HDL values), smoking, diabetes and ECG-LVH (Haq et al. 1995). A revised Sheffield table has since been developed which identifies coronary risk for thresholds specified in most guidelines, namely 15% and 30% risk over ten years (Wallis et al. 2000).

5.3.6 The New Zealand guidelines

The New Zealand guidelines and charts are based on the Framingham risk equation and predict the five year risk of a cardiovascular event – MI, new angina, CHD death, fatal or non fatal stroke or transient ischaemic attack, congestive cardiac failure or peripheral vascular disease. Risk is based on age, sex, systolic and diastolic blood pressure, ratio of total cholesterol to HDL cholesterol,

smoking and diabetes. The guidelines can be used for those aged 35–75 who do not already have symptomatic cardiovascular disease (National Health Committee 1995) (Dyslipidaemia Advisory Group 1996).

5.3.7 The Joint British guidelines

The Joint British guidelines are based on the recommendations of the British Cardiac Society, British Hyperlipidaemia Association, British Hypertension Society and British Diabetic Association. The risk prediction is based on the Framingham equation and is used to estimate the 10 year risk of MI or CHD death in people aged 32–74 who do not have established CHD or atherosclerosis. The estimate is based on age, sex, systolic and diastolic blood pressure, total cholesterol, HDL cholesterol, smoking, diabetes and ECG-LVH (Wood et al. 1998b).

5.3.8 Unsuitability of existing equations

Framingham has the advantage over many other studies in that it generated data for both men and women in a wide range of age groups over a long period of time. However, whilst the Framingham equations and their derivatives are widely used, there are some caveats in relation to their use with other populations. Framingham equations were not designed for use in people with pre-existing cardiovascular disease, since this group were excluded from the study. As such, they can only be used to assess risk for primary prevention. In addition, the equations have been shown to overestimate absolute risk when applied to low risk populations, such as those in Europe (Laurier et al. 1994) (Hense et al. 2003) (Brindle et al. 2003) (Empana et al. 2003). Furthermore, the data are derived from a predominately white, middle class, American population and as such, the equations may not accurately predict risk for those in ethnic minority groups or on low incomes. Despite their limitations, these multiple risk scores are one of the best and most widely used methods of predicting absolute risk.

Assessment of risk using Framingham based or other, alternative equations requires information on both total and HDL cholesterol. At present, general practice patients are not routinely screened for hyperlipidaemia, since it is neither cost effective in terms of targeting risk nor feasible in terms of workload (NHS

Centre for Reviews and Dissemination 1998). In addition, the versions of GPASS in use at the outset of the study did not record cholesterol readings. The aim of this study was to provide general practices with feedback relating to all patients at risk, not just those with their risk factors recorded. In addition, the feedback was to be based on data collected as part of routine practice rather than on data collected specifically for the purposes of the study. As such, it was not possible to utilise an existing risk predictor, since data on cholesterol would be unavailable.

5.4 The Hyper absolute risk equation

5.4.1 Development of a new equation

Between 1972 and 1976, all residents of Renfrew and Paisley in the West of Scotland aged 45 to 64 years were invited to complete a questionnaire and attend a cardio-respiratory examination as part of the Paisley-Renfrew (Midspan) study. Almost 80% of those contacted, 15,406 men and women, participated in screening (Watt et al. 1995). Mark Upton, who at the time of this study was a Wellcome Research Fellow in Clinical Epidemiology conducting a survey on the offspring of over 4000 of the original Paisley-Renfrew couples, and Alex McConnachie, a statistician, used Midspan data to develop an equation for this study – the Hyper equation.

Record linked follow up data together with baseline screening information collected between 1974 and 1976 were used to develop a logistic regression model which predicts absolute risk of death from stroke over the next ten years. Data used were from the Paisley population only since the original Renfrew questionnaire did not ask specifically about treatment for hypertension. The model was developed using data for a random 50% sample of the Paisley population (n=6,121; 66 (1.08%) stroke deaths over ten year follow up). The equation incorporates a constant plus patient age, systolic blood pressure (mm Hg), current smoker (yes/no), diabetes (yes/no), previous stroke (yes/no) and on antihypertensive treatment (yes/no). There is no term for gender since gender by itself did not have an association with stroke death during the first ten years of these data. There were also no important gender-risk factor interactions. As such, the model can be used for both men and women (Table 5.2). The fit of the model could not be rejected using the Hosmer-Lemeshow statistic ($X^2 = 13.05$, p=0.11); the area under the Receiver Operating Characteristic (ROC) curve was 77.7%. The model was then used to predict the risk of stroke on the remaining Paisley population (n=6,195; 78 (1.26%) stroke deaths over ten year follow up). The fit of the model could not be rejected using the Hosmer-Lemeshow statistic ($X^2 = 8.49$, p=0.58); the area under the ROC curve was 76.7%.

5.4.2 Comparison with Framingham equations

At the outset of the study, prior to electronic data collection, a medical records review was conducted for a small sample of elderly hypertensive patients (n=21) from a general practice not participating in the study. The data collected were those required for both the Hyper equation and the Joint British guidelines, one of the most commonly used risk predictors in general practice, including cholesterol and ECG-LVH. The data were then entered into the risk models and the two scores for each patient compared. Scores from the Hyper equation consistently followed the pattern determined by the Joint British guidelines and in 71% of cases, scores were almost identical (Figure 5a). In the remaining six patients, the Hyper equation consistently predicted higher levels of absolute risk. However, each of these patients was at very high risk. All six were diabetic, all were already receiving antihypertensive treatment, five had blood pressure >140/90, one had a previous stroke, three were smokers and four were aged 73–78. Prediction of absolute risk is always likely to incorporate some error. However, the Hyper equation was not underestimating risk, nor did it appear to be overestimating risk for those who were not at higher risk.

5.5 Risk feedback

The data required by the Hyper equation (section 5.4.1) were exported from MS Access into a MS Excel spreadsheet. These data were then re-coded according to their relative weightings and the risk score was automatically calculated using formulae stored in the spreadsheet. Information on individual patient risk was provided only to practices in the Strategic group. This information was presented in the form of a colour coded list prioritising patients according to their risk level. Patients at the top of the list in red were at greatest risk of death from stroke, patients at the bottom in green were at lowest risk. Feedback was provided on patients with diagnosed hypertension regardless of blood pressure level and on patients who did not have diagnosed hypertension but who had a blood pressure of ≥160 / ≥90 mm Hg. Patients without a blood pressure recorded were excluded. Feedback included both those who had already had a stroke and those who had not. The feedback list contained the patient's ID, age-group, sex, date of last recorded blood pressure, systolic and diastolic blood pressure, whether they had diagnosed hypertension, whether they were receiving antihypertensive drug treatment, smoking status, whether they had diabetes, whether they had a previous stroke and their absolute risk.

For the purposes of the risk equation, never smokers and ex smokers were considered to be non-smokers; only current smokers were regarded as smokers Patients without a Read coded diagnosis of hypertension, diabetes or stroke were regarded as not having the disease. However, patients who did not have a record of smoking status could not be regarded as non-smokers. The risk equation does not calculate risk unless each of the fields has an entry. Thus patients without a record of smoking status had two risk scores predicted, one based on their being a smoker, the other on being a non-smoker.

Practices were provided with feedback for patients with an absolute risk of 10% or more. No instruction was given as to how these patients should be managed, since the purpose of the study was to determine the impact of the provision of feedback on decision making, not to direct decision making. However, in order to minimise any influence that might be brought to bear by providing selected

feedback, practices were informed that they could receive risk scores for all patients if they wished.

5.6 Summary

Whilst various risk predictors are currently in existence, some of which are widely used in primary care, it was not possible to make use of these in this research. The equation developed specifically for the study, the Hyper equation, allowed patient risk to be predicted using individual items of data which were not only major risk factors for stroke, but were also accessible in electronic patient records. Changes in patient risk over the period under study are presented in the results chapter (chapter 6, section 6.8).

Table 5.1 – Comparison of commonly used cardiovascular risk predictors

DETAILS OF PREDICTOR			VARIABLES INCORPORATED							
Model (year)	**Source**	**Age range**	**Asymptomatic patients**	**Age**	**Sex**	**Systolic BP**	**Cholesterol**	**Smoking**	**Diabetes**	**ECG-LVH**
Framingham equations (1991)	Framingham Heart Study	30-74	x	x	x	x	x	x	x	x
Dundee coronary risk disk (1991)	UK Heart Disease Prevention Project	35-64				x	x	x		
PROCAM risk function (1993)	*Pro*spective *C*ardiovascular *M*ünster study	35-65	x	x		x	x	x	x	
Joint European guidelines (1994)	Framingham equations	30-70	x	x	x	x	x	x		
Sheffield table (1995)	Framingham equations	52-70	x	x	x	x	x	x	x	x
New Zealand guidelines (1995)	Framingham equations	35-75	x	x	x	x	x	x	x	
Joint British guidelines (1998)	Framingham equations	32-74	x	x	x	x	x	x	x	x

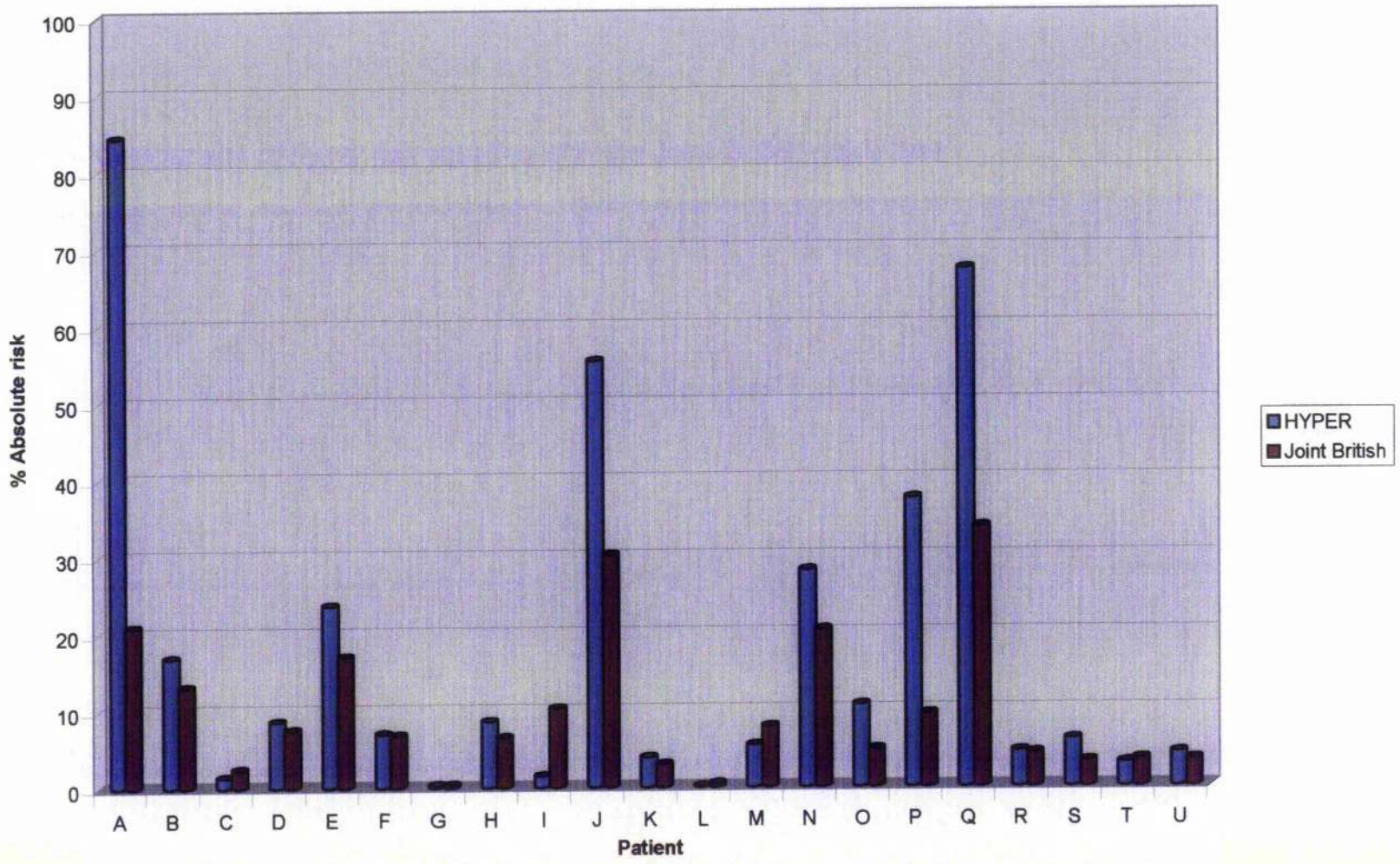
Table 5.2 – Hyper equation to calculate absolute risk of stroke death

LOGIT = constant + age group + SBP + smoker + diabetes + stroke + treatment

Likelihood of sustaining a CVA over 10-years P = 1/1+exp (-LOGIT)

VARIABLE		SCORE
Constant		- 7.9892
Age group	45 – 49	0
	50 – 54	0.4362
	55 – 59	0.8533
	60 – 64	1.7752
	65 – 69	2.1579
	70 – 74	2.6973
	75 – 79	3.2368
SBP		0.0119 (per mm Hg)
Current smoker	Yes	0.9364
	No	0
Diabetes	Yes	1.6120
	No	0
Previous stroke	Yes	1.6244
	No	0
On drug treatment	Yes	1.0243
	No	0

Figure 5a – Comparison of Hyper risk equation with the Joint British guidelines



Chapter 6

RESULTS

6.1 Introduction

This section presents the results obtained from electronic data collection, questionnaire surveys and casenote review. The organisational characteristics of participating practices will be presented first, followed by figures relating to identification, treatment and control of elderly hypertensive patients at the study outset, and changes in these figures over time. The initial results relate to all of the practices that returned one or more batch of electronic data; the comparative analyses are based only on those practices which returned data over time (n=34). Figures relating to mean systolic pressure and levels of control, adjusted for practice and patient factors, will also be presented. Finally, data relating to patient risk and the characteristics of those patients who went on to have a stroke will be shown. All results reported in the tables and in the text are given for the Control group first, followed by the Audit group, followed by the Strategic group.

6.2 Participating practices

In total, 54 practices were recruited to the study. The target number of practices required was achieved in five of the nine sampling strata (Table 6.1). Medium sized practices were well represented, whilst small and large practices, particularly those with high deprivation, were under represented.

Two practices withdrew from the study shortly after recruitment and before data collection began, leaving 52 participating practices (Figure 6a).

6.3 Practice characteristics

6.3.1 Population coverage

The 52 participating practices were located in eleven of the twelve mainland Scottish health boards. More than one quarter were from Greater Glasgow, the largest health board area, followed by Lothian (12%) and Forth Valley (12%). They incorporated members from almost half (46%) of the 80 possible Local Health Care Co-operatives (Table 6.2). Combined, the practices represented a population of over 260,000 patients, equivalent to almost 5% of the total population of Scotland (Table 6.3).

6.3.2 Practice structure and organisation

At the outset of the study, practices in all three groups were similar in terms of number of partners, list size and deprivation payment level (Table 6.4). Approximately one quarter of practices in each group were categorised as having low deprivation (Control 21% *v* Audit 25% *v* Strategic 23%), with the majority having between 5–15% (42% *v* 50% *v* 65%).

Almost all of the practices had a practice nurse available, but there was a marked, although not statistically significant, difference between the Control group and the other two groups with respect to training practice status (50% *v* 29% *v* 25%, X^2=0.272, DF=2, p=0.257). In addition, the availability of a register of patients with hypertension (89% *v* 57% *v* 75%) and the provision of a hypertension clinic (44% *v* 29% *v* 25%) and recall system (78% *v* 64% *v* 63%) was also greater in the Control group (Table 6.5). The majority of practices in the Audit (70%) and Strategic (63%) groups used a previously arranged appointment as their primary method of recall, whilst the remainder used either letters and / or telephone reminders. Conversely, only 36% of practices in the Control group used pre-arranged appointments, half used either letters and / or telephone reminders and the remainder noted the need for recall on the repeat prescription card or appointment list.

Comparisons of organisational characteristics were also made by practice size (Table 6.6) and deprivation payment level (Table 6.7). Although not statistically significant, around one quarter of the small and medium sized practices had training status compared with almost two thirds of the large practices (24% *v* 28% *v* 62%; X^2=5.39, DF=2, p=0.068). Conversely, the availability of a hypertension register and provision of a clinic and recall system decreased as practice size increased (Table 6.6), with the difference in the occurrence of recall systems between small to large practices being statistically significant (94% *v* 61% *v* 46%, X^2=8.67, DF=2, p=0.013).

When compared by practice deprivation payment level, whilst not statistically significant, each of five organisational factors considered was generally more frequent as deprivation increased from 0% to ≥25% (Table 6.7). The difference was particularly marked in relation to the availability of a hypertension register (58% *v* 73% *v* 100%, X^2=5.16, DF=2, p=0.076) and provision of a hypertension clinic (17% *v* 39% *v* 40%, X^2=2.01, DF=2, p=0.366).

During the period under study, amongst other organisational changes, three practices gained an additional partner, seven changed partners, seven changed practice managers and two became training practices (Table 6.8).

6.4 Electronic clinical data

The first batch of electronic patient data was downloaded in October 1999 and the last in December 2001. Data were returned by 47 of the 52 participating practices. Three practices returned a single batch of data which was corrupted and could not be used. Useable data were obtained from a total of 44 practices; from 37 practices in the first Electronic Questionnaire (EQ), 25 in the second and 28 in the third (Table 6.9). Twelve practices provided useable data in all three EQ runs, 22 provided data in two and ten provided data in one. Thus, comparable data were available for 34 practices.

The amount of data extracted varied with each EQ run. In total, the 44 practices generated an electronic record for a total of 265,572 patients, 217,125 of which were permanently registered (Table 6.10). The records contained almost 500,000 items of measurement related information, blood pressures, weights etc., over four million Read coded items, symptoms, diagnoses etc., and over 7 million items of data relating to prescribing. More than 26,000 of the permanently registered patients were aged between 65 and 79 years; 7,204 had a recorded diagnosis of hypertension (Table 6.11).

6.4.1 Validation of data

Retrospective casenote review was conducted for 229 patients from ten practices. Due to the difficulties described in chapter 3 (section 3.4.2), in relation to linking patient identifiers, comparisons between the paper and electronic record could only be made for 192 of these patients (Control n=84; Audit n=80; Strategic n=28). Comparisons were made for all of the variables required for practice feedback, namely hypertension diagnosis, presence of diabetes, presence of previous stroke, antihypertensive treatment, most recent blood pressure reading and smoking status (Table 6.12).

Agreement across the groups was high for diagnosis of hypertension (90%), diabetic status (98%) and previous stroke (96%). Kappa co-efficient for agreement beyond chance was 0.89. Agreement was also high for antihypertensive treatment (95%, kappa=0.82, Figure 6b). Discrepancies related

to these items were primarily due to a diagnosis or treatment being recorded in the casenote but not in the electronic record (hypertension n=16; previous stroke n=7; antihypertensive treatment n=7). Agreement for smoking status was lower (84%, kappa=0.70). There was concurrence for less than one quarter of blood pressure readings (23%, kappa=0.32, Figure 6c). In the main, discrepancies were due either to the most recent blood pressure having been recorded in the casenote and not updated on computer (62%), or to the most recent record having been recorded on the computer only (15%). Thus, only 36% of patients had their most recent blood pressure recorded in their electronic records. Of the 119 patients whose most recent blood pressure was recorded in the casenote, the level of pressure recorded in the electronic record was the same as that recorded in the casenote for 60%, that is both records were high or both were normal (Table 6.13). Whilst records did not correspond for 40% of patients, there was no systematic bias in recording between the groups and no group consistently recorded only normal blood pressures in their electronic records. In the majority of cases where the two readings did not correspond, the electronic record contained a reading of ≥160 / ≥90, whilst the casenote contained a normal reading.

Thus, it is likely that most patients in this study will have been correctly included or excluded from practice feedback. However, there may have been discrepancies where patients did not already have a diagnosis of hypertension. Those whose blood pressure was recorded as high in the casenote but normal in the electronic record will not have been identified as potential hypertensives and as such will have been missed from feedback. Those whose blood pressure was recorded as high in the electronic record but normal in the casenote will have been incorrectly included as potential hypertensives. Systolic blood pressure was one of several factors included in the Hyper absolute risk equation and as such, where discrepancies between records related to systolic pressure, this may have affected the score allocated. However, this is unlikely to have affected the scores substantially. For example, a patient with undiagnosed hypertension, in the 65-79 age range, with no additional risk factors and a systolic blood pressure of 160 mm Hg, is allocated an absolute risk score of 5.2%. If that person's pressure is in fact 150 mm Hg, their risk is reduced to 4.6%. In either case, they would have been excluded from practice feedback since their risk was <10% (section 2.9). If that person has one risk factor, for example smoking, risk is increased from 11.1% to

12.3%. If they have diabetes, their risk increases from 19.6% to 21.6%. In both cases, the patient would have been included in feedback. In the first, the practice may be less likely to have intervene, in the second given the relatively high risk score, they may well have done. In this situation, whilst targeting may be appropriate given the risk, in relation to hypertension management, it may be misplaced. However, given the results of the validation exercise, this is likely to have been an issue for only a minority of patients. Furthermore only 639 of the 7,198 patients eligible to be included in final feedback (8.8%) were undiagnosed with one or more risk factors.

6.5 Rule of halves at study outset

6.5.1 Identification

Data from the first EQ returned by 37 practices, established that the majority of patients aged 65–79 in each group had a blood pressure recorded on computer (Table 6.14). This was within normal limits for around half of those patients (55.7% *v* 45.1% *v* 47.6%) but left sizable proportions of patients whose blood pressure was ≥160 / ≥90. Of those, only one third had been identified as having hypertension (38.7% *v* 35.8% *v* 35.3%, X^2=5.27, DF=2, p=0.072).

6.5.2 Treatment and control

Few of the patients diagnosed with hypertension were without a recorded blood pressure (Table 6.15). The majority were receiving antihypertensive treatment and the difference between the three groups, although small, was significant (88.0% *v* 85.7% *v* 81.7%, X^2=27.28, DF=2, p<0.001). In addition, around half of the patients in each group who were receiving treatment were not adequately controlled (52.3% *v* 42.4% *v* 48.2%, X^2=25.76, DF=2, p<0.001).

6.6 Changes to the rule of halves

The following data relate to the 34 practices which returned two or more sets of electronic data (Control n=12; Audit n=9; Strategic n=13). Initial and final figures were compared; if a practice returned three sets of data, the first and last were compared.

6.6.1 Practice organisation and structure

The practices in all three groups returning multiple sets of data were similar in terms of number of partners, list size and median deprivation payment level (Table 6.16). Practices in the Control and Audit groups were evenly spread across the low, medium and high deprivation categories, whilst the majority of practices in the Strategic group had medium deprivation (n=9, 69%).

Almost all of the practices had a practice nurse available, but again, there was a clear, although not statistically significant, difference between the Control group and the other two groups with respect to training practice status and the provision of a hypertension clinic. The difference in relation to recall systems was not as great as had been the case overall (67% *v* 56% *v* 54%, X^2=0.48, DF=2, p=0.788), although a greater proportion of practices in both the Control and Strategic groups had a hypertension register available compared with the Audit group (92% *v* 44% *v* 69%, X^2=5.54, DF=2, p=0.063, Table 6.17).

6.6.2 Levels of computerisation and use

Data from the survey on levels of computerisation showed that 28 of the 34 practices (82%) used both paper and electronic records for recording clinical data. All 34 electronically recorded recall information for all patients (Table 6.18). Doctors in all of the Audit group practices had a computer available in their consulting room compared with 90% of the Control group practices and just over three quarters in the Strategic group. There was a similar pattern for data entry by GPs. Only half of the practices in each group stated that they electronically recorded measurement data and diagnoses for all patients. One third of Control

group practices used mainly computerised guidelines, compared with only 11% of practices in the Audit group and 8% in the Strategic group (Table 6.18).

6.6.3 Changes in identification of patients with hypertension

The majority of 65–79 year olds in each group had a blood pressure recorded at the initial download, with the lowest proportion observed in the Audit group (78.3% *v* 66.2% *v* 79.0%, Table 6.19). The numbers increased over the study period, with the largest improvement seen in the Audit group.

The greatest proportion of patients whose initial blood pressure was within normal limits was found in the Strategic group, where more than half of the patients had a blood pressure of <160/90 mm Hg (49.5% *v* 40.1% *v* 51.9%, Table 6.19). This improved over the study period in all three groups, rising to almost two thirds in the Strategic group and to more than half in the Control group (58.0% *v* 47.3% *v* 61.4%).

Of those patients whose blood pressure was initially ≥160 / ≥90 mm Hg, more than 40% of those in the Control group had been diagnosed as having hypertension, compared with just over one third in the other two groups, a difference which was statistically significant (41.2% *v* 37.7% *v* 36.0%, X^2=11.20, DF=2, p=0.004). By the end of the study, identification had improved in all three groups and again the difference was statistically significant; the improvement made in the Control and Audit groups was respectively three times and twice that made in the Strategic group (49.3% *v* 43.8% *v* 38.6%, X^2=39.03, DF=2, p<0.001).

6.6.4 Changes in treatment and control of diagnosed hypertensives

Only a small proportion of patients diagnosed with hypertension did not have an initial blood pressure recorded electronically, more so in the Audit group than in the other two groups (8.9% *v* 24.7% *v* 3.9%, Table 6.20). The numbers in each group decreased over the study period, with the greatest improvement observed in the Audit group (-0.6% *v* -6.7% *v* -1.1%). Over 40% of the patients in each group had an initial high blood pressure (45.4% *v* 42.1% *v* 42.5%). These numbers reduced over the study period, falling to nearer one third in the Strategic and Control groups (35.0% *v* 38.3% *v* 34.6%).

The majority of patients in each group were initially receiving antihypertensive treatment, the greatest proportion found in the Control group and the lowest in the Strategic group, differences which were statistically significant (88.2% *v* 86.1% *v* 84.3%, X^2=10.64, DF=2, p=0.005, Table 6.20). Over the study, the numbers of treated patients increased to more than 90% in all three groups, with the greatest improvement found in the Strategic group which showed an increase three times greater than that observed in the Control group and more than twice that observed in the Audit group (91.4% *v* 90.5% *v* 93.9%, X^2=16.95, DF=2, p<0.001).

Initially, more than half of the patients with diagnosed hypertension in the Strategic group were receiving treatment and were adequately controlled, compared with over 40% in the Control group and one third in the Audit group (45.8% *v* 34.0% *v* 53.4%, X^2=98.87, DF=2, p<0.001). By the end of the study, the numbers had risen by around 10% in each group. However, more than one third of all patients with diagnosed hypertension remained uncontrolled (57.8% *v* 43.8% *v* 62.4% X^2=126.59, DF=2, p<0.001, Table 6.20).

6.6.5 Comparison with patients aged 45–64

Comparisons were made with patients aged 45–64 as a means of determining where the study groups targeted effort in relation to hypertension management. Fewer patients aged 45–64 whose blood pressure was initially ≥160 / ≥90 mm Hg were identified as hypertensive and this was observed across the three groups (Figure 6d). Similar figures to those found for patients aged 65–79, with respect to diagnosed and treated patients (84.7% *v* 80.8% *v* 80.8%) and treated and controlled patients (47.3% *v* 34.9% *v* 49.2%) were seen.

6.6.6 Changes by practice size

There were significant differences between small (1–2 GPs), medium (3–4 GPs) and large (≥5 GPs) sized practices in relation to the numbers of hypertensive patients identified, treated and controlled (Table 6.21). The proportion of patients identified as hypertensive and treated with antihypertensive medication tended to increase as practice size increased, whilst the proportion treated and controlled increased with reduced practice size (small 69.0% *v* medium 60.1% *v* large 57.7%, X^2=20.21, DF=2, p<0.001).

6.6.7 Changes by practice deprivation level

There were significant differences between practices in low (0%), medium (5–15%) and high (≥20%) deprivation payment levels in relation to the numbers of hypertensive patients identified, treated and controlled (Table 6.22). The proportions of patients identified, treated and controlled tended to increase as deprivation level increased (final control: low 53.6% *v* medium 58.6% *v* high 68.7%, X^2=40.41, DF=2, p<0.001).

6.7 Changes for patients with linked records

The remainder of the results relate to comparisons made for patients on whom absolute risk feedback had been based, that is, those patients who had a recorded diagnosis of hypertension or who did not have a recorded diagnosis of hypertension, but whose blood pressure was ≥160 / ≥90 mm Hg. In the case of the Audit and Control groups, these data were compared for those patients who would have been on absolute risk feedback had it been provided. Data were compared for a total of 5,103 patients. Around 60% in each group were female, 20% were smokers, 10% had diabetes and 5% had a record of a previous stroke (Table 6.23). Fewer of the most affluent patients were from the Audit group and fewer of the most deprived patients were from the Strategic group.

6.7.1 Mean blood pressure

There was a significant difference in the initial mean systolic blood pressure for patients aged 65–79 across the three groups (153.3 mm Hg *v* 156.0 mm Hg *v* 152.5 mm Hg, $p<0.001$, Table 6.24). This fell in all three groups, with the largest reduction found in the Control group (3.3 mm Hg *v* 1.7 mm Hg *v* 2.7 mm Hg). There was also a significant difference in mean diastolic pressures, which also fell over the study period, again with the largest reduction seen in the Control group (2.2 mm Hg *v* 1.3 mm Hg *v* 2.0 mm Hg, Table 6.24).

Mean systolic blood pressure for patients with diagnosed hypertension was lower than for patients aged 65–79 generally, with the lowest levels found in the Strategic group (150.0 mm Hg *v* 153.0 mm Hg *v* 148.8 mm Hg, $p<0.001$, Table 6.25). This was also the case for mean diastolic pressure. Again, both fell in all three groups over the period of study, the largest reductions being seen in the Control group.

6.7.2 Final systolic blood pressure

Final systolic blood pressure for each patient was analysed adjusting for their initial systolic reading. This model also accounted for the patient's sex, smoking status (current, non-smoker, ex-smoker and unknown) and Carstairs deprivation

category (1–7). The practice factors of training status, availability of a practice nurse, hypertension register and recall system were also adjusted for. The lowest unadjusted mean systolic blood pressure was found in the Strategic group (Table 6.26). After adjusting for clustering, and for practice and patient level factors, there was a significant difference in mean systolic pressure between the Strategic and Audit groups (3.09, CI 1.28–5.71, p=0.019).

6.7.3 Final level of hypertension control

Final level of control of hypertension was analysed adjusting for the patient's sex, smoking status and deprivation category and for the practice factors of training status and practice nurse, and hypertension register and recall systems, which were more predominant in Control group practices. These were entered into a logistic model along with a binary indicator of hypertension control (Table 6.27). The greatest proportions of control were found in the Strategic and Control groups (45.7% *v* 33.5% *v* 45.5%, Table 6.28). After adjusting for clustering, patient and practice effects, there was a significant difference in the level of control of hypertension in the Strategic group compared with the other two groups (1.72, CI 1.09–2.70, p=0.019).

6.8 Changes in absolute risk

There was a significant difference between the groups in relation to patients whose level of risk increased or reduced. At the end of the study, level of risk had remained static for just under half of the patients in the Audit group, compared with around 40% in the Control group and less than one third in the Strategic group (41.8% *v* 48.9% *v* 31.4%, Table 6.29). Conversely, risk had increased for half of patients in the Strategic group and for around 40% in the other two groups (41.6% *v* 39.9% *v* 49.9%). Risk was reduced for between 10–20% of patients in each group (16.6% *v* 11.2% *v* 18.7%). Differences between the groups in relation to changes in absolute risk were statistically significant (X^2=116.10, DF=4, $p<0.001$).

6.8.1 Revised blood pressure records

There was a significant difference in the proportion of patients in each group who had their blood pressure record updated during the period of study (Table 6.30). More than 80% of the patients in the Strategic had an updated record compared with just over half of the Control group and less than half of the Audit group (57.5% *v* 43.2% *v* 82.3%, X^2=559.73, DF=2, $p<0.001$).

6.8.2 Changes in recorded risk factors

The greatest change in risk factors related to control of blood pressure and this was significantly different across the groups (Table 6.31). The greatest proportion of newly controlled patients was observed in the Control group and the least in the Audit group (16.3% *v* 11.4% *v* 15.5%, X^2=73.42, DF=6, $p<0.001$). There was no statistically significant difference in the numbers of patients in each group who went on to have a stroke (1.5% *v* 1.6% *v* 1.6%) or who were diagnosed with diabetes (2.5% *v* 2.3% *v* 2.8%). There was however, a significant difference in relation to changes in smoking status. Twice as many patients in the Strategic group had their record changed to reflect that they were a non-smoker or ex-smoker (1.7% *v* 2.0% *v* 4.9%) whilst fewer patients in that group were newly recorded as current smokers (1.3% *v* 0.8% *v* 0.6%, X^2=145.45, DF=8, $p<0.001$, Table 6.31).

6.8.3 Changes for patients with reduced risk

Around one third of the 816 patients whose level of risk fell had blood pressure which remained controlled during the period of study (Table 6.32). Almost half of the patients in the Control and Audit groups had newly controlled blood pressure, as did just over one third of patients in the Strategic group (45.5% *v* 44.7% *v* 36.2%, X^2=14.87, DF=6, p=0.021). In addition, 52 patients were now non-smokers or ex-smokers, the majority of them in the Strategic group, a difference which was statistically significant (1.7% *v* 6.7% *v* 10.1%, X^2=105.37, DF=6, p<0.001).

6.8.4 Changes for patients with increased risk

Approximately half of the 2,263 patients whose risk level increased had uncontrolled blood pressure which remained uncontrolled throughout the study (45.7% *v* 56.6% *v* 44.3%, X^2=33.33, DF=6, p<0.001, Table 6.33). There were no statistical differences between the groups in relation to the 79 patients who had a new stroke or the 121 patients who were newly diagnosed with diabetes, although there was a significant difference in the numbers newly recorded as smokers (3% *v* 2.1% *v* 1.2%, X^2=19.02, DF=6, p=0.004).

6.8.5 Attention bias

Analysis of initial and final blood pressure control was also conducted for patients with isolated hypertension, that is, no additional stroke risk factors, compared with patients who had at least one of the risk factors of smoking, diabetes or previous stroke. Whilst there were significant differences in levels of control between the three study groups, there were no systematic differences related to the presence of additional risk factors (Table 6.34). Data from the casenote review showed that patients with additional risk factors had more visits to the GP in a year (median visits 12 *v* 8), had their blood pressure recorded more often (median record 6 *v* 4) and had higher mean systolic blood pressure (152.4 mm Hg *v* 146.5 mm Hg) and lower mean diastolic pressure (79.6 mm Hg *v* 81.3 mm Hg).

6.8.6 Characteristics of patients with new stroke

Seventy nine patients had a new stroke during the period of study, 13 of these also had a record of a previous stroke (14.8% *v* 19.1% *v* 16.1%, Table 6.35). Two thirds of the patients in the Audit and Strategic groups had been diagnosed with hypertension, compared with over 90% in the Control group. The majority were receiving antihypertensive treatment. Prior to this stroke, half of the patients were in the low risk category (48.2% *v* 52.4% *v* 54.8%), whilst only one third were at highest risk (22.2% *v* 33.3% *v* 35.6%).

6.8.7 Co-existing disease

It was also possible to determine the presence of co-morbidity for 4,129 patients with diagnosed hypertension (Table 6.36). Two thirds (65.6%) had co-existing major disease. The degree of co-morbidity ranged from one to seven additional major conditions. One third (33.5%) had two or more additional conditions, 14% had four or more, 5.3% had four or more and 1.5% of patients had five or more major conditions in addition to their hypertension. More than 900 of the patients had cardiovascular disease (22.2%), 17.4% had depression or other mental health problems and 8.2% had a cancer. Three hundred of the patients had already had a stroke.

There was no increase in the prevalence of co-morbidity with increasing deprivation. Two thirds (67%) of affluent patients (deprivation categories 1 and 2) had co-morbidity, as did 66% of those living in deprivation categories 3–5 and 61% of those living in the most deprived areas (6–7).

6.9 Summary

The results of this study demonstrate that there was a significant difference between the Control group and the other two groups in relation to the number of practices with training status. In addition, the availability of a hypertension register, hypertension clinic and recall system was also greater in the Control group. Validation of electronic data against casenotes showed that whilst recording of diagnoses, treatment and smoking status was high, only one third of patients had their most recent blood pressure recorded electronically.

At the outset of the study, the majority of patients aged 65–79 had a blood pressure recorded, as did almost all diagnosed hypertensive patients. However, around half of the treated hypertensive patients in each group were not controlled. Results for the 34 practices returning data over time demonstrate that the numbers of 65–79 year olds with a blood pressure recorded increased in each group, with the largest improvement seen in the Audit group. The greatest proportion of patients whose initial blood pressure was within normal limits was found in the Strategic group. This increased in all three groups, rising to almost two thirds in the Strategic group and to more than half in the Control group. More than 40% of the patients in the Control group whose blood pressure was initially uncontrolled were diagnosed as hypertensive, compared with just over one third in the other two groups, a difference which was statistically significant. Identification improved in all three groups and the improvement made in the Control and Audit groups was two to three times that made in the Strategic group.

During the study, the numbers of treated patients increased to more than 90% in all three groups, with the greatest improvement in the Strategic group. The numbers of patients treated and adequately controlled rose by around 10% in each group. However, more than one third of all patients with diagnosed hypertension remained uncontrolled.

The largest reduction in observed systolic and diastolic blood pressure was seen in the Control group. In all three groups, mean pressure for diagnosed hypertensive patients was lower than for patients aged 65–79 generally, with the lowest levels found in the Strategic group. The lowest mean systolic blood pressure was found

in the Strategic group and the greatest proportions of control in the Strategic and Control groups. After adjusting for clustering, patient and practice effects, there was a significant difference in the level of control in the Strategic group compared with the other two groups.

Absolute risk was reduced for between 10–20% of patients in each group. The largest reduction was found in the Strategic group. More than 80% of the patients in the Strategic group had their blood pressure updated compared with around half in the Audit and Control groups. There was no significant difference in the numbers of patients in each group who went on to have a stroke or who were diagnosed with diabetes. However, twice as many patients in the Strategic group had their record changed to reflect that they did not smoke and fewer patients in that group were newly recorded as smokers.

Table 6.1 – Recruited practices by strata

DEPRIVATION PAYMENT LEVEL	PRACTICE SIZE					
	1-2 GPs		3-4 GPs		≥ 5 GPs	
	Require*	Recruit**	Require	Recruit	Require	Recruit
0% (low)	7	6	4	4	2	2
5-15% (medium)	7	7	11	11	10	9
≥ 20% (high)	9	7	7	7	3	1

* Number of practices required from stratum (n=60)

** Number of practices recruited from stratum (n=54)

Figure 6a – Flow of practices through the study

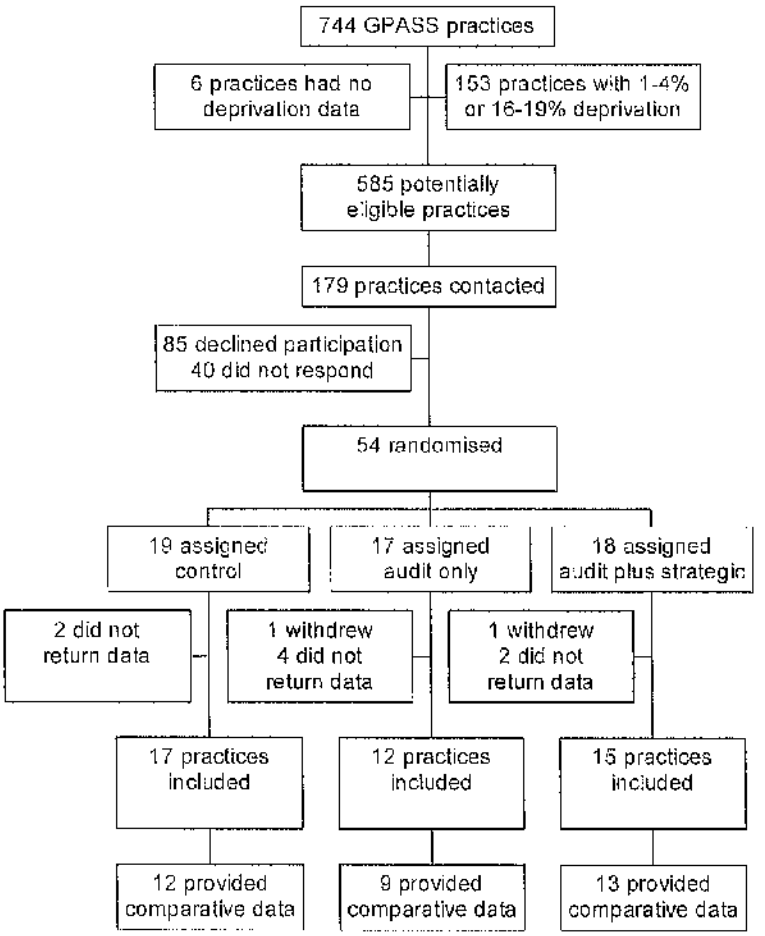


Table 6.2 – Local Health Care Co-operatives covered by participating practices

HEALTH BOARD (TOTAL LHCCs)	NUMBER OF PRACTICES
Argyll & Clyde (n=7)	
Inverclyde LHCC	1
Lomond LHCC	1
West Renfrew LHCC	2
Ayrshire & Arran (n=7)	
Ayr, Prestwick & Troon LHCC	3
Irvine, Kilwinning & Dundonald LHCC	1
Stevenston, Saltcoats & Kilwinning LHCC	1
Borders (n=2)	
Borders LHCC	1
Borders West LHCC	1
Dumfries & Galloway (n=4)	
Wigtownshire LHCC	2
Forth Valley (n=2)	
Forth Valley LHCC (North)	3
Forth Valley LHCC (South)	3
Greater Glasgow (n=16)	
Anniesland/Bearsden/Milngavie LHCC	1
Camglen LHCC	1
Dennistoun LHCC	1
Drumchapel LHCC	1
Eastern Glasgow LHCC	1
Greater Shawlands LHCC	1
North Glasgow LHCC	1
Riverside LHCC	2
South West Glasgow LHCC	2
Strathkelvin LHCC	2
Westone LHCC	1
Grampian (n=8)	
Central Aberdeenshire LHCC	2
Deeside LHCC	1
Moray LHCC	1
Highland (n=9)	
East Sutherland LHCC	1
Inverness LHCC	2
Lanarkshire (n=8)	
Clydesdale LHCC	1
Hamilton/Blantyre LHCC	1
Motherwell LHCC	2
Wishaw/Newmains/Shotts LHCC	1
Lothian (n=8)	
Midlothian LHCC	1
North East Edinburgh LHCC	2
South Central Edinburgh LHCC	1
South East Edinburgh LHCC	1
West Lothian LHCC	1
Tayside (n=4)	
Arbroath & Friockheim LHCC	1

Table 6.3 – Proportion of Scottish population covered by participating practices: comparison with the Scottish Continuous Morbidity Recording project

HEALTH BOARD	HB POPULATION	CMR PROJECT			HYPER TRIAL		
		Practices	Patients	HB Coverage	Practices	Patients	HB Coverage
Argyll & Clyde	436,059	5	25,707	5.9%	4	17,200	3.9%
Ayrshire & Arran	389,390	7	58,881	15.1%	5	47,431	12.2%
Borders	107,898	2	8,780	8.1%	2	10,200	9.5%
Dumfries & Galloway	152,308	6	24,513	16.1%	2	3,979	2.6%
Fife	356,850	9	77,796	21.8%	0	0	0.0%
Forth Valley	294,012	7	43,997	15.0%	6	26,701	9.1%
Grampian	546,418	8	56,930	10.4%	4	22,634	4.1%
Greater Glasgow	974,753	6	29,778	3.1%	14	62,579	6.4%
Highland	217,324	6	28,488	13.1%	3	6,571	3.0%
Lanarkshire	582,229	4	19,435	3.3%	5	20,326	3.5%
Lothian	829,171	10	32,413	3.9%	6	35,825	4.3%
Tayside	408,587	2	9,706	2.4%	1	6,608	1.6%
TOTALS	**5,294,999**	**72**	**416,424**	**7.9%**	**52**	**260,054**	**4.9%**

Table 6.4 – Practice size and deprivation level at study outset

PRACTICE CHARACTERISTIC	STUDY GROUP (Practices)		
	Control (n=19)	**Audit (n=16)**	**Strategic (n=17)**
Number of GPs – mean (range)	3.4 (1–11)	3.5 (1–6)	3.5 (1–6)
List size – mean	4624 (750–18335)	5231 (1000–11500)	5207 (1900–9000)
Deprivation payment – median	8% (0–54)	9% (0–43)	8% (0–28)
Low deprivation (0%)	4 (21%)	4 (25%)	4 (23%)
Medium deprivation (5-15%)	8 (42%)	8 (50%)	11 (65%)
High deprivation (≥ 20%)	7 (37%)	4 (25%)	2 (12%)

Table 6.5 – Practice structure and organisation at study outset

PRACTICE CHARACTERISTIC	STUDY GROUP (Practices)			CHI-SQUARED TEST RESULT
	Control (n=18)*	Audit (n=14)*	Strategic (n=16)*	
Training practice	9 (50%)	4 (29%)	4 (25%)	$X^2 = 2.72$; df = 2; p=0.257
Practice nurse	16 (89%)	12 (86%)	15 (94%)	$X^2 = 0.53$; df = 2; p=0.767
Hypertension register	16 (89%)	8 (57%)	12 (75%)	$X^2 = 4.23$; df = 2; p=0.120
Hypertension clinic	8 (44%)	4 (29%)	4 (25%)	$X^2 = 1.64$; df = 2; p=0.440
Recall system	14 (78%)	9 (64%)	10 (63%)	$X^2 = 1.10$; df = 2; p=0.576

* Relates to practices which returned a questionnaire prior to the collection of electronic data (n=48)

Table 6.6 – Practice structure and organisation by practice size

PRACTICE CHARACTERISTIC	PRACTICE SIZE			CHI-SQUARED TEST RESULT
	1-2 GPs (n=17)*	3-4 GPs (n=18)*	≥5 GPs (n=13)*	
Training practice	4 (24%)	5 (28%)	8 (62%)	$X^2 = 5.39$; df = 2; p=0.068
Practice nurse	15 (88%)	15 (83%)	13 (100%)	$X^2 = 2.30$; df = 2; p=0.317
Hypertension register	15 (88%)	13 (72%)	8 (62%)	$X^2 = 2.92$; df = 2; p=0.232
Hypertension clinic	7 (41%)	6 (33%)	3 (23%)	$X^2 = 1.09$; df = 2; p=0.581
Recall system	16 (94%)	11 (61%)	6 (46%)	$X^2 = 8.67$; df = 2; p=0.013

* Relates to practices which returned a questionnaire prior to the collection of electronic data (n=48)

Table 6.7 – Practice structure and organisation by deprivation payment level

PRACTICE CHARACTERISTIC	DEPRIVATION PAYMENT LEVEL			CHI-SQUARED TEST RESULT
	0% (n=12)*	5–15% (n=26)*	≥20% (n=10)*	
Training practice	4 (33%)	9 (35%)	4 (40%)	$X^2 = 0.12$; df = 2; p=0.941
Practice nurse	9 (75%)	25 (96%)	9 (90%)	$X^2 = 3.94$; df = 2; p=0.139
Hypertension register	7 (58%)	19 (73%)	10 (100%)	$X^2 = 5.16$; df = 2; p=0.076
Hypertension clinic	2 (17%)	10 (39%)	4 (40%)	$X^2 = 2.01$; df = 2; p=0.366
Recall system	8 (67%)	17 (65%)	8 (80%)	$X^2 = 0.75$; df = 2; p=0.687

* Relates to practices which returned a questionnaire prior to the collection of electronic data (n=48)

Table 6.8 – Practice changes between recruitment and end of study

CHANGE IN PRACTICE CHARACTERISTIC	STUDY GROUP		
	Control	Audit	Strategic
Addition of partner	1	1	1
Loss of partner	1	-	-
Change of partner	3	6	-
Addition of practice nurse	1	1	-
Loss of practice nurse	-	-	-
Change of practice manager	6	-	1
Became training practice	-	-	2
No longer training practice	1	-	-

Table 6.9 – Electronic data returns by practice

PRACTICE	HEALTH BOARD AREA	EQ 1	EQ 2	EQ 3
A01	GGHB	■	■	■
C02	Lothian		■	■
A03	Highland			
S04	Ayrshire & Arran	■	■	■
C05	GGHB	■	■	
S06	Lothian	■	■	■
C07	Grampian	■	■	■
S09	Forth Valley	■	☒	■
A10	Lothian	■	☒	☒
C11	Dumfries & Galloway	■	☒	■
S12	Argyll & Clyde	■	■	
A13	GGHB	■		
S14	Lothian	■	■	■
A15	Grampian	■	☒	■
S16	Lothian	■	☒	■
S17	Argyll & Clyde	■	■	■
C18	Lothian	■	■	■
S19	Tayside	■		■
C20	Forth Valley	■	■	■
C21	Argyll & Clyde		■	■
C22	Lanarkshire			
A23	Lanarkshire	■	■	■
A24	Forth Valley	■	☒	■
S25	Ayrshire & Arran	■	■	
A26	GGHB	■	■	
A27	Grampian		■	■
S28	Lanarkshire	☒		
C29	Highland	■		☒
A30	GGHB			
S31	Forth Valley	■		■
S32	GGHB	■		■
C33	GGHB	■	■	■
A34	GGHB	■		
C35	Ayrshire & Arran		■	■
C36	GGHB	■		
C37	GGHB	■	■	
A38	Forth Valley	■	■	
A39	GGHB			
S40	GGHB			
A41	Highland			☒
S42	Forth Valley	■		
C43	Lanarkshire		■	
S44	Dumfries & Galloway	■		☒
C46	Borders	■	■	■
A47	Lanarkshire	■	■	
C48	Argyll & Clyde	■		■
A49	Ayrshire & Arran	■	■	■
C50	GGHB			■
C51	Ayrshire & Arran	☒		
S52	Grampian	■	☒	■
C53	Borders	■	☒	☒
S54	GGHB	☒	■	■

■ Practice returned data
☒ System problem prevented data return or processing

Table 6.10 – Content of electronic data returned by participating practices

DATA EXTRACTED	EQ EXTRACTION PERIOD (Practices)		
	Extract 1 (n=37)	**Extract 2 (n=25)**	**Extract 3 (n=28)**
Total number of patients	197,702	124,368	182,743
Number of patients aged 65–79	23,512	14,197	20,744
Items of measurement data	308,474	327,327	329,571
Items of Read coded data	2,810,505	2,162,668	3,150,223
Items of prescribing data	2,400,823	3,390,391	6,127,119

Total number of practices returning data during the study	44
Total number of patients for whom data was extracted	217,125
Total number of patients aged 65–79	30,345
Total number of measurement items extracted	498,748
Total number of Read coded items extracted	4,431,067
Total number of prescribing items extracted	7,576,425

Table 6.11 – Electronic data for patients aged 65–79

EXTRACTION PERIOD	STUDY GROUP (PRACTICES)		
Extract 1	**Control (n=12)**	**Audit (n=11)**	**Strategic (n=14)**
Number of patients aged 65–79	5,777	6,584	8,796
Mean per practice (range)	481 (122–1014)	599 (199–1290)	628 (239–1375)
With diagnosed hypertension	1,511	1,466	1,972
Mean per practice (range)	126 (18–344)	133 (30–342)	141 (39–315)
Extract 2	**Control (n=11)**	**Audit (n=7)**	**Strategic (n=7)**
Number of patients aged 65–79	5,828	4,250	4,119
Mean per practice (range)	530 (129–954)	607 (199–1292)	588 (229–1334)
With diagnosed hypertension	1,757	1,137	1,065
Mean per practice (range)	160 (24–355)	162 (32–365)	152 (56–360)
Extract 3	**Control (n=11)**	**Audit (n=6)**	**Strategic (n=11)**
Number of patients aged 65–79	4,979	4,731	7,547
Mean per practice (range)	453 (127–970)	789 (191–1297)	686 (192–1328)
With diagnosed hypertension	1,657	1,366	1,927
Mean per practice (range)	151 (39–319)	228 (72–442)	175 (63–342)

Table 6.12 – Validation of electronic data

ITEM VALIDATED	STUDY GROUP (Patients)		
	Control (n=84)	Audit (n=80)	Strategic (n=28)
Diagnosis of hypertension			
Agreement in both record formats	79 (94%)	68 (85%)	26 (93%)
Diagnosis in casenote only	4	10	2
Diagnosis on electronic record only	1	2	0
Diagnosis of diabetes			
Agreement in both record formats	83 (99%)	77 (96%)	28 (100%)
Diagnosis in casenote only	0	2	0
Diagnosis on electronic record only	1	1	0
Diagnosis of previous stroke			
Agreement in both record formats	81 (96%)	78 (98%)	26 (93%)
Diagnosis in casenote only	3	2	2
Diagnosis on electronic record only	0	0	0
Receiving anti-hypertension drug(s)			
Agreement in both record formats	77 (92%)	78 (98%)	28 (100%)
Treatment in casenote only	5	2	0
Treatment in electronic record only	2	0	0
Most recent blood pressure			
Recorded in both record formats	18 (21%)	13 (16%)	9 (32%)
Most recent in casenote only	52	54	13
Most recent in electronic record only	10	13	6
Dates tally, variance in reading	4	0	0
Recorded smoking status			
Agreement in both record formats	68 (81%)	71 (89%)	23 (82%)
Smoker in casenote, not in electronic	3	1	1
Smoker in electronic, not in casenote	9	3	1
Variance between non / no record	4	5	3

Figure 6b – Comparison of electronic and paper records for diagnoses and antihypertensive drug treatment

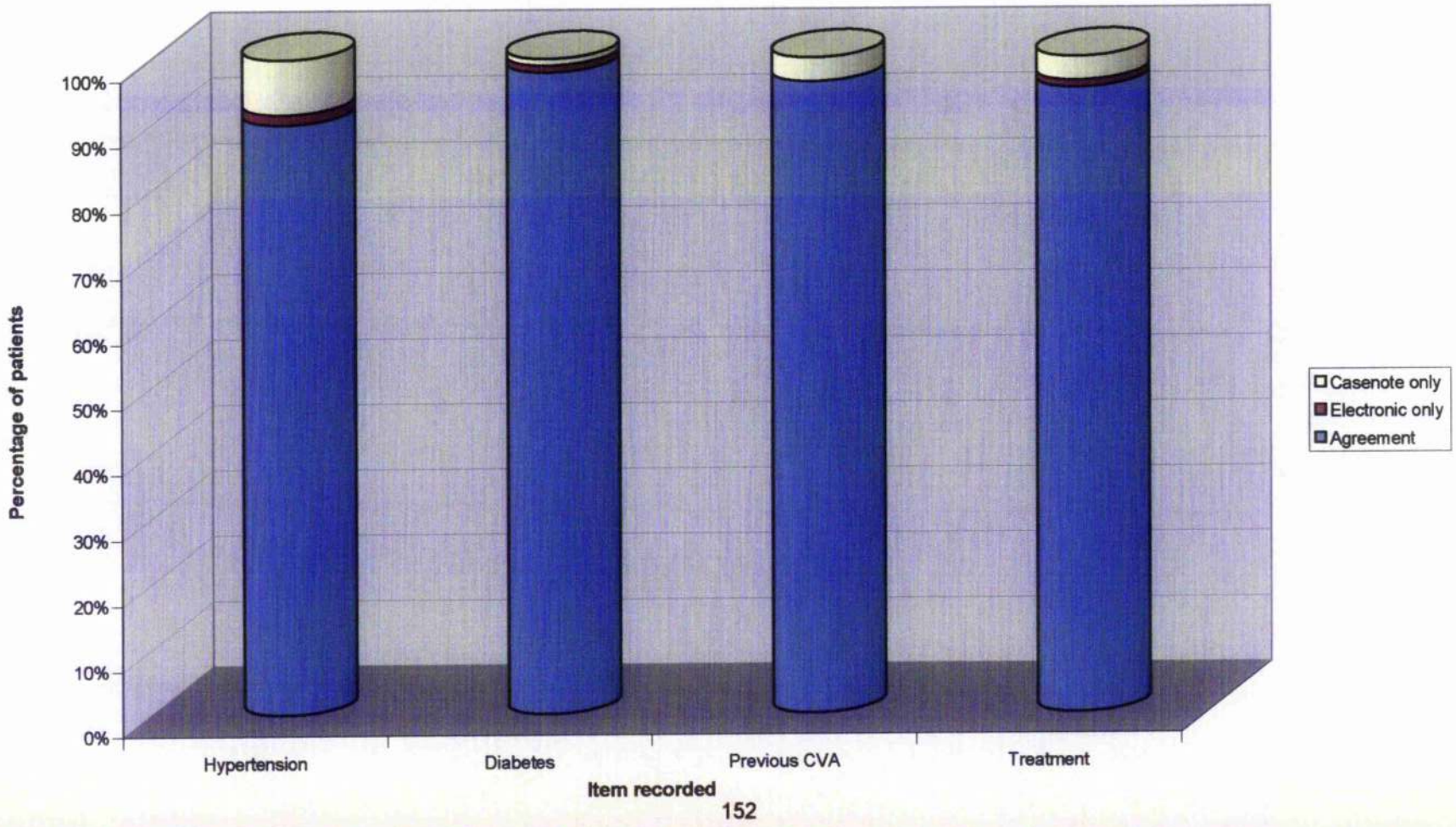


Figure 6c – Comparison of electronic and paper records for most recent blood pressure recording and smoking status

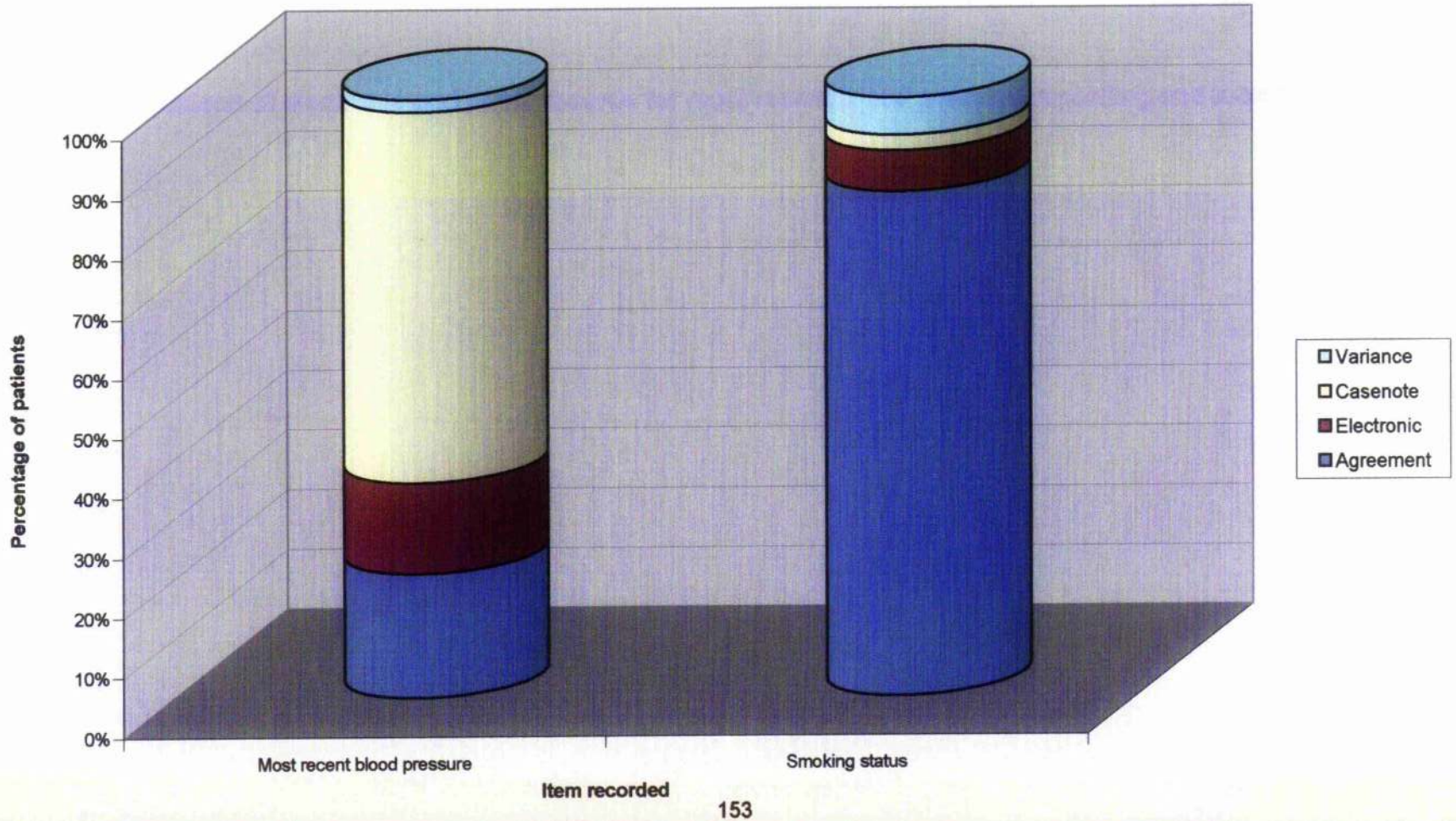


Table 6.13 – Comparison of blood pressure levels for patients with most recent recording in casenote (n=119)

BLOOD PRESSURE LEVEL RECORDED	STUDY GROUP (Patients)		
	Control (n=52)	Audit (n=54)	Strategic (n=13)
<160/90 or ≥160/90 in both formats	31 (60%)	29 (54%)	11 (84%)
<160/90 in casenote, ≥160/90 on computer	12 (23%)	18 (33%)	1 (8%)
≥160/90 in casenote, <160/90 on computer	9 (17%)	7 (13%)	1 (8%)

Table 6.14 – Identification of hypertension in 65–79 year olds at baseline*

PATIENT VARIABLE	STUDY GROUP (Practices)			CHI-SQUARED TEST RESULT
	Control (n=12)	**Audit (n=9)**	**Strategic (n=14)**	
All patients: mean (range)	481 (122–1014)	599 (199–1290)	628 (239–1375)	
Male	44.3%	42.0%	44.1%	
Female	55.7%	58.0%	55.9%	
BP recorded	86.5%	73.5%	74.4%	
BP <160/90	55.7%	45.1%	47.6%	
BP ≥160 / >90	30.8%	28.4%	26.8%	
BP ≥160 / ≥90, diagnosed hypertensive	**38.7%**	**35.8%**	**35.3%**	**X^2 = 5.27; df = 2; p=0.072**

Based on data returned in the initial Electronic Questionnaire

Table 6.15 – Treatment and control of 65–79 year old diagnosed hypertensives at baseline

PATIENT VARIABLE	STUDY GROUP (Practices)			CHI-SQUARED TEST RESULT
	Control (n=12)	Audit (n=9)	Strategic (n=14)	
Hypertensive patients: mean (range)	126 (18–344)	163 (30–342)	141 (39–315)	
BP <160/90	52.3%	41.3%	48.3%	
BP ≥160 / ≥90	45.5%	45.7%	42.3%	
No record of BP	2.1%	13.0%	9.4%	
Diagnosed hypertensive, on treatment	**88.0%**	**85.7%**	**81.7%**	$X^2 = 27.28$; df = 2; p<0.001
Treated, no record of BP	2.0%	11.5%	8.6%	
Treated, BP ≥160 / ≥90	45.7%	46.2%	43.2%	
Diagnosed, on treatment, BP controlled	**52.3%**	**42.4%%**	**48.2%%**	$X^2 = 25.76$; df = 2; p<0.001

Table 6.16 – Size and deprivation status of practices returning comparative data (n=34)*

PRACTICE CHARACTERISTIC	STUDY GROUP (Practices)		
	Control (n=12)	Audit (n=9)	Strategic (n=13)
Number of GPs – mean (range)	3.2 (1–6)	4.0 (2–6)	3.8 (1–6)
List size – mean	3972 (750–6700)	5667 (1500–-11500)	5602 (1900–9000)
Deprivation payment – median	8% (0–37)	9% (0–22)	8% (0–23)
Low deprivation (0%)	4 (33%)	3 (33%)	3 (23%)
Medium deprivation (5-15%)	3 (25%)	3 (33%)	9 (69%)
High deprivation (≥ 20%)	5 (42%)	3 (33%)	1 (8%)

* Practices which returned data in two or more Electronic Questionnaires. If the practice returned data in all three, the first and the last were compared.

Table 6.17 – Practice structure and organisation of practices returning comparative data

PRACTICE CHARACTERISTIC	STUDY GROUP (Practice)			CHI-SQUARED TEST RESULT
	Control (n=12)	Audit (n=9)	Strategic (n=13)	
Training practice	7 (58%)	2 (22%)	4 (31%)	$X^2 = 3.34$; df = 2; p=0.189
Practice nurse	10 (83%)	8 (89%)	13 (100%)	*
Hypertension register	11 (92%)	4 (44%)	6 (69%)	$X^2 = 5.54$; df = 2; p=0.063
Hypertension clinic	5 (42%)	2 (22%)	3 (23%)	$X^2 = 1.34$; df = 2; p=0.511
Recall system	8 (67%)	5 (56%)	7 (54%)	$X^2 = 0.48$; df = 2; p=0.788

* Unable to run Chi-squared test due to lack of data in some cells

Table 6.18 – Computer use in practices returning comparative data

FEATURE OF COMPUTER UTILISATION	STUDY GROUP (Practices)		
	Control (n=12)	Audit (n=9)	Strategic (n=13)
Terminal available in all doctor rooms	11 (92%)	9 (100%)	10 (77%)
Terminal available in all nurse rooms	10 (83%)	8 (89%)	10 (77%)
GP data entry	10 (83%)	9 (100%)	10 (77%)
Nurse data entry	11 (92%)	7 (78%)	11 (85%)
Minimum dataset collected for all patients	9 (75%)	6 (67%)	10 (77%)
Disease registers totally/largely computerised	6 (50%)	7 (78%)	7 (54%)
Clinical records totally/largely computerised	1 (8%)	1 (11%)	1 (8%)
Call and recall totally/largely computerised	7 (58%)	8 (89%)	10 (77%)
Highlighting tasks totally/largely computerised	2 (18%)	4 (44%)	6 (46%)
Guidelines totally/largely computerised	4 (36%)	1 (11%)	1 (8%)
Past medical history entered for all patients	9 (75%)	7 (78%)	11 (85%)
Recall information entered for all patients	12 (100%)	9 (100%)	13 (100%)
Measurement data entered for all patients	6 (50%)	5 (56%)	6 (50%)
Diagnosis entered for all patients	6 (50%)	5 (56%)	4 (36%)

Table 6.19 – Change in identification of hypertension in 65–79 year olds

PATIENT VARIABLE	STUDY GROUP (Practices)						CHI-SQUARED TEST RESULT
	CONTROL (n=12)		AUDIT (n=9)		STRATEGIC (n=13)		
	Initial	Final	Initial	Final	Initial	Final	
All patients: mean (range)	507 (122–954)	518 (127–970)	603 (199–1290)	641 (191–1297)	645 (239–1375)	646 (192–1328)	
Male	44.3%	44.5%	42.3%	43.5%	44.3%	45.2%	
Female	55.7%	55.5%	57.7%	56.5%	55.7%	54.8%	
BP recorded	78.3%	81.5%	66.2%	72.3%	79.0%	84.5%	
BP <160/90	49.5%	58.0%	40.1%	47.3%	51.9%	61.4%	
BP ≥160 / ≥90	28.8%	23.5%	26.1%	25.0%	27.1%	23.1%	
BP ≥160 / ≥90, diagnosed hypertensive – INITIAL	41.2%		37.7%		36.0%		**X^2 = 11.20; df = 2; p=0.004**
BP ≥160 / ≥90, diagnosed hypertensive – FINAL	49.3%		43.8%		38.6%		**X^2 = 39.03; df = 2; p<0.001**

Table 6.20 – Change in treatment and control of 65–79 year old diagnosed hypertensives

PATIENT VARIABLE	STUDY GROUP (Practices)						CHI-SQUARED TEST RESULT
	CONTROL (n=12)		AUDIT (n=9)		STRATEGIC (n=13)		
	Initial	Final	Initial	Final	Initial	Final	
Hypertensive patients: mean (range)	132 (18–344)	171 (39–355)	141 (30–365)	184 (32–442)	148 (55–315)	166 (63–342)	
No record of BP	8.9%	8.3%	24.7%	18.0%	3.9%	2.8%	
BP <160/90	45.7%	56.7%	33.3%	43.7%	53.6%	62.6%	
BP ≥160 / ≥90	45.4%	35.0%	42.1%	38.3%	42.5%	34.6%	
Diagnosed hypertensive, on treatment – INITIAL	**88.2%**		**86.1%**		**84.3%**		**X^2 = 10.64; df = 2; p=0.005**
Diagnosed hypertensive, on treatment – FINAL	**91.4%**		**90.5%**		**93.9%**		**X^2 = 16.95; df = 2; p<0.001**
Treated, no record of BP	8.6%	7.7%	22.6%	17.9%	3.3%	2.8%	
Treated, BP ≥160 / ≥90	45.7%	34.5%	43.4%	38.3%	43.4%	34.9%	
Diagnosed, on treatment, BP controlled – INITIAL	**45.8%**		**34.0%**		**53.4%**		**X^2 = 98.87; df = 2; p<0.001**
Diagnosed, on treatment, BP controlled – FINAL	**57.8%**		**43.8%**		**62.4%**		**X^2 = 126.59; df = 2; p<0.001**

Figure 6d – Comparison of hypertensive patients identified, treated and controlled: 65–79 vs. 45–64

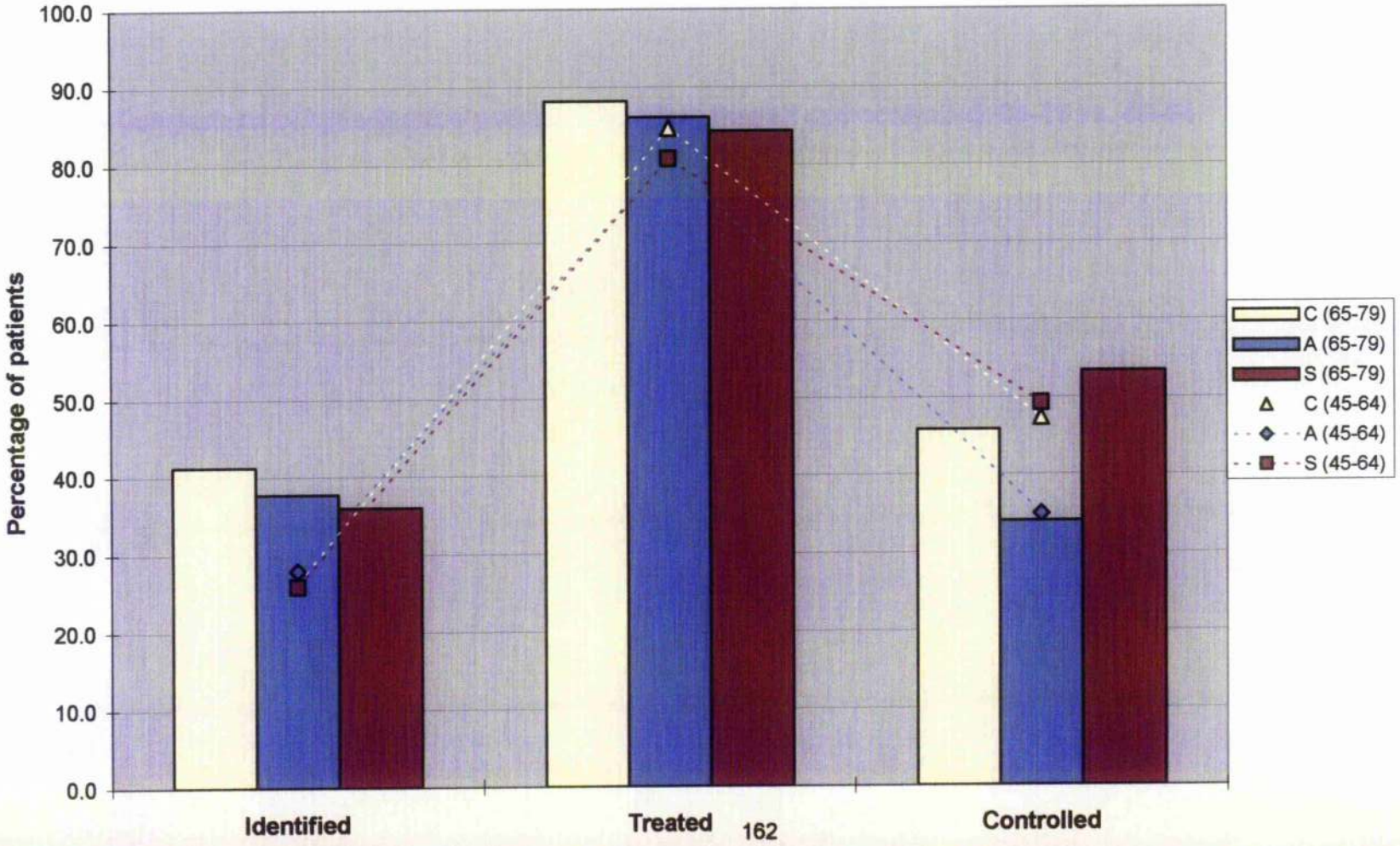


Table 6.21 – Identification, treatment and control by practice size

RULE OF HALVES	PRACTICE SIZE			CHI-SQUARED TEST RESULT
	1-2 GPs	3-4 GPs	≥5 GPs	
Identified – INITIAL	43.8%	38.3%	51.3%	$X^2 = 51.35$; df = 2; p<0.001
Identified – FINAL	46.2%	45.3%	52.5%	$X^2 = 14.02$; df = 2; p=0.001
Treated – INITIAL	81.3%	91.1%	87.7%	$X^2 = 30.95$; df = 2; p<0.001
Treated – FINAL	93.9%	92.4%	94.4%	$X^2 = 5.18$; df = 2; p=0.075
Controlled – INITIAL	57.5%	53.3%	48.5%	$X^2 = 11.98$; df = 2; p=0.003
Controlled – FINAL	69.0%	60.1%	57.7%	$X^2 = 20.21$; df = 2; p<0.001

Table 6.22 – Identification, treatment and control by practice deprivation payment level

RULE OF HALVES	DEPRIVATION PAYMENT LEVEL			CHI-SQUARED TEST RESULT
	0%	5-15%	≥20%	
Identified – INITIAL	44.4%	43.5%	48.9%	$X^2 = 6.36$; df = 2; p=0.042
Identified – FINAL	46.8%	46.3%	58.8%	$X^2 = 26.71$; df = 2; p<0.001
Treated – INITIAL	84.6%	87.3%	92.1%	$X^2 = 20.52$; df = 2; p<0.001
Treated – FINAL	93.1%	94.0%	92.9%	$X^2 = 1.67$; df = 2; p=0.435
Controlled – INITIAL	44.0%	51.1%	57.6%	$X^2 = 23.22$; df = 2; p<0.001
Controlled – FINAL	53.6%	58.6%	68.7%	$X^2 = 40.41$; df = 2; p<0.001

Table 6.23 – Characteristics of patients with matched records (n=5103)*

PATIENT FACTOR	STUDY GROUP (Patients)		
	Control (n=1813)	Audit (n=1339)	Strategic (n=1951)
Male	40.5%	37.1%	40.5%
Female	59.5%	62.9%	59.5%
Patient deprivation category			
1-2 (most affluent)	19.1%	1.5%	39.3%
3-5	45.8%	82.4%	55.3%
6-7 (most deprived)	35.1%	16.1%	5.4%
Smoking status			
No record	15.9%	15.4%	12.3%
Non-smoker / ex-smoker	63.4%	65.4%	66.7%
Smoker	20.7%	19.2%	21.0%
Diabetic	9.9%	9.5%	8.7%
Previous stroke	5.1%	4.8%	4.3%

* Patients on whom feedback was provided and whose initial and final data could be linked for comparison

Table 6.24 – Change in mean blood pressure for patients aged 65–79 with matched records

MEAN BLOOD PRESSURE	STUDY GROUP (Patients)			RESULTS OF ANOVA
	Control (n=1813)	Audit (n=1339)	Strategic (n=1951)	
Initial systolic	153.3	156.0	152.5	p<0.001
Final systolic	150.0	154.3	149.8	p=0.005
Reduction in systolic	**3.3 mm Hg**	**1.7 mm Hg**	**2.7 mm Hg**	
Initial diastolic	86.2	87.1	85.9	p<0.001
Final diastolic	84.0	85.8	83.9	P<0.001
Reduction in systolic	**2.2 mm Hg**	**1.3 mm Hg**	**2.0 mm Hg**	

Table 6.25 – Change in mean blood pressure for diagnosed hypertensive patients aged 65–79 with matched records

MEAN BLOOD PRESSURE	STUDY GROUP (Patients)			RESULTS OF ANOVA
	Control (n=1165)	Audit (n=775)	Strategic (n=1258)	
Initial systolic	150.0	153.0	148.8	p<0.001
Final systolic	146.6	151.3	145.7	P<0.001
Reduction in systolic	**3.4 mm Hg**	**1.7 mm Hg**	**3.1 mm Hg**	
Initial diastolic	84.3	85.5	83.6	p<0.001
Final diastolic	81.8	83.8	81.3	P<0.001
Reduction in systolic	**2.5 mm Hg**	**1.7 mm Hg**	**2.3 mm Hg**	

Table 6.26 – Summary results of mixed model for final systolic blood pressure in patients aged 65–79 with matched records

FINAL SYSTOLIC PRESSURE	STUDY GROUP (Patients)		
	Control (n=1813)	**Audit (n=1339)**	**Strategic (n=1951)**
Mean final SBP	150.0	154.3	149.8
Model adjusted SBP	151.2	152.7	149.6
vs. Control (95% CI)	--	**1.43 (-0.65, 4.14); p=0.723***	**-1.66 (-3.98, 0.33); p=0.398***
vs. Strategic (95% CI)	**1.66 (-0.33, 3.98); p=0.398***	**3.09 (1.28, 5.71); p=0.019***	--

* Bonferroni corrected and adjusted for patient's initial SBP, sex, smoking status, social deprivation and practice level factors of training status, practice nurse, hypertension register and recall system

Table 6.27 – Summary results of GEE model for final control of hypertension in patients aged 65–79 (yes / no)

VARIABLE	RR	95% CI	p-value
Trial arm			
Audit v Strategic	0.540	0.331 to 0.880	**0.013**
Control v Strategic	0.582	0.370 to 0.915	**0.019**
Strategic v Control	1.718	1.093 to 2.703	**0.019**
Audit v Control	0.928	0.550 to 1.568	**0.782**
Initial control (yes v no)	20.9	17.6 to 24.9	**<0.001**
Sex (male v female)	1.015	0.881 to 1.170	**0.835**
Smoking status			
Current v unknown	1.139	0.896 to 1.448	**0.287**
Non-smoker v unknown	1.310	1.060 to 1.619	**0.012**
Ex-smoker v unknown	1.176	0.910 to 1.519	**0.213**
Social deprivation			
Unknown v 7	0.515	0.325 to 0.818	**0.005**
1 v 7	0.546	0.344 to 0.865	**0.010**
2 v 7	0.431	0.275 to 0.677	**<0.001**
3 v 7	0.468	0.306 to 0.717	**<0.001**
4 v 7	0.623	0.421 to 0.923	**0.018**
5 v 7	0.639	0.422 to 0.968	**0.035**
6 v 7	0.656	0.447 to 0.962	**0.031**
Practice level variables			
Training status	0.870	0.577 to 1.310	**0.504**
Practice nurse availability	0.451	0.237 to 0.855	**0.015**
Hypertension register	1.594	0.960 to 2.649	**0.072**
Recall system	1.568	0.991 to 2.479	**0.055**

Table 6.28 – Summary results of GEE model for final proportion of controlled hypertensives aged 65–79 with matched records

FINAL CONTROL	STUDY GROUP (Patients)		
	Control (n=1813)	**Audit (n=1339)**	**Strategic (n=1951)**
Final proportion controlled	45.7%	33.5%	45.5%
Mean predicted proportion	46.5%	35.4%	49.4%
Adjusted RR (95% CI)	1.00	**0.93 (0.55, 1.57); p=0.782***	**1.72 (1.09, 2.70): p=0.019***

* Adjusted for patient's initial hypertension control, sex, smoking status, social deprivation and for the practice level factors of training status, practice nurse, hypertension register and recall system.

Table 6.29 – Change in level of absolute risk* for patients aged 65–79 with matched records

LEVEL OF RISK	STUDY GROUP (Patients)			CHI-SQUARED TEST RESULT
	Control (n=1813)	Audit (n=1339)	Strategic (n=1951)	
Reduced risk	16.6%	11.2%	18.7%	
Increased risk	41.6%	39.9%	49.9%	$X^2 = 116.10$; df = 4; p<0.001
No change	41.8%	48.9%	31.4%	

* Change related to any increase or decrease in the level of absolute risk, regardless of the size of the change

Table 6.30 – Updated blood pressure record for patients aged 65–79 with matched records

BLOOD PRESSURE RECORD	STUDY GROUP (Patients)			CHI-SQUARED TEST RESULT
	Control (n=1813)	Audit (n=1339)	Strategic (n=1951)	
Electronic record Updated during study	57.7%	43.2%	82.3%	$X^2 = 559.73$; df = 2; p<0.001
Electronic record not updated during study	42.3%	56.8%	17.7%	

Table 6.31 – Change in risk factors for patients aged 65–79 with matched records

RISK FACTOR	STUDY GROUP (Patients)			CHI-SQUARED TEST RESULT
	Control (n=1813)	Audit (n=1339)	Strategic (n=1951)	
Blood pressure				
Newly controlled	16.3%	11.4%	15.1%	$X^2 = 73.42$; df = 6; p<0.001
Newly uncontrolled	3.8%	4.0%	5.5%	
Stroke status				
New CVA	1.5%	1.6%	1.6%	$X^2 = 1.89$; df = 4; p=0.756
Diabetes status				
New diabetes	2.5%	2.3%	2.8%	$X^2 = 3.50$; df = 4; p=0.477
Previously diabetic*	0.2%	0.0%	0.2%	
Smoking status				
New non / ex smoker	1.7%	2.0%	4.9%	$X^2 = 145.45$; df = 8; p<0.001
New smoker	1.3%	0.8%	0.6%	

* Patients who previously had a diagnosis of diabetes on computer which was subsequently deleted

Table 6.32 – Risk reducing factors in patients with reduced risk

RISK FACTOR	STUDY GROUP (Patients)			CHI-SQUARED TEST RESULT
	Control (n=301)	Audit (n=150)	Strategic (n=365)	
Newly controlled	45.5%	44.7%	36.2%	$X^2 = 14.87$; df = 6; p=0.021
Still controlled	33.6%	26.0%	34.2%	
Previously diabetic	0.7%	0.0%	1.1%	$X^2 = 4.27$; df = 4; p=0.370
New non / ex smoker	1.7%	6.7%	10.1%	$X^2 = 105.37$; df = 6; p<0.001

Table 6.33 – Risk increasing factors in patients with increased risk

RISK FACTOR	STUDY GROUP (Patients)			CHI-SQUARED TEST RESULT
	Control (n=755)	Audit (n=534)	Strategic (n=974)	
Newly uncontrolled	6.9%	9.2%	8.1%	$X^2 = 33.33$; df = 6; p<0.001
Still uncontrolled	45.7%	56.6%	44.3%	
New CVA	3.2%	2.8%	2.8%	$X^2 = 4.96$; df = 4; p=0.291
New diabetes	5.4%	5.4%	5.2%	$X^2 = 0.41$; df = 2; p=0.979
New smoker	3.0%	2.1%	1.2%	$X^2 = 19.02$; df = 6; p=0.004

Table 6.34 – Control of hypertension in patients aged 65–79 with and without risk factors

PATIENT CHARACTERISTIC	STUDY GROUP			CHI-SQUARED TEST RESULT
	Control	Audit	Strategic	
Isolated hypertension				
Controlled at outset	50.7%	45.7%	57.0%	$X^2 = 17.34$; df = 2; p<0.001
Controlled at end	57.6%	51.8%	64.0%	$X^2 = 25.85$; df = 2; p<0.001
Additional risks				
Controlled at outset	53.3%	44.0%	52.7%	$X^2 = 6.39$; df = 2; p=0.41
Controlled at end	65.3%	51.6%	67.1%	$X^2 = 26.27$; df = 2; p<0.001

Table 6.35 – Initial characteristics of patients who had a new stroke

PATIENT FACTOR		STUDY GROUP (Patients)		
		Control (n=27)	Audit (n=21)	Strategic (n=31)
Male		44.4%	42.9%	61.3%
Female		55.6%	57.1%	38.7%
Age group				
	65 – 69	37.0%	52.4%	41.9%
	70 – 74	33.3%	19.1%	32.3%
	75 – 79	29.6%	28.6%	25.8%
Deprivation category				
	1-2 (most affluent)	14.3%	0.0%	34.6%
	3-5	76.1%	94.1%	46.1%
	6-7 (most deprived)	9.6%	5.9%	19.2%
Hypertensive status				
	Diagnosed	92.6%	66.7%	67.7%
	Undiagnosed	7.4%	33.3%	32.3%
Treatment				
	Anti-hypertensive drugs	92.6%	66.7%	83.9%
	No anti-hypertensive drugs	7.4%	33.3%	16.1%
Smoking status				
	No record	7.4%	28.6%	32.3%
	Non-smoker / ex-smoker	59.3%	52.4%	48.4%
	Smoker	33.3%	19.1%	19.4%
Diabetic		22.2%	9.5%	22.6%
Previous stroke		14.8%	19.1%	16.1%
Initial absolute risk				
	Low (0–15%)	48.2%	52.4%	54.8%
	Medium (15–25%)	29.6%	14.3%	9.7%
	High (>25%)	22.2%	33.3%	35.6%

Table 6.36 – Prevalence of major morbidity in diagnosed hypertensive patients aged 65–79 (n=4129)

CONDITION	NUMBER OF PATIENTS (%)*	PERCENT *
Ischaemic heart disease	915	22.2
Circulatory system problems	794	19.2
Osteoarthritis / other arthropathy	748	18.1
Depression / mental health problem	717	17.4
Respiratory disease	517	12.5
Diabetes	465	11.3
Cancer	338	8.2
Breast	63	1.5
Gastro-intestinal	30	0.7
Gynaecological	25	0.6
Prostate	15	0.4
Lung	14	0.3
Other	212	5.1
Stroke	300	7.3
Renal disease	79	1.9
Epilepsy	50	1.2

* Patients have more than one condition; therefore percentages do not total 100

Chapter 7

DISCUSSION

7.1 Chapter overview

The research reported in this thesis has raised many issues worthy of discussion, both with respect to the study methodology and its findings, and to developments within general practice. This chapter discusses these issues in detail, beginning with reflections on the methods used to carry out this research. This is followed by consideration of the issues related to changes in the rule of halves over time and the importance of practice organisation in relation to those changes. The content of the feedback provided is discussed along with important factors related to the communication of risk. Finally, the importance of practitioner and patient behaviour is considered, as are the implications of using electronic data in this type of research. The chapter ends with a summary of the potential impact, good and bad, of the 2003 General Medical Services (GMS) contract.

Two different types of analyses were conducted in this study (section 2.11); cluster analysis of final systolic blood pressure and final proportion of patients controlled in each group (Results tables 6.26 and 6.28), and comparative analyses of all other data, including the proportion of hypertensive patients observed to be identified, treated and controlled (6.5–6.25; 6.29–6.35). The results presented in this chapter have been distinguished as resulting from either cluster analysis or comparative analysis and have been discussed in relation to the issues that they raise.

7.2 Reflections on the study methodology

This study was designed to evaluate the impact of feedback, developed from electronic records, on management of hypertension in patients aged 65–79. This was done by means of a randomised controlled trial comparing a group which did not receive feedback with one which received audit feedback and another which received strategic feedback prioritising patients at risk of stroke. The methods have been described in chapter 2 and additional chapters have reported specific issues related to the development and conduct of the study (chapters 3 and 4). As is the case with most research, there are aspects of this study which proved strengths; there are also aspects which could have been carried out in a different way.

7.2.1 Practice recruitment

One of the main limitations to the study relates to the numbers of practices taking part. The original sample size calculation was based on recruiting 60 practices, 20 to each of the three study arms. In reality, only 52 practices were recruited and of those only 34 practices returned more than one set of electronic data. However, this calculation was based on acquiring data from 40 patients in each practice. Clearly, even considering only those 34 practices which returned multiple sets of data, more than 2,400 patients were included. In addition, the ICC used in the calculation was estimated conservatively at 0.1, compared with 0.06 suggested by Fahey and Peters (Fahey & Peters 1996). This reduced number of practices still gives 80% power to detect differences of 15% or more, assuming a lower but still acceptable ICC of 0.04.

7.2.2 Sampling criteria

The organisational and the structural characteristics of practices will undoubtedly impact on whether and how they respond to feedback information. When recruiting practices to a study of this type, it was therefore important to attempt to account for those factors which were likely to have the greatest impact. Level of practice computerisation may determine the sorts of data that are collected electronically and as such, influence the knowledge that can be gleaned from

those data. However, that may be more likely to impact on a practice's ability to generate feedback for research rather than their ability to utilise it. In addition, geographic and health board location may influence practice decision making and activity, reflecting either population need or local priorities. Nonetheless, at the outset of the study we considered that two of the most important determinants of practice response to the intervention would be the availability of practitioners and existing practice workload. It was therefore decided to use these as sampling criteria and eligible practices were stratified by practice size and by deprivation payment level, a proxy for workload, before recruitment began.

Results from the study have shown that practices recruited to the three groups were similar in terms of number of partners, practice list size and deprivation payment levels (Table 6.4). However, data obtained from the Practice Structure Questionnaire showed a marked, although not statistically significant difference, between the Control group and the other two groups with respect to training practice status. In addition, and most likely as a result of this, there were also greater numbers of practices in the Control group with a register of hypertensive patients, running a hypertension clinic and operating a recall system for hypertension (Table 6.5).

Accreditation for training practice status is granted only if a practice meets certain criteria, relating both to services for patient and to the primary care team itself. Training practices are expected to manage chronic diseases in line with existing guidelines and there are several criteria related to this which are likely to impact on management of hypertension (NHS Education for Scotland 2002). These criteria include the provision of evidence that,

> *"The practice collects information on the factors that put their patients' health at risk, including smoking habit, alcohol intake, and blood pressure"*
>
> *"The practice maintains a register of patients with chronic disease and there are agreed definitions for entering data"*
>
> *"The team ensures that systematic call and recall of patients on their register is taking place and that they are reviewed regularly....."*

"The team has developed protocols for the management of chronic disease which are to guide the care that they provide"

"The team audits their chronic disease management regularly"

Practices which have been granted training practice status are required to demonstrate that they have a formalised approach to the management and continued audit of care for patients with chronic diseases. This may explain why the Control group had the best rates of identification and treatment at the outset of the study and why they demonstrated improvements in these and the largest observed improvement in the proportion of patients controlled, despite having received no feedback. Thus, if a similar type of study were to be carried out in the future, it would be prudent to include training practice status as a stratification variable.

7.2.3 Participating practices

The recruitment strategy used in this study was designed to try and ensure that the participants were representative of general practices in Scotland. Practices were stratified by size and deprivation and a random sample from each stratum was then contacted by letter and invited to participate. Eight iterations of this process were necessary and a total of 179 practices were contacted, 17% of the total number of practices in Scotland at that time. Fifty four of these practices gave initial agreement to take part, a recruitment rate of 30%; 52 actually participated, 87% of the planned sample. Given the aim of the study and the population required, this was a valid method of trying to minimise bias, the issue of training practice status notwithstanding. Whilst the rate of participation is relatively low, it is in keeping with results from similar studies recruiting in general practice. This includes the Australian National Blood Pressure study, which employed a range of methods, including peer to peer recruitment, financial incentives, reimbursement of consultation and treatment costs and continuing vocational registration for a three year period, and had an uptake rate of 24% (Reid et al. 2001). In addition, actual recruitment in relation to the planned sample is better than in many other trials, which often achieve less than 75% (Charlson & Horwitz 1984).

There is little evidence in the literature in relation to optimum strategies for recruitment to trials. In the main, what evidence there is relates to recruitment of patients. A recent report from the Health Technology Assessment programme on the factors limiting the quality and progress of randomised controlled trials, outlines possible reasons for poor recruitment (Prescott et al. 1999). These include time constraints, lack of availability of practice staff to support participation, rewards and recognition, impact on the doctor-patient relationship, concern for patients, perceived importance of the trial, loss of autonomy and incompatibility of the study protocol with normal practice. Many of these constraints were not relevant to the study reported in this thesis. There was no formal obligation on practitioners to change their practice, there was unlikely to be any impact on the doctor-patient relationship and there was also no research related clinical contact with patients which might cause concern. In addition, we attempted to minimise the level of general practitioner involvement and all contact with a practice was generally made via the Practice Manager. However, whilst practices were randomly identified for contact, it is possible that there was some partiality in relation to those who agreed to participate. This selection bias may have favoured those who were interested in the topic, had the capacity to participate and did not wish financial incentive. As such, the results obtained may reflect this self selection, particularly in relation to practices in the Control group, who it could be argued, gained little from participation.

7.2.4 The patient population

The research described in the introduction (chapter 1) has demonstrated overwhelming evidence that treatment of hypertension produces significant reductions in cardiovascular risk and that those reductions are greater for older patients (section 1.2.4). Consequently, the numbers of elderly hypertensive patients who need to receive antihypertensive treatment in order to prevent a cardiovascular event, such as stroke, is considerably lower than for younger people. However, the benefits demonstrated in the majority of previously reported trials relate to patients aged 79 or less, since patients older than this have generally been excluded. The benefits of treating patients aged 80 or over have not yet been established. Indeed, those studies which have included this subgroup

of patients suggest that although treatment can reduce stroke, it may also have an adverse effect on overall CVD mortality (Gueyffier et al. 1999).

In 1994, the Hypertension in the Very Elderly Trial (HYVET) was established to assess the benefits of antihypertensive treatment in those aged 80 and over. The trial is still ongoing, but results from the pilot, published in 2003, suggest that whilst the incidence of stroke was reduced, estimated mortality suggests that there may be excess deaths with active treatment (Bulpitt et al. 2003). When the study reported in this thesis was undertaken, the recommendations made in the British Hypertension Society guidelines related only to management of patients aged up to 79 years. Thus, this study involved only older patients aged 65–79.

7.2.5 Population coverage

One of the strengths of this study relates to the extent of its coverage in relation to the general practice population of Scotland. The 52 participating practices comprised 5% of all Scottish general practices and encompassed eleven of the twelve mainland health board areas. The population covered, over 260,000 patients and around 5% of the total population of Scotland, was equivalent to two thirds that provided by the 72 practices participating in the national Continuous Morbidity Recording project (416,000; 7.9%; Table 6.3). However, this study included more than double the number of practices from NHS Greater Glasgow and consequently more than double the coverage of that area compared with CMR (number of practices 14 *v* 6; health board population 6.4% *v* 3.1%). NHS Greater Glasgow is the largest health board in Scotland. It also incorporates 80% of the most deprived postcode areas in Scotland. Not only are some parts of Glasgow the most deprived in the UK, but the inequalities in health that exist between the most affluent and the most deprived patients living there are greater than anywhere else in the country (Shaw, Dorling, Gordon, & Davey-Smith 1999). As such, this study provides greater representation of practices located in areas of higher deprivation.

7.3 The rule of halves

7.3.1 Changes in identification, treatment and control

At the outset of this study, most 65–79 year olds in each of the study groups had a blood pressure recorded on computer and just over one third of those with a blood pressure of ≥160 / ≥90 mm Hg were diagnosed as being hypertensive. More than 80% of those patients were receiving antihypertensive treatment and around half were adequately controlled. Comparative analysis showed that by the end of the study, the numbers of patients identified, treated and controlled had increased in all three study groups. Between 40 and 50% of those whose blood pressure was ≥160 / ≥90 mm Hg had been diagnosed, more than 90% of those who were diagnosed were being treated and around 60% of those who were being treated were controlled (Tables 6.19–6.20).

The greatest improvements in treatment were observed in the Strategic group, which received not only audit feedback, but also a list prioritising patients in terms of their absolute risk of death from stroke. The increase in the proportion of patients diagnosed and treated in that group was three times that of the Control group and twice that of the Audit group. Whilst the observed increase in the proportion of patients with controlled blood pressure was not as great as in the Control group, results from the GEE cluster analysis model demonstrated that at the end of the study, a significantly greater proportion of patients were controlled in the Strategic group compared with both the Audit and Control groups (Table 6.26). In addition, the lowest mean systolic pressure was observed in the Strategic group, although mixed model cluster analysis showed that the difference between the Strategic and Control groups was not significant (Table 6.28).

Given these results, it might appear inconsistent that one model demonstrated a significant difference in mean systolic pressure between the Strategic group and the Audit group only, whilst the other showed a significant difference in control between the Strategic group and both the Audit and Control groups. However, this variance is feasible, since different statistical methods were used to ask different questions of the data. The significance levels demonstrated will depend on the models used and the tests carried out. In the analyses presented here, one

model (mixed model for systolic blood pressure; Table 6.26) used a continuous outcome, whilst the other (GEE model for final blood pressure control; Table 6.28) used a binary outcome. The first compared difference in means and the second relative risk; consequently, the significance levels are not directly comparable. Additionally, in the mixed model for final systolic blood pressure, significance levels were adjusted for multiple testing and as such, the p-values are more stringent than in the GEE model. That being the case, it is likely that the differences in control demonstrated did actually exist at that given threshold. Use of a different threshold to denote controlled hypertension would change the results. Furthermore, if the direction of the two sets of results is considered, a feature which is also important, these are in fact similar. Results for both models are in the same direction, with the Strategic group being better than both the Audit and Control groups.

In clinical practice, stabilising hypertension differs for different patients. For some patients, starting treatment is enough to significantly lower their blood pressure and they require little in the way of follow up. Others may not respond well to medication, may suffer side effects and require several changes in prescription and intensive follow up. As such, the benefits of treatment are not always immediately observed. At the outset of this study, the proportion of patients receiving treatment was greater in the Control group than in either of the other two groups. Conversely, the proportion of patients adequately controlled was greatest in the Strategic group. Comparative analyses showed that by the end of the study, the greatest proportion of treated patients was seen in the Strategic group whilst the greatest increase in the proportion of controlled patients was observed in the Control group. Given the time and effort that is likely to be involved in controlling blood pressure, it could be postulated that the Control group were seeing the benefits of treatment initiated prior to this study, whilst the Strategic group, who demonstrated the greatest improvement in treatment during the study, would not see the benefits in the short term.

In this, as in other pragmatic trials in primary care, there are various factors which might have impacted on the results observed, in addition to the true effect of the intervention. The potentially confounding nature of training practice status has already been discussed (section 7.2.2) and it is possible that there were other,

undetermined factors which occurred during the period under study and which acted as confounders, influencing either management or treatment of hypertension, or a practice's engagement with and consequently its response to this research. Such confounders might have occurred at various levels, for example LHCC-wide hypertension audits, PCT prescribing initiatives and guidelines, or national programmes such as the Scottish Programme for Improving Clinical Effectiveness in Primary Care (SPICE-PC), which was established in 1999 and which some practices may have participated in (SPICE-PC website; www.ceppc.org/spice). In this study, attempts were made to account for known confounding variables, both prior to recruitment and at the analysis phase. The cluster analysis models used took account of training status as well as other practice and patient level factors. However, it may be the case that other, unidentified but relevant variables should also have been included and this may account for some of the variation in significance demonstrated between the two models. Nonetheless, cluster analysis has considered the major factors likely to have impacted on management and as such, the results produced by the analyses can be accepted as valid.

7.3.2 Existence of a new rule

The comparative analyses carried out in this study have shed additional light on the rule of halves. If the levels of identification, treatment and control stated in the rule of halves are assumed, 50% of all those with hypertension will be diagnosed, 25% will be treated and 12.5% will be controlled. These results have shown that for the population studied, the rule of halves no longer exists to the extent that it once did. Whilst the levels of identification found here are akin to those suggested by the rule, levels of treatment and control are better. Three quarters of all hypertensive patients in this study, that is those patients who had a diagnosis of hypertension or had a blood pressure of ≥160 / ≥90 mm Hg, were receiving antihypertensive treatment. Almost 40% of all patients were controlled. This study has shown significant improvements since previous work carried out in Scotland by Smith et al. in the 1980s, which found that 31% of all hypertensives were treated and only 17% were adequately controlled (Smith et al. 1990). It has also demonstrated an improvement on the more recent level of 33% controlled, found using data from the Scottish MONICA surveys (Chen et al. 2003).

Such improvements in the rule of halves have also been shown in recent studies carried out elsewhere in the UK. Fahey and Lancaster found that 51% of hypertensives in Northamptonshire were treated and around 30% were controlled (Fahey & Lancaster 1995). A study in Merseyside showed similar levels of improvement, with 64% of hypertensive patients on treatment and 28% controlled (Cranney, Barton, & Walley 1998). In London, an even greater improvement was shown. In an audit of electronic records in 22 practices, Hooker et al. found that 67% of hypertensive patients were treated and 61% were controlled (Hooker et al. 1999). In a more recent study in which a random one in seven sample of the records of patients aged 65–80 from 51 practices were audited, Duggan et al. found that 70% of hypertensive patients they identified were treated, whilst 20% were controlled (Duggan et al. 2001).

Thus, it would appear that in relation to treatment, the opposite of the rule is becoming the case, that 25% of all hypertensive patients *will not* be treated. Yet, whilst the levels of control demonstrated by the study reported in this thesis are better than would perhaps be expected, 60% of all hypertensive patients and 40% of those who are being treated are not adequately controlled. Research using data from the Framingham study, has demonstrated that the rate of use of antihypertensive medications in the United States increased from less than 4% in the 1950s to more than 26% in the 1980s (Mosterd et al. 1999). The authors conclude that this has been responsible for a reduction in the prevalence of hypertension over the same period from 24% to 8%. Given the period over which this change was achieved, it is likely to be some time before the increased rates of prescribing for hypertension shown in UK studies over the past decade result in even greater improvements in control. However, it is interesting to note that regardless of group, diagnosed hypertensive patients in the current study were found to have a lower average blood pressure than the average for all 65–79 year olds (Tables 6.24–6.25), although it is not possible to determine whether this is a treatment effect or the result of an atypical group of patients.

7.3.3 Implications of improving on the rule of halves

Whilst adopting a strategic approach to target those at high risk of cardiovascular disease is less resource intensive than a mass screening approach (Marshall &

Rouse 2002), there are consequences associated with making improvements in the proportion of hypertensive patients identified, treated and controlled. Tudor Hart demonstrated the significant increase in staff time and consultation length that can arise from a more organised approach to disease management (Hart 1992). He estimated that actively trying to reduce the rule of halves would increase workload by at least 12%. This does not account for the time requirements involved in keeping up to date with recording or the increase in prescribing costs which would undoubtedly occur as a result of higher levels of disease detection. Qualitative work on statin prescribing has shown that practitioners are aware of these issues, which have the potential to act as barriers to the performance of disease prevention (Kedward & Dakin 2003).

Whilst cost and workload implications will vary depending on the blood pressure threshold used to denote hypertension and the level of cardiovascular risk selected for intervention (Baker, Priest, & Jackson 2000), nonetheless, the prevalence of hypertension will continue to increase with an expanding elderly population. As such, so too will the volume of work required to manage it.

7.3.4 Significance of the definition of hypertension

The British Hypertension Society guideline in use when this study was undertaken, and on which the thresholds applied here are based, recommended intervention for hypertension when systolic blood pressure was ≥160 mm Hg and/or diastolic pressure was ≥90 mm Hg (Sever et al. 1993). New guidelines published during the period covered by this research now regard hypertension as existing at a lower threshold of ≥140 / ≥90 mm Hg (Scottish Intercollegiate Guideline Network 2001) (Ramsay et al. 1999) (Williams et al. 2004). In their study on the rule of halves in Merseyside, Cranney et al demonstrated the significance of the level of blood pressure used to denote hypertension (Cranney, Barton, & Walley 1998). When control was assumed at the level of <160/90 mm Hg, they found that only 19% of the hypertensive population were adequately controlled. However, when it was assumed at the level of ≤160 / ≤90, there was a 9% increase in the proportion of patients meeting the target. In their comparison of hypertension guidelines from the UK, US, Canada, New Zealand and the World Health Organisation, Fahey and Peters found that the proportion of

hypertensive patients controlled ranged from around 18% to 85%, depending on the criteria used (Fahey & Peters 1996). More recently, data from the 1998 Health Survey for England was used to compare control of hypertension using the threshold that had been used in previous surveys, ≥160 / ≥95 mm Hg, with the new threshold of ≥140 / ≥90 (Primatesta, Brookes, & Poulter 2001). This demonstrated that 39% of hypertensives were controlled using the old definition, but only 17% were controlled using the new definition.

Thus, it is extremely unlikely that use of this lower level in the study reported in this thesis would have produced the scale of improvements that were observed when using the higher threshold.

7.4 The relevance of practice organisation

In his paper on prevention of cardiovascular disease, Geoffrey Rose likened the occurrence of stroke in hypertension to the occurrence of complications in pregnancy (Rose 1981). He suggested that an obstetrician confronted by a case of eclampsia would ask, *"What went wrong?"* He further suggested that a good general practitioner confronted by the occurrence of a stroke in an untreated or badly treated hypertensive patient would ask the same question. In relation to the prevention of stroke he added,

> *"When one occurs it suggests a possible failure of practice organisation"*

7.4.1 The importance of practice size

One of the findings of a study determining the effectiveness and cost of three different types of feedback, was that smaller practices performed preventive care significantly better than larger practices (Szczepura et al. 1994). More recently, in a study from Netherlands, feedback combined with outreach visits by trained facilitators was implemented as a means of improving decision making for patients with cardiovascular disease, including those with hypertension (Frijling et al. 2003). As part of the intervention, facilitators discussed barriers to change with practices and helped them select issues for improvement and methods for implementing change. Whilst the effects of the intervention were small, the researchers found that the practice characteristics which predicted success of the intervention in relation to hypertension management were older GPs (mean age >45 years), single handed practice, non training practice and smaller list size (<2,500 patients per GP).

As described earlier in this chapter (section 7.2.2), training status requires a practice to maintain a register of patients with chronic diseases and ensure systematic call and recall of those patients. When the organisational characteristics of practices participating in this study were compared by practice size, 24% of the small (1–2 GPs) and 28% of the medium sized (3–4 GPs) practices had training status, compared with 62% of the large practices (≥5 GPs).

However, the availability of a hypertension register and recall system decreased as practice size increased, with less than half of large practices operating a recall system compared with 94% of small practices (Table 6.6). This would suggest that larger practices, regardless of their training status, are not selecting hypertension as one of the chronic diseases which they choose to manage more formally. Thirteen of the practices participating in this study had five or more GPs. List size in those practices ranged from 5,456 to 18,335 patients, with an average list size of 8,400. If the level of prevalence shown in the recent UK health surveys is assumed, a practice with a patient population of 8,400 is likely to have around 2,000 adult hypertensive patients. If the higher threshold of ≥160/≥95 mm Hg is used to denote hypertension, around 1,200 patients could be hypertensive. Thus, there are significant workload implications related to operating a recall system for hypertension in a large practice and it may be for that reason that fewer of the larger practices in this study were doing so.

7.4.2 The importance of practice structure

In a UK study on secondary prevention of coronary heart disease, audit with feedback was compared to the provision of assistance in setting up a disease register and recall system, either for follow up by the GP or by the practice nurse (Moher et al. 2001). The researchers found that after 18 months, around 80% of patients in the nurse and GP recall groups had been adequately assessed compared with only 52% in the audit group. In addition, whilst the difference was not statistically significant, adequate assessment was higher in the nurse recall group than in the GP recall group.

The findings from this study would support the hypothesis that use of a recall system can enhance disease management. Levels of identification, treatment and control observed in participating practices were compared by practice size (Table 6.21) and whilst the proportion of identified and treated patients increased as practice size increased, the proportion of controlled patients increased as practice size reduced. Twice as many of the small practices operated a recall system and it could be postulated that this facilitated the achievement of better control in that group. It may also be the case that whilst larger practices are as able as smaller practices to initiate treatment in the majority of their identified hypertensives, the

differing level of workload related to having a larger patient population precludes the intensity of follow up required to ensure adequate monitoring and subsequent control of those patients.

The method of recall used may also be of relevance in helping practices achieve better management of hypertension. The majority of practices in the Audit (70%) and Strategic (63%) groups used a previously arranged appointment as their main method of recall, compared with only 36% of practices in the Control group. The predominant method used by practices in that group was a reminder either by letter or by telephone and this may have contributed to the improvements which occurred in that group. Previous work evaluating the use of different methods of recall for preventive care has demonstrated improvements with targeted patient reminders. Studies by McDowell et al. on reminders for blood pressure screening, cervical screening and immunisations found that computer generated letters and telephone calls to patients were consistently the most effective methods of recall (McDowell, Newell, & Rosser 1989a) (McDowell, Newell, & Rosser 1989b) (McDowell, Newell, & Rosser 1986). In addition, Cochrane reviews on cervical screening (Forbes, Jepson, & Martin-Hirsch 2004) and immunisations (Szilagyi et al. 2000) report benefits from written and telephone reminders.

When structural characteristics were compared by practice deprivation payment level, practices receiving higher levels of payment were more likely to have a hypertension register, hypertension clinic and recall system (Table 6.7). These practices also tended to have larger proportions of their hypertensive patients identified, treated and controlled (Table 6.22). Anecdotal evidence suggests that it is extremely difficult to recruit practices working in deprived areas to primary care research projects. Thirteen of the practices taking part in this study (25%) were classed as being highly deprived, that is they received deprivation payments for more than 20% of their patient population. Their participation in itself may demonstrate that they are atypical of deprived practices in general. However, more of the deprived practices than the non deprived practices had a hypertension register and recall system. This was also true for the availability of a practice nurse and although by no means conclusive, there is some evidence to suggest that nurse led management of hypertension leads to improvements in levels of control (Oakeshott et al. 2003). Therefore, it may well be the case that better practice

organisation, even in areas of high deprivation where levels of morbidity are higher and as a consequence workload greater, leads to better disease management.

7.5 The feedback intervention

Results from the comparative analyses conducted in this study have shown that the greatest changes in blood pressure recording were observed in the Audit feedback group, which had the lowest preliminary blood pressure recording level, followed by the Strategic feedback group (Table 6.19). Improvements in identification were greater in the Control and Audit groups than in the Strategic group, whilst the greatest change in the proportion of hypertensive patients treated was observed in the Strategic group. Both the Audit and Strategic groups increased the proportion of patients adequately controlled by almost 10%, although the largest increase was seen in the Control group (12%). Results from the cluster analysis, which incorporated adjustment for clustering, practice and patient effects demonstrated that a significantly greater proportion of patients were controlled in the Strategic group compared with the other two groups. Thus, the results demonstrate that providing practices with feedback developed from electronic patient records can have an impact on detection and management of hypertension in the elderly. However, the impact was relatively small and the Control group, which had not received feedback, also made improvements. Similarly, it is interesting to note that this group demonstrated greater improvements than the group which received audit only feedback. Previous sections in this chapter have discussed the methodological and organisational factors which are likely to have influenced the results obtained (sections 7.2.2, 7.3.1 and 7.4.1). However, it may also be the case that certain aspects of the feedback itself precluded its uptake and therefore impacted on its ability to be of maximum use.

7.5.1 The composition of the feedback

When this study began, the versions of the GPASS system in use by participating practices did not store more than one blood pressure reading per patient and each new entry replaced the previous entry in a patient's record. The feedback reports were therefore based on the most recent electronic blood pressure, regardless of when it had been recorded. Results from the data validation exercise demonstrated that only one third of the patients whose records were reviewed had their most recent blood pressure recorded in the electronic record; for most, it was

recorded in the casenote and the electronic record had not been updated (62%; Table 6.12). Practices in the feedback groups may have been aware of this discrepancy in their own practice and as such, been sceptical about the accuracy of the feedback and as a consequence, sceptical about its usefulness. Feedback for practices in the Strategic group also contained the date of the patient's blood pressure reading and this may explain the significant difference observed in relation to the numbers of patients in that group whose electronic blood pressure was updated during the course of the study (Table 6.30).

Many significant trials in this field have been based on casual blood pressures, that is, a blood pressure which has been recorded on a single occasion. Previous research as part of the Framingham study has demonstrated that whilst the use of casual blood pressure does not enable a precise assessment of an individual's previous levels of blood pressure, it is highly predictive of future cardiovascular disease (Vasan et al. 2002) (Gordon, Sorlie, & Kannel 1976). Furthermore, a study from the Netherlands, in which the predictive value of repeated blood pressure measurements was assessed, concluded that casual blood pressure measurement leads to an underestimation of an individual's long term risk of stroke (Keli, Bloemberg, & Kromhout 2004). Thus, the use of a single blood pressure measurement in this study is likely to have underestimated rather than overestimated patient risk. However, whilst use of a single measure may be valuable for research of this type, guidelines recommend that treatment for hypertension should be initiated in patients whose have sustained high blood pressure. Those with a single reading of high blood pressure should be given non pharmacological advice and have their blood pressure monitored over a period of several months (Ramsay et al. 1999). As such, use of casual blood pressure measurements is not recommended for the diagnosis and management of hypertension in clinical practice. That being the case, it may have influenced practice response to the feedback provided.

Practices in the feedback groups were provided with the average results for the other practices in their group, enabling them to make comparisons of their performance. Few of the studies which have used feedback as an intervention have compared feedback with and without peer comparison and indeed, the Cochrane review of this area has not been able to determine whether or not there

is an added effect (Jamtvedt, Young, Kristoffersen, Thomson O'Brien, & Oxman 2004). However, a meta-analysis combining trials which evaluated peer comparison feedback per se, found a statistically significant, but modest, effect on various clinical procedures including screening, prescribing and test ordering (Balas et al. 1996).

The additional feedback for practices in the Strategic group provided a prioritised list of patients according to their absolute risk of stroke. Whilst the report also contained data on the numbers of patients identified, treated and controlled, allowing the practice to immediately determine the likely level of workload involved in trying to improve on this, it may also have been of value to have provided some measure of the benefits of intervening. Patients who did not have a record of smoking status were allocated two risk scores, one on the basis of their being a smoker, the other on the basis of their being a non-smoker. It may have been useful to practices to have been provided with this sort of multiple scoring for each patient on the list. Those patients who were untreated could have been allocated an additional score based on treatment being initiated, those whose blood pressure was ≥160 / ≥90 mm Hg could have been allocated a score based on blood pressure being controlled and those who were smokers could have been allocated a score based on stopping smoking.

However, whilst it would have been of interest and possibly of value to have differed the content of the feedback during the study in relation to the provision or otherwise of peer comparisons and multiple scores, the number of practices involved and the complexity of processing and analysing data for feedback would have made this extremely difficult.

7.5.2 The recipient of the feedback

Whilst practices participating in this study were not obliged to alter their current behaviour, implicit within the study was the desire to change practice. The ultimate outcome of controlling hypertension is the prevention of stroke and other cardiovascular diseases. Whilst this is done at an individual patient level and requires the individual patient to adhere to treatment regimes and possibly modify lifestyle factors, it can only be achieved through activity on the part of practitioners. The methodology for the study was designed with a view to

minimising the amount of active involvement required from practices prior to their receiving feedback. Inevitably, this also resulted in a 'top down' approach to the conduct of the study. In such circumstances, it can be difficult to ensure participants' sustained engagement with the research.

An alternative strategy might have been to have identified and recruited a group of participants who were interested in the methodology, since such a group might have been more likely to utilise the feedback and act upon it. Whilst the information provided in the feedback was designed to be used strategically to target those most at risk, so too the provision of the feedback itself could have been used strategically, targeting those most inclined to change their behaviour. Whilst the study would have been open to criticisms of bias and reduced generalisability, it may also have been a more accurate reflection of everyday practice, where those practices and practitioners who are interested are also the ones who adopt new initiatives, or indeed, utilise guidelines.

7.5.3 The timing of the feedback

Workload within practices varies, as do practice priorities. The nature of the study meant that it was not possible to accommodate the work cycles of every practice and ensure that each received feedback at the most appropriate time. Whilst attempts were made to account for confounding structural factors, by stratifying practices prior to recruitment, it was neither possible nor feasible to incorporate every possible one. During the period under study, amongst other organisational changes, three practices gained an additional partner, one practice lost a partner, nine had a change in partner, two gained a practice nurse, seven changed practice managers and two became training practices (Table 6.8). These changes were not distributed evenly across the study groups, and it is unlikely that such changes would be evenly spread, even given randomisation. The purpose of randomisation was to obviate the possibility of systematic bias, by distributing those characteristics which might influence outcome randomly across the groups. In so doing, within the limits of chance variation, the intervention and control groups would be similar at the outset of the study. Indeed, there were no significant differences between the groups at baseline (Tables 6.4-6.5). The practice changes outlined occurred after the study began and throughout its

duration. In addition, they are more likely to have been related to personal circumstances and decisions made by individuals within individual practices than to any pre-determined organisational characteristics. As such, they occurred within the limits of chance variation between study groups and it would not have been possible to have foreseen them or to have controlled for them.

The situations created by each of these changes is likely to have involved a great deal of time on the part of the practice, whether in relation to recruitment of new team members, to those new members familiarising themselves with the practice and its population or in ensuring that the practice would be granted training status. Undoubtedly, the priorities of a practice will change under such circumstances and the ability to participate in targeted patient care, or indeed in research, may well be affected. In addition, end of year practice audits, staff absenteeism and changes in practice initiatives such as winter flu vaccinations, will undoubtedly have affected response to feedback. However, given these factors and given that elderly hypertensives are one of several groups requiring care, the results of the study are encouraging.

7.6 Communication of risk

The communication of risk is an area not without its challenges. Much of the debate surrounds the public's understanding of risk and the language used to communicate risk. Commentators have described the difficulties of using standardised language since understanding and interpretation of particular terms are likely to vary with each individual patient (Edwards, Elwyn, & Mulley 2002). Similarly, patients' understanding of particular conditions and of the consequences of their lifestyle choices will also vary. Previous work on coronary heart disease has shown that those who perceive themselves to be more at risk are more likely to change their behaviour in order to reduce that risk (Van der Pligt 1998). However, research carried out in the West of Scotland with children from the original Misdpan population, found that people are not always aware that they are at risk (Watt et al. 2000) and if they are aware, the extent of that awareness varies by individual characteristics and knowledge (Hunt, Emslie, & Watt 2001). Such variations in understanding and resultant behaviour will also be present when risk information is communicated to practitioners.

7.6.1 Framing risk data

The study reported in this thesis used a risk equation to provide practices in the Strategic group with data on absolute risk of stroke for individual patients. Assessment of absolute risk is considered a more accurate way of determining the benefits of preventive action and also allows patients to be prioritised by need. However, as discussed earlier in this thesis (section 1.2.6), risk data can be also presented either as relative risk, or relative risk reduction, or as numbers needed to treat. One of the most important factors determining practitioners' responses to risk data is the way in which the data are presented, or framed.

Data presented as a relative risk reduction appear impressive. Indeed, presenting risk reduction in relative rather than absolute terms is generally favoured by pharmaceutical companies since the effects appear more marked. However framing data in this way can be misleading, since full information on the comparison group is necessary if the patient's risk is to be set in the appropriate context (Gigerenzer & Edwards 2003). Despite this, there is some evidence to

suggest that practitioners respond best to information on hypertension management when it is presented in this way. In one study, comparisons of data presented as relative risk reduction, absolute risk reduction, differences in event free patients and numbers needed to treat were carried out with 73 GPs attending a continuing education course (Cranney & Walley 1996). Risk data were presented as part of a clinical scenario and relative risk was found to be the only presentation which had a significant influence on practitioners' decision to prescribe.

In a more recent study, cardiovascular risk presented as absolute risk or numbers needed to treat was compared as part of a randomised controlled trial evaluating the provision of computerised decision support (Fahey, Montgomery, & Peters 2001). No difference was found between the two methods of presentation in relation to reductions in cardiovascular risk at twelve months or in mean systolic and diastolic blood pressure. The study also found that cardiovascular risk in both groups increased over the study period. In the study presented here, both comparative and cluster analyses showed that the reduction in mean blood pressure was no greater in the group receiving absolute risk data than in the other two groups (Tables 6.24–6.26). Risk of stroke increased for 40–50% of patients across the groups, with the largest proportion observed in the Strategic group (Table 6.29). Such increases are to be expected in an ageing hypertensive population. However, risk reduced for 10–20% of all patients, with the greatest reduction observed in the Strategic group. Most of the patients in each group whose risk was reduced now had controlled blood pressure. In addition, a significantly greater number of patients in the Strategic group were now recorded as being non-smokers or ex-smokers. This, in particular, is likely to have made a considerable contribution to the changes in risk observed in that group (Table 6.32).

The complexities of this study and the derivation of data for feedback would have made it extremely difficult to have presented data either as relative risk reduction or as number needed to treat. However, it could be postulated that feedback to the Strategic group might have had a greater impact if relative risk reduction rather than level of absolute risk had been used.

7.6.2 Uncertainty in predicting risk

> *"Remember, then, that [scientific thought] is the guide of action; that the truth at which it arrives is not that which we can ideally contemplate without error, but that which we may act upon without fear....."(William Kingdon Clifford 1955)*

Recent work in the UK has demonstrated that primary care practitioners are unable to accurately estimate cardiovascular risk in high risk groups, including elderly hypertensives, without the aid of some sort of risk prediction tool (McManus et al. 2002) (Montgomery et al. 2000a). Indeed, Montgomery et al. concluded that,

> *"... management of hypertension in the community is unlikely to be based on realistic estimates of either benefit or harm"*

Whilst risk predictors can improve upon the estimation of risk, they are not without their limitations. There are currently various risk prediction tools available, the majority based on equations developed from the Framingham Heart and Offspring studies (chapter 5). Such tools are widely used in the UK, despite increasing evidence that they do not accurately predict risk in European populations (Empana et al. 2003) (Brindle et al. 2003). Furthermore, Framingham equations were derived using data from a white, middle class population and as such may not accurately predict risk for those in lower socioeconomic or ethnic minority groups. However, whilst hypertension is a major risk factor for stroke, and for other cardiovascular diseases, it is by no means the only risk factor. Cholesterol, smoking status, co-morbidity, weight and lifestyle factors are also important (Padwal, Straus, & McAlister 2001). Targeting patients for preventive treatment based on estimation of their cardiovascular risk is more accurate than counting these risk factors or indeed targeting them individually.

In the study reported here, a new equation to predict risk was developed, the Hyper equation. At the outset of the study, it was not possible to obtain cholesterol data from electronic patient records in the GPASS system and as such, it was not possible to use an existing predictor (section 5.4). Comparison of risk generated by this equation and by the widely used Joint British guidelines

demonstrated that the Hyper equation was consistent in its estimations. Nonetheless, predicting absolute risk is not without error, and the tools used, including the equation used in this study, can only reach an approximation of the truth. However, general practice as a speciality is concerned with the management of uncertainty. It is a discipline in which intuition and experience are as important as scientific knowledge. That being the case, and as suggested by the above extract from William Clifford, it does not appear unreasonable, nor indeed uncommon, to sacrifice some certainty in order to gain some clarity.

7.6.3 Primary and secondary prevention

The majority of risk prediction tools are used to assess risk for primary prevention, that is, risk in people who have not already developed cardiovascular disease. Those with pre-existing disease were excluded from the Framingham study and as a result, the equations developed were not designed for use in this patient group. In addition, in relation to hypertension, most assume that the patient has been newly diagnosed and the prediction of risk is designed as a means of informing the decision of whether or not to initiate treatment. The Hyper equation used in this study can be applied to both primary and secondary prevention, since previous stroke is included as a variable in the regression model. In addition, it does not assume a new diagnosis, but predicts stroke risk based on whether the individual is currently receiving antihypertensive medication. As such, it could be argued that it has the ability to provide risk prediction suited to the realities of general practice.

7.7 The importance of behaviour

As discussed earlier in this thesis, there is an extensive literature on the benefits of treating hypertension. The study reported here was concerned with the utilisation of existing practice data to inform decision making in practice rather than with providing education on disease management. Although feedback was based on recommendations from existing guidelines, practices were under no obligation to change their behaviour, nor were they provided with guideline based treatment or management recommendations for specific patients. The gap between the implementation of best evidence in practice – best practice – and actual care is well recognised and there is an extensive literature on how this gap can be reduced, much of it related to the implementation of guidelines. In the case of hypertension, there is considerable variation in the guidelines themselves, both in relation to their content and their recommendations. However, previous research in the area has concluded that other factors contribute to these differences (Fahey & Peters 1997).

The feedback provided to practices participating in this study was an innovation designed to facilitate improved decision making. As such, its adoption, like that of guidelines, is dependent on a variety of factors. Its perceived usefulness and superiority over existing methods, whilst important, is only one such factor. Everett Rogers, an academic and researcher in communication, developed a theoretical model describing the adoption and diffusion of innovations (Rogers 2003). As part of his theory, he suggests that adopters judge an innovation on its possession of five attributes; it can be tested on a limited basis before adoption – trialability; it has visible results – observability; it is more beneficial than other such innovations or the current situation – relative advantage; it is not too complex – complexity; it fits in with existing practices and values – compatibility. One of the most important factors affecting the use of innovations in general practice is compatibility. Inherent within this, is practitioner behaviour. There are various theories of human behaviour and researchers are now attempting to utilise these models as a means of enhancing the use of interventions to improve clinical practice (Walker et al. 2003). Whilst studying behaviour was not part of the study reported here, it will undoubtedly have impacted upon the results. The following paragraphs consider some potential influences.

7.7.1 Existing team culture

Some of the organisational issues which may have had an impact on the improvements in hypertension management demonstrated in this study, both by practices which received feedback and by those which did not, have already been discussed (section 7.4). However, the relationship between practice structure and the provision of care is complex and there are likely to be many factors at play. A recent study carried out by researchers from the UK's National Primary Care Development Centre suggests that what is important is not the individual structural elements, but the interaction between these and the primary care team (Bower et al. 2003). Not only was the size of the practice, its level of deprivation and its training status important, but also the 'team climate'. This is a composite of information sharing, participation in decision making, support for innovation, reflexivity in relation to practice, clarity of objectives and team working. Bower et al. found that higher team climate scores were associated with better care for some chronic diseases. Practices rather than individual practitioners agreed to take part in this study and we did not determine whether each member of the primary care team had been asked about or indeed had agreed to participation. Thus, if the premise of the study or the value of changing practice was not acceptable to the whole practice team, this will undoubtedly have lessened the impact of the intervention.

7.7.2 Barriers to change

A recent supplement to the Medical Journal of Australia on *Adopting Best Evidence in Practice*, highlighted the need to identify and understand the barriers and incentives to changing practice (Sanson-Fisher, Grimshaw, & Eccles 2004) (Grimshaw & Eccles 2004) (Grol & Wensing 2004). Barriers which have previously been identified in relation to management of hypertension in the elderly include time pressures, existing workload, poor team work, inadequate computing systems and the absence of peer support (Cranney, Barton, & Walley 1999). Similar obstacles have been demonstrated in relation secondary prevention of coronary heart disease (Summerskill & Pope 2002). It is possible that the use or otherwise of feedback in this study could have been enhanced had potential barriers and facilitators to its utilisation been explored with each practice.

Nonetheless, many of the potential barriers are inherent within general practice and the solutions out with the capability and scope of this research project. However, a project has now been funded by the European Commission, Research-based Education and Quality Improvement (ReBEQI; www.rebeqi.org), which has the aim of narrowing the gap between research and practice. Part of the project involves establishing a framework for the selection, implementation and evaluation of interventions designed to improve quality of care in practice. This is expected to include a suite of tools which will enable researchers to identify barriers to change and thus select appropriate interventions.

7.7.3 The science of medicine versus the art of medicine

In the study reported here, the threshold used to denote high blood pressure was ≥160 / ≥90 mm Hg. Thresholds for treatment of hypertension in the elderly vary between guidelines. In addition, thresholds for treatment vary between practices. In 1993, around 500 of the practices using the GPASS system were asked to indicate which values of systolic and diastolic blood pressure they would classify as normal, borderline raised or raised and at what levels they would diagnose hypertension (Henderson et al. 1996). The results of this survey demonstrated wide variation in thresholds for treatment amongst general practitioners in Scotland. Only 61% would classify a systolic pressure of 160 mm Hg as hypertensive and only 52% a diastolic of 90 mm Hg. It has also been shown that there is variation in the frequency of blood pressure measurement before treatment (Fahey & Silagy 1994). Whilst there is evidence to suggest that there is a discrepancy between actual activity and reported activity in the management of hypertension in the elderly (Eccles et al. 1999), it is possible that many of the practitioners participating in this study would not have intervened at the level used in the feedback, nor have acted on the basis of that single blood pressure reading.

It could be argued that some of the discrepancies between best practice and actual practice relate to the pull between the science and the art of medicine. In his book on medical automation, Payne described two different classes of data, one relating to variables that could be counted, the other to data too numerous to count (Payne 1966). He classed the first as related to the science of medicine and the second to the art of medicine. Assessment of risk, part of the science of medicine, is not the

only factor considered when managing hypertension. The practitioner is best placed to know his or her patient and may not recognise that patient in the guideline, or indeed the feedback presented. Best practice neither accounts for shared decision making nor the implications of initiating treatment in individuals in their individual circumstances. It does not incorporate drug side effects, quality of life or the potential impact on the doctor-patient relationship. In short, it does not consider holistic care and leaves little room for intuition and experience.

7.7.4 Attitudes towards treatment

Whilst evidence from trials demonstrates the benefits of treating hypertension in elderly patients, other studies suggest that practitioners are reluctant to initiate treatment in this group and more inclined to treat younger patients (Dickerson & Brown 1995) (Ebrahim 1998). However, that was not found to be the case in the study reported here. Comparisons were made between patients aged 65–79 and those aged 45–64 as a means of determining whether the study groups appeared to target effort at younger patients. No difference was found between the two age groups in relation to the proportions of hypertensive patients identified, treated and controlled (Figure 6d). Furthermore, comparative analysis was conducted for observed blood pressure control in patients with and without additional risk factors in order to determine possible bias in relation to patients' clinical characteristics. Whilst there were significant differences in levels of control between the three study groups, there were no systematic differences related to the presence of additional risk factors (Table 6.34).

7.7.5 Current priorities

Two thirds of the hypertensive patients included in this study had at least one other major chronic disease in addition to their hypertension, some had as many as seven (Table 6.36). Almost one quarter of the patients already had cardiovascular disease, almost 20% had mental health problems and almost 10% had cancer. Many may also have had social or family problems. Whilst there is increasing awareness of the extent of co-morbidity, particularly in deprived populations (Macleod et al. 2004), there is still little understanding of the implications of this for individuals. Even less is known about the impact on practice. It is possible, perhaps even likely, that patients will have problems which are of greater concern

to them, and indeed to their practitioner, than control of a condition which often has no symptoms. Undoubtedly, the existence of co-morbidity will have implications for best practice, not least in relation to the application of guidelines for individual conditions. It should be relatively easy to ensure that a patient with hypertension is started on the best treatment and has their blood pressure regularly monitored. However, if that patient also has osteoarthritis, is housebound and depressed because of it, regular blood pressure measurement may not take priority. Previous research, has shown that practitioners are reluctant to initiate antihypertensive treatment in patients who are otherwise well (Duggan, Ford, & Eccles 1997). It has also shown their awareness of the need to consider existing physical, emotional and social circumstances in those who are not (Summerskill & Pope 2002).

Patient choice and awareness of hypertension will also influence the decision to treat and indeed adherence to treatment. Patients will not always share practitioners' opinions that treatment is worthwhile, indeed members of the public have been shown to require lower numbers needed to treat before they would agree to taking medication (Steel 2000). Previous qualitative work in the area has demonstrated that the decision to take antihypertensive medication is a balance between reservations about treatment and reasons for treatment (Benson & Britten 2002). Many patients adhere to their regime despite suffering side effects and this can be related to trust in their practitioner. The perceived lack of such a relationship can have the opposite effect (Gascón et al. 2004). In addition, patient awareness of the disease is likely to be a major factor. A study in which patients were asked to comment on the problem summary of their electronic record, found that 10% of hypertensive patients considered themselves cured, since medication had returned their blood pressure to normal (Lauteslager et al. 2002).

7.8 Implications of utilising electronic patient data

This study was an exercise in Development as well as in Research and many of the learning points arose from this aspect of the project, particularly in relation to using electronic patient data for strategic decision making. This required reflection on project methodology, with alterations having to be made to accommodate what was feasible. Whilst attempting to adhere to a rigorous project methodology added extra pressure to the Development, it also helped expedite it, which in turn added value to the Research, since methodological difficulties had to be overcome. Some of these difficulties could be predicted, such as the technical problems inherent in generating data in this way, the variety of GPASS system versions in use across the country and the difficulty in keeping practices engaged enough to consistently return data over a substantial period of time. Others could not have been so easily foreseen.

7.8.1 Patient identification

Perhaps the most important difficulty related to the contention between ensuring patient confidentiality and facilitating targeted patient intervention. Adherence to data protection regulations meant that it was not possible to extract patients' Community Health Index. This number, which is allocated to each patient in Scotland and is unique to them, allows identification of patients in each NHS sector. It is a searchable field in the GPASS system and would have allowed practices to identify patients included in feedback. In the absence of this, the only identifier available was the patient's GPASS ID, which is not searchable in practice. This problem was further compounded when existing GPASS identifiers were replaced as practices upgraded to newer versions of the GPASS system. As such, linkage of patient data became extremely difficult.

The need to ensure appropriate access to and use of patient data has led to increasing difficulties for the type of study reported here. Fear of litigation has led to the production of various pieces of guidance, both for health professionals and for the research community, guidance which itself is often contentious, open to interpretation and not always the subject of widespread consensus. It is

debatable whether it benefits patients and it could be argued that valuable opportunities to improve patient care and outcomes could be missed because of it.

The issue of data protection notwithstanding, in Scotland at least, the actual process of accessing electronic patient data from primary care is getting easier. The majority of practices are now using New GPASS and extracting the sorts of data that were required for this study is now more straightforward and able to be done in practice. Use of the Windows™ system allows data from patients' clinical records to be exported to Microsoft Office packages such as Access and Excel. Expertise will still be required to link these individual pieces of data in a way which allows the prediction of risk for high risk groups, but the overall procedures will be much quicker. In the extraction of data for the present study, ensuring practice data returns took five months, data processing three months and data analysis a further two to three months. Thus, the benefits in terms of time, of extracting data directly from practices in a ready to use format will be substantial.

7.8.2 The reliability of data

The quality of data held in electronic patient records can be measured in variety of ways including its completeness, accuracy and currency. In order to assess this, it is necessary to compare these data with some sort of gold standard. In the case of this study, electronic data were compared against data held in patients' casenotes to determine whether the items used to generate patient risk were reliable. Data from the survey on levels of computerisation showed that 82% of practices used both paper and electronic records for recording clinical data (Table 6.18). Only half reported electronically recording diagnosis and measurement related data for all patients. Thus, validation of electronic data was necessary but not without its difficulties. The most important is that this process assumes that the written records themselves are accurate. Finding major diagnoses, particularly for conditions such as hypertension, was not easy without the use of the computer generated summary, usually stored at the front of the casenote. Whilst there may have been a series of high blood pressures recorded in the patient's clinical notes there was often no written record of a diagnosis. In some cases, there was a record of the patient being issued with a prescription for antihypertensive medication. However, many of the drugs in this class are licensed for use in

several conditions and it is possible that the drug in that case had been provided for a condition other than hypertension. In addition, the variation in the format and content of casenotes between practices made maintaining consistency of data collection for research purposes difficult. Thus, validation of patient records is becoming increasingly difficult without the use of the computer, since in many ways, electronic and manual records are in fact shared.

The validation exercise showed that the reliability of electronic data for diagnoses was high, as it was for antihypertensive treatment. Agreement between record formats for smoking status was slightly lower, whilst only one third of patients had their most recent blood pressure recorded in their electronic record. For the majority this was recorded in the casenote, a factor which will undoubtedly have impacted on the accuracy and possibly the relevance of the feedback provided. Recent reviews of the quality of electronic records in primary care have demonstrated that whilst quality is relatively high, exceptionally so for some conditions, there is still room for improvement (Thiru, Hassey, & Sullivan 2003) (Jordan, Porcheret, & Croft 2004). That finding is reiterated in this study, although improvements over the course of the research were observed. The Strategic group, whose practices had been provided with the date of the patient's most recent blood pressure, updated the record of more than 80% of patients. What is not known is whether that improvement in recording was translated into a change in patient care.

7.8.3 Variations in recording

Data from the survey on levels of computerisation showed that there were differences between practices in relation to the numbers of GPs and practice nurses who had access to a computer during consultations (Table 6.18). Most likely as a consequence of this, there was also variation in relation to whether these groups actually entered data. In addition, only 75% of practices reported collecting a minimum dataset for each patient. Differences in the users and the uses of computers in primary care will undoubtedly impact on the types, quantity and currency of the data that are available in each practice. This in turn, has implications for the interpretation of those data. Indeed, this is even more pertinent when patients have two record formats. If a patient does not have a

record of smoking status in his or her electronic record, it cannot be implied that they are a non-smoker, since it may be recorded elsewhere. Conversely, if a patient does not have a record of diabetes, in all probability, they are not diabetic, since electronic records are generally complete in relation to diagnoses.

The way in which electronic data are recorded also has implications for its use. The clinical coding system produced by the Royal College of General Practitioners in the late 1950s contained 500 rubrics, or terms (College of General Practitioners 1959). The Read classification used today contains 125,000 terms. The newest version, Clinical Terms Version 3, incorporates over 200,000 terms. The intricacies of such systems mean that ensuring the identification of all relevant patients in a particular group is complex. There is no single term to denote each condition, nor is there a single term to denote particular states. Whilst the term 'smoker' is used, it is qualified by 'trivial', 'light', 'moderate' etc. Even identifying non-smokers and ex-smokers requires the inclusion of several terms. In the study reported here, identification of patients with hypertension required searching for 67 different Read codes, diabetes required 189 codes, stroke required 65 codes and smoking status required 52 codes. One hundred and sixty seven antihypertensive medications were used. Such a strategy may have mistakenly identified patients who had a relevant 'history of' or administrative code, but who should not have been included. In addition, there are likely to be differences in the way in which the codes are used in practice with resultant inconsistencies between users coding the same thing. The number of codes contained in the hierarchy means that the majority are extremely specific. Others however, may not be specific enough. As such, a code may not accurately capture the meaning required by the practitioner entering the data, it may simply be the nearest to the meaning required (Brown et al. 2003). Whilst not necessarily important in a study such as the one reported here, this is likely to be of relevance in other research.

Attempts are being made, however, to deal with these issues and create standardisation in the use of clinical coding. Scottish Clinical Information Management in Primary Care (SCIMP) has developed a set of 800 codes as a means of trying to ensure consistent recording of disease and its management across Scotland (Morris et al. 2002). In this system, practitioners are encouraged

to use one single code to denote a specific condition, thereby creating more consistent recording across practices. At the end of 2001, the core 300 codes were published and sent to every practice in Scotland and the full set of 800 published on the SCIMP website. Undoubtedly, a move away from larger, more complex disease classifications and towards the type first introduced by the RCGP almost 50 years ago will be of major benefit, not only to practices, but also to researchers.

7.9 Potential of the 2003 GMS contract

The study reported here was forward looking in its focus in relation to the use of routinely collected data, held on primary care computer systems, as a means of impacting on disease management at a population level. This had not been done in Scotland prior to the establishment of this work. However, the political and financial implications of the new GMS contract are likely to ensure that these sorts of methods are implemented in practice more rapidly than would occur through the dissemination of research findings (British Medical Association 2003). Clearly, the data required for this study had a research focus, and it could be argued that practitioners have ready access to the data required for the care of individual patients, albeit held in more than one source. However, findings from the study, in relation to inadequate control of high blood pressure and the completeness and currency of electronic data, have implications in terms of the requirements of the new contract.

Remuneration in the new contract is partly derived by the acquisition of points, which are allocated on the basis of various organisational and clinical targets. These points are used as a proxy for quality. Quality indicators for hypertension comprise 19% of the clinical points available and 10% of the overall total. Whilst, as this study demonstrates, practices already collect vast amounts of data relating to chronic disease management, formalisation of indicators in this way is new. There is now increased pressure on practitioners to improve on data collection in order to reach set targets. In management of hypertension, more than half of the points available relate to adequate control of blood pressure to the level of $\leq$150 / $\leq$90 mm Hg. Since achieving control can be a protracted process which is not always rewarding and which relies as much on the patient as on the practitioner, surely there is a perverse incentive not to improve on the identification aspect of the rule of halves. Previous work in diabetes has shown that smaller practices may be likely to have greater variability in achieved quality each year (Guthrie et al. 2003). However, the results of this study suggest that with a condition as prevalent as hypertension, larger practices may find it more difficult to reach targets.

The 1990 GMS contract was primarily responsible for the widespread adoption of computer systems in primary care. Perhaps the legacy of the 2003 GMS contract will be rapid improvement in the quality of the electronic records held in those systems. In the late 1960s, there was emerging unease about the impact that the use of information technology might have on practitioner-patient relationships. In his article on computers in general practice, Marshall Marinker expressed concern that such systems demands,

> *"... that they [doctors] sum up a consultation with the title of a disease"* (Marinker 1969)

Contractual obligations and other initiatives which encourage data recording are intended to improve patient care. Indeed, it is likely that they will do so for individual conditions. However, the danger is that holistic care will be lost if practitioners begin to treat the data rather than the patient.

Chapter 8

CONCLUSIONS

The rule of halves indicates that half of the hypertensive population are not known, half of those known are not treated, and half of those treated are not controlled. The study reported here has demonstrated, as have others in the field, that levels of identification, treatment and control of hypertension have improved, to the extent that a new rule now exists. Sixty percent of all hypertensive patients and 40% of treated hypertensives were not controlled at the end of this study. However, whilst the impact was small, the results show that providing practices with strategic feedback, developed from electronic patient data, can impact on identification and management of hypertension in the elderly and produce consequent increases in blood pressure control.

The relationship between organisational structure, practitioner behaviour and the provision of care is complex and there are likely to be many contributing factors. However, this study suggests that particular organisational features and practice characteristic facilitate improved control of hypertension. Smaller practices and practices with training practice status appeared more able to make improvements on the rule of halves.

The study also demonstrated the utility of electronic primary care data and whilst a certain amount of the research related to the development of methods to enable retrieval and processing of these data, the difficulties encountered have largely been addressed through advances in clinical record keeping systems. The 2003 GMS contract for general practice is likely to make increasing demands on electronic data to support claims for reimbursement based on the quality of care being provided to patients (British Medical Association 2003). This study demonstrates that improvements are already under way, but that utilisation of the unique methodology developed as part of this research can have an additional effect on an important quality indicator. This methodology, which utilises data linkage techniques to combine individual patient data, can provide strategic information to help practices identify at risk patients more readily. This could be applied to other conditions or aspects of care where quality improvement is necessary. Indeed, system advances mean that the method could now be adapted for use in primary care, allowing practitioners to generate lists of priority patients at a suitable time and as frequently as required.

This study has shown that improvements to the rule of halves can be made and that remote processing of primary care data can be used to facilitate those improvements. However, there are still questions to be answered. In particular, how would blood pressure control and risk of stroke be affected by providing tailored risk data to patients, what will be the impact of the new GMS contract on identification, treatment, control and risk and why do smaller practices appear to achieve better control of hypertension than their larger contemporaries?

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Appendices

Appendix 1: Audit group feedback

Explanatory Information

These data relate only to:

- information recorded on your practice computer system
- patients registered as "Live" (de-registered and temporary patients are excluded)
- patients aged 65-79 years

- The threshold for high blood pressure being used in the HYPER trial study is a systolic pressure of ≥160 or a diastolic pressure or ≥90
- Patients are taken as having a "Record of BP" if a measurement of systolic and diastolic blood pressure was recorded on their computer record. No time limit was applied.
- Patients are taken as having hypertension if a diagnosis is recorded in their computer record
- The presence of one or more of the following READ codes was taken as denoting a diagnosis of hypertension:

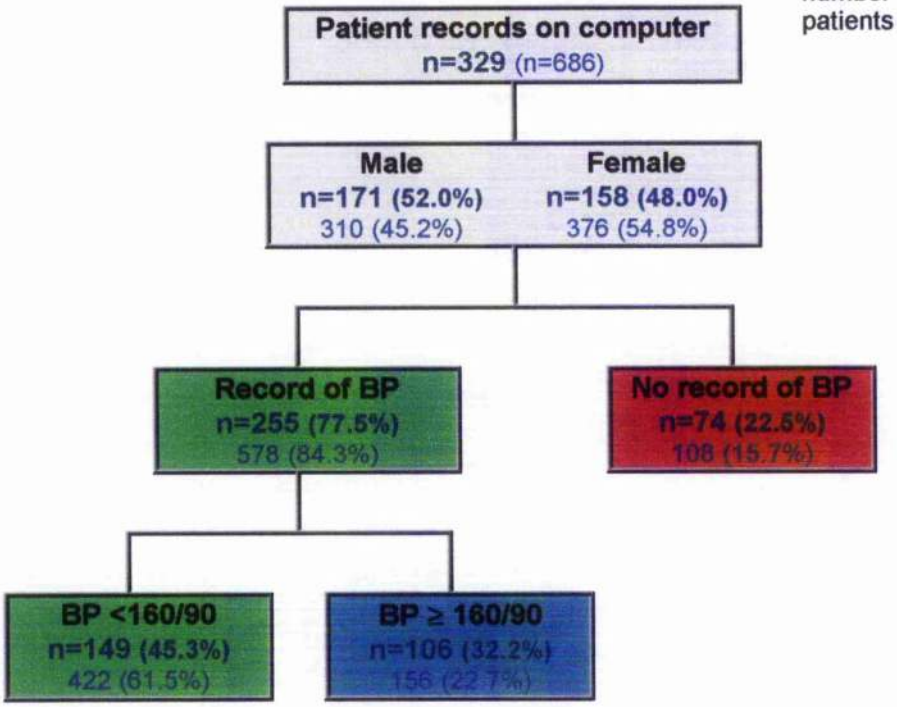
  1. 14a2. (H/O: hypertension)
  2. 6627. or 6628. (good/poor hypertension control)
  3. 6629. (hypertension follow-up default)
  4. 662F. or 662G. or 662H. (hypertensive treatm. started/changed/stopped)
  5. 662O. (on treatment for hypertension)
  6. 8B26. (antihypertensive therapy)
  7. 8HT5. (referral hypertension clinic)
  8. 9N03. or 9N1y2 (seen in hypertension clinic)
  9. 9OI.. (hypertension monitoring)
  10. G20.. (essential hypertension)
  11. G21.. or G22.. or G23.. (hypertensive heart/renal/heart+renal disease)
  12. G24.. (secondary hypertension)

- When selecting data for this feedback report, priority was given to information recorded with dates over undated information. If no dated information was available, undated information was used.
- Percentages in Fig 1. and the Summary Table are based on the total number of patients aged 65-79
- Percentages in Fig 2. are based on the number of hypertensive patients aged 65-79

- Results for your practice are in DARK BLUE text
- Average results for all practices in the Strategic group are bracketed and in LIGHT BLUE text
- Due to the rounding process used, there may be some variation in percentages of +/- 0.1

Fig 1. All registered patients aged 65-79

N.B. Percentages in Fig 1. and the Summary Table are based on the total number of registered patients aged 65-79



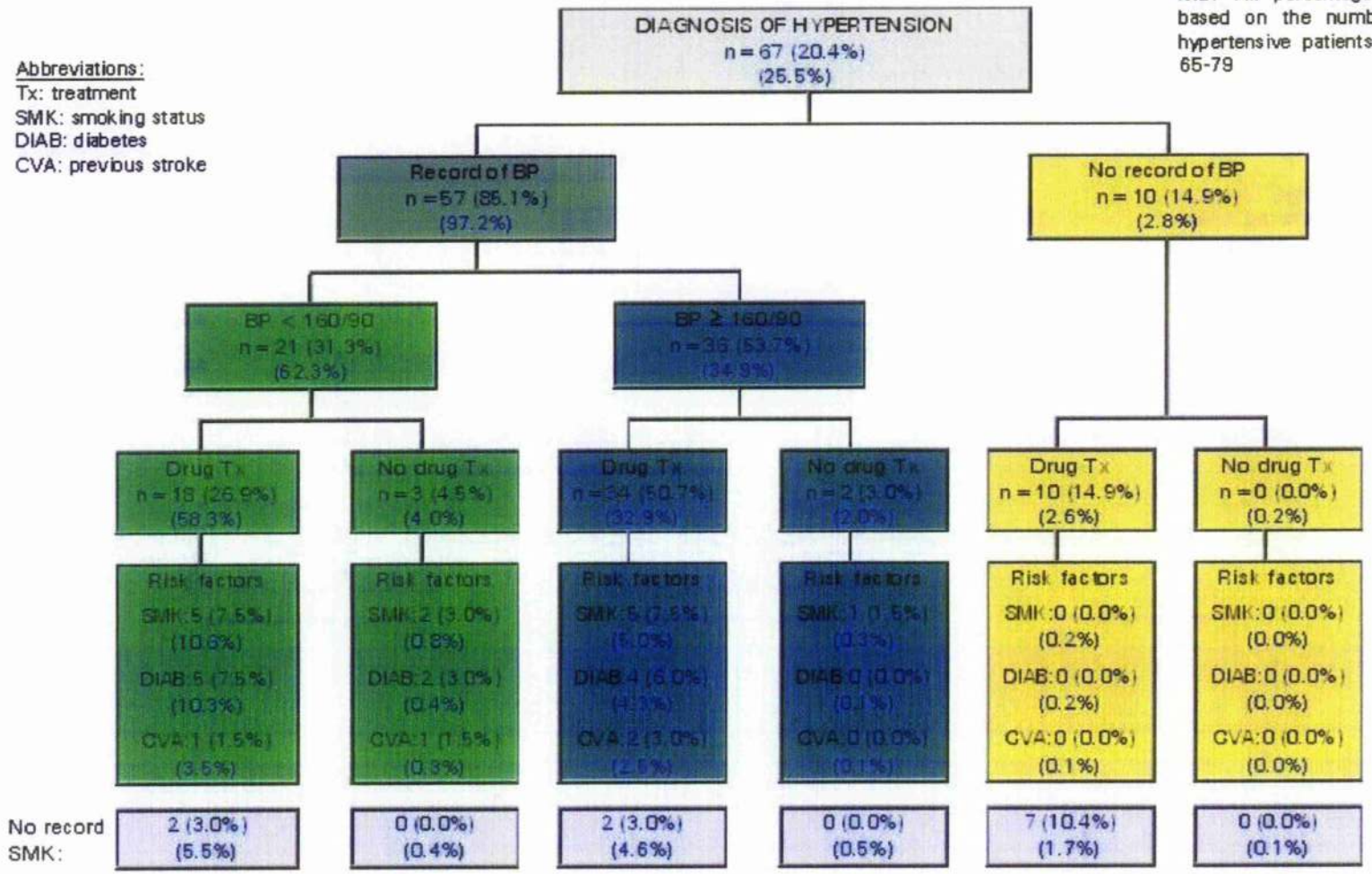
Summary Table	You	Group ave.
Patients with no BP recorded:	**22.5%**	**(15.7%)**
With recorded diagnosis of hypertension	**3.0%**	**(0.7%)**
With recorded cardiovascular risk factors - 1	**0.0%**	**(0.1%)**
- 2	**0.0%**	**(0.0%)**
- 3	**0.0%**	**(0.0%)**
Patients with recorded BP of ≥160/90:	**32.2%**	**(22.7%)**
With recorded diagnosis of hypertension	**10.9%**	**(8.9%)**
With recorded cardiovascular risk factors - 1	**3.6%**	**(2.4%)**
- 2	**0.0%**	**(0.3%)**
- 3	**0.0%**	**(0.0%)**

- Results for your practice are in **DARK BLUE** text
- Average results for all practices in the Stretegic group are bracketed and in LIGHT BLUE text

Fig 2. Patients with diagnosed hypertension aged 65-79

N.B. All percentages are based on the number of hypertensive patients aged 65-79

Abbreviations:
Tx: treatment
SMK: smoking status
DIAB: diabetes
CVA: previous stroke



Appendix 2: Additional Strategic group feedback

HYPER trial – 'turning data into knowledge'

Practice ID: xxx

Absolute risk for patients aged 65-79

Patient ID	Age Group	Sex	Date of Last BP	Systolic BP	Diastolic BP	Diagnosed HTN	Drug therapy	Smoking	Diabetes	Previous stroke	Absolute Risk (%)	If Smoker*	If Non-Smoker*
161	075_079	F	12/10/01	142	70	Diagnosed	Yes	Smoker	Yes		62.5	–	–
1592	075_079	M	08/01/96	160	80	Diagnosed	Yes	Non		Yes	45.0	–	–
2150	075_079	M	23/05/00	160	100	Undiagnosed	Yes	Non	Yes		44.7	–	–
285	075_079	F	06/06/96	150	100	Diagnosed	Yes	Ex	Yes		41.8	–	–
1985	075_079	M	27/05/98	150	70	Diagnosed		Smoker	Yes		39.7	–	–
917	070_074	F	15/06/94	170	90	Diagnosed	Yes	Non		Yes	35.0	–	–
279	070_074	M	22/01/02	168	86	Diagnosed	Yes	Non	Yes		34.2	–	–
937	070_074	F	18/06/98	166	88	Diagnosed	Yes	Non	Yes		33.6	–	–
1289	065_069	M	23/10/97	130	85	Diagnosed	Yes	Smoker		Yes	33.2	–	–
826	075_079	M	07/01/91	166	77	Diagnosed	Yes	Smoker			31.2	–	–
1707	075_079	F	26/03/93	160	78	Diagnosed	Yes	Smoker			29.2	–	–
2276	070_074	F	14/12/01	148	74	Diagnosed	Yes	Non	Yes		29.0	–	–
2411	070_074	M	03/08/93	145	90	Diagnosed	Yes	Non	Yes		28.3	–	–
2463	070_074	M	02/12/99	140	60	Diagnosed	Yes	Non	Yes		27.1	–	–
2420	075_079	M	09/03/89	150	90	Undiagnosed	Yes	Smoker			26.8	–	–
1851	070_074	M	09/11/01	126	66	Diagnosed	Yes	Non	Yes		23.9	–	–
351	065_069	F	03/06/94	170	85	Undiagnosed	Yes	Non		Yes	23.9	–	–
324	070_074	M	30/03/99	120	85	Diagnosed		Smoker		Yes	21.4	–	–
1638	070_074	M	05/05/92	170	120	Diagnosed	Yes	Smoker			21.3	–	–
984	070_074	M	12/02/01	160	80	Undiagnosed	Yes	Smoker			19.4	–	–
2647	070_074	M	12/09/01	160	106	Undiagnosed	Yes	Smoker			19.4	–	–
2251	070_074	F	01/09/92	150	100	Diagnosed	Yes	Smoker			17.6	–	–
1709	070_074	M	03/03/92	145	120	Undiagnosed	Yes	Smoker			16.7	–	–

Absolute risk >25% | Absolute risk 20-25% | Absolute risk 15-20% | Absolute risk 10-15%

* Patients with no record of smoking status have been allocated two risk scores; one based on being a Smoker, the other on being a Non-Smoker

Patient ID	Age Group	Sex	Date of Last BP	Systolic BP	Diastolic BP	Diagnosed HTN	Drug therapy	Smoking	Diabetes	Previous stroke	Absolute Risk (%)	If Smoker*	If Non-Smoker*
1173	070_074	F	30/11/94	140	90	Undiagnosed	Yes	Smoker			15.9	--	--
2516	075_079	F	25/01/93	170	95	Undiagnosed	Yes	Non			15.4	--	--
938	075_079	M	18/06/98	165	104	Diagnosed	Yes	Ex			14.6	--	--
503	075_079	F	01/03/93	160	100	Undiagnosed	Yes	Non			13.9	--	--
1731	075_079	M	23/11/93	160	95	Undiagnosed	Yes	Non			13.9	--	--
1944	075_079	M	17/12/88	160	105	Diagnosed	Yes	Ex			13.9	--	--
918	075_079	M	08/10/97	164	86	Undiagnosed		Smoker			13.4	--	--
176	075_079	F	03/04/89	150	90	Undiagnosed	Yes	Non			12.5	--	--
1976	075_079	M	24/09/90	150	90	Undiagnosed	Yes	Non			12.5	--	--
390	075_079	M	14/04/94	140	90	Diagnosed	Yes	Non			11.3	--	--
2054	065_069	M	30/11/95	150	90	Undiagnosed	Yes	Smoker			11.1	--	--
289	065_069	M	29/03/99	145	80	Diagnosed	Yes	Smoker			10.5	--	--
1646	075_079	M	15/01/90	130	90	Diagnosed	Yes	Non			10.1	--	--
1677	070_074	M	12/10/01	144	74	Diagnosed	Yes	No record	Yes		--	49.9	28.0
2893	070_074	F	16/07/01	210	120	Undiagnosed	Yes	No record			--	30.3	14.6
2607	075_079	M	16/06/95	150	95	Undiagnosed	Yes	No record			--	26.8	12.5
508	070_074	M	17/04/98	160	85	Diagnosed	Yes	No record			--	19.4	8.6
1635	070_074	F	16/11/91	160	85	Undiagnosed	Yes	No record			--	19.4	8.6
2136	070_074	M	30/04/92	150	80	Diagnosed	Yes	No record			--	17.6	7.7
2311	065_069	M	13/09/93	170	110	Diagnosed	Yes	No record			--	13.6	5.8

Absolute risk >25% | Absolute risk 20-25% | Absolute risk 15-20% | Absolute risk 10-15%

* Patients with no record of smoking status have been allocated two risk scores; one based on being a Smoker, the other on being a Non-Smoker

Appendix 3: Practice Structure Questionnaire

UNIVERSITY of GLASGOW

HYPER Trial

'Turning data into knowledge'

Practice Structure Questionnaire

GPASS User: **XXX**

HYPER trial number: **01**

Your practice is one of 52 Scottish practices which are participating in HYPER trial, a study looking at the usefulness of providing GPs with computerised feedback on management of hypertension. As part of this we are trying to determine the resources which are available to practices so that we can identify any changes which take place over the period of the study.

Some months ago we asked you to provide us with initial information about this for your practice. We would be grateful if you would complete this 2nd questionnaire and return it to us in the envelope provided as soon as possible. All of the information provided will be treated in confidence. If you have any questions about this questionnaire, please contact:-

Liz Mitchell
University of Glasgow Department of General Practice
4 Lancaster Crescent, Glasgow, G12 0RR
Tel 0141 211 1666 *Fax* 0141 211 1667
E-mail edm1a@clinmed.gla.ac.uk

For office use only

PRACTICE ID | | |

QUESTIONNAIRE B (6) 12 18 24

RETURN DATE | | / | | / | |

1. Are the premises **Tick one box only**

Practice owned	1
Health Board owned	2
Privately rented	3
Other	

If OTHER, please specify _____

2. Is the practice an approved training practice? **Tick one box only**

Yes	1
No	0

3a. Are the medical records summarised? **Tick one box only**

Yes	1
No	2
Partially	3

3b. If YES, are they? **Tick one box only**

Paper	1
Computerised	2
Both	3

4. What is the total practice list size? ☐

5. For what percentage of patients do you receive deprivation payments?

B4 payments	%
B3 payments	%
B2 payments	%
B1 payments	%

6. How many of the following GPs work in the practice? (Whole Time Equivalent)

Principals	
Assistants	
Trainees	
Other	

If OTHER, please specify _____

7. How many of the following nurses work in or from the practice? (WTE)

Practice nurses	
Health visitors	
District nurses	
Others – for example, CPN, Liaison	

If OTHER, please specify _____

Please go to the next page now

8. How many other staff work in the practice? (WTE)

Practice Manager	☐
Receptionists	☐
Secretaries	☐
Clerical staff	☐
Other	☐

If OTHER, please specify _____

9. Does the practice have an appointment system? **Tick one box only**

Yes, for all surgeries	☐ 1
Yes, for some surgeries	☐ 2
No	☐ 3

10a. Approximately how many consultations per week are there....?

Per GP (WTE)	☐ 1
Per Practice Nurse (if applicable)	☐ 2

10b. What is the average consultation time....?

For GP consultations	☐ Minutes
For Practice Nurse consultations (if applicable)	☐ Minutes

11. Does the practice hold a hypertension register? **Tick one box only**

Yes	☐ 1
No	☐ 0

12a. Does the practice hold a hypertension clinic? **Tick one box only**

Yes	☐ 1
No	☐ 0

If NO go to Question 13

12b. If YES, how often is this held? _____

12c. Who normally conducts the clinic? **Tick one box only**

GP only	☐ 1
Practice nurse only	☐ 2
GP and practice nurse	☐ 3
Mainly practice nurse but GP available	☐ 4

12d. How many patients are usually seen at the clinic? ☐

Please go to the next page now

12e. Which patients do you see in the clinic? **Tick one box only**

All patients with hypertension	☐ 1
Specific groups of hypertensive patients	☐ 2
Others	☐ 3

If GROUPS or OTHER, please specify _____

12f. How long does a clinic usually last?

☐ Hours ☐ Minutes

13a. Does the practice have a recall system for hypertensive patients? **Tick one box only**

Yes	☐ 1
No	☐ 0

13b. If YES, is it? **Tick one box only**

By letter	☐ 1
By telephone	☐ 2
Appointment arranged at previous visit	☐ 3
Other	☐

If OTHER, please specify _____

13c. How often are hypertensive patients recalled?

_____

Please give the date when this questionnaire was completed ☐☐ / ☐☐ / ☐☐

Thank you for your help

Appendix 4: Computerisation questionnaire

14. In what year did your practice first acquire a computing system for collecting patient information e.g. registration details, diagnoses? _____

15. Are there computers/terminals in the consulting rooms used by the **doctors** in your your practice?

All of the consulting rooms ☐
Some of the consulting rooms ☐
None of the consulting rooms ☐

16. Are there computers/terminals in the rooms used by the **nurses** in your practice?

All of the rooms ☐
Some of the rooms ☐
None of the rooms ☐

17a. Is there a designated person or group of people in the practice with responsibility for computer related issues e.g. breakdowns, hardware/software purchasing etc.?

Yes ☐
No ☐

17b. If YES, is this *(please tick all that apply)*

GP ☐
Nurse ☐
Practice Manager ☐
Computer operator/Data input clerk ☐
Receptionist ☐
Other ☐

If OTHER, please specify _____

18a. Who in the practice enters data onto the computer *(please tick all that apply)*

GP(s) ☐
Nurse(s) ☐
Practice Manager ☐
Computer operator/Data input clerk ☐
Receptionist(s) ☐
Other ☐

If OTHER, please specify _____

18b. Has the practice allocated computer entry of specific types of information to a particular person or group of people e.g. registration data to receptionists?

Yes ☐
No ☐

18c. If YES, is this *(please tick all that apply)*

GP ☐
Nurse ☐
Practice Manager ☐
Computer operator/Data input clerk ☐
Receptionist ☐
Other ☐

If OTHER, please specify _____

18d. How long ago was data entry organised in this way?

☐ Years ☐ Months

19a. Is there a designated person with responsibility for IT related training?

Yes ☐
No ☐

19b. If YES, is this person

GP ☐
Nurse ☐
Practice Manager ☐
Computer operator/Data input clerk ☐
Receptionist ☐
Other ☐

If OTHER, please specify _____

20a. Does your practice have a branch surgery?

Yes ☐
No ☐

20b. If YES, is there access to the computerised patient record system there?

Yes ☐
No ☐

21. In your practice, what record system is currently used for each of the following tasks

		Totally/largely Paper-based	**Both computerised and paper-based**	**Totally/largely Computerised**
a.	Patient registration	1	2	3
b.	Appointments	1	2	3
c.	Disease registers	1	2	3
d.	Clinical records	1	2	3
e.	Referral letters	1	2	3
f.	Acute prescribing	1	2	3
g.	Repeat prescribing	1	2	3
h.	Call and recall	1	2	3
i.	Highlighting future tasks (e.g. record BP)	1	2	3
j.	Guidelines / protocols	1	2	3

22a. Does the computer record for the **majority** of patients in your practice date from

The patient's birth
The patient's registration with the practice
Installation of the computer system

22b. If REGISTRATION or INSTALLATION OF THE COMPUTER SYSTEM, has the practice decided to retrospectively enter some or all data recorded before this date?

Yes
No

23a. Has the practice agreed on a minimum set of data which should be collected for each patient?

Yes
No
Don't know

23b. If YES, is this data collected for

All patients
Specific groups of patients

24a. Is there any patient information which the practice has decided not to record?

All patients
Specific groups of patients

24b. If YES, please give details?

25. What patient information is routinely recorded on computer?

		Not entered	Entered for some	Entered for all
	Administration:			
a.	Registration details	1	2	3
b.	Family history	1	2	3
c.	Past medical history	1	2	3
d.	Routine prevention (e.g. immunisations)	1	2	3
e.	Recall information (e.g. smears)	1	2	3
f.	Details of fees	1	2	3
	Consultation:			
g.	Presenting complaint/symptom(s)	1	2	3
h.	Clinical findings on examination	1	2	3
i.	Measurements (e.g. BP, peak flow)	1	2	3
j.	Diagnosis	1	2	3
k.	Drugs prescribed	1	2	3
l.	Acute problems	1	2	3
m.	Ongoing problems	1	2	3

n.	Drug side-effects	1	2	3
o.	Drug contra-indications	1	2	3
	Referrals:			
p	Referrals to other primary care (e.g. chiropody)	1	2	3
q.	Referrals to secondary care	1	2	3
r.	Other referrals	1	2	3
s.	Investigations	1	2	3
t.	Results of investigations	1	2	3
u.	Secondary care management	1	2	3

26a. How many **GPs** in your practice usually record data onto the computer during or directly after consultations? _____

26b. How many **nurses** in your practice usually record data onto the computer during or directly after consultations? _____

27. How strongly do you agree or disagree with the following statement: "computerisation of patient data been well received by the practice team as a whole"?

Strongly agree	**Agree**	**Neither agree nor disagree**	**Disagree**	**Strongly disagree**
1	2	3	4	5

Position held by person completing questionnaire: _____

Date completed: _____

Thank you very much for your help

Appendix 5: Casenote review proforma

DATE OF DOWNLOAD:

Practice ID | **Patient ID**

HYPER ID | **D o B**

Gender Male ☐ Female ☐

Diagnosis of hypertension Yes ☐ No ☐

Drug treatment Yes ☐ No ☐

Visits in period

Practice (GP) ☐
(PN / HV) ☐
Hospital ☐

Number BP records in 12-month period ☐ 1st ☐ / ☐ No record ☐

Blood pressure readings

	S	D	Date	PRACT	HOSP
1		/			
2		/			
3		/			

Smoking status Current ☐ Ex ☐ Non ☐ No record ☐

Cholesterol Total ☐ HDL ☐

ECG Yes ☐ No ☐
LVH Yes ☐ No ☐

Co-morbidity

Hypertension ☐ Diabetes ☐ Stroke ☐

NOTES

Appendix 6: Data release form

UNIVERSITY
of
GLASGOW

HYPER trial – 'turning data into knowle dge'
Data Release Consent Form

The data on this disk may be used for two purposes and we would like to confirm your consent for:

- HYPER Trial _____

and that you will release anonymised practice data for,

- EQ _____

as previously described to you by personnel from that project.

Please complete:

Name: _____

For: (practice name) _____

GPASS user number: _____

Signed: _____

Date: _____

HYPER Trial. University of Glasgow, Dept. of General Practice
4 Lancaster Crescent Glasgow G12 0RR
Tel: 0141 211 1666 Fax: 0141 211 1667 email: edm1a@clinmed.gla.ac.uk

Appendix 7: Hypertension Read codes

Read codes used to indicate diagnosed hypertension (n=67)

READ CODE	DESCRIPTOR
14A2.	H/O: hypertension
6627.	Good hypertension control
6628.	Poor hypertension control
6629.	Hypertension: follow-up default
662F.	Hypertension treatment started
662G.	Hypertensive treatment changed
662H.	Hypertension treatment stopped
662O.	On treatment for hypertension
8B26.	Antihypertensive therapy
8HT5.	Referral hypertension clinic
9N03.	Seen in hypertension clinic
9N1y2	Seen in hypertension clinic
9OI..	Hypertension monitoring admin.
9OI1.	Attends hypertension monitor.
9OI2.	Refuses hypertension monitor.
9OI3.	Hypertension monitor offer default
9OI4.	Hypertension monitor 1st letter
9OI5.	Hypertension monitor 2nd letter
9OI6.	Hypertension monitor 3rd letter
9OI7.	Hypertension monitor verbal invite
9OI8.	Hypertension monitor phone invite
9OI9.	Hypertension monitor deleted
9OIA.	Hypertension monitor check done
9OIZ.	Hypertension monitoring admin NOS
G20..	Essential hypertension
G200.	Malignant essential hypertension
G201.	Benign essential hypertension
G202.	Systolic hypertension
G20z.	Essential hypertension NOS
G21..	Hypertensive heart disease
G210.	Malignant hypertensive heart disease
G2100	Malignant hypertensive heart disease - no CCF
G2101	Malignant hypertensive heart disease + CCF
G210z	Malignant hypertensive heart disease NOS
G211.	Benign hypertensive heart disease
G2110	Benign hypertensive heart disease - no CCF
G2111	Benign hypertensive heart disease + CCF
G211z	Benign hypertensive heart disease NOS
G21z.	Hypertensive heart disease NOS
G21z0	Hypertensive heart disease NOS - no CCF
G21z1	Hypertensive heart disease NOS + CCF
G21zz	Hypertensive heart disease NOS
G22..	Hypertensive renal disease
G220.	Malignant hypertensive renal disease
G221.	Benign hypertensive renal disease
G222.	Hypertensive renal disease + renal failure
G22z.	Hypertensive renal disease NOS
G23..	Hypertensive heart + renal disease
G230.	Malignant hypertensive heart + renal disease
G231.	Benign hypertensive heart + renal disease
G232.	Hypertensive heart & renal disease + (congestive) heart failure
G233.	Hypertensive heart & renal disease + renal failure
G234.	Hypertensive heart & renal disease + both (congestive) heart & renal failure
G23z.	Hypertensive heart + renal disease NOS
G24..	Secondary hypertension
G240.	Secondary malignant hypertension

READ CODE	DESCRIPTOR
G2400	Secondary malignant renovascular hypertension
G240z	Secondary malignant hypertension NOS
G241.	Secondary benign hypertension
G2410	Secondary benign renovascular hypertension
G241z	Secondary benign hypertension NOS
G244.	Hypertension 2ndry endocrine disorder
G24z.	Secondary hypertension NOS
G24z0	Secondary renovascular hypertension NOS
G24zz	Secondary hypertension NOS
Gyu20	[X] Other secondary hypertension
Gyu21	[X] Hypertension, 2ndary other renal disease

Appendix 8: Diabetes Read codes

Read codes used to indicate diagnosed diabetes (n=189)

READ CODE	DESCRIPTOR
13B1.	Diabetic diet
1434.	H/O: diabetes mellitus
14P3.	H/O: insulin therapy
2G5A.	O/E-Right diabetic foot at risk
2G5B.	O/E-Left diabetic foot at risk
42W..	Hb. A1C - diabetic control
42W1.	Hb. A1C < 7% - good control
42W2.	Hb. A1C 7-10% - borderline
42W3.	Hb. A1C > 10% - bad control
42WZ.	Hb. A1C - diabetic control NOS
44UZ.	Blood glucose 14+ mmol/L
44Uz.	Blood glucose raised NOS
44V3.	Glucose tolerance test diabetic
66A..	Diabetic monitoring
66A1.	Initial diabetic assessment
66A2.	Follow-up diabetic assessment
66A3.	Diabetic on diet only
66A4.	Diabetic on oral treatment
66A5.	Diabetic on insulin
66A8.	Has seen dietician - diabetes
66A9.	Understands diet - diabetes
66AD.	Fundoscopy - diabetic check
66AG.	Diabetic drug side effects
66AH.	Diabetic treatment changed
66AH0	Conversion to insulin
66AI.	Diabetic - good control
66AJ.	Diabetic - poor control
66AJ0	Chronic hyperglycaemia
66AJ1	Brittle diabetes
66AJ2	Loss of hypoglycaemic warning
66AJz	Diabetic - poor control NOS
66AK.	Diabetic - cooperative patient
66AL.	Diabetic - uncooperative patient
66AM.	Diabetic - follow-up default
66AN.	Date diabetic treatment start
66AO.	Date diabetic treatment stopped
66AP.	Diabetes: practice programme
66AQ.	Diabetes: shared care program
66AR.	Diabetes management plan given
66AS.	Diabetic annual review
66AZ.	Diabetic monitoring NOS
8A12.	Diabetic crisis monitoring
8A13.	Diabetic stabilisation
8A17.	Self monitoring blood glucose
8A18.	Self monitoring urine glucose
8A19.	Self monitoring blood + urine glucose
8CA41	Patient advised re diabetic diet
8H2J.	Admit diabetic emergency
8H3O.	Non-urgent diabetic admission
8H4F.	Referral to diabetologist
8H7C.	Refer, diabetic liaison nurse
8HKE.	Diabetology D.V. requested
8HLE.	Diabetology D.V. done
8HME.	Listed for Diabetology admission
8HVU.	Private referral diabetologist
9N1Q.	Seen in diabetic clinic
9OL..	Diabetes monitoring admin.
9OL1.	Attends diabetes monitoring
9OL2.	Refuses diabetes monitoring

READ CODE	DESCRIPTOR
9OL3.	Diabetes monitoring default
9OL4.	Diabetes monitoring 1st letter
9OL5.	Diabetes monitoring 2nd letter
9OL6.	Diabetes monitoring 3rd letter
9OL7.	Diabetes monitoring verbal invite
9OL8.	Diabetes monitoring phone invite
9OL9.	Diabetes monitoring deleted
9OLA.	Diabetes monitor. check done
9OLZ.	Diabetes monitoring admin NOS
C10..	Diabetes mellitus
C100.	Diabetes mellitus - no complications
C1000	Diabetes mellitus no complications - juvenile
C1001	Diabetes mellitus no complications - adult
C100z	Diabetes mellitus no complications - onset NOS
C101.	Diabetes mellitus with ketoacidosis
C1010	Diabetes mellitus + ketoacidosis - juvenile
C1011	Diabetes mellitus + ketoacidosis - adult
C101y	Other specified Diabetes mellitus + ketoacidosis
C101z	Diabetes mellitus + ketoacidosis - onset NOS
C102.	Diabetes mellitus + hyperosmolar coma
C1020	Diabetes mellitus + hyperosmolar coma - juvenile
C1021	Diabetes mellitus + hyperosmolar coma - adult
C102z	Diabetes + hyperosmolar coma NOS
C103.	Diabetes mellitus. + ketoacidotic coma
C1030	Diabetes mellitus.+ ketoacidotic coma - juvenile
C1031	Diabetes mellitus.+ ketoacidotic coma - adult
C103y	Other specified diabetes mellitus with coma
C103z	Diabetes mellitus + ketoacidotic coma NOS
C104.	Diabetes mellitus with nephropathy
C1040	Diabetes mellitus + nephropathy - juvenile
C1041	Diabetes mellitus + nephropathy - adult
C104y	Other specified diabetes mellitus + renal complications
C104z	Diabetes mellitus + nephropathy NOS
C105.	Diabetes mellitus+ eye manifestation
C1050	Diabetes mellitus + eye manifestation - juvenile
C1051	Diabetes mellitus + eye manifestation - adult
C105y	Other specified diabetes mellitus + ophthalmic complications
C105z	Diabetes mellitus + eye manifestation NOS
C106.	Diabetes mellitus. with neuropathy
C1060	Diabetes mellitus + neuropathy - juvenile
C1061	Diabetes mellitus + neuropathy - adult
C106y	Other specified diabetes mellitus + neuropathic complications
C106z	Diabetes mellitus + neuropathy NOS
C107.	Diabetes mellitus + peripheral circulatory disease
C1070	Diabetes + peripheral circulatory disease - juvenile
C1071	Diabetes + peripheral circulatory disease - adult
C1072	Diabetic gangrene - adult
C1073	IDDM peripheral circulatory disorder
C1074	NIDDM peripheral circulatory disorder
C107y	Other specified diabetes mellitus + peripheral circulatory comps.
C107z	Diabetes + peripheral circulatory disease NOS
C108.	Insulin dependent diabetes mellitus
C1080	Insulin dependent diabetes mellitus + renal complications
C1081	Insulin dependent diabetes mellitus + ophthalmic complications
C1082	Insulin dependent diabetes mellitus + neuropathic complications
C1083	Insulin dependent diabetes mellitus + multi complications
C1084	Unstable insulin dependent diabetes mellitus
C1085	Insulin dependent diabetes mellitus + ulcer
C1086	Insulin dependent diabetes mellitus + gangrene
C1087	Insulin dependent diabetes mellitus + retinopathy
C1088	Insulin dependent diabetes mellitus - poor control

READ CODE	DESCRIPTOR
C1089	Insulin dependent diabetes adult onset
C108y	Other specified diabetes mellitus + multiple complications
C108z	Unspecified diabetes mellitus + multiple complications
C109.	Non-insulin dependent diabetes mellitus
C1090	Non-insulin dependent diabetes mellitus + renal complications
C1091	Non-insulin dependent diabetes mellitus + ophthalmic comps.
C1092	Non-insulin dependent diabetes mellitus + neuropathic comps.
C1093	Non-insulin dependent diabetes mellitus + multi complications
C1094	Non-insulin dependent diabetes mellitus + ulcer
C1095	Non-insulin dependent diabetes mellitus + gangrene
C1096	Non-insulin dependent diabetes mellitus + retinopathy
C1097	Non-insulin dependent diabetes mellitus - poor control
C10A.	Malnutrition-related diabetes mellitus
C10A0	Malnutrition-related diabetes mellitus + coma
C10A1	Malnutrition-related diabetes mellitus + ketoacidosis
C10A2	Malnutrition-related diabetes mellitus + renal complications
C10A3	Malnutrition-related diabetes mellitus + ophthalmic complications
C10A4	Malnutrition-related diabetes mellitus + neuropathic complications
C10A5	Malnutrition-related diabetes mellitus + periph. circulatory comp
C10A6	Malnutrition-related diabetes mellitus + multiple complications
C10A7	Malnutrition-related diabetes mellitus without complications
C10AW	Malnutrition-related diabetes mellitus + unspecified complications
C10AX	Malnutrition-related diabetes mellitus + other specified comps.
C10B.	Diabetes mellitus induced by steroids
C10B0	Steroid induced diabetes mellitus without complications
C10y.	Diabetes mellitus + other manifestation
C10y0	Diabetes mellitus + other manifestation - juvenile
C10y1	Diabetes mellitus + other manifestation - adult
C10yy	Other specified diabetes mellitus + other specified complications
C10yz	Diabetes mellitus + other manifest NOS
C10z.	Diabetes mellitus + unspecified complications
C10z0	Diabetes mellitus + comp NOS - juvenile
C10z1	Diabetes mellitus + comp NOS - adult
C10zy	Other specified diabetes mellitus + unspecified complications
C10zz	Diabetes mellitus + unspecified complications NOS
C11y0	Steroid induced diabetes
Cyu2.	[X]Diabetes mellitus
Cyu20	[X]Other specified diabetes mellitus
Cyu21	[X]Malnutrition-related diabetes mellitus +other specified comps.
Cyu22	[X]Malnutrition-related diabetes mellitus + unspecified comps.
Cyu23	[X]Unspecified diabetes mellitus + renal complications
F1711	Autonomic neuropathy - diabetes
F3450	Diabetic mononeuritis multiplex
F35z0	Diabetic mononeuritis NOS
F372.	Polyneuropathy in diabetes
F3720	Acute painful diabetic neuropathy
F3721	Chronic painful diabetic neuropathy
F3722	Asymptomatic diabetic neuropathy
F3813	Myasthenic syndrome + diabetes
F3y0.	Diabetic mononeuropathy
F420.	Diabetic retinopathy
F4200	Background diabetic retinopathy
F4201	Proliferative diabetic retinopathy
F4202	Preproliferative diabetic ret
F4203	Advanced diabetic maculopathy
F420z	Diabetic retinopathy NOS
F4407	Diabetic iritis
F4640	Diabetic cataract
G73y0	Diabetic peripheral angiopathy
K01x1	Nephrotic syndrome + diabetes mellitus
Kyu03	[X]Glomerular disorders / diabetes mellitus

READ CODE	DESCRIPTOR
M0372	Cellulitis in diabetic foot
M2710	Ischaemic ulcer diabetic foot
M2711	Neuropathic diabetic ulcer - foot
M2712	Mixed diabetic ulcer - foot
N0300	Diabetic cheiroarthropathy
N0301	Diabetic Charcot arthropathy
R0542	[D]Gangrene of toe in diabetic
R0543	[D]Widespread diabetic foot gangrene

Appendix 9: Stroke Read codes

Read codes used to indicate previous stroke (n=65)

READ CODE	DESCRIPTOR
14A7.	H/O: CVA/stroke
14AK.	H/O: Stroke in last year
662M.	Stroke monitoring
G61..	Intracerebral haemorrhage
G610.	Cortical haemorrhage
G611.	Internal capsule haemorrhage
G612.	Basal nucleus haemorrhage
G613.	Cerebellar haemorrhage
G614.	Pontine haemorrhage
G615.	Bulbar haemorrhage
G616.	External capsule haemorrhage
G617.	Intracerebral haemorrhage intraventricular
G618.	Intracerebral haemorrhage multiple local
G61X.	Intracerebral haemorrhage hemisphere unspecified
G61X0	Left side intracerebral haemorrhage unspecified
G61X1	Right side intracerebral haemorrhage unspecified
G61z.	Intracerebral haemorrhage NOS
G62z.	Intracranial haemorrhage NOS
G63..	Precerebral arterial occlusion
G630.	Basilar artery occlusion
G631.	Carotid artery occlusion
G632.	Vertebral artery occlusion
G633.	Multiple / bilateral precerebral arterial occlusion
G63y.	Other precerebral artery occlusion
G63y0	Cerebral infarction/thrombosis/precerebral artery
G63y1	Cerebral infarction /embolism/precerebral artery
G63z.	Precerebral artery occlusion NOS
G64..	Cerebral arterial occlusion
G640.	Cerebral thrombosis
G6400	Cerebral infarction/thrombosis/cerebral artery
G641.	Cerebral embolism
G6410	Cerebral infarction/embolism/cerebral artery
G64z.	Cerebral infarction NOS
G64z0	Brainstem infarction
G64z1	Wallenberg syndrome
G64z2	Left sided cerebral infarction
G64z3	Right sided cerebral infarct
G66..	Stroke/CVA unspecified
G660.	Middle cerebral artery syndrome
G661.	Anterior cerebral artery syndrome
G662.	Posterior cerebral artery syndrome
G663.	Brain stem stroke syndrome
G664.	Cerebellar stroke syndrome
G665.	Pure motor lacunar syndrome
G666.	Pure sensory lacunar syndrome
G667.	Left sided CVA
G668.	Right sided CVA
G6760	Cerebral infarction /cerebral vein thrombosis, non pyo
G677.	Occlusion/stenosis cerebral artery, n rslt cer infl
G6770	Occlusion + stenosis/midl cerebral artery
G6771	Occlusion + stenosis/anterior cerebral artery
G6772	Occlusion + stenosis/post cerebral artery
G6773	Occlusion + stenosis/cerebellar artery
G6774	Occlusion/stenosis/multiple + bilateral cerebral artery
G681.	Sequelae/intracerebral haemorrhage
G683.	Sequelae/cerebral infarction
G68X.	Sequelae/stroke, n specified/haemorrhage, infarction
G6W..	Cerebral infarction, unspecified occlusion/stenosis precerebral artery
G6X..	Cerebral infarction /unspecified occlusion, stenosis/cerebral artery

READ CODE	DESCRIPTOR
Gyu62	[X]Other intracerebral haemorrhage
Gyu63	[X]Cerebral infarction/unspecified occlusion, stenosis/cerebral artery
Gyu64	[X]Other cerebral infarction
Gyu65	[X]Occlusion + stenosis/other precerebral artery
Gyu66	[X]Occlusion + stenosis/other cerebral arteries
Gyu6C	[X]Sequelae/stroke, n spc/haemorrhage, infarction

Appendix 10: Smoking status Read codes

Read codes used to indicate smoking status (n=52)

READ CODE	DESCRIPTOR
137..	Tobacco consumption
1371.	Never smoked tobacco
1372.	Trivial smoker - < 1 cig/day
1373.	Light smoker - 1-9 cigs/day
1374.	Moderate smoker - 10-19 cigs/d
1375.	Heavy smoker - 20-39 cigs/day
1376.	Very heavy smoker - 40+cigs/d
1377.	Ex-trivial smoker (
1378.	Ex-light smoker (1-9/day)
1379.	Ex-moderate smoker (10-19/day)
137A.	Ex-heavy smoker (20-39/day)
137B.	Ex-very heavy smoker (40+/day)
137C.	Keeps trying to stop smoking
137D.	Admitted tobacco cons untrue?
137E.	Tobacco consumption unknown
137F.	Ex-smoker - amount unknown
137G.	Trying to give up smoking
137H.	Pipe smoker
137I.	Passive smoker
137J.	Cigar smoker
137K.	Stopped smoking
137L.	Current non-smoker
137M.	Rolls own cigarettes
137N.	Ex pipe smoker
137O.	Ex cigar smoker
137P.	Cigarette smoker
137Q.	Smoking started
137R.	Current smoker
137S.	Ex smoker
137Z.	Tobacco consumption NOS
9OO..	Anti-smoking monitoring admin.
9OO1.	Attends stop smoking monitor
9OO2.	Refuses stop smoking monitor
9OO3.	Stop smoking monitor default
9OO4.	Stop smoking monitor 1st letter
9OO5.	Stop smoking monitor 2nd letter
9OO6.	Stop smoking monitor 3rd letter
9OO7.	Stop smoking monitor verbal invite
9OO8.	Stop smoking monitor phone inv
9OO9.	Stop smoking monitoring delete
9OOA.	Stop smoking monitor check done
9OOZ.	Stop smoking monitor admin. NOS
E251.	Tobacco dependence
E2510	Tobacco dependence-unspecified
E2511	Tobacco dependence-continuous
E2512	Tobacco dependence-episodic
E2513	Tobacco dependence-in remission
E251z	Tobacco dependence NOS
Eu171	[X]Harmful use of tobacco
Eu172	[X]Tobacco dependence syndrome
ZV4K0	[V]Tobacco use
ZV6D8	[V]Tobacco abuse counselling

Appendix 11: Antihypertensive drugs

Drug names indicating antihypertensive medication (n=167)

BNF CHAPTER / CLASS	NON-PROPRIETORY (PROPRIETORY)
2.2.1 Thiazides and related diuretics	Bendrofluazide Chlorothiazide (Saluric) Cyclopenthiazide (Navidrex) Indapamide (Natrilfix) Mefruside (Baycaron) Metolazone (Metenix) Xipamide (Diurexan)
2.2.2 Loop diuretics	Bumetanide (Burinex) Frusemide (Lasix)
2.4 Beta-adrenoceptor blocking drugs	Acebutolol (Secadrex, Sectral) Atenolol (Beta-Adalat, Co-tenidone, Kalten, Tenben, Tenif, Tenoret, Tenoretic, Tenormin) Betaxolol (Kerlone) Timolol Maleate (Betim, Blocadren) Bisoprolol Fumarate (Emcor, Monocor, Monozide) Carvedilol (Eucardic) Celiprolol Hydrochloride (Celectol) Esmolol Hydrochloride (Brevibloc) Propranolol (Inderal, Inderetic, Inderex) Labetalol Hydrochloride (Trandate) Metoprolol Tartrate (Betaloc, Lopresor) Nebivolol (Nebilet) Nadolol (Corgard, Corgaretic) Oxprenolol Hydrochloride (Trasicor, Trasidrex) Pindolol (Viskaldix, Visken) Sotalol Hydrochloride (Beta-Cardone, Sotacor)
2.5.1 Vasodilator antihypertensive drugs	Hydralazine Hydrochloride (Apresoline) Minoxidil (Loniten)
2.5.2 Centrally acting antihypertensive drugs	Clonidine Hydrochloride (Catapres, Dixarit) Methyldopa (Aldomet)
2.5.4 Alpha-adrenoceptor blocking drugs	Doxazosin (Cardura) Indoramin (Baratol, Doralese) Prazosin Hydrochloride (Hypovase) Terazosin (Hytrin)
2.5.5.1 ACE inhibitors	Captopril (Capoten, Capozide) Cilazapril (Vascace) Enalapril Maleate (Innovace, Innozide) Fosinopril (Staril) Lisinopril (Carace, Zestril, Zestoretic) Moexipril Hydrochloride (Perdix) Perindopril (Coversyl) Quinapril (Accupro, Accuretic) Ramipril (Tritace) Trandolapril (Gopten, Odrik, Tarka)

BNF CHAPTER / CLASS	NON-PROPRIETORY (PROPRIETORY)
2.5.5.2 Angiotensin-II receptor inhibitors	Candesartan Cilexetil (Amias) Irbesartan (Aprovel) Losartan Potassium (Cozaar) Valsartan (Diovan)
2.6.2 Calcium channel blockers	Amlodipine Besylate (Istin) Diltiazem Hydrochloride (Adizem, Angitil, Calcicard, Dilcardia, Dilzem, Slozem, Tildiem, Viazem, Zemtard) Felodipine (Plendil) Isradipine (Prescal) Lacidipine (Motens) Lercanidipine Hydrochloride (Zanidip) Nicardipine Hydrochloride (Cardene) Nifedipine (Adalat, Adipine, Anglopine, Cardilate, Coracten, Coroday, Fortipine, Hypolar, Nefidipress, Nifedotard, Nifelease, Nifensar, Nivaten, Slofedipine, Tensipine, Unipine) Nisoldipine (Syscor) Verapamil Hydrochloride (Cordilox, Securon, Univer, Verapress, Vertab)

Appendix 12: Audit trail for the development of search queries

Audit trail for generation of feedback data [1]

- Copied tables *Clinical events*, *Measurements*, *Patients* and *Prescriptions* to a new database called "Analyse HYPER data".
- Created a new table called MORBIDITY MASTER, which contains Practice ID, Patient ID, Read code, Diagnosis date and Update date. Update date contains information on when data records were imported to the table.
- Created an append query called BRING IN EVENTS which links *Patients* and *Clinical events*. This query adds records containing Patient ID, Practice ID, Read code, Diagnosis date and Update date to MORBIDITY MASTER. Records selected are limited by age criteria [>044 and <080] and patient registration status [live = L]. All variables are grouped in ascending order and only the most recently dated Read code is imported [last]. Discovered on testing that grouping by 'last' for Diagnosis date did not import the most recent Read code. Changed to 'Max' and tested again. Using 'Max' selects a dated Read code over an undated Read code if both are available.

  Test complete 26.2.00
- Created a delete query called WIPE MORBIDITY MASTER. This query deletes all information held in MORBIDITY MASTER.

  Tested 13.2.00 / 26.2.00
- Created a macro called IMPORT NEW DATA. This macro runs the WIPE MORBIDITY MASTER query followed by the BRING IN EVENTS query. This allows the same tables and queries to be used each time a new dataset is obtained. Previous data will be archived before this query is run.

  Tested 13.2.00 / 26.2.00
- Created a find duplicates query called FIND DUPLICATES FOR MORBIDITY MASTER. Running this query ensures that there are no duplicates in the table.
- Created a select query called VERIFY MORBIDITY AGAINST EVENTS. This query links *Patients*, MORBIDITY MASTER and *Clinical events*. It is run to ensure that there are no relevant records in the *Clinical events* source data which have not been transferred to MORBIDITY MASTER.
- Created a select query called SORTED MEASUREMENTS. This query is run on *Measurements* and contains Practice ID, Patient ID, Measurement date, Systolic, Diastolic, Height, Weight, Parity and Gravida. Records selected are limited to those where Systolic and Diastolic have a BP reading [is not null, is not –1, is not 0]. Practice ID, Patient ID and Measurement are grouped and sorted in ascending order.

  Tested 28.2.00
- Created a select query called PATIENT DATA. This query links *Patients* and SORTED MEASUREMENTS and contains Practice ID, Patient ID, Age-band, Sex, Registration status, Depcat score, Measurement date, Systolic and Diastolic. All variables are grouped and only the most recent record for each patient is imported [last]. All patients are included even if they have no Systolic and / or Diastolic reading.

  Test complete 29.02.99; Re-test complete 20.3.00 [2]

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[1] All processes were developed using 'HYPER data' as the sample. This contains baseline data from three practices. These practices were chosen as they are New GPASS practices which have the smallest {1,999}, largest {16,400} and average {5,217} numbers of patients. Process began 10.2.00, completed 24.5.00.

[2] After linking "Analyse Hyper data" with tables held in "Hyper extract 1", PATIENT DATA, CHECK BP RECORDED, HYPERTENSIVES AND MORBIDIY VERBOSE were subsequently tested using three different practices; {1 New Gpass–4,547}, {1 UNIX–6,859} and {1 DOS–767}.

- Created a select query called EXTRACT STUDY AGE GROUP. This query extracts data from *Patients* for all relevant patients [>44 and <80 and of live status]. It also contains one created variable; Age Group. This inserts either '45-64' or '65-79' for each patient depending on their age band.

  Test complete 28.2.00 / 29.2.00

- Created a crosstab query called AGE AND SEX BY PRACTICE. This query is run on EXTRACT STUDY AGE GROUP and plots Practice ID and Age Group against total patient count, total count for females and total count for males.

  Test complete 28.2.00 / 29.2.00

- Created a select query called CHECK BP RECORDING. This query links *Patients* and PATIENT DATA and contains Patient ID, Practice ID, Sex, Age-band, Registration status, LastOfSystolic and LastOfDiastolic. It also contains three created variables; Age Group, BP Recorded and Hypertensive Reading. BP Recorded inserts 'No' or 'Yes' depending on whether the patient has an entry for diastolic and systolic pressure. Hypertensive Reading inserts 'Missing', 'Normal BP' or 'Query HBP' depending on whether their BP is 0, -1 or null, <160/90 or ≥160/90.

  Test complete 1.3.00

- Created a crosstab query called AGE & BP RECORDING BY PRACTICE. This query is run on CHECK BP RECORDING and plots Practice ID and Age Group against total patient count, total count for BP recorded and total count for BP not recorded.

  Test complete 1.3.00

- Created a crosstab query called AGE & BP LEVEL BY PRACTICE. This query is run on CHECK BP RECORDING and plots Practice ID and Age Group against total patient count, total count for 'Missing', total count for 'Normal BP' and total count for 'Query HBP'.

  Test complete 1.3.00

- Created a crosstab query called BP LEVEL BY PATIENT. This query is run on CHECK BP RECORDING and plots Practice ID and Patient ID against Hypertensive Reading to give one variable per patient; either 'Missing', 'Normal BP' or 'Query HBP'.

  Test complete 1.3.00

- Created a select query called HYPERTENSIVES. This query links PATIENT DATA and MORBIDITY MASTER and contains Practice ID, Patient ID, Sex, Systolic, Diastolic and Measurement date. It also contains the created variables Hypertensive Reading and Age Group. Records selected are limited by our age criteria [>044 and <080] and relevant hypertension READ codes.

  Test complete 10.3.00; Re-test complete 21.3.00

- Created a crosstab query called HYPERTENSIVE BY LEVEL BY PRACTICE. This query is run on HYPERTENSIVES and plots Practice ID and Age Group against total hypertensive patient count, total count for 'Missing', total count for 'Normal BP' and total count for 'Query HBP'.

  Test complete 10.3.00

- Created a select query called SORTED DIABETES. This query links MORBIDITY MASTER and READFILE and contains Practice ID, Patient ID, Read code, Diagnosis date and rubric. Records selected are limited by our criteria [relevant diabetes READ codes]. All variables are group and Practice ID and Patient ID are sorted in ascending order.

  Tested 11.3.00

- Created a select query called MORBIDITY DIABETES. This query is run on SORTED DIABETES and contains Practice ID, Patient ID, Read code, Diagnosis date and rubric. All variables are grouped and only the most recently dated READ code is imported [last].

  Test complete 11.3.00

- Created a select query called SORTED STROKE. This query links MORBIDITY MASTER and READFILE and contains Practice ID, Patient ID, Read code, Diagnosis date and rubric. Records selected are limited by our criteria [relevant stroke READ codes]. All variables are group and Practice ID and Patient ID are sorted in ascending order.

  Tested 11.3.00

- Created a select query called MORBIDITY STROKE. This query is run on SORTED STROKE and contains Practice ID, Patient ID, Read code, Diagnosis date and rubric. All variables are grouped and only the most recently dated READ code is imported [last].

  Test complete 11.3.00

- Created a select query called SORTED SMOKING. This query links MORBIDITY MASTER and READFILE and contains Practice ID, Patient ID, Read code, Diagnosis date and rubric. Records selected are limited by our criteria [relevant smoking READ codes]. All variables are grouped and Practice ID and Patient ID are sorted in ascending order.

  Tested 11.3.00

- Created a select query called MORBIDITY SMOKING. This query is run on SORTED SMOKING and contains Practice ID, Patient ID, Read code, Diagnosis date and rubric. All variables are grouped and only the most recently dated READ code is imported [last].

  Test complete 11.3.00

- Created a group of select queries called DRUGS 1-5. These queries are run on *Prescriptions* and contain Practice ID, Patient ID, Drug name and Start date. Records selected are limited by our criteria [5 batches of relevant anti-hypertensive drugs].

- Created a union query called ALL DRUGS. This query contains Practice ID, Patient ID, Drug name and Start date and combines the results of DRUGS 1, DRUGS 2, DRUGS 3, DRUGS 4 and DRUGS 5. Only unique records are included [Script type was excluded from this set of queries as it resulted in duplicate Drug name and Start date data if one script was acute and the other repeat].

  Test complete 12.3.00

- Created a select query called DRUG THERAPY. This query is run on ALL DRUGS and contains Practice ID, Patient ID and Start date. All variables are grouped and only the most recently dated script is imported [max] [Drug name] was excluded as this resulted in duplicate entries if the date was identical].

  Test complete 13.3.00

- Created a select query called MORBIDITY VERBOSE. This query links HYPERTENSIVES, MORBIDITY DIABETES, MORBIDITY SMOKING, MORBIDITY STROKE and DRUG THERAPY. It contains Practice ID, Patient ID, Sex, LastOfSystolic, LastOfDiastolic, LastOfMeasurement date, Hypertensive Reading, Age Group, Smoking: Read code, Stroke: Read code, Diabetes: Read code and Therapy: MaxOfStartDate. This query gives a record in each category for every hypertensive.

  Test complete 13.3.00; Re-test complete (excluding drugs)

- Added "Age-band" to the HYPERTENSIVES select query.

- Added "Age-band" to the MORBIDITY VERBOSE select query.

  Test complete 31.3.00

- Created a select query called BP 160/90+. This query is run on PATIENT DATA and contains Practice ID, Patient ID, Age-band, Sex, Systolic, Diastolic and Measurement date. It also contains the created variables Hypertensive Reading and Age Group. Records selected are limited by our age criteria [>044 and <080].

  Tested 5.4.00

- Created a select query called POSSIBLE HYPERTENSIVES. This query links HYPERTENSIVES and BP 160/90+. It contains Practice ID, Patient ID, Age-band, Sex, Systolic, Diastolic, Measurement date, Hypertensive Reading and Age Group. It also contains a created variable called Diagnosed HTN which inserts 'Undiagnosed' for each patient in the query. Records selected are limited to those which are included in BP 160/90+ and are not in HYPERTENSIVES i.e. patients with a high blood pressure and no diagnosis of hypertension.

  Test complete 23.5.00

- Created a variable in HYPERTENSIVES called Diagnosed HTN. This inserts 'Diagnosed' for each patient in the HYPERTENSIVES query.

  Tested 5.4.00

- Added "Diagnosed HTN" to the MORBIDITY VERBOSE select query.

  Test complete 5.4.00

- Created a select query called MORBIDITY POSSIBLE. This query links POSSIBLE HYPERTENSIVES, MORBIDITY DIABETES, MORBIDITY SMOKING, MORBIDITY STROKE and DRUG THERAPY. It contains Practice ID, Patient ID, Age-band, Sex, LastOfSystolic, LastOfDiastolic, LastOfMeasurement date, Diagnosed HTN, Hypertensive Reading, Age Group, Diagnosed HTN, Smoking: Read code, Stroke: Read code, Diabetes: Read code and Therapy: MaxOfStartDate. This query gives a record in each of these categories for every possible hypertensive patient.

  Test complete 23.5.00

- Created a union query called COMPLETE MORBIDITY. This query combines the results of MORBIDITY VERBOSE and POSSIBLE HYPERTENSIVES MORBIDITY and contains Practice ID, Patient ID, Age-band, Sex, LastOfSystolic, LastOfDiastolic, LastOfMeasurement date, Diagnosed HTN, Hypertensive Reading, Age Group, Diagnosed HTN, Smoking: Read code, Stroke: Read code, Diabetes: Read code and Therapy: MaxOfStartDate. This query gives a record in each of these categories for every hypertensive or possible hypertensive patient.

  Test complete 24.5.00