Risk awareness in secondary stroke prevention

Julia Suzanne Slark

Department of Clinical Neuroscience

Imperial College Cerebrovascular Research Unit

Imperial College London

London

This thesis is submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy from Imperial College London.

The contents of this thesis is an original work and all else is appropriately referenced.

Abstract

Stroke is the single largest cause of disability and second highest cause of death globally. It is estimated that 10 million people a year are affected by stroke in the United Kingdom (UK). Of the 130,000 annual new stroke occurrences in the UK, one third will go on to have a further stroke. Recurrent stroke is more likely to be fatal than first stroke and survivors are more likely to be left with major disability. Many stroke patients do not adhere to secondary prevention strategies due to complex reasons, including lack of appreciation of their high risk of a secondary cardiovascular event. Long-term secondary prevention remains a desired goal in the management of stroke survivors, however, studies have shown that current strategies are not routinely and universally working. **Hypothesis**: Raising awareness of secondary stroke risk may improve stroke survivor's adherence to secondary prevention strategies after stroke. **Results**: A survey of the general public (n=1019) and a population-based study of over 600 stroke survivors found that knowledge about Blood Pressure (BP) and stroke risk factors was poor in high risk populations. Only 55% of stroke survivors were able to cite any well-known vascular risk factors. However, those who were appropriately risk-aware significantly improved their health behaviour post-stroke by consuming less alcohol ($P<0.001$), less salt ($P=0.05$) and eating a healthy diet ($P=0.02$). Further, In a Randomised Controlled Trial setting an intervention to increase risk awareness was successful in increasing awareness ($P=0.04$) and resulted in a significant increase in knowledge of stroke sub-type (95% CI 0.72-0.677, $P<0.001$), risk factor control of systolic BP (95% CI 12.1-10.4, $P=0.01$) and increased the number of healthy lifestyle behaviour changes made at follow-up ($P<0.001$). **Conclusions**: Increasing risk awareness is potentially an important mechanism to improve health behaviour following stroke and may improve risk factor control as part of secondary stroke prevention.

Acknowledgements

First and foremost I wish to thank my supervisor, Dr Pankaj Sharma of the Department of Neurosciences at Imperial College Cerebrovascular Research Unit, for his support and guidance throughout my PhD.

I would also like to extend my gratitude to my colleagues from Imperial College Cerebrovascular Research Unit (ICCRU) for all their support and encouragement, both emotionally and practically. A special thanks to Renata Schanz, Dr Paul Bentley and Muhammad Saleem Khan for their practical assistance and expertise with statistical analysis and to Professor Azeem Majeed from the Department of Epidemiology at Imperial College London for sharing his Epidemiological expertise. I also want to extend many thanks to my NHS colleagues from the Imperial Stroke Centre at Imperial College Healthcare NHS Trust for their support and enthusiasm about my project.

I would also like to take this opportunity to thank my friends, family and my partner for all their love and support during the past 3 years and more recently for their generosity of time to read chapters and their unwavering faith and encouragement. Finally, I dedicate this thesis to my mother, who despite being no longer with us, is my role model and at the heart of all that I do.

List of Publications

* Publications and Presentations relevant to this thesis

*Slark J & Sharma P. Peripheral arterial disease. REACH data on atherothrombosis: information for the general practitioner. 2008. GP Fact file. Medical Imprint.

*Slark J and Sharma P. Cerebrovascular disease and its relationship to other vascular beds: a comprehensive review of the literature. Vascular Disease Prevention 2009; 6: 1-8.

*Slark J. Adherence to secondary prevention strategies after stroke. A review of the literature. British Journal of Neuroscience Nursing. 2010; 6: 282-286.

Dundas J, Bennett B and Slark J. Stroke and TIA management in Neuroscience Nursing: Evidence based Theory and Practice. Eds. Woodwood S & Mestecky A. Pubs, Wiley-Blackwell. 2011; section IV; chapter 22.

Slark J and Makamahadze C. The development of a stroke support group. British Journal of Neuroscience Nursing. 2011; 7: 429-432.

Yadav S, Schanz R, Maheshwari A, Khan MS, Slark J, de Silva R, Bentley P, Froguel P, Kooner J, Shrivastav P, Prasad K, Sharma P. Bio-Repository of DNA in Stroke (BRAINS): A study protocol. BMC Med Genet. 2011; 12: 34.

*Slark J, Bentley P, Majeed A, Sharma P. Awareness Of Stroke Symptomatology And Cardiovascular Risk Factors Amongst Stroke Survivors. Journal of Stroke and Cerebrovascular Diseases. http://dx.doi.org/10.1016/j.jstrokecerebrovasdis.2010.09.010.

*Slark J, Bentley P, Saleem Khan M, Sharma P. Perceptions of Blood Pressure in the general public: a survey to identify if knowledge of BP influences control in the healthy and hypertensive population. (In Manuscript)

Oral and Poster Presentations

*British Hypertension Society, Cambridge. Awareness and perceptions of blood pressure in the general public: oral presentation. Won award for best research abstract presentation. 2009. London

*London Hypertension Society. ‘Appreciation of vascular risk’. Oral presentation. 2009. London

*UK Stroke Forum. Glasgow. Understanding knowledge of stroke and perception of future risk of vascular events in a high risk stroke population. Poster presentation.2010. Glasgow

Contents

Abstract 2

Acknowledgements 3

List of Publications 4

Contents 5

List of Figures and Tables 11

Glossary of terms 13

Chapter one: Introduction 14

1.1 Cerebrovascular disease 15

1.2 The National Stroke Strategy 16

1.3 Cardiovascular disease as a global issue 17

1.4 Worldwide styles of public health 18

1.5 Vascular disease: evidence from clinical trials 20

1.6 Pathophysiology of atherosclerosis 22

1.7 Stroke recurrence 22

1.8 Secondary stroke prevention 23

1.9 Risk 24

1.10 Communicating risk 28

1.11 Risk perception 28

1.12 Risk assessment 31

1.13 Risk associated with vascular disease in a high risk population 32

1.14 Established stroke risk factors 34

1.14.1 Transient Ischaemic Attack (TIA) 34

1.14.2 Age and silent brain infarction 35

1.14.3 Hypertension 36

1.14.4 Diabetes 38

1.14.5 Hyperlipidaemia 39

1.14.6 Smoking 40
1.14.7 Heart disease 41
1.14.8 Carotid artery stenosis 42
1.14.9 Atrial fibrillation 42
1.14.10 Metabolic syndrome and Obesity 43
1.14.11 Alcohol 44
1.14.12 Ethnicity 45
1.14.13 Health inequalities targets 47
1.14.14 Physical inactivity 48
1.14.15 Renal artery disease 49
1.14.16 Peripheral artery disease (PAD) 51
1.14.17 Retinal artery disease 53
1.14.18 Retinal vein disease 54
1.14.19 Patent foramen ovale (PFO) 54
1.15 Genetics of stroke 55
1.16 Health behaviour 56
1.17 Illness perceptions and beliefs 61
1.18 Adherence 62
1.18.1 Measuring adherence 64
1.18.2 Barriers to adherence 65
1.18.3 Suggestions to improve adherence 66
1.18.4 Understanding risk as a means of improving adherence 67
1.19 Health literacy 69
1.20 Chapter 1: Tables and Figures 72

Chapter two: Silent brain infarction in the presence of systemic vascular disease: a systematic review and meta-analysis 73
2.1 Introduction 74

2.1.1 Silent brain infarction 75
2.1.2 Silent brain infarction in healthy populations 77
2.1.3 Impact on outcome in stroke patients 78
2.1.4 Silent brain infarction in the presence of acute ischaemic stroke 78
2.1.5 Silent brain infarction in the presence of coronary artery disease 79
2.1.6 Silent brain infarction in the presence of peripheral artery disease 80
2.2 Aims and Objectives 81
2.3 Methodology 81
2.3.1 Meta-analysis 81
2.3.2 Search strategy and selection criteria 82
2.3.3 Study selection 82
2.4 Results 83
2.4.1 Data extraction and analysis 83
2.4.2 Silent brain infarction in the presence of acute ischaemic stroke 84
2.4.3 Silent brain infarction in the presence of coronary artery disease 84
2.4.4 Silent brain infarction in the presence of peripheral artery disease 84
2.5 Discussion 85
2.6 Chapter 2: Tables and Figures 89

Chapter three: Knowledge of stroke and risk perception in a stroke population. 98
3.1 Introduction 99
3.2 Aims and objectives 101
3.3 Methodology 102
3.4 Analysis 104
3.5 Results 104
3.5.1 Knowledge of stroke and heart attack 105
3.5.2 Self-reported vascular risk factors 105
3.5.3 Hypertension 105

3.5.4 Smokers 105
3.5.5 Knowledge of risk factors 105
3.5.6 Knowledge of stroke signs and symptoms 106
3.5.7 Illness perception 106
3.5.8 Risk Perception 107
3.5.9 Lifestyle changes since stroke 108
3.5.10 Medication taking 108
3.6 Limitations 109
3.7 Discussion 109
3.8 Chapter 3: Tables and Figures 115

Chapter four: Understanding knowledge of blood pressure in the general public 121
4.1 Introduction 122
4.2 Quality and outcomes framework 123
4.3 Relation between knowledge and BP control 125
4.4 Health literacy in long term conditions 126
4.5 Adherence as a tool to controlling BP 126
4.6 Physician approaches to BP control 128
4.7 Local population 129
4.8 Aims and Objectives 130
4.9 Methodology 130
4.9.1 Study design 131
4.9.2 Power Calculation 131
4.9.3 Validation of the Omron 637IT 131
4.9.4 Consent 132
4.9.5 Professional responsibility 132
4.9.6 Analysis 132
4.10 Results 132

4.10.1 Population Characteristics 132
4.10.2 Knowledge of a ‘normal’ BP 133
4.10.3 Knowledge of own BP 133
4.10.4 BP recordings 133
4.10.5 Hypertensive Vs Healthy populations 133
4.11 Limitations 134
4.12 Discussion 134
4.13 Chapter 4: Tables and figures 138

Chapter five: Individual risk awareness intervention in stroke (IRAIS) study 142
5.1 Introduction 143
5.2 Risk awareness 144
5.3 Barriers to risk factor awareness and control 145
5.4 Risk management 146
5.5 Ethnicity 147
5.6 Raising risk awareness to change behaviour 147
5.7 Aims and objectives 151
5.8 Methodology 151
5.8.1 Trial design 152
5.8.2 Risk modelling for secondary stroke risk 153
5.8.3 Independent variables 154
5.8.4 Power calculation 157
5.8.5 Inclusion criteria 157
5.8.6 Exclusion criteria 157
5.8.7 Randomisation and blinding 158
5.8.8 Intervention 158
5.8.9 Analysis 159
5.9 Results 160

5.9.1 Past medical history 161
5.9.2 Medication taking 161
5.9.3 Pre-stroke behaviours 161
5.9.4 Risk awareness and perception 162
5.9.5 Knowledge of cause and type of stroke 162
5.9.6 Knowledge of risk factors 162
5.9.7 Behaviour changes after stroke 163
5.9.8 Risk factor control 164
5.10 Limitations 164
5.11 Discussion 164
5.12 Chapter 5: Tables and Figures 172

Chapter six: Conclusions and Discussion 181
6.1 Introduction 182
6.2 Risk of recurrence 183
6.3 Risk factors 184
6.4 Stroke and risk factor knowledge 185
6.5 Risk perception 186
6.6 Risk awareness 188
6.7 Medication taking 189
6.8 Methodology challenges 189
6.9 Overall significance 190
6.9.1 Clinical significance and changes to practice 191
6.10 Future research 192
References 195
Appendices 227

List of Figures and Tables

Figure 1.1: Risk of Stroke recurrence.....72

Figure 2.1: SBI in the presence of acute ischaemic stroke.....89

Figure 2.2: SBI in the presence of coronary artery disease.....90

Figure 2.3: SBI in the presence of peripheral artery disease.....90

Table 2.1. Silent brain infarction in acute ischaemic stroke. 93

Table 2.2: Silent brain infarction in coronary artery disease.....96

Table 2.3: Silent brain infarction in peripheral artery disease.....97

Table 3.1: Population demographics.....115

Table 3.2: Self-reported stroke risk factors.....116

Table 3.3: Medications 116

Figure 3.1: Risk factors for stroke 117

Figure 3.2: Knowledge of stroke using modified FAST 117

Table 3.4: Perception of stroke: Cause 118

Table 3.5: Perception of stroke: Consequence 118

Table 3.6: Perception of stroke: Future perspective.....119

Figure 3.3: Awareness of risk and effects on behaviour.....119

Figure 3.4: Number of lifestyle behaviour changes 120

Table 4.1: British Hypertension Society Guidelines for Hypertension Management (2004) 138

Table 4.2: Population characteristics.....139

Table 4.3: Blood pressure knowledge 139

Table 4.4: Hypertensive coding results for study population 140

Figure 4.1: Knowledge of ‘normal’ BP 140

Figure 4.2: Knowledge of own BP 141

Figure 4.3: Knowledge of ‘normal’ BP in hypertensive group associated with lower BP readings 141

Figure 5.1: IRAIS Study design flow chart.....172

Table 5.1: Population characteristics for IRAIS 172

Figure 5.2: Medical interventions performed 174

Table 5.2: Past medical history 175

Figure 5.3: Knowledge of stroke sub-type at follow-up.....176

Table 5.3: Medication taking behaviours.....177

Figure 5.4: Number of behaviour changes made 178

Figure 5.5: Breakdown of behaviour changes at follow-up.....179

Table 5.4: Risk factor control.....180

Glossary of terms

BP	Blood pressure
BHF	British Heart Foundation
BMI	Body Mass Index
CAD	Coronary artery disease
CVD	Cardiovascular disease
CV	Cerebrovascular
DH	Department of Health
HBM	Health Belief Model
HTN	Hypertension
IHD	Ischaemic heart disease
NAO	National Audit Office
NHS	National Health Service
NICE	National Institute for Clinical Excellence
NIHSS	National Institute of Health Stroke Scale
MRS	Modified Rankin Scale
MRC	Medical Research Council
PAD	Peripheral Artery Disease
PFO	Patent Foramen Ovale
RCP	Royal College of Physicians
SBI	Silent Brain Infarction
SARF	Social Amplification of Risk Framework
UK	United Kingdom
US	United States
WHO	World Health Organisation

Chapter one: Introduction

1.1 Cerebrovascular disease

Stroke is the 2nd leading cause of death globally (WHO 2011) and the single largest cause of disability in the UK (Stroke Association 2010). Nationally, stroke is responsible for 9% of all deaths in men and 13% in women (National Audit Office (NAO) 2005). Stroke can be defined as a clinical syndrome consisting of a rapidly developing neurological deficit and persisting for 24 hours, or leading to death, in the absence of other diseases that could explain the symptoms (Hatano 1976). Of the 130,000 annual stroke occurrences in the UK, one third is likely to go on to have a further stroke. Recurrent stroke is more likely to be fatal than first stroke and survivors are more likely to be left with major disability (Rothwell 2007). Stroke recurs in up to 20% of patients often within the first year and within the first 90 days following a Transient Ischaemic Attack (TIA) (Talelli & Greenwood 2008, Bushnell et al 2009, Feasby & Barnett 2007).

Cerebrovascular (CV) disease is part of a family of atherothrombotic diseases including peripheral arterial disease (PAD) and coronary artery disease (CAD) and ischaemic heart disease (IHD).The term 'cardiovascular disease' (CVD) is used to describe this family of vascular diseases. CVD's are responsible for more than 17 million deaths per year worldwide (WHO 2011). Cardiovascular Diseases (CVDs) are the number one cause of death globally and more people die annually from CVDs than from any other cause. An estimated 17.1 million people died from CVDs in 2004, representing 29% of all global deaths (WHO 2011). Of these deaths, an estimated 7.2 million were due to coronary heart disease and 5.7 million were due to stroke. Ischaemic stroke caused by atherosclerotic plaque or cardio-embolic thrombus is the most common stroke subtype, accounting for 85% of first events, while haemorrhagic causes (primary intracerebral haemorrhage) account for 15% of all strokes (Pendlebury et al 2009) .

By 2030, almost 23.6 million people will die from CVDs globally, mainly from heart disease and stroke. These are projected to remain the single leading causes of death (WHO 2011). Stroke currently costs the National Health Service (NHS) approximately £7 billion per year with direct and indirect costs (NAO 2005) and affects the wider economy by £1.8 billion. Stroke patients occupy 20% of all acute hospital beds. One third of stroke patients are likely to remain dependent on others

for all aspects of care, therefore the burden on informal caregivers is vast and the loss of earnings for individuals and their families can be catastrophic.

1.2 The National Stroke Strategy

The Department of Health (DH) have recognised the importance of developing better services for stroke patients by including specific milestones, targets and actions in The National Service Framework for Older People (NSF Standard-5) in 2001 (DH 2001). The National Stroke Strategy was more recently launched in 2007 (DH 2007) and followed on from the NSF for older people to modernise services and deliver the latest treatments for stroke, with specific disease reduction targets to reduce the death rate from stroke, coronary heart disease and related diseases in people under the age of 75 years by at least 40% by the year 2010. This target has been achieved but the strategy continues to set a clear direction for the development of stroke services in England up to 2017 (DH 2011).

The Stroke Strategy was developed in conjunction with stakeholders from stroke charities, health professionals within the NHS, social care professionals and stroke survivors and their families. The strategy includes campaigns to improve stroke awareness in the general populations, for example, the F.A.S.T (Face-Arm-Speech-Time) campaign was launched in 2009 and includes strong imagery to highlight the visible signs and symptoms of stroke (DH 2009). As part of the Stroke Strategy smaller networks were set up within the NHS with the objective to bring together clinicians, health professionals and managers from all the organisations in order to work together to improve local services for patients. England has been divided into 28 stroke network regions and London is divided into 5 networks.

There are clear guidelines set out for the diagnosis and management of acute stroke in the UK, as well as guidance on secondary prevention measures in the National Clinical Guidelines for Stroke (RCP 2008) and the National Institute of Clinical Excellence (NICE 2008) stroke guidance documents. For secondary stroke prevention general recommendations suggest each patient should have an individualised, comprehensive strategy for stroke prevention and it should be implemented as soon as possible after the stroke/TIA and continue in the long term (RCP 2008). The guidelines suggest some detail regarding when information should be given to patients' e.g.

- Given first in hospital setting
- Reinforced at every opportunity by all health professionals involved in patient care
- Provided in an appropriate format for the patient, taking into account both their stroke specific impairments and their personal situation.

The guidelines state that patients should have their risk factors reviewed and monitored regularly, at a minimum, on a yearly basis (RCP 2008). It is useful for all health professionals involved in stroke patient care to have clear guidance that is evidence based for equity of care across the country and to reinforce secondary prevention measures to patients. Risk factors for vascular disease include hypertension, diabetes, smoking, Atrial Fibrillation (AF), hypercholesterolaemia, obesity, physical inactivity and poor diet. The British Heart Foundation (2003) also identified 9 key risk factors for CVD; smoking, poor diet, physical inactivity, hypertension, obesity, diabetes, psychosocial aspects, alcohol, high cholesterol. However, modification of reversible risk factors can reduce morbidity and mortality and improve survival and longevity (Chaudhry et al 2008).

Despite the clear evidence for risk factor management (Chaudhry 2008, Rothwell 2007), many stroke patients do not adhere to secondary prevention strategies due to complex reasons, including their lack of appreciation of their high future secondary cardiovascular (myocardial/stroke) event rate. Long-term secondary prevention remains a desired goal in the management of stroke survivors. However, studies have shown that current strategies are not routinely and universally working, with cholesterol remaining high, many patients still smoking and others remaining obese at 1 year (Qureshi 2001). The importance of investigating patient perceptions of their health beliefs is becoming more recognised as the key to understanding their decision–making behaviours and coping processes (Cooper 2007).

1.3 Cardiovascular disease as a global issue

Over 80% of the world's deaths from cardiovascular diseases occur in low to middle income countries (WHO 2011). People in low to middle income countries are more exposed to risk factors leading to vascular diseases and other non-communicable diseases and they are also less exposed to prevention strategies and treatments

than people in high income countries. Also people in low-middle income countries have less access to effective, equitable health care to treat the vascular diseases and as a result, die younger from the diseases. At a macro-economic level vascular disease places a heavy burden on the economies of the low-middle income countries, more so because people die younger and in their most productive years. Heart disease, stroke and diabetes are estimated to reduce the Gross Domestic Product (GDP) between 1-5% in low-middle income countries experiencing rapid economic growth as many die prematurely (WHO 2011). It is estimated over the next 10 years (2006-2015) China will lose $558 billion in foregone national income due to the combination of heart disease, stroke and diabetes (WHO 2011).

The largest increase in number of deaths from CVDs will occur in the South-East Asia Region (WHO 2011). However, stroke death rates have been falling in the US, from 1996-2006 stroke death rates fell 33.5% (Lloyd-Jones et al 2010). This is undoubtedly due to improvements in health care and medical technologies, however, it has been suggested (Pennant et al 2010) that variations in the incidence of CVD related illness in the UK are caused by geographical, ethnic and social disparities and death rates are three times higher among lower socioeconomic groups than among more affluent groups. Bunker (2001) suggests that elimination of inequalities in healthcare could increase life expectancy of the most disadvantaged groups by up to 9 years. However, medical advances in the west are responsible for a rise in the ageing population and a higher prevalence of older people living with chronic diseases including cardiovascular disease (Yusuf 2000). Prevalence of stroke is reducing in the West due to improved care and advances in risk factor management, however, the ageing population brings with it increasing incidence of stroke, therefore the challenge remains to optimise secondary prevention in patients with vascular diseases. NICE (2010) estimate the cost of treating disease that could be prevented through lifestyle or behaviour modification represents a considerable burden on Western budgets and this is one of the reasons why there has been an increase in government led initiatives to improve public health.

1.4 Worldwide styles of public health

Different countries have different ways to influence the health behaviours of their individual populations, often affected by the political regimens of the country at a certain time. Some have a dogmatic, command fashioned approach to public health

and others allow a more communicative and democratic approach. Health education in China has been characterised by centrally led, top-down messages and methods. This is exemplified by the Patriotic Health Campaign, (PHCC) established in the 1950's and is still operating to some extent today (Wang 2000). Through this campaign the Chinese population were told what they should and shouldn't do in order to improve health. As part of the PHCC campaign the government declared 'war' on the 'four devils – flies, mosquitos, mice and sparrows'. The people were instructed to clean their homes, schools and workplaces and were instructed to practice personal hygiene techniques daily. The PHCC committee organised inspections to check implementation of these actions. This campaign continued throughout the 1960's and 1970's in China as the dominant form of health promotion. The main outcome of the campaign was the control of serious infectious diseases e.g. cholera, malaria and plague. However, Wang (2000) argues that health education in China has to evolve to respond to social and political changes over the years. Both WHO and Unicef have heavily influenced health promotion in China during the last two decades, with the introduction of 2-way communication, however, Wang (2000) suggests health messages continue to be limited to narrow spectrums of commands and inspections. More recently China faces new challenges in health care due to pollution and newer infectious diseases such as HIV and sexually transmitted diseases, despite this, mortality due to chronic disease and cancer have become the leading cause of death in the overall population (WHO 2011) and Wang (2000) suggests health education programmes aimed at increasing critical health understanding need to be developed and involve more than simple transmission of health information commands to the masses.

In England, during the 1960's and 1970's health promotion campaigns focussed on promoting healthy lifestyles to prevent non-communicative diseases. The early campaigns focussed on the transmission of information based on the simplistic relationship between communication and behaviour change (Nutbeam 2000). However, over time it became apparent that simple transmission of information failed to account for social and economic differences in the population. The expected outcomes of the campaigns were not successfully achieved in all aspects of society. It became clear that only socially and economically affluent members of society were reacting to the messages. It was assumed these groups had higher educational and literacy levels and personal skills to receive health messages communicated through

traditional media routes. The introduction of school based health education programmes in the 1980's considerably strengthened health promotion messages and started the development of new theories to improve the national approach to health promotion messages to influence of behaviour.

Most industrialised countries aim to influence their populations with information about disease risk and prevention, although this isn't always particularly effective. Canada, however, is reporting success in terms of hypertension management, in contrast to other industrialised nations (McAlister et al 2011). Canada has among the lowest mean levels of systolic BP around the World, researchers suggest these findings may go some way to explaining the greater-than-expected reduction in cardiovascular mortality seen in Canada during the last decade. The main difference seems to be that Canada is the only country in the world that annually updates its hypertension guidelines, this results in continuous publicity, unlike countries that update guidelines every 5 years, with 6 months of high level publicity which declines to relatively nothing for the following 4 and a half years. They suggest the annual updates ensure concomitant continuing education programmes for health professionals in particular. From 1992-2009 prevalence remained at 21% for the population, however, hypertension control improved for the country as a whole by 13.2% to 64.6%, improvement in awareness 56.9% to 82.5% and treatment of hypertensives from 34.6% to 79% (McAllister et al 2011). This success in control may be in part, down to the improvement in awareness of hypertension management in both the public and in health professionals.

1.5 Vascular disease: evidence from clinical trials

Atherothrombosis, ischaemic heart disease (IHD), CVD and PAD are all associated with the main cause of mortality on a world-wide scale and are predicted to be the leading cause of death world-wide by 2020 (Bhatt & Steg 2007). In the Health Survey for England (DH 2003) in 2003 the prevalence of IHD (angina and heart attack) was 6.4% in men and 4.1% in women and with stroke added, the cardiovascular (CV) disease prevalence was 7.9% and 5.8%, respectively. The National clinical guidelines for stroke (RCP 2008) suggest the risk for further stroke is highest early after stroke or TIA, 10% within the first week, 20% first month rising up to 30-43% over the next 5 years. It is now widely recognised that patients who survive a stroke or Transient Ischaemic Attack (TIA) are at a relatively high risk for

subsequent vascular events, including recurrent stroke, myocardial infarction (MI) and death from vascular causes, (Touze et al 2005, Hackam & Spence 2007) reflecting the shared common risk factors and pathological mechanisms (Adams et al 2003).

The CAPRIE (1996) (Clopidogrel versus Aspirin in patients at risk of Ischaemic events) study showed that approximately one quarter of the medium risk individuals had multi-vascular disease and in 1 in 30 individuals CVD, IHD and PAD were all present. People with symptomatic atherosclerosis in 1 vascular bed are at a higher risk of subsequent events in other beds (Barnett et al 2007). Therefore, patients who suffer a stroke are at a high risk of going on to suffer another stroke or heart attack, with a 10 year risk of 42.8% (Jenkinson 2007). These reports have been supported by the findings from the REACH (REduction of Atherothrombosis for Continued Health) registry which evaluated the long term risk of atherothrombotic events in an at risk population. REACH has already demonstrated that a significant proportion of people with PAD, CVD or IHD will have disease in more than 1 vascular location. In 1 year follow-up 8.29% of patients with CVD went on to have a further vascular event while CV event rates increased significantly with the number of symptomatic locations ($p=0.0043$) (Morrell and Kassianos 2007). 40% of patients with CVD demonstrated multi-vascular involvement with many of these affected beds being clinically silent yet ultimately exposing patients to increasing risk profiles with each bed involved. However, fewer than 20% of patients with cardiovascular disease are reaching their target lipid levels (Chaudhry et al 2008) despite clear recommendations that implementation and adherence to secondary risk reduction strategies are important for reducing the risk of recurrent stroke.

Steg et al (2007) performed a large international study of stable or high at-risk populations with established atherosclerosis receiving contemporary risk reduction therapies. The 1 year event rates were high and accrued almost linearly over time and the hard event rates for CV death, MI or stroke increased markedly within the number of symptomatic arterial disease locations. Despite receiving evidence-based preventative drug therapy, this vascular stable population experienced a 4.7% yearly rate of hard events (Steg et al 2007). During the 1 year follow-up approximately 1-in-7 patients with established arterial disease experienced either a hard CV event or required hospitalisation for an atherothrombotic event. Patients with established

arterial disease experienced 2-3 times higher event rates than patients with multiple risk factors only. These data support the need for increased awareness among physicians and patients alike, of the amount of cross-risk that is related to the overlap between the various locations of atherosclerosis.

1.6 Pathophysiology of atherosclerosis

Atherosclerosis develops early on as a protective response to various insults on the arterial endothelium and smooth muscle cells. Over time the initial lesion of a 'fatty streak' and aggregation of lipid-rich macrophages, advances with excessive inflammatory fibro-proliferation and remodelling of the vessel wall. The resulting complex accumulation of atherosclerotic plaque is covered by a dense cap of connective tissue and smooth muscle cells overlying a lipid necrotic core (Ross 1993). As these plaques increase in size and complexity, further luminal narrowing and arterial stenosis limits the flow of blood to the surrounding tissues. Consequently, a perfusion imbalance between oxygen supply and demand exists, forming the underlying pathogenesis of cerebral and cardiac ischaemia. The ultimate rupture or erosion of an unstable vulnerable plaque gives rise to thrombus formation, or distant embolism of particles, precipitating complete occlusion of a vessel, activation of the ischaemic cascade, cell death and an acute cardiovascular event (Ogata 2011, Poddar et al 2010).

1.7 Stroke recurrence

The cumulative risk of stroke recurrence varies greatly up to 10 years. Studies have shown considerable variation in the estimation of risk of stroke recurrence in both early years and the long term (19% in Manhattan to 32% in Perth). Accurate identification of the time at which patients are at the greatest risk of stroke recurrence is important for risk factor modification and secondary prevention measures. However, a systematic review and meta-analysis by Mohan et al (2011) also demonstrated wide variations in recurrence across all studies at different time points (figure 1.1).

Figure 1.1 shows the estimates of risk of stroke recurrence across all the included studies (Mohan et al 2011).The risk of stroke recurrence was reported to range from 1.1% in South London, UK (Mohan et al 2009) to 15% in Oxfordshire, UK (Coull et al 2004) by 1 month, from 7.0% in Lisbon, Portugal (Salgado et al 1996) to 20.6% in Nanjing, China (Xu et al 2007) by 1 year and from 16.2% in South London, UK

(Mohan et al 2009) to 35.3% in Hisayama, Japan (Hata et al 2005) by 5 years; and from 14% in Rome, Italy (Prencipe et al 1998) to 51.3% in Hisayama, Japan (Hata et al 2005) by 10 years after initial stroke. Mohan et al (2011) suggest genuine differences in populations, temporal changes in stroke management and secondary prevention may be important factors which contribute to the disparity in stroke recurrence rates. Also the definition of stroke recurrence may also be a contributing factor towards the variations and some studies include TIA as a first event while others do not. However, it is important to note rates of recurrence are substantial even at their lowest and they increase proportionally over time in all studies.

1.8 Secondary stroke prevention

Secondary stroke prevention offers a unique opportunity to decrease stroke rates and mitigate the devastating consequences of this disease. Advances in medical treatments have played a large role in reducing secondary stroke rates. Randomised controlled trials (RCTs) have clearly shown the benefits of secondary prevention with antithrombotic and antihypertensive therapies in patients with ischaemic stroke (Diener 2004, Eccles 1998). The Anti-platelet trialist's collaboration demonstrated a 23% risk reduction in important vascular events through the use of prophylactic antiplatelet agents among patients who had had a previous stroke (Antiplatelet Trialists 1994). It is well recognised that reduction in systolic BP by as little as 10mmHg can reduce the risk of stroke by approximately 23% (Asplund et al 2009) and Statins to reduce serum cholesterol have been shown to effectively reduce secondary stroke by as much as 25% (SPARCL 2009) as well as possible reductions in stroke severity (Goldstein et al 2009). It is also recognised that glycaemic control is shown to reduce the occurrence of microvascular complications and is recommended in multiple guidelines for secondary stroke prevention (Sacco et al 2006). In addition to drug treatments, lifestyle behaviour changes have also been shown to reduce stroke risk, such as smoking cessation in smokers which has a 20% increased risk (Cole 2011).

Secondary prevention strategies should be implemented early, monitored frequently and maintained long-term after a stroke (Ovbiagele et al 2004). However, Hillen et al (2000) concluded in their population based study of antithrombotic and antihypertensive management 3 months after ischaemic stroke that secondary prevention appears to be inadequate. They found high rates of non-treatment among

457 patients with ischaemic stroke who were appropriate for treatment 3 months following the event. It was identified that 24.4% of patients suitable for antiplatelet therapy did not receive it, however, it remains unclear whether the reason for this lies at the door of the acute Trust for failure to communicate the need for preventive therapy, the GP for the discontinuation of treatments or the patient for non-adherence. This is disappointing as cardiovascular and stroke risk factor management has been made a national and international priority for some years now, despite this studies have shown treatment remains suboptimal (Hillen et al 2000).

1.9 Risk

There are many inconsistent and ambiguous meanings attached to the term “risk”, this has led to widespread confusion and many different approaches to risk management in different fields (Hubbard 2009). The Oxford English Dictionary (2011) online definition of risk is “(exposure to) the possibility of loss, injury or other adverse or unwelcome circumstance; a chance or situation involving such a possibility”. Risk is also seen as the potential that a chosen action or activity (including the choice of inaction) will lead to a loss or undesirable outcome. The notion implies that having a choice can have an influence on the outcome. Potential losses themselves have been called “risks” and almost any human endeavour carries some risk, but some are more risky than others. The International Organization for Standardization (ISO 2002) Guide 73 definition of ‘risk’ is the ‘effect of uncertainty on objectives’. In this definition, uncertainties include events which may or may not happen and uncertainties caused by a lack of information or ambiguity. Another definition is that risks are future problems that can be avoided or mitigated, rather than current ones that must be immediately addressed (Hubbard 2009). Occupational Health and Safety Advisory Services (OHSAS 2007) defines risk as the product of the probability of a hazard resulting in an adverse event. Hanson (2007) goes on to suggest the word ‘risk’ refers rather vaguely to situations in which it is possible but not certain that some undesirable event will occur. Hubbard (2007) gives us five variations where the term risk can be used to describe the possibility of an event or action:

1. Risk = the unwanted event which may or may not occur.

An example of the usage is: “Lung cancer is one of the major risks that affect smokers”.

2. Risk = the cause of an unwanted event which may or may not occur.

   An example of the usage is: “Smoking is by far the most important health risk in industrialised countries”. (The unwanted event is a disease caused by smoking). Both 1 and 2 are qualitative senses of risk, the word also has quantitative senses.

3. Risk = the probability of an unwanted event which may or may not occur.

   An example of the usage is: “The risk that a smoker’s life is shortened by a smoking related disease is approx. 50%”.

4. Risk = the statistical expectation value of an unwanted event which may or may not occur.

5. Risk = the fact that a decision is made under conditions of known probabilities (“decision under risk” as opposed to “decision under uncertainty”) (Hubbard 2007).

The expectation value of a possible negative event is the product of its probability and some measure of its severity, for example, it is common to use the number of people killed to measure of the severity of an accident. With this measure of severity, the “risk” associated with a potential accident is equal to the statistically expected number of deaths and Hubbard (2007) suggests that other measures of severity give rise to other measures of risk (Hubbard 2007).

Although expectation values to estimate a potential outcome have been calculated since the 17th century, the use of the term “risk” in this sense is relatively new. It was introduced into risk analysis in the influential Reactor Safety Study WASH-1400, (Rasmussen et al 1975) which is now obsolete.

Financial risk is often defined as the unexpected variability of returns and includes both potential worse-than-expected as well as better-than-expected returns. However, in information security, risk is defined as ‘the potential that a given threat

will exploit vulnerabilities of an asset or group of assets and thereby cause harm to the organisation. The mathematical formulations of risk describe the notion of risk as a statistical model of the expected value of some outcome seen as undesirable. This combines the probabilities of various possible events and some assessment of the corresponding harm in a single value. In a formula that can be used in a simple case of binary possibility, risk is; Risk = (probability of the accident happening) X (expected loss in case of the accident) (Tapeiro C 2004)

It has been suggested that fear can be used as an intuitive risk assessment. De Becker (1997) suggests people rely on their fear and hesitation to keep them out of the most profoundly unknown circumstances and that 'true fear is a gift' as it is the survival signal that sounds in the presence of danger. It has also been suggested that risk could be the way we collectively measure and share 'true fear' where there is a fusion of rational doubt, irrational fear and a set of biases based on our prior experiences. Recognising and respecting the irrational influences on human decision making may do much to reduce disasters caused by naïve risk assessments that pretend to rationality but in fact merely fuse shared biases together (De Becker 1997). Leventhal's work started in the 1970's looking at how 'fear' messages in acute situations may lead people to taking health promoting actions such as wearing seat-belts or quitting smoking (Leventhal 1997, cited by Hale et al 2007). The changes in law requiring drivers and their passengers to wear seatbelts was what ultimately changed behaviour in the 70's, however the campaigning messages from that period used strong imagery to portray the message. Nevertheless changing the law would have significantly reinforced the behaviour change and now it is second nature to secure a seatbelt when getting into a car.

Slovic (1993) introduces trust as an important aspect of the risk perception problem. This has become so during recent years as trust has been pointed out as important in risk management in industry and the distrust which is linked to risk perception and political activism. Slovic (1993) suggests trust is important in all forms of human social interaction and offers lack of trust is an underlying factor of the controversies surrounding technological hazards. Slovic (1993) cites Starr (1985) who pointed out the public's lack of concern about risks of tigers in urban zoos as evidence that the acceptance of risk lies strongly in the confidence held in the risk management. This is a key message for health professionals, as patients who have confidence and trust

in the risk information provider may gain a greater understanding of the risk information being delivered and be more likely to undertake risk modifications suggested by the risk manager in this case.

Risk in personal health can be reduced by primary prevention action that may decrease early causes of illness or by secondary prevention actions after a person has been identified as having measureable clinical signs and symptoms recognised as risk factors for a certain disease. Tertiary prevention reduces the negative impact of an already established disease by restoring function and reducing disease related complications (Hubbard 2007). Insurance is a risk-reducing investment in which the buyer pays a small fixed amount to be protected from a potential large loss. Gambling is a risk-increasing investment, wherein money on hand is risked for a possible large return, but with the possibility of losing it all. Purchasing a lottery ticket is a very risky investment with a high chance of no return and a small chance of a very high return. In contrast, putting money in a bank at a defined rate of interest is a risk-averse action that gives a guaranteed return of a small gain and precludes other investments with possibly higher gain (Hubbard 2007).

In his seminal work ‘Risk, Uncertainty, and Profit,’ Knight (1921) established the distinction between risk and uncertainty:

“ ... Uncertainty must be taken in a sense radically distinct from the familiar notion of Risk, from which it has never been properly separated. The term "risk," as loosely used in everyday speech and in economic discussion, really covers two things which, functionally at least, in their causal relations to the phenomena of economic organization, are categorically different. ... The essential fact is that "risk" means in some cases a quantity susceptible of measurement, while at other times it is something distinctly not of this character; and there are far-reaching and crucial differences in the bearings of the phenomenon depending on which of the two is really present and operating. ... It will appear that a measurable uncertainty, or "risk" proper, as we shall use the term, is so far different from an immeasurable one that it is not in effect an uncertainty at all. We ... accordingly restrict the term "uncertainty" to cases of the non-quantitative type….”

Thus, Knightian uncertainty is immeasurable and not possible to calculate, while in the Knightian ‘sense' risk is measurable.

Risk carries many different meanings and there are many formal methods to assess or measure risk. Some quantitative definitions of risk are well-grounded in statistical theory and lead to statistical estimates, but some are more subjective and in many cases a critical factor is in human decision making.

1.10 Communicating risk

Medical advances have made it possible to identify high and low risk populations for various diseases, however, communicating risk to patients has its challenges as the concept of risk has so many theoretical definitions and means different things to different people. It has been suggested that the particular effects of risk information on patient behaviour are relatively unknown and it is unknown if perceptions can be altered or translated into specific actions. A systematic review (Edwards et al 2000) of 82 studies identified that risk communication interventions may be most effective when including individual risk estimates rather than general risk information. Edwards et al (2000) found that patients appeared to be more amenable to make behaviour changes with risk estimates given during a discussion between the health professional and patient rather than attending screening sessions.

1.11 Risk perception

The study of risk perception arose out of the observation that experts and lay people often disagreed about how risky various technologies and natural hazards were. The mid 1960's saw the rapid rise of nuclear technologies, however, despite this successful scientific advancement, public perception shifted against this new technology. Fears of both longitudinal dangers to the environment as well as immediate disasters creating radioactive wastelands turned the public against this new technology. The scientific and governmental communities asked why public perception was against the use of nuclear energy when all of the scientific experts were declaring how safe it really was. The need to identify what factors influenced public opinion and perception was important for the future of this industry and has therefore influenced the growing field of research into risk and risk perception.

Psychometric research identified a broad domain of characteristics of risk perception that may be condensed into 3 factors in a high factor order which are; 1) the degree to which a risk is understood, 2) the degree to which it evokes a feeling of dread, 3) the number of people exposed to the risk. A dread elicits visceral feelings of terror, uncontrollable, catastrophe, inequality and uncontrolled. All unknown risk is new and

unknown to science. The more a person dreads an activity or occurrence, the higher its' perceived risk and the more that person wants the risk reduced (Slovic et al 1987). In health, certainly the concept of the more a person dreads the recurrence of an unpleasant or painful experience such as a myocardial infarction (MI) the more they want to avoid that experience again is a useful parody to use for improving adherence to secondary prevention strategies, however if the experience was painless, which stroke often is, then the elicited perception of dread is non-existent and may be less useful, however that is not to say that the experience of suffering a stroke is not something that a person might fear or dread recurrence of but they might not be as aware of the experience in the absence of pain.

Risk perception in stroke has been studied and Dearborn et al (2009) investigated the perception of risk and knowledge of risk factors in women at high risk for stroke. They suggest risk perception is a key element in understanding how persons become motivated to change health behaviours. Despite being at a high risk for stroke, the women in this study perceived their risk to be the same as their low risk peers. They also found that stroke knowledge of risk factors or warning signs did not predict perception of risk.

To reduce stroke risk, it has been suggested that perception of risk is a parameter that is separate from stroke knowledge and presence of personal risk factors but may be useful in predicting the likelihood of initiating a behaviour change in high risk patients (Dearborn et al 2009). In secondary stroke prevention risk perception could be affected by the patient's experience of their first stroke and their dread of recurrence as suggested by Slovic et al (1987) could be useful for health professionals to discuss during consultation to increase patients understanding of the possibility of recurrence of their stroke. However, the challenge of how to communicate risk to patients remains high. In the British Family Heart Study (Wonderling et al 1996) people were more likely to cite smoking and family history of heart disease as important risk factors than hypertension and cholesterol (Marteau et al 1995). Here, a message of risk has been conveyed but the levels of risk are proportioned inaccurately towards smoking and family history rather than towards hypertension which carries a much higher risk for vascular events. The Social Amplification of Risk Framework (SARF) (Kasperson et al 1988), combines research in psychology, sociology, anthropology and communications theory. SARF outlines

how communications of risk events pass from the sender through intermediate stations to a receiver and in the process which serve to amplify or attenuate perceptions of risk. Amplifications occur at two stages: in the transfer of information about the risk and in the response mechanisms of society or the target population (Kasperson et al 1988). All links in the communication chain such as individuals, groups and media contain filters through which information is sorted and understood. The theory attempts to explain the process by which risks are amplified, receiving public attention or attuned, receiving less public attention. The theory may be used to compare responses from different groups in a single event or analyse the same risk issue in multiple events. In a single risk event some groups may amplify their perception of risks while other groups may attune or decrease their perception of risks. The main theory of SARF states that risk events interact with individual psychological, social and other cultural factors in ways that either increase or decrease populations perceptions of risk. Therefore when developing public or population based health messages all aspects of culture, society and personal psychological perceptions should be taken into account, so a single message will not necessarily reach every member of the population you seek to reach. Therefore, for stroke risk perception there is an argument for specific individual messages to influence risk perception and behaviour positively.

Townend et al (2006) found that although their stroke population were found to fear recurrent stroke and reported ‘worrying about ‘having another’, their belief in causal controllability remained low even up to 9 months post stroke and indicated less than moderate confidence in their ability to prevent a recurrence. This suggests a population-wide perception that stroke recurrence is uncontrollable and influenced more by personal beliefs or experiences than risk factor control or confidence in health professionals to treat risk factors. Townend et al (2006) highlight patient interpretation of the suddenness of the onset of the stroke syndrome as a reaction of ‘why now? Their participants asked advice on what things they should or shouldn’t do to avoid overexertion, possibly as a way of explaining the suddenness of onset they looked for strenuous or stressful situations which have recently occurred. Medical and lifestyle risk factors can only explain how risk and damage builds up over time and don’t explain to patients the reason for suddenness of the onset at one particular time in their life. Townend et al (2006) found their participants expressed a fatalistic approach to stroke prevention. They believed ‘nothing could stop’ a

recurrence, which highlights a decreased sense of control but may also suggest a lack of faith in medical professional interventions to prevent recurrence. Further research is needed to identify psychologically sophisticated interventions to reduce fear recurrence and improve adherence to medical treatments and recommended behaviour change.

Social scientists have theorized about the concept of 'risk management' in a number of different ways, including risk management as a tool for controlling future uncertainty (Giddens 1991, Beck 1992 cited by Redfern 2008) as a means of categorizing individuals in to social groups (Eichar 1989) for allocating responsibility and apportioning blame (Lupton 1995) and as a mechanism for surveillance and socio-political control (Armstrong 1995). However in the context of stroke secondary prevention, we have taken risk management to mean a specific clinical construct defined in recent health policy for older people and stroke management (Department of Health 2001, Royal College of Physicians 2008) that is, the design of strategies to prevent future strokes. In this context 'risk' refers both to risk factors (characteristics of the individual patient's body or behaviour making them risky) and the probability of having a subsequent stroke.

1.12 Risk assessment

The Framingham study has been used for 30 years to produce 'health risk appraisal' systems to predict primary and subsequent risk of IHD and stroke. The risk appraisal models have proven to be useful to clinicians in understanding the multi-factorial nature of IHD in particular (D'Agostino et al 2000). It is, however, well known that the study is limited by being based mainly on a predominantly European population. Notwithstanding this limitation, the length of the study provides us with the most comprehensive overview of the effects of CV disease available to date. Conversely, the strengths of the MOnica Risk, Genetics, Archiving and Monograph (MORGAM) (Asplund et al 2009) study are that it includes a very large number of population-based cohorts of both men and women across Europe and that it includes both fatal and nonfatal strokes with individual validation of the diagnosis in the majority of stroke events. With more than 3100 stroke events, MORGAM is, by far, the largest prospective stroke study performed. There are many reasons why stroke risk factors would have varying impact in different populations, whether they are defined by sex, age, or geography. In addition to genetic variations, the burden of socioeconomic

risk factors in whole populations or subsets may well interact with classical cardiovascular risk factors to modify the risk of stroke (Asplund et al 2009).

D'Agostino et al (2000) and Wolfe et al (1991) used the Framingham study risk models to identify cross-risk for IHD, stroke and diabetes. They found the models to be useful tools to gain a better understanding of the relationship between risk factors and the occurrences of CVD events in subjects who are free of CVD, as well as individuals who have had a prior event or are at particularly high risk of an event (D'Agostino et al 2000).

The Joint British Society guidelines suggest that all adults from 40 years onwards, who have no history of CVD or diabetes, and who are not already on treatment for BP or lipids, should be considered for an opportunistic comprehensive CVD risk assessment in primary care (JBS 2005). Younger adults (<40 years) with a family history of premature atherosclerotic disease should also have their CV risk factors measured. Risk assessment should include ethnicity, smoking habit history, family history of CVD, and measurements of weight, waist circumference, BP, non-fasting lipids (total cholesterol and HDL cholesterol), and non-fasting glucose. Those not found at this comprehensive CV risk assessment to be at high total CVD risk based on the Joint British Societies' charts (JBS 2005), or started for other reasons on drug therapy to lower BP, lipids, or glucose, should have their risk assessment repeated, ideally within 5 years. Under the age of 40 years the 10 year total CVD risk will usually be low but the risk in the coming years, assuming risk factors do not change, can be tracked forward to older age groups. Over the age of 70 years CVD risk is usually > 20% over 10 years, especially for men, but they suggest that total CVD risk should still be formally estimated. However, this will underestimate the true total CVD risk of a person older than 70 years. For people with established atherosclerotic cardiovascular disease, hypertension with target organ damage, familial dyslipidaemias such as familial hypercholesterolaemia, or diabetes, formal risk estimation is not necessary as all these people are at high total CVD risk and their risk factors should be treated.

1.13 Risk associated with vascular disease in a high risk population

Comprehensive approaches to the control of vascular diseases have resulted in a 60% decline in mortality rates over a 25-year period (WHO 2002). At least four-fifths of recurrent vascular events in patients with CV diseases might be prevented by the

application of a comprehensive, multi-factorial approach as suggested by Hackam & Spence (2007). Following a comprehensive literature review (Hackam & Spence 2007) to identify randomized controlled trials reporting on the efficacy of secondary prevention strategies, strategies were combined on a multiplicative scale and cumulative risk reduction were computed over a 5 year interval. They concluded the combination of 5 proven strategies applied to survivors of an initial stroke or TIA including, dietary modification, exercise, aspirin, statin and antihypertensive agent could result in an 80% risk reduction with a number needed to treat of ~5. This finding is influential and highlights the effectiveness of treatments for secondary stroke prevention. However, compliance with treatment is usually substantially lower in routine clinical practice than in closely monitored and motivated trial populations and it is still up to the healthcare professional to educate the patient in a way that helps them to understand the level of risk and the need for lifestyle and medical modifications (Rothwell 2007).

Van Wijk et al (2005) looked at the long-term determinants of survival and risk of vascular events following TIA or minor ischaemic stroke and found that approximately 10 years after a first event 54% of the participants had experienced at least 1 new vascular event. They found that the risk of a vascular event was highest shortly after the ischaemic event and reached its lowest point at about 3 years and then gradually rose again afterwards. One explanation they gave for the gradual rise of increased risk after the 3 year period was the possible decline in drug compliance and from the reduced attention to lifestyle factors in follow-up. In light of the substantial risk of recurrence of subsequent ischaemic events and advances in therapeutic treatments which have demonstrated to be effective for secondary prevention, Vickrey et al (2002) suggest that further research should be performed to look at assessment and care patterns for secondary prevention to determine whether there are gaps between actual care and the evidence based recommendations. This could be useful in light of the study by Qureshi et al (2001), who reported in 1252 survivors of MI and stroke from the National Health and Nutrition Examination Survey 3, that only 35% of hypertensives were controlled. Blood glucose in diabetes was controlled in only about 50% and cholesterol was poorly controlled in 46%. About 18% of individuals were also still smoking cigarettes.

1.14 Established stroke risk factors

Stroke risk factors can be divided into modifiable and non-modifiable. Non-modifiable risk factors are those that cannot be influenced by environment or behaviour change, such as age, gender and ethnicity. Modifiable risk factors are those that are thought to be influenced by medications or a change in behaviour such as diet, exercise or smoking cessation.

Hypertension, Diabetes Mellitus (DM), Atrial Fibrillation (AF) and high cholesterol are the highest ranking medically controllable risk factors for stroke whereas smoking, alcohol consumption and obesity rank as the most important lifestyle risk factors (Andersen et al 2010). The mechanisms for risk factors for vascular diseases lead to the activation of the renin-angiotensin system and oxidative stress. This leads to elevated asymmetric dimethylarginine (ADMA), low-grade inflammation and dyslipidaemia which are all common pathophysiological mechanisms that play a role in this association with vascular disease (Schiffrin et al 2007).

AF, hypertension and obesity are more common in women, where DM and previous Myocardial Infarction (MI) are more often found in men (Reeves et al 2008). Stroke risk factors are most commonly found in men before the age of 70-80 years after which the gender differences equalize, except for hypertension and AF which continue to be relatively more prevalent in women (Andersen et al 2010). However, one reason for this could be due to ‘mortality displacement’, which is a decrease in the prevalence of a risk factor in a population due to excess mortality of the people within that population with that specific risk factor. An example of this would be a decrease in the prevalence of hypertension in men over the age of 70-80 years due to the excess mortality of men with hypertension in that population (Andersen et al 2010).

1.14.1 Transient Ischaemic Attack (TIA)

TIA is a known risk factor for stroke (Purroy et al 2007) and stroke recurrence after the initial event. Stroke recurrence studies which included TIA as a first event (Coull et al 2004), showed a substantially higher stroke recurrence at 30 days than those studies which excluded TIA (Mohan et al 2011). Timing is an important factor in predicting subsequent risk for cerebrovascular events following TIA. When combining previous TIA and stroke, there is an increased risk that goes up over time, a cumulative risk of almost 25% for a subsequent stroke 3 years after a TIA or a

stroke When examining separate studies of post-TIA and post-stroke outcomes, it has been suggested that in the first 30 days the risk for stroke is similar: 4% to 8% for the risk of stroke after TIA and 3% to 10% for the risk of recurrent stroke after stroke (Sacco 2004). Johnston et al (2007) have more recently suggested patients with TIA are generally unstable, with recent studies showing that between 4–20% will have a stroke within 90 days after a TIA, half within the first 2 days. The differential risk between TIA and stroke is suggested to be small and does not take into account such aspects as controlling for other risk factors. Sacco (2004) infers people with TIA may have less severe disease, less hypertension, and less co-morbidity compared with stroke patients, which makes it slightly less likely for them to progress to stroke than for stroke patients to have a recurrence.

1.14.2 Age and silent brain infarction

Age is the highest non-modifiable risk factor for stroke. The risk of stroke increases each year by 9% in men and 10% in women (Asplund et al 2009). Life expectancy is longer for women (Heron et al 2009) and women are older than men at stroke onset (Petrea et al 2009). However, risk factors which affect the elderly more may therefore have a higher impact on women and stroke causality than men (Andersen et al 2010). The prevalence of hypertension, DM and MI have been found to decrease in the elderly (>70-80years), however, this could be due again to mortality displacement in the populations with these risk factors.

Common risk factors for cardiovascular disease undergo rapid changes in frequency and distribution with advancing age. Diabetes may be one of the most important risk factors that continue to have a consistent relationship with the risk of thromboembolic stroke throughout life. Attention to the risk of an embolic event due to atrial fibrillation is also critical because of the large increases in stroke incidence that can be attributed to this condition (Wolf et al 1991, Curb et al 1996). The Honolulu Heart Program (Hakim et al 1999) reports physically active lifestyles in older middle age seem to be protective against stroke, and current findings suggest that this effect extends to the elderly population. Cigarette smoking has also long been known to promote thrombo-embolic and haemorrhagic events, and although it becomes a less common habit with advancing age, its effects on haemorrhagic events persist (Kurth et al 2003).

Silent brain infarctions (SBI) are parenchymal brain lesions seen on imaging (CT or MRI) characteristically associated with no clinical signs and symptoms corresponding to stroke (Masuda et al 2001). SBI is an independent risk factor for stroke (Vermeer et al 2003). SBI's are known to be associated with a vascular origin and are reportedly seen frequently in asymptomatic elderly people (Longstreth et al 1996, Howard et al 1998, Vermeer et al 2002). The Framingham cohort were investigated and showed a prevalence of 10.7% SBI on MR imaging in stroke free, community dwelling participants in mid-life (Das et al 2008). Several studies have examined the incidence of SBI and its relation to risk factors for stroke. Two recent studies (Vermeer et al 2003 and Bernick et al 2001) both found that risk of stroke increased 2-3 fold in the presence of silent brain infarctions on MRI in an elderly population. Vermeer et al (2003) stated an absolute risk of stroke within 4 years was 11.7% for participants with SBI compared to 2.3% for those without SBI. The majority of these studies demonstrated that age and hypertension, strongly and independently correlated with SBI which would highlight an association with cerebrovascular disease.

1.14.3 Hypertension

Hypertension is the most common treatable or modifiable risk factor for stroke (Volpe et al 2006, Bosworth et al, 2006). Individuals with pre-hypertensive levels of Blood Pressure (BP), as defined by 120/80 to 139/89 mmHg, also have an increased risk of developing vascular disease and stroke compared with those with optimal BP <120/80 mmHg. The highest association for hypertension is among African and Caribbean people, those with diabetes mellitus and those with a high BMI (Kshirsagar et al 2007).

A Meta-analysis of 147 randomised controlled trials demonstrated a 41% reduction of stroke by blood pressure lowering (Law et al 2009). By as little as a 10mmHg reduction in systolic blood pressure as much as a 28% reduction in the risk of recurrent stroke can be achieved (Rodgers et al 1996). Other Meta-analyses of randomised controlled trials confirm an approximate 30%-40% risk reduction in stroke with BP lowering (Yusuf et al 2000, Lawes et al 2004). It has been estimated that nearly half (45%) of all strokes in patients who are on treatment for hypertension could be attributed to poorly controlled hypertension (Li et al 2005). Recent studies have shown that patients and public are aware of the link between hypertension and

stroke but do not appreciate the consequences of uncontrolled hypertension (Volpe and Dedhiya, 2006), however it has been suggested that patients who recognize their increased risk for stroke are more likely to engage in stroke prevention practices than those who do not (Samsa et al 1997). Volpe and Dedhiya (2006) found that the public and hypertensive patients alike did not consider hypertension as a serious health problem and only a third of the respondents in their study knew that hypertension could be asymptomatic.

It has been estimated that for the population as whole worldwide, 75% of strokes occur in 90% of individuals with a blood pressure greater than 155/95 (MacMahon and Rogers 1994). In a population based study, Oliveria et al (2005) found that hypertensive patients had a general understanding of 'hypertension' but were less knowledgeable about specific factors related to their condition and specifically their own level of BP control. There is no standardized tool available to assess knowledge or awareness of hypertension (Oliveria et al 2005). Cohort studies have indicated that, in the Asia Pacific region as well as in North America and Western Europe, each 10 mmHg lower systolic BP is associated with a decrease in risk of stroke of approximately one third in subjects aged 60-79 years (Lawes et al 2004). The association is continuous down to levels of at least 115/75 mmHg and is consistent across sexes, regions, and stroke subtypes and for fatal and nonfatal events. The proportional association is age dependent but is still strong and positive in those aged 80 years. Data from randomized controlled trials, in which mean age at event was approximately 70 years, indicate that a 10 mmHg reduction in systolic BP is associated with a reduction in risk of stroke of approximately one third. Per mmHg systolic BP reduction, the relative benefits for stroke appear similar between agents, by baseline BP levels, and whether or not individuals have a past history of CVD. There is, however, evidence of greater benefit with a larger BP reduction. Epidemiologically expected benefits of BP lowering for stroke risk reduction are broadly consistent across a range of different population subgroups with greater benefits from larger BP reductions. The MORGAM project (Asplund et al 2009) investigated the relative risk for stroke by Age, Sex and population based in 18 European populations and identified for each 10mmHg increase in BP, the risk of stroke increased by 23-29%. The Perindopril Protection Against Recurrent Stroke Study (PROGRESS) (2001) was designed to test the effects of BP-lowering regimens in 6105 patients with stroke or TIA within a 5 year period. The intervention

involved single (ACE1) or combination (ACE1 plus diuretic) therapy in both hypertensive (>160 mmHg systolic or >90 mmHg diastolic) and non-hypertensive patients with stroke or TIA. The combination therapy resulted in a 43% (95% CI, 30-54) reduction in the risk of recurrent stroke and a 40% (95% CI, 29-49) reduction in risk of major vascular events (PROGRESS 2001).

There is also debate regarding BP control in the elderly. Beckett et al (2008) reported on a retrospective cohort analysis of elderly patients over 80years of whom 84.5% were taking antihypertensive medication which showed a shorter survival for those patients with a systolic BP below 140mmHg, even after adjustment for known predictors of death (Oates et al 2007). They reported that the 36% reduction in the risk of stroke may be offset by the possible adverse effects of treatment of hypertension in this very elderly population. However, the HYVET (Hypertension in the Very Elderly Trial) study sought to provide some clarity and found evidence that antihypertensive treatment with Indapamide (sustained release), with or without perindopril in the very elderly e.g. persons over 80 years of age or older, aimed to achieve a target blood pressure of 150/80 mm Hg is in fact beneficial and is associated with reduced risks of death from stroke, death from any cause and heart failure (Beckett et al 2008).

1.14.4 Diabetes

The impact of diabetes on stroke is an important factor due to the increasing incidence of diabetes globally (Air & Kissela 2007). Diabetes Mellitus (DM) is estimated to affect 3.7% of the UK population (Diabetes UK 2007). DM remains an independent risk factor for systemic atherosclerosis and increases the risk of Atherothrombosis via detrimental effects on the vessel wall (Chi & Jaff 2008). The Framingham study found a 2.5-fold incidence of ischaemic stroke in diabetic men (Kannel et al 1983). More recently DM was one of two independently associated risk factors for recurrent stroke in the Oxfordshire Stroke Project with 9.17% of recurrent strokes attributable to DM (Hillen et al 2003). It has been suggested diabetics are as much as 2.9 times more likely than non-diabetics to have a stroke for reasons that diabetes appears to amplify high risk, non-modifiable risk factors for stroke (Air & Kissela 2007). DM is more associated with small vessel disease than large vessel disease, Tuttolomondo et al (2008) found the prevalence of lacunar stroke sub-types was highest in hypertensive and diabetic patients. Surprisingly, Touze et al (2005)

found no correlation between diabetes mellitus prevalence at baseline and risk of MI during follow-up and suggested the link between diabetes mellitus and small vessel disease as a possible explanation for this. The association between diabetes and small vessel disease does appear to carry a lower risk of MI during follow-up (Diener et al 2004). The association between diabetes and stroke is undoubtedly related to the pathologic changes observed in the brain vessels. It has however, been suggested that the changes in a diabetic brain differ from non-diabetics due to diabetic angiopathy rather than atherosclerotic angiopathy. Therefore further research needs to be performed to understand if established treatments need to be reviewed further for diabetic patients at risk of stroke or other vascular diseases. Giorda et al (2007) found during 4 year follow-up of over 4,000 patients with diabetes, 296 stroke events. In patients with no history of CV disease the age-standardised incidence of stroke was 5.5 in men and 6.3 in women, this went up to 13.7 in men and 10.8 in women with a history of CV disease. They identified age and history of stroke as the main predictors of stroke in diabetes. The Greater Cincinnati-Northern Kentucky Stroke Study (GCNKSS) (Kissela et al 2005) found the risk for ischaemic stroke in white diabetics was higher at every age-group compared with non-diabetic patients. Both these studies identify diabetic patients of any age with a previous stroke have a high risk of recurrent vascular events and should be treated aggressively with secondary prevention therapies.

1.14.5 Hyperlipidaemia

Hyperlipidaemia is a well-established risk factor for CV disease (Heart Protection Study 2002). It initiates atherosclerosis by disturbing the normal homeostatic function of the endothelium and vascular wall (Kinlay et al 2001). Raised Low Density Lipid (LDL) levels in the plasma increase the rate of delivery and retention of LDL in the arterial wall, this leads to reactive oxygen species depleting antioxidants to oxidize fatty acids on the LDL surface transforming it to oxidized LDL particles. Oxidized LDL will activate the overlying endothelial cells, the combination will go on to inhibit the production of nitric oxide and rapidly convert the available nitric oxide to the inactive metabolite. This drop in nitric oxide causes detrimental effects on the vascular wall and in turn causes recruitment of inflammatory cells and leads to atherosclerotic lesions (Kinlay et al 2001). A large amount of data has been collected to support the use of statin therapy to reduce CV risk and several recent meta-analyses assessing the risk reduction on statin therapy have shown that statin therapy provides high

levels of protection for all-cause mortality and non-haemorrhagic strokes and other vascular diseases such as CKD and CAD (Pedersen et al 1998, O'Regan et al 2008, Strippoli et al 2008, Gould et al 2007). Statins both reduce levels of low density lipids and increase levels of high density lipids which have been shown to decrease the risk of stroke during follow-up (Asplund et al 2009). As well as producing a potent low density lipid-lowering effect, Statins also contain anti-inflammatory, antithrombotic and vaso-active effects which might act as a neuro-protector, leading to possible reductions in stroke severity (Goldstein et al 2009). The Medical Research Council (MRC) and British Heart Foundation (BHF) identified a relative risk reduction of 25% for an endpoint of stroke in the Heart Protection Study (HPS) but found no significant reduction in stroke risk in patients with existing cerebrovascular disease (Collins et al 2004). Over 4.9 years (576 subjects) results from the SPARCL (Statin Treatment and Stroke Outcome in the Stroke Prevention by Aggressive Reduction in Cholesterol Levels) trial showed reductions in fatal, severe, moderate and mild outcomes using the Modified Rankin Scale (MRS) measure of disability. Primary endpoint of time to first fatal or non-fatal stroke was increased by 16% in the intervention group which received Atorvastatin 80mgs (Amarenco et al 2009).

1.14.6 Smoking

Up to one quarter of all strokes are attributable to cigarette smoking, which independently increases the relative risk of stroke about three-fold (Hankey & Warlow 1999). The mechanisms for tobacco smoke exposure increasing stroke risk are numerous as the smoke contains over 4000 different harmful chemicals. The chemicals promote the development of free radicals that induce vascular endothelial dysfunction and inflammation which can lead to the development of atherosclerotic processes (Cole 2011). Smoking in itself reduces the life expectancy of the average smoker by 14 years (Cole 2011). A 20% risk of stroke is directly associated with smoking and while both the general public and global healthcare systems are aware of the risk associated with smoking, the prevalence of tobacco use over the last 25 years remains largely unchanged (Cole 2011). The risk is dependent upon the amount of cigarettes smoked (Cole 2011, Hajat et al 2004). Risk is equally high in both male and female smokers but it declines considerably and rapidly after smoking cessation, thus supporting a causal relationship. Studies performed across varying ethnicities and populations demonstrate a highly consistent association between smoking and ischaemic stroke risk, with current smokers having a 2-4 fold increased

risk of ischaemic stroke compared with lifelong non-smokers or individuals who have stopped smoking >10 years (Shah & Cole 2010). Interestingly in ethnicity studies of stroke patients (Hajat et al 2004) UK Whites are more likely to smoke than UK Black African and UK Black Caribbean populations. It has been suggested that smoking introduces a very high risk of stroke in young and middle aged individuals (Andersen et al 2010) in particular and therefore are a population where information for prevention should be targeted.

1.14.7 Heart disease

Coronary artery disease (CAD) is an independent risk factor for stroke (Wolf et al 1992). In the Framingham study CAD increased the possibility of stroke events independent of other well-known cardiovascular risk factors (Kannel et al 1983). The incidence of stroke at 10 years follow-up in acute myocardial infarction (AMI) patients was 19.5% and 29.3% for men and women respectively (Wolf et al 1996). One third of patients with ischaemic stroke already have clinical manifestations of CAD, such as angina or a past myocardial infarction (MI) (Sandercock et al 1989).

A meta-analysis to identify the incidence of stroke after MI found 21.4 strokes occurred per 1000 MI at 1 year (Witt 2006). Conversely, there is an average annual incidence of 1% for MI after TIA (Burns 2011) and a 2.2% annual risk has been shown through meta-analysis for MI after stroke/TIA (Touze et al 2005). Following an acute ischaemic stroke, although there is a high short-term risk of recurrent stroke, the leading cause of mortality is CAD (Vickrey et al 2002, Touze et al 2005, Adams et al 2003, Dhamoon 2006). It is probable that those with an established previous history of Ischaemic Heart Disease (IHD) will account for the majority of subsequent coronary events following stroke, with known cardiac disease at entry in around a quarter of all stroke patients (Adams 2003).

There is a risk of ‘silent’ and asymptomatic IHD in the presence of TIA and stroke (Adams et al 2003). Rokey et al (1984) and Di Pasquale et al (1986) both showed abnormal myocardial imaging and asymptomatic IHD in 41% and 28% of their study populations, respectively. Subtypes of ischaemic stroke related to underlying atherosclerosis such as carotid, vertebral or intracranial stenosis, are associated with a higher risk of IHD than non-atherosclerotic subtypes of stroke (Adams et al 2003, Rothwell et al 2005).

A systematic review and meta-analysis of the risk of MI and vascular death after TIA and ischaemic stroke showed that after a stroke or TIA the risk of MI and non-stroke vascular death are each 2% per annum (Touze et al 2005). Other smaller studies suggested that between 25-60% of stroke patients without any clinical evidence of IHD may have (silent) myocardial ischemia on non-invasive tests (Adams et al 2003). While atherosclerosis may explain 20-40% of stroke, strokes related to atherosclerosis are at a higher risk of MI or non-stroke death than other patients (Touze et al 2005).

1.14.8 Carotid artery stenosis

Several other but smaller studies suggest that patients with carotid stenosis have a high prevalence of IHD (Urbinati et al 1992, Sconocchini et al 1997). Sconocchini et al (1997) evaluated 133 patients with asymptomatic and symptomatic significant (>50%) carotid stenosis for the presence of IHD using stress-exercise electrocardiography (SE). The study demonstrated that 25% of patients with no history or IHD had latent myocardial ischemia. They concluded that screening with SE was easy, inexpensive and safe and would allow early detection of those patients who need more active treatments.

Patients with identified carotid, vertebral or intracranial atherosclerosis may therefore be at highest risk of MI or non-stroke death and may be a group which would benefit from CV investigation on diagnosis of atherosclerosis in a single bed.

1.14.9 Atrial fibrillation

Atrial Fibrillation (AF) is responsible for at least 15-20% of all stroke in the United States (US) (Lloyd-Jones et al 2010) and is the most common cardiac rhythm disorder and a major risk factor for ischaemic stroke (Ogawa et al 2011). The prevalence of AF increases significantly in the elderly, affecting approx 9-14% of the population of over 80 year olds in North America and Western Europe (Feinberg et al 1995, Ninios et al 2010).

AF causes stroke due to the increased coagulation activity in the left atrium of the heart. Patients with paroxysmal AF are at an increased risk even during the sinus rhythm period (Koretsune Y 2009). A risk reduction of up to 50% can be achieved in stroke patients with non-rheumatic AF through the use of anticoagulation therapy (European AF Trial study group 1993) and Warfarin has for years been the drug of

choice to treat AF. Its use has seen a reduction in the risk of stroke in patients by up to 68% (Ezekowitz et al 2009). However, due to the complexities of taking and monitoring the drug, therapeutic range is achieved in less than two-thirds of patients (Matchar et al 2002). New oral anticoagulants such as Dabigatran require less monitoring and may provide a better alternative to Warfarin. Dabigatran is administered orally at fixed doses, has a rapid onset of action, predictable pharmacokinetics and minimal food/drug interactions (Mavrakanas and Bounameaux 2011). By adopting new oral anticoagulants the process may improve through simplification and the numbers of patients achieving a therapeutic anticoagulant range may increase and therefore stroke incidence may be positively affected.

1.14.10 Metabolic syndrome and Obesity

The Metabolic Syndrome is characterised by a number of vascular risk factors such as, elevated BP, high blood glucose, obesity and hyperlipidaemia. Boden-Albala et al (2008) performed a study looking at the association between the metabolic syndrome and stroke. The study was part of the Northern Manhattan Study and 3298 stroke-free community residents were prospectively followed up for a mean of 6.4 years. The metabolic syndrome was defined according to the National Cholesterol Education Program (NCEP) Adult Treatment Panel III guidelines (ATP III update 2004). The study showed that more than 44% of the cohort had the metabolic syndrome (48% of women vs. 38% of men, P=0.0001), which was more prevalent among Hispanics (50%) than whites (39%) or blacks (37%). The metabolic syndrome was associated with increased risk of stroke (HR=1.5; 95% CI, 1.1 to 2.2) and vascular events (HR=1.6; 95% CI, 1.3 to 2.0) after adjustment for socio-demographic and risk factors. The effect of the metabolic syndrome on stroke risk was greater among women (HR=2.0; 95% CI, 1.3 to 3.1) than men (HR=1.1; 95% CI, 0.6 to 1.9) and among Hispanics (HR=2.0; 95% CI, 1.2 to 3.4) compared with blacks and whites. The estimates suggest that elimination of the metabolic syndrome would result in a 19% reduction in overall stroke, a 30% reduction of stroke in women and a 35% reduction of stroke in Hispanics.

However, there is still debate about the metabolic syndrome as an independent risk factor for CVD with the absolute CV risk of the metabolic syndrome not necessarily higher than those of its individual components (Qiao et al 2007). The prevalence of the metabolic syndrome varies according to definition, ethnicity and gender (Qiao et

al 2007). Subjects with the metabolic syndrome are at increased vascular risk but whether it is a useful CV risk marker above and beyond the risk associated with its individual components remains uncertain.

Obesity is defined as a body mass index (BMI) of >30kg/m2. Worldwide obesity has more than doubled since 1980. In 2008, 1.5 billion adults, 20 and older, were overweight. Of these over 200 million men and nearly 300 million women were obese. 65% of the world's population live in countries where overweight and obesity kills more people than underweight. In the US, 63% of men and 55% of women are considered overweight and 30% of the population are considered obese (Kurth 2002). It does not look as though the problem is improving as nearly 43 million children under the age of five were overweight in 2010 (WHO 2011). Obesity is preventable and is independently associated with increased stroke risk. There is also an association between obesity and risk of cardiovascular disease in middle aged individuals (Kurth et al 2002, Janssen et al 2007). Obesity is strongly associated with major stroke risk factors including hypertension, diabetes and hyperlipidaemia, however some studies have shown increasing BMI is associated with a steady increase in ischaemic stroke, independent of any other risk factors (Kurth et al 2002). Wilson et al (2002) found overweight and obesity categories were highly related to risk of hypertension in both men and women. The incidence of new diabetes was increased in overweight men and obese persons of both sexes. Interestingly approx. 21% of diabetes in men in this study (Wilson et al 2002) was attributable to overweight and obesity but only 3% in women. This may be a contributing factor towards the high incidence of stroke in men, however, Wilson et al (2002) could find no reason for the weaker relations in women. They summarize, overweight and obesity are associated with an increased risk for the development of cardiovascular risk factors and CVD itself. However, the risk may be reversible as the MORGAM project (Asplund et al 2009) identified 1 unit of Body Mass Index (BMI) increased the risk of stroke in men by 2%, therefore even a moderate reduction in BMI may alternatively reduce stroke risk.

1.14.11 Alcohol

There is widespread alcohol consumption in the general population. It is suggested that 44% of adults over the age of 18 years consume 12 or more alcoholic drinks per year in the US. Studies have reported conflicting results regarding the risk of stroke

and alcohol consumption over the past twenty years. However, Reynolds et al (2003) performed a meta-analysis of 19 cohort studies to identify the risk association between alcohol and stroke. The meta-analysis showed that consumption of more than 60g of alcohol per day was associated with an increased risk of total stroke (1.64%), ischaemic stroke (1.69%) and haemorrhagic stroke (2.18%). These results show that heavy alcohol consumption increases the relative risk of stroke whereas light to moderate consumption may provide a protective element against total and ischemic stroke. Several studies describe a j-shaped association between alcohol and ischaemic stroke (Djousse et al 2002, Hillborn et al 1999, Berger et al 1999). Reducing alcohol consumption in heavy drinkers should be an important approach to stroke prevention in the general population (Reynolds et al 2003), however, health professionals should think carefully how best to share this information with patients at high risk of first or second stroke in order to ensure the most accurate information is relayed regarding the potential for misunderstanding the benefits of moderate drinking compared with the harm caused by consuming large amounts of alcohol.

1.14.12 Ethnicity

Understanding ethnic differences in stroke is a crucial element of understanding the aetiology of stroke (Sacco et al 2001). The incidence of stroke in black populations is approximately twice as high in the United States (US) black and United Kingdom (UK) black populations compared with the local white populations. The population attributable risk depends on both the prevalence and risk associated with each risk factor. Certain populations have a higher prevalence of physiological risk factors for ischaemic stroke. The South London Stroke Register (Hajat et al 2004) identified hypertension as significantly associated with stroke, in keeping with other studies (Sacco et al 2001), however, Ethnic differences were demonstrated in the population attributable risk with values of 38% for white, 46% for black Caribbean, and 59% for black African subjects. Black African subjects have been shown to have the highest prevalence of hypertension regardless of their geographical location (Sacco et al 2001, Hajat et al 2004). However, an interesting finding in the South London Stroke Register is the population attributable risk from smoking was less in black Caribbean and black African groups compared with the European group, and for DM the risk was 2-fold greater in the black Caribbean population compared with the black African and white groups (Hajat et al 2004). However, both coronary artery disease and AF are more common in White populations (Lynch et al 1999, Wolf et al 1996). These

findings go a great deal further to highlighting the need to inform and educate stroke patients at least individually if not with ethnicity specific risk factor advice.

Different ethnic populations also have different lifestyle behaviours. UK black stroke patients have been shown to behave differently to white stroke patients with a lower prevalence of smoking and heavy alcohol intake (Hajat et al 2001). This is an important finding for the development and implementation of stroke prevention programmes.

Stroke prevention relies heavily on the treatment of risk factors in all high risk groups. Studies to understand ethnic differences in stroke risk are key to preventing stroke in different populations who have higher or lower prevalence of different behaviours or physiological markers for stroke risk. Prevention programmes specifically designed and implemented to ethnic groups may be helpful for both physiological and behaviour risk factor management.

In the UK according to the 2001 census 92% of the UK population is White, 4% Asian or Asian British, 2% Black or Black British and 1.5% Mixed. The UK census classified ethnicity into 16 groups. Bhopal (2007) discusses the tensions which highlight the range of approaches and challenges in responding to ethnic disparities in the UK. Race and ethnicity are important variables in health care management and noteworthy in stroke prevention as risk is increased in different ethnic populations. Healthcare for ethnic minority groups has been found to be inferior compared to white Europeans in a range of diseases including stroke (Bourke et al 2006). It has been suggested that Physicians advice and behaviour may vary depending on perceived patient attributes (Smedley et al 2002), also ethnic minority groups have reported lower levels of trust and satisfaction with their providers in physicians, health plans and hospitals in general (Morales et al 2001, Collins et al 2002, Hunt et al 2005, Shi et al 2005). Cultural diversity programmes for training health care professionals have been shown to improve patient outcomes including compliance but as yet there are no UK requirements for inclusion in professional training except for psychiatry (Bentley et al 2008).

The Health Survey for England (HSE) (2003) showed that BME groups have generally worse health than the overall population. Evidence suggests poorer socio-economic status of BME groups is the main factor driving ethnic health inequalities

(Parliamentary Office of Science and Technology (POST) 2007). Bhopal (2007) challenges us to achieve better health for ethnic minority populations. The Department of Health have published several documents and targets to improve health inequalities focussing on socio-economic status but not specifically for BME groups. The HSE (2003) also showed that BME groups as a whole were more likely to report ill-health and that ill-health starts at a younger age among BME groups compare to white British. Some BME groups experience worse health than others, surveys commonly show that Pakistani, Bangladeshi and Black-Caribbean people report the poorest health, however, Chinese people report better health than white-British. BME groups are known to have higher rates of vascular disease than white-British but lower rates of cancer (POST 2007).

1.14.13 Health inequalities targets

The NHS Plan (2000) committed to two national Public Service Agreement (PSA) targets to reduce health inequalities, which were set up in February 2001:

- To reduce by at least 10% the gap between the fifth of local authorities with the worst health and deprivation indicators and the population as a whole, by 2010.

- To reduce by at least 10% the gap in infant mortality between routine and manual groups and the population as a whole, by 2010.

Since then, a number of local authorities have agreed health inequalities targets as part of their Local Area Agreements. In some cases, the targets attract financial incentives through the reward element initiative. Local authorities, their partners and communities have been encouraged to collaborate on delivery in the hope of ensuring greater accountability for meeting the targets. Nonetheless, evidence shows that health inequalities remain at large and POST (2007) suggest the biggest ethnic variation for health in the UK is seen in the elderly ethnic minority groups.

Chin et al (2007) suggest health disparities originate from societal factors such as poverty and unequal educational opportunities, which continue to be a challenge for all western countries. They also reported on the published annual Disparities Report by The Agency for Healthcare, Research and Quality to provide a national overview of disparities in the US. The 2006 report documents that racial and ethnic minorities continue to receive poorer quality of care as compared to whites in 22 essential quality of care measures. Specifically, Hispanics receive poorer quality of care as

compared to non-Hispanic whites in 77% of these measures, African Americans 73%, American Indians and Alaska Natives 41%, and Asian Pacific Islanders 32% (US Department of health and human services 2006).

As global movement increases its momentum still further, the challenge in health care is to be aware of individual ethnic biological differences which affect health as well as the cultural and religious influences which affect behaviour. Socio-economic status is an important factor, however as health professionals, information and education is key to providing all members of society with the opportunity to participate in their health care through improved health literacy and knowledge.

1.14.14 Physical inactivity

Numerous studies have shown that low physical fitness is an independent predictor of death from cardiovascular disease among healthy, middle-aged men and women (Wenger 1996, Elsawy & Higgins 2010). Recent findings continue to provide evidence of the overwhelming benefit of physical activity on stroke prevention. One of the more important findings from Sacco et al (2001) study was the elevated Etiological Factor (EF) (estimates the proportion of strokes attributable to a specific risk factor) for physical inactivity found in all 3 race-ethnic groups (Europeans, Blacks and Hispanic Caribbean's) indicating physical inactivity is an important risk factor for all ethnic groups and populations. It has however, been argued that subjects who report a lack of physical activity may have an undiagnosed or subclinical condition that prevents such activity and that physically fit subjects may adopt other health-promoting habits. However, Lee et al (2003) identified in a meta-analysis of 23 studies (18 cohort and 5 Case-controls) looking at physical activity and stroke, that demonstrated highly active individuals had a 25% lower stroke risk or mortality compared with inactive or unfit individuals. By decreasing the risk burden of physical inactivity stroke risk among all race-ethnic groups could be substantially altered (Sacco et al 2001). Physical activity, although seen as a lifestyle behaviour, can have an impact on physiological stroke risk factors as it lowers BP and weight, improves glucose tolerance and can enhance overall cardiovascular health (Lee et al 2003). Disability after stroke can be substantial and neurological deficits can affect patient's ability to initiate and tolerate exercise. This provides a challenge to health professionals, patients and carers to establish safe and effective physical activities

after stroke to aid recovery and reduce the risk of further stroke and CV disease (Sacco et al 2006).

1.14.15 Renal artery disease

Impaired renal function is a strong independent predictor of cardiovascular mortality and morbidity in the absence of any previous history (Elsayad et al 2007, Townsend 2008). Traditional risk factors seem to account for much but not all of this excess risk. There is a significant burden of CVD risk factors among patients with chronic kidney disease (CKD) and these patients are more likely to be treated for hypertension, elevated low density lipoprotein cholesterol (LDL-C) levels, and diabetes, but rates of control of risk factors are uniformly low in those with and without CKD (Parikh et al 2006). However, their predisposition to CV disease persists even after adjustment for this overabundance of standard risk factors. Early detection of CKD can not only slow the progression to end-stage renal disease but also identify risk factors for stroke and CV disease (Hostetter 2004).

Impaired renal function is measured by low Glomerular Filtration Rate (GFR) which has also been shown to be associated with markers of cerebral small vessel disease on MRI (Ikram et al 2008). The population based study of a large sample of elderly people (>60 years) from the Rotterdam Scan Study (Ikram et al 2006), showed that compared with those with normal kidney performance persons with reduced renal function had a smaller brain volume, smaller deep white matter volume and more white matter lesions and that these findings were independent of CV risk factors. GFR may be an easy and readily measureable indicator of cerebral small vessel disease in patients with kidney problems. Understanding the interplay of vascular disease between the kidney and the brain may hold the promise of identifying novel strategies to reduce the risk of damage to either organ (Seliger et al 2008).

Cystatin C is a serum protein that is filtered out of the blood by the kidneys and serves as a measure of kidney function. Cystatin C is produced steadily by all types of nucleated cells in the body. Deo et al (2008) performed a study for the Health, Ageing and Body composition study, to evaluate whether impaired kidney function predicted the risk of fatal CV disease independent of prevalent and incident CV events. Higher Cystatin-C concentrations were significantly associated with CV disease (Deo et al 2008). Although end-stage renal disease substantially increases the risks of death and CV disease (Seliger et al 2003), the effects of less severe

kidney dysfunction on these outcomes are less well defined (Go et al 2004, Mann et al 2001). The HOPE study aimed to determine whether mild renal insufficiency increased CV risk and whether ramipril, an angiotensin converting enzyme inhibitor, decreased that risk. 980 patients with mild renal insufficiency measured by an increased serum Creatinine (>1.4 mg/dL; 124 µmol/) and 8307 patients with normal renal function were investigated for a primary outcome measure of CV death, MI or stroke. The cumulative incidence of the primary outcome was higher in patients with renal insufficiency than those without. Ramipril reduced the incidence of the primary outcome in patients with and without renal insufficiency. The study showed that patients with pre-existing vascular disease or diabetes combined with an additional CV risk factor and mild renal insufficiency had a significantly increased risk for subsequent CV events (Mann et al 2001) but importantly, this risk was reversible.

Shlipak et al (2002) concluded through a study aimed to determine the prevalence of elevated risk through serum Creatinine levels (>1.4 mg/dL; 124 µmol in women and >1.5 mg/dL; 133 µmol/L in men) that renal insufficiency is a marker for elevated CVD risk in elderly (>65 years age) adults. Older individuals demonstrated more significant differences in hypertension prevalence, treatment and control. The prevalence of hypertension was significantly higher among those with compared with those without CKD. These differences were more evident among older individuals, consistent with previously published data demonstrating lower rates of blood pressure (BP) control among older individuals with mild to moderate CKD (Parikh et al 2006). Poor kidney function is also highly prevalent in the elderly population together with more widespread small vessel disease in the brain (Ikram et al 2008).

Whether CV disease is a risk factor for the progression or development of worsening kidney disease was studied by Elsayed et al (2007). This study looked at 13,826 individuals, used an increase in serum Creatinine level and a reduced estimated GFR (eGFR) as markers of a kidney function decline. They concluded that CV disease is indeed independently associated with kidney function decline and the development of CKD. This is an important finding which reiterates the importance of the need to be aware of the interconnectors between diseases and the independent impact one has on the other. Peripheral Artery Disease (PAD) has also been shown to have a high prevalence in patients with renal insufficiency (O'Hare et al 2004).

Both the kidney and brain are low resistance end-organs and are exposed to high-volume blood flow (Schiffrin et al 2007). The similarities in the vascular supply to these organs could be useful as vascular disease in one organ may inform us about vascular disease in the other (Seliger et al 2008). Prevention and treatment of CVD are major considerations in the management of individuals with CKD. Less is known regarding the CVD risk factor burden among individuals with earlier stages of CKD, many of whom are not necessarily treated for CKD or do not manifest clinical CVD. However, relatively minor renal abnormalities such as a slightly reduced GFR or micro albuminuria, but even within normal ranges, may be associated with increased risk of vascular events (Schiffrin et al 2007). Moderate CKD is an independent risk factor for CV disease, suggesting a need to better understand CV risk factor burden and rates of risk factor treatment and control in this group.

The limitation with evaluation studies of the prevalence of renal disease in association with CV disease is that different studies appear to use different markers for diagnosis of renal disease, with some using GFR, some Cystatin C and others serum Creatinine levels. However, all these measures are well defined biochemical markers of reduced kidney function but nevertheless this possibly blurs the association between renal disease and CV disease risk, as each marker used for renal disease may have an alternative independent influence on atherosclerotic events.

1.14.16 Peripheral artery disease (PAD)

PAD is defined by atherosclerotic obstruction of the abdominal aorta and arteries to the legs that reduces arterial flow during exercise and/or at rest (Chi & Jaff 2008). Approximately one third of patients with PAD have typical claudication defined as pain in one or both legs on walking, primarily affecting the calves, that does not go away with continued walking and is relieved by rest. In patients with claudication, the severity of the condition increases slowly with 25% have worsening claudication, and 5% undergo an amputation within 5 years. Less than 5 -10% of patients have critical leg ischaemia (ischaemic pain in the distal foot, ischemic ulceration or gangrene), but their risk of limb loss is substantial (Hiatt 2001). Only ~10-30% of patients with PAD present with classic symptoms of intermittent claudication (Chi & Jaff 2008). This may be a reason for its under-diagnosis and clinicians reliant on a classic history of claudication could miss the majority of cases (Hirsch et al 2001).

This is of concern as patients with PAD, even in the absence of a history of MI or ischaemic stroke, have approximately the same relative risk of death from CV causes as patients with a history of IHD or CVD (Hiatt WR 2001). The age-adjusted prevalence of PAD is approximately 12%, and the disorder affects men and women equally. Patients with PAD are usually regarded as a group that is at particularly high risk of cardiac ischaemic events, yet PAD is commonly both under-diagnosed and undertreated (Steg et al 2007).

Vickrey et al (2002) found that the PAD cohort in their study of secondary ischaemic events among persons with atherosclerotic vascular disease experienced the highest case fatality or proportion of secondary events that were fatal stroke, fatal MI and other vascular deaths. The REACH registry findings support these findings with PAD patients experiencing the highest rates of CV death and major CV events due to an atherothrombotic event (Steg et al 2007). However, Janes et al (2008) performed a multivariate analysis that showed compared to patients with IHD, patients with PAD had decreased use of antiplatelet agents, statins and ACE inhibitors and during hospital admission, treatment was significantly less likely to be initiated in patients with PAD. This is a significant discovery and should raise awareness to health professionals of the importance of treating patients with PAD as aggressively as they would a patient with CAD.

The Ankle Brachial Index (ABI) may be the most reliable detector of PAD (Chi & Jaff 2008) in high risk patients. It compares systolic BP in the dorsarlis pedis and/or posterior tibial arteries of the lower limbs to that of the brachial artery with the use of a hand-held Doppler device (Chi & Jaff 2008). As this is the simplest, most inexpensive, reliable and reproducible method of identifying PAD it may be used on patients with a history of CV disease and stroke, to easily identify if there is atherosclerosis in another vascular bed resulting in a further increase in the risk of vascular disease. The Scandinavian Simvastatin Survival Study (Pedersen et al 1998) revealed that the use of simvastatin reduced episodes of new or worsening intermittent claudication providing evidence that if treated with CV disease risk factor management strategies, PAD patients can have a positive outcome. The Heart Protection Study (HPS 2002) went on to conclude that simvastatin not only reduced the risk of a first event being suffered by a person but also reduced the risks of subsequent events for many types of high risk patients including those with PAD .

1.14.17 Retinal artery disease

A study to determine if hypertensive retinopathy (HTR) is an indicator of silent brain infarction (SBI) in asymptomatic hypertensive subjects using MRI and retinal photography has been undertaken (Kwon et al 2007). 14% of subjects had the presence of HTR and, following multivariate analysis, age (OR, 1.07; 95% CI, 1.03 - 1.10) and HTR (OR, 2.01 for grade 1; OR, 3.03 for grade 2) were the independent indicators for the presence of SBI. The higher the grade of HTR, the more prevalent the presence of SBI than in persons with normal retina (by linear association test, p=0.001).

Mitchell et al (2005) performed a study investigating retinal micro vascular signs as a potential risk of stroke and stroke mortality. The purpose of this study was to assess the relation of retinal micro vascular signs and incident stroke and stroke mortality in an older population. The authors took retinal photographs on baseline participants (3,654 patients aged 49+ years) of the Blue Mountains Eye Study from 1992 to 1994 (Ivers et al 1999). They assessed the presence of retinopathy (micro aneurysms, retinal haemorrhages) in participants without diabetes and retinal arteriolar signs in all participants using standardized grading protocols. Incident stroke, TIA and CVD deaths (combined stroke events) were identified at follow-up examinations during 1997 - 1999. During a 7-year period they reported 859 participants died, 97 (11.3%) of which died of CVD causes. Of survivors, 24 had confirmed incident of stroke, and 11 had incident TIA. Combined stroke events were more frequent in participants with retinopathy (5.7%), with moderate-severe arteriovenous nicking (4.2%), or with focal arteriolar narrowing (7.2%) compared with those without (1.9%). After controlling for age, sex, systolic BP, smoking, and self-rated health, retinopathy was significantly associated with combined stroke events (relative risk (RR) 1.7, 95% CI 1.0 to 2.8) in persons without diabetes. This association was stronger in those without severe hypertension (RR 2.7, CI 1.2 to 6.2) or in persons with 2 or more retinal micro vascular signs (RR 2.7, CI 1.5 to 5.2). Generalized or focal arteriolar narrowing or arteriovenous nicking was not independently associated with combined stroke events after multivariate adjustment. They concluded that in older Australians without diabetes, retinopathy signs predict stroke or stroke-related death independent of traditional stroke risk factors (Mitchell et al 2005).

Mead et al (2002) performed a comparison study of risk factors in patients with transient and prolonged eye and brain ischemic events. It was the largest study to date to compare risk factors in ischaemic stroke, cerebral TIA, retinal artery occlusion (RAO) and amaurosis fugax. The results showed that severe ipsilateral carotid stenosis was more common in eye than brain events and atrial fibrillation was more common in brain than eye events. Atrial fibrillation was more often associated with prolonged stroke and RAO than transient cerebral TIA and amaurosis fugax symptoms. These data suggest that brain and eye events reflect distinct patterns of vascular disease and risk factors that probably have relevance to the pathophysiology of the event and its prognosis. They suggest focusing management of subgroups of patients with different cerebrovascular ischemic symptoms to target stroke prevention more effectively.

1.14.18 Retinal vein disease

Patients with retinal vein occlusions (RVO) are at increased risk of CV disease (Martin SC et al 2002). The risk of future CV disease was determined by this group using the Framingham algorithm and the risk estimated to guide decision about preventative treatment for CV disease in this patient group. The study concluded that RVO is a presenting complaint in a group of patients at increased risk of CV disease. They agreed that long-term follow up data demonstrates an increased risk of mortality from CV disease in patients with RVO. For patients presenting with RVO, this may be the first indication of developing atherosclerosis and could be used as an early indicator and initiation of treatment may be helpful at this time.

1.14.19 Patent foramen ovale (PFO)

PFO is a persistence of an embryonic defect in the inter-arterial septum (Sacco et al 2006). The prevalence of PFO in the general populations is high at approx. 25%, however, it is approximately doubled in the presence of ischaemic stroke patients (Kent & Thaler 2010). This has been generally attributed to paradoxical embolism and many physicians recommend closure to prevent recurrence. However, there has been much debate regarding the importance of PFO closure in relation to stroke recurrence and prevention. Kent and Thaler (2010) have gone some way to provide further evidence that PFO is indeed an important risk factor for stroke after the initial event, however, the benefit of closure remains in questions. In the PFO in

cryptogenic stroke study (PICSS), PFO was found in 39% of patients between the ages of 30-85 years (Homma et al 2002).

1.15 Genetics of stroke

Genetics as a cause of stroke are thought to arise as a consequence of polygenic or multifactorial influences whereby multiple genes each exert a small influence or risk on phenotype, with individuals showing different combinations of genetic and environmental influences (Bevan and Markus 2004). Understanding the genetic contributions to ischaemic stroke is important to explain the minority cases of stroke that occur in the absence of established risk factors (Bentley et al 2010) but they may also go some way to explain why some people are more susceptible to vascular disease and stroke than others despite similar risk factors and environmental influences. Bentley et al (2010) suggest there are a growing number of studies reporting positive genetic associations with stroke. They performed a comprehensive meta-analysis (Bentley et al 2010) of the causal relationship of susceptibility genes to ischaemic stroke and found positive gene associations. From a total of 37,481 identified ischaemic stroke cases, they identified six candidate genetic polymorphisms reliably associated with ischaemic stroke (Factor V Leiden, ACE (Angiotensin Converting Enzyme), MTHFR (Methylenetetrahydrofolate reductase), Prothrombin, PAI-1 (Plasminogen activator inhibitor), Glycoprotein-III). However, whilst the effect size of each of the positive gene associations was small (odd ratios of 1.11 to 1.60), the overall contribution that genetic factors make towards stroke is likely to be relatively large given the frequency of these risk variants in the general population (from 3 to 45% each). The sum of the population attributable risks across all the gene associations identified in the Meta analysis was 30% (Bentley et al 2010).

Ischaemic stroke involves a series of pathophysiological processes often occurring over many years, and each may be influenced by a number of different genes. When referring to stroke, a distinction must be made between isolated stroke in which there are no additional physical characteristics and conditions in which stroke is just one feature of a multi system disorder. CADASIL (cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy), is the only form of isolated stroke to display familial patterns of inheritance in which the responsible gene has been identified (Kalaria et al 2002). The presence of this

appears to confer an increased risk of ischaemic stroke, and specifically of cardio-embolic and large vessel stroke subtypes (Gretarsdottir et al 2003). The gene identified was phosphodiesterase 4D (PDE4D), which is a regulator of cyclic AMP levels (Houslay et al 2003) and is proposed to control the level of smooth muscle proliferation and immune function in vessels, which leads to the proliferation of atherosclerosis and ultimately an increase in ischaemic stroke risk.

1.16 Health behaviour

For patients with multiple vascular risk factors, lifestyle and behaviour change is one way to reduce risk, however risk factor reduction by addressing lifestyle has been shown to be poorly implemented, with discussion of lifestyle recorded in only 37% of consultations in the Royal College of Physicians sentinel audit for stroke (RCP 2004). It is well documented that patients with chronic diseases inconsistently adhere to secondary prevention advice and strategies (Hillen et al 2000, Mouradian et al 2002, Horne et al 2009). Gilham and Endacott (2010) go as far as to suggest there is little stroke-specific evidence to inform the effectiveness of lifestyle change to modify stroke risk factors after first stroke. However, improving adherence to medications does have the potential to have a major impact on cardiovascular disease prevention (Silcock & Standage 2007). In order to understand how to improve patient adherence to secondary prevention strategies it is important to understand more about why patients make decisions to adhere or non-adhere or why they chose not to undertake a lifestyle modification which may have the potential to reduce their risk of recurrent stroke and vascular events.

Several theories of behaviour change were developed in the 1980's as more sophisticated health promotion programmes were being considered beyond the simplistic transmission of information which failed to succeed beyond affluent, higher socio-economic sections of the populations (Nutbeam 2000). These programmes focused on developing personal and social skills required to make positive health behaviour choices. Examples of theories of behaviour change include, the theory of planned behaviour (Azjen and Fishbein 1980), social learning theory (Bandura 1986) and updated versions of the health belief model (Lewin 1951 cited by Kritsonis 2004, Becker et al 1974,Glanz 2002). Such theories were developed to go some way to explain the complex relationships between knowledge, beliefs and perceived 'norms' and provide guidance on how to develop educational programmes to promote

behavioural change in a set of given circumstances. Few theories have been used to specifically study stroke survivors, however, recently the Cerebrovascular Attitudes and Beliefs Scale (CABS) was designed using the Health Belief Model (HBM) as a framework to understand stroke survivors' perceptions of their risk of future stroke (Sullivan and Waugh 2007). CABS is still in its' developmental stage and was therefore not used as a measure of stroke-related health behaviour in this thesis, however, following further development and validity testing, the tool will be extremely useful in the development of interventions for stroke prevention in the future. Despite this progress in stroke, interventions which have relied primarily on communication and education have mostly failed to achieve substantial results in terms of closing the gap in health status between different social and economic groups in society (Nutbeam 2000). Other mechanisms used in chronic illnesses include patient self-efficacy, intention to comply with treatment advice, attitudes and motivation. Theories of reasoned action and planned behaviour have also been used to explain variations in medication adherence such as the Beliefs about Medicines questionnaire (Horne et al 1999) which assesses patient's beliefs about the necessity of prescribed medications for controlling their illness and their concerns about the potential adverse consequences of taking them.

Subjective risk factor perception is an important component of the motivation to change unhealthy life-styles. As far back at the 1970's there was clear evidence that demographic variables such as socioeconomic status, gender, ethnicity and age affects the extent to which people adopt preventive health behaviours (Rosenstock 1974). However, it also became clear that health education and financed services were not enough to change health behaviours alone and there was another aspect of human psychological behaviour which affected a patient's likelihood to undertake preventive action and follow medical advice (Sheeran and Abraham 2003). Lewin (1951) described the idea of 'valence', that is the rendering of a behaviour as more or less attractive. This lead to the idea that the likelihood of experiencing a health problem, the severity of the consequences of that problem and the perceived benefits of health behaviour in combination with its potential costs could be key beliefs guiding health behaviour (Lewin 1951).

The HBM is a useful framework for understanding the relationships between health beliefs and health behaviour. The model fundamentally focuses on two aspects of

individuals representations of health and health behaviour, threat perception and behaviour evaluation (Sheeran and Abraham 2003). Threat perception depends upon two beliefs, perceived susceptibility to illness or health breakdown and anticipated severity of the consequences of such illness. Behaviour evaluation consists of two distinct sets of beliefs, those concerning the benefits of recommended health behaviour and those concerning the costs or barriers to enacting the behaviour. The perception of these consequences of behaviour is relevant to stroke survivors and may affect their motivation to change lifestyles or adhere to potentially large additions to current medication levels. The model takes individual perceptions and modifying factors and is able to predict likelihood of action (Glanz et al 2002). The HBM (Glanz et al 2002) focuses on attitudes and beliefs of individuals based on the understanding that a person will take a health-related action from core assumptions, if that person; (1) feels that a negative health condition can be avoided, (2) has a positive expectation that by taking a recommended action, he/she will avoid a negative health condition and (3) believes that he/she can successfully take a recommended health action (i.e. s/he can physically take the medication or take physical activity). In order to change, patients need to understand the consequences of the disease and also their behaviours, in order to initiate the suggested change. The HBM suggests 'risk perception' is a key element to understanding how a person becomes motivated to change their behaviour (Glanz et al 2008). Prochaska and Velicer's (1997) Transtheoretical model of health behaviour change was developed to measure a person's 'readiness to change' and used six stages, 1) pre contemplation (no intention to change), 2) contemplation (thinking about making a change), 3) preparation (intending to make a change in the immediate future 4) action (changing the health behaviour), 5) maintenance (working to prevent a relapse back into unhealthy or risky behaviour and 6) termination (zero temptation and 100% self-efficacy). The Transtheoretical model uses stages of change to integrate processes and principles of change from different theories of intervention. The model, originally used in smoking cessation rapidly expanded to apply to a broad range of health and mental health behaviours (Prochaska & Velicer 1997). Both models have been integral to the development of studies exploring human behaviour. The HBM is used within this thesis for the development of questions and both theories were used during the development and communication of the intervention in the RCT.

The theory of planned behaviour was developed from the theory of reasoned action (Ajzen & Fishbein 1975) which is based upon the relationship between attitudes and behaviour and the principle of compatibility (Ajzen 1988). The main theory is based upon the assertion that each attitude and behaviour has four elements, an action, target, context and time. It is thought that the attitudes and behaviour will be most positive when both are measured at the same time in conjunction with the four elements. Hence any particular behaviour consists of (a) an action or behaviour, (b) performed on or toward a target, (c) in a context, (d) at a time or occasion. For example, a person concerned about oral hygiene (a) brushes (b) their teeth (c) in the bathroom (d) every morning after breakfast. This example illustrates how behaviour can be aggregated over a range of occasions. In the study of health behaviours it is the repeat performance of a single behaviour that is useful in predicting future behaviours (Ajzen 1988). The theory was developed further by adding to the model the concept of perceived behavioural control, which is the individuals perception of the extent to which performance of a behaviour is easy or difficult (Connor & Sparks 2003). This theory would be useful in identifying beliefs and values of health that might be influential in changing attitudes towards secondary prevention which may result in improved adherence to strategies, however there has been criticism that communication strategies alone are ineffective in changing attitudes (Connor & Sparks 2003). However the theory gives a greater understanding of how clearly defining an action or behaviour may be useful in changing behaviours in the long-term. Both models have been used to study behaviours in patients with chronic diseases such as diabetes, heart disease and hypertension, however none have been used to specifically predict stroke survivor's behaviours (Rhodes et al 2005).

Some researchers believe it is possible to improve risk perception in the general public through the provision of information and through awareness campaigns (Kraywinkel et al 2007). However, the stroke population is complex and may require a more targeted strategy to improve their risk perceptions and adherence. Patient-centred strategies may lead to the identification of better tools to improve adherence (Schedlbauer et al 2007, Silcock & Standage 2007) while randomized controlled trials have shown specific health behaviour modification interventions can be successful, such as advice to give up smoking (Law et al 1995) and healthy eating in nurse-led CVD follow-up programmes (Wood et al 2008). However, it remains

unclear what aspects of the programmes influence behaviour besides the added contact with a health professional.

However, other studies have shown brief interventions have little impact on risk factor control and do not appear to have any long-term benefit (McManus et al 2009), however in the short term it has been suggested that patients feel more satisfied with the information provided to them about stroke disease, risk factors and who to contact in the event of problems, therefore at the very least there is evidence of an improvement in patient experience. Specifically targeted programmes may be beneficial to the stroke population if they are individually designed. Some studies (Sudlow et al 1997, Hillen et al 2003, Van Wijk et al 2005) have shown some association between smoking cessation and specific socio-demographic characteristics of stroke survivors such as younger age and males. However, Sienkiewicz-Jarosz (2009) investigated the relationship between degrees of nicotine dependence and smoking abstinence 3 months after ischaemic stroke in order to explore predictors for smoking abstinence after stroke. This study suggests dependent smokers have greater difficulty quitting smoking due to more withdrawal symptoms and stronger nicotine cravings. This is an important factor in identifying specific prevention programmes for individuals, ensuring physiological assistance is provided for those who we can predict will struggle to make behaviour changes more than others.

Notwithstanding these successes, studies to examine if improvements have been made to long-term management of chronic vascular diseases such as coronary heart disease, diabetes and hypertension with the formal introduction of pay-for-performance targets have shown no improvement in blood pressure, blood glucose or cholesterol control (Crawley et al 2009). Indeed, even improved patient knowledge has failed to guarantee higher levels of adherence supporting the opposite view that poor knowledge does not necessarily lead to low adherence (Silcock and Standage 2007). Studies investigating interventions to improve adherence have been unable to identify advantages in any one type of intervention (Schedlbauer et al 2004, Horne et al 2005). The provision of medically accurate information may improve knowledge but may not improve mood or perceived health status and therefore the patient's own perspectives about stroke and their recovery. Preliminary studies of additional risk factor advice provision have produced disappointing results for lifestyle change

following stroke (Townend et al 2006). It is therefore an important consideration to include individuals' prior personal experience, beliefs, fears and perceptions prior to developing an intervention if it is to be successful for long term behavioural change.

1.17 Illness perceptions and beliefs

It is becoming increasingly recognised that a person's perception of illness can affect how they react to change lifestyles and adhere to treatment prevention strategies to reduce the risk of recurrence of their illness. However, it is still not understood how best healthcare professionals can measure or influence perception to improve patients adherence to secondary prevention. The illness perception questionnaire (IPQ) (Weinman1996) is a theoretically derived measure comprising five scales to assess the cognitive representation of illness. The five scales assess, identity – the symptoms the patient associates with the illness, cause – personal ideas about the aetiology of the illness, time-line – the perceived duration of the illness, consequences – expected effects and outcome and cure control- how one controls or recovers from the illness (Weinman et al 1996). Understanding patients' representations of their illness may be a useful tool to understanding the psychological impact of the illness and may help to influence behaviour change following stroke. The IPQ can be used as a framework and amended to include items which are specific to a particular illness or patient population which makes it a useful tool to study the stroke population. In cardiac rehabilitation studies it has been shown that socio-demographic variables and beliefs about illness are related to the non-attendance at the programmes rather than medical variables (Cooper et al 2007). Patients who were older, with lower incomes or who were more likely to deny the severity of their condition or believed they had little or low personal control over the cause of their heart condition were less likely to attend (Cooper et al 2007). It is reasonable then to suggest that what patients believe about their treatment and illness may strongly influence their adherence to the rehabilitation or prevention programmes designed for them.

The health belief model and theory of planned behaviour are the two psychological theories which have been frequently used as the frameworks to examine health beliefs in the context of compliance (Ross et al 2004). Sullivan and Waugh (2007) used the health belief model as a framework to develop the CABS measure of stroke related health beliefs. It measures survivor's beliefs and attitudes about their

susceptibility to future stroke, the perceived seriousness of stroke and likely benefits and barriers associated with undertaking behaviours to reduce stroke risk. Most participants in this small study (n=42) changed at least some behaviours post stoke to reduce their stroke risk which may be an indication that measuring perception inadvertently increases awareness and perception of risk, which in turn increases the likelihood of behaviour change taking place. Ross et al (2004) theorise that health beliefs not only predict compliance but that they may be more consistent in doing so than demographic variables which can vary widely. They propose that health beliefs mediate the relationship between demographic variables such as age and gender and compliance. Age, gender and other characteristics of a population may lead patients to have different health beliefs. It is also important to consider how receiving low risk information may affect a patient's behaviour (Cooper 2007). Patients who receive information that their risk of future stroke or heart disease is low may negatively alter their behaviour falsely believing they have a lower than 'normal' risk for recurrence.

1.18 Adherence

Adherence is defined as the extent to which the patient's behaviour matches the recommendations agreed with a prescriber (Horne et al 2005). It assumes that there is a partnership between the patient and provider and that the patient is not simply a passive participant (Bushnell et al 2009) However, adherence is the result of a complex set of perceptions, attitudes, cognitive abilities, intentions and behaviours (O'Carroll et al 2010). Adherence to secondary prevention measures has been shown to reduce the risk of future vascular events, (Husted 2009, Horne 2005, Chaudhry & McDermott 2008) is associated with lower mortality and suboptimal adherence can reduce any positive effects from secondary prevention medications and strategies (Albert 2008). Despite this, non-adherence has been reported in over 40% of patients taking maintenance therapies for such chronic diseases such as inflammatory bowel disease (Horne et al 2008) and several studies have identified poor adherence rates for antithrombotics, lipid lowering, antihypertensives and smoking cessation in stroke populations (Mouradian et al 2002, Hillen et al 2000). Nevertheless, the appropriate use of medication is key to the self-management of most chronic illnesses (Horne & Weinman 1999) and can significantly reduce the risk of secondary stroke (Husted 2009, Chaudhry & McDermott 2008, Rothwell 2007). The Duke Databank for Cardiovascular disease identified patients between 1995-

2002 who self-reported use of Aspirin, β-Blockers, lipid lowering medications and a combination of all three drugs in patients with CAD (Newby et al 2006). The rates of self-reported use were reported as, Aspirin 71%, β-Blocker 46%, lipid lowering medications 44% and a combination of all three in only 21%. In this study they identified a lower adjusted mortality was associated with consistent use of the medications, however, they were unable to differentiate between patient non-adherence and physician non-prescribing as the main cause of the low levels of self-reported adherence (Newby et al 2006). Self-reported adherence to medications is often suboptimal (O'Carroll et al 2010) and is associated with elevated mortality (Albert 2008).

Most non-adherence reports relate to negative attitudes to treatment (Phatak et al 2006, Kane et al 2006, Horne et al 1999) and to the way in which patients judge their personal need for on-going medications (Horne et al 2008). Improving adherence to medications has the potential to have a major impact on cardiovascular disease prevention (Silcock & Standage 2007). The most current Cochrane systematic review of interventions to improve adherence to medications for chronic diseases concluded that "current methods to improve adherence for chronic health problems are mostly complex and not very effective so the full benefits of treatment cannot be realised" (Haynes et al 2008). They suggest high priority should be given to fundamental and applied research to assist patients to follow medications prescriptions for long-term medical disorders (Haynes et al 2008).

Approaches that are physician focused and patient centred, such as frequent follow-up and better education of patients about cardiovascular disease have been suggested (Chaudhry & McDermott 2009) as ways of improving adherence particularly in the management of hyperlipidaemia. More specifically, closer monitoring and greater attention is required by clinicians and a better understanding of the disease is required by patients (Chaudhry & McDermott 2009). However there is also evidence that many physicians fail to adhere to guidelines for treatment of patients with atherosclerosis (Husted 2009). Potential reasons for this have been budget restrictions and access to treatments or concerns regarding excess bleeding particularly for anti-platelet treatment in the elderly population (Husted 2009).

Patient's perceptions about their need for medication may vary according to their underlying health beliefs and this is particularly so for asymptomatic conditions such

as hypertension and hyperlipidaemia (Horne et al 2005). Adherence figures for statins suggest that fewer than 50% of patients were still taking lipid-lowering therapy at 6 months after initiation (Jacobson 2004) and it's been estimated between 30-50% of patients with hypertension regularly take their anti-hypertensive medications (Stephenson 1999, cited by O'Carroll et al 2010). Such long-term therapies for asymptomatic conditions, as well as the number of medicines taken are particularly associated with a lower adherence (Husted 2009).

1.18.1 Measuring adherence

Several measurement frameworks have been devised to measure patients' adherence to medications in particular (Horne et al 1999), including the Beliefs about Medicines Questionnaire (BMQ) (Horne & Weinman 1999) and the Medication Adherence Report Scale (MARS-5) (Horne et al 2008). Horne et al (1997) initially proposed a theoretical framework to explain how beliefs may influence patients' decision making about medication taking. The framework suggests adherence decisions are influenced by a cost-benefit assessment in which personal beliefs about the necessity of the medication for maintaining or improving health are balanced by the patient against concerns about the potential adverse effects of taking it (Horne & Weinman 1999). Several studies have highlighted the difficulties in measuring adherence e.g. the incidence of non-adherence to aspirin therapy may be underestimated by physicians (Shantsila and Lip 2008, Husted 2009). Measuring biochemical markers of inhibition of platelet aggregation (Husted 2009) in patients prescribed aspirin is one suggested technique to measure adherence but this is only relevant to a single aspect of identifying adherence compared with the totality of secondary preventative strategies. Measures used to assess medication adherence can be varied, however, the gold standard assessment of medication concordance is by electronic counting or pill-counting methods (Dunbar-Jacob et al 1996).

Self-reporting by patients to measure adherence is a useful method but it has been argued that self-reported compliance is not accurate enough to justify its use. However, studies that have compared different types of measurement have found it useful (Choo et al 1999 & Di Matteo et al 2002). One author went as far as to suggest that self-reporting should be used in all studies of compliance (Choo et al 1999). It is certainly the most economical and practical measure of adherence open to health professionals (Ross et al 2004) and may be a useful tool if used in

conjunction with more empirical measures. However, it is important to recognise the limitations of self-reporting as it is subject to self-presentational and recall biases. It has also been suggested patients may overestimate the extent of their adherence in an attempt to "please the doctor" or believe that admitting to non-adherence may result in adverse judgement or penalties (Horne & Weinman 1999) or may affect their ongoing care.

1.18.2 Barriers to adherence

The concept of 'unintentional non-adherence' has been described in chronic conditions (Horne et al 2008) and stroke survivors (Silcock & Standage 2007) when patients are prevented from adhering to risk reduction strategies due to limitations caused by their stroke syndrome, such as physical or cognitive problems (Horne et al 2008, Silcock & Standage 2007). This is particularly problematic for all stroke patients however those with mild cognitive problems are at risk also as they tend to receive less support compared to those with severe cognitive problems.

Muscle pain and pain interference with daily activities has been associated with non-adherence to statin therapy (Chaudhry and McDermott 2008). The muscle-related symptoms or myopathies are adverse side-effects of statins and the fear of such has prompted some patients to discontinue medications. It is thought the myopathy may be related in part to statin inhibition of the endogenous synthesis of coenzyme Q10 which is considered an essential cofactor for mitochondrial energy production (Chaudhry & McDermott 2008). Studies investigating patients with chronic diseases have suggested severity of illness, addictive behaviours such as smoking and alcohol use and the presence of psychosocial factors such as depression are also related to poor adherence (Osterberg and Blaschke 2005, Wu et al 2008). These factors are themselves common in stroke patients and may be a reason for high rates of non-adherence in this population.

Recent evidence also implicates ethnic origin as a determinant of the type and level of health care received, suggesting that inequalities exist as a function of ethnic or social background. Very few studies have attempted to address this question. Pandian et al (2005) reported that awareness of stroke risk factors among high-risk individuals in India was poor and did not differ significantly from those respondents who had no risk factors at all. Moreover, even the medical profession underestimates risk with regard to ethnic minorities (Bourke et al 2006). Work from our group has

shown that such minorities are less likely to receive appropriate care following stroke compared to their white Caucasian counterparts (Bourke et al 2006), a similar finding was replicated by Jacobs et al (2006) in stroke and by Baljaran et al (1991) in heart disease. Teaching and training health professionals about risk and health care needs of ethnic minorities are severely lacking nationwide (Bentley et al 2008).

1.18.3 Suggestions to improve adherence

Benner et al (2004) found that patients who received a follow-up visit and a serum cholesterol test were 45% more likely to be adherent to statin medications than those who did not. In a recent population-based study 2 cohorts of patients were identified: those prescribed a statin and who were followed-up with subsequent cholesterol testing and upward titration of statin therapy to reach their target as necessary, and the second cohort who were prescribed the statin without any further follow-up (Wei et al 2007). Adherence to the statin in the patients with follow-up was found to be significantly better than those without. This suggests there is a clinical benefit to following these patients up and the health benefits in stroke/cardiac event prevention would outweigh costs incurred through clinical investigation and follow-up. Reviewing a patient's medications list at each outpatient appointment can be time consuming but necessary to ensure medications are being taken (Chaudhry & McDermott 2008) and gives patients an opportunity to discuss any concerns regarding their medications with a health professional.

Studies investigating interventions to improve adherence have been unable to identify advantages in any one type of intervention (Schedlbauer et al 2004, Horne et al 2005). The provision of medically accurate information may improve knowledge but may not improve mood or perceived health status and therefore the patient's own perspectives about stroke and their recovery. Preliminary studies of additional risk factor advice provision have produced disappointing results for lifestyle change following stroke (Townend et al 2006). Studies have shown that patient education alone may not be sufficient to promote health behaviour change (Sullivan & Waugh 2007). Knowledgeable patients do not always change their behaviour. Indeed, even improved patient knowledge has failed to guarantee higher levels of adherence supporting the opposite view that poor knowledge does not necessarily lead to low adherence (Silcock and Standage 2007). These studies show conflicting ideas relating to education and knowledge and their influence on adherence, suggesting

the possibility that knowledge itself has little impact on what makes humans behave in the healthiest way. However, in clinical practice it would be negligent to abstain from providing information regarding disease management and risk factor awareness, however, it might be useful for health professionals to be aware that information alone may not make a patient change their behaviour to reduce their risk or control their symptoms.

1.18.4 Understanding risk as a means of improving adherence

It is important for patients to have an understanding of their risk of future vascular events in order to improve adherence to therapeutic and life-style modifications in all ethnic groups (Samsa et al 1997, Muller-Nordhorn et al 2006, Dearborn & McCullough 2009). A lack of knowledge and understanding of risk of future events may affect attitudes to behaviour change following stroke. Social scientists argue that any behavioural change first requires understanding of the disease (Dearborn & McCullough 2009) e.g. educating and motivating patients to understand the benefits and risks of statin therapy may be an important step for ensuring the benefits of management cited in clinical trials are translated to the general population (Pearson & Kopin 2003). In two studies of smokers' perceptions of their chances of getting lung cancer, although in both studies the smokers rated their chances higher than non-smokers, they rated their own chances as only about average and in one study 44% considered that smoking caused cancer but only for those whose daily consumption was higher than their own. This could be an indication of poor risk perception of lung disease in the presence of smoking and suggests unrealistic optimism regarding chances of getting a smoking related illness in this population (Repucci et al 2007 and Perett-Watel et al 2007).

Although most studies have focussed on the general public, Samsa et al (1997) looked at the knowledge of risk of stroke among patients at increased risk and showed that only 42% of patients with a history of previous stroke were aware of their future stroke risk and as few as 27% recalled being informed of any risk by their physician. In 2001, Qureshi reported that only 35% of hypertensives were appropriately controlled and 50% of diabetics had adequate blood glucose control. Cholesterol was poorly controlled in 46% and 18% of individuals were still smoking cigarettes after their first stroke. This was supported by Crosquelois and Bogousslavsky (2006) who at 3 month follow up concluded that cerebrovascular risk

factor control was not optimal. They concluded that this may be related to poor patient awareness and knowledge and highlighted that older patients and patients who had made an excellent recovery were at particular risk of poor awareness and adherence to risk modifications.

Samsa et al (1997) reported that respondents most likely to be aware of their stroke risk were younger as were those who reported their current health status as poor. Indeed, one year post stroke Redfern et al (2000) found 27% of patients still smoked (mostly young, white males), 36% were obese and 4% drank excessively. However, half of those who still smoked at 3 months had reduced the amount they smoked, suggesting that they were willing to change their risk factors but might have needed further support to give up completely. Sappok et al (2001) found that higher age, more severe neurological deficit on admission and a cardio-embolic cause were associated with better long-term compliance, however it is important to add that older age and severe neurological deficit suggest a need for more direct care which indicates further assistance is given with medication taking and lifestyle choices. Women and younger patients (< 75years) with heart failure are known to be less adherent than men and older people (Granger et al 2009). Conversely, Lip et al (2002) performed a study looking at ethnic differences in patient perceptions of AF and anticoagulation therapy found only 63% of patients aware of their cardiac condition, with South Asians and African Caribbean's significantly less aware of AF compared to their European counterparts ($p<0.001$). Worryingly, in this study 61% felt that AF was not a 'serious' condition and only 52% associated it as the reason for commencement on warfarin therapy.

Dearborn and McCullough (2009) in a study of women at high risk of stroke found that they were often unable to identify their health condition as a risk factor for stroke and their risk perception was low. Women who were high-risk still perceived their risk to be the same as their peers. This continued lack of perceived risk and lack of knowledge of risk factors has considerable consequences for health professionals working with first time stroke survivors to ensure high risk individuals adhere to stroke prevention strategies.

Vascular disease is a real risk to health in a huge population and patients with a history of vascular disease are at risk of further vascular events. Patients with stroke are at a particularly high risk of further stroke but secondary prevention strategies

can reduce that risk. However, despite studies to investigate stroke behaviours and theories which have identified strategies to study patient risk reduction behaviours, adherence to secondary prevention strategies in stroke patients is still disappointingly low and ineffective.

1.19 Health literacy

Adherence is influenced by low health literacy among patients (Colledge et al 2008). The WHO definition of health literacy is "the cognitive and social skills which determine the motivation and ability of individuals to gain access to understand and use information in ways which promote and maintain good health" (WHO 1998). Nutbeam (2000) describes 3 types of health literacy;

Basic – implies a fundamental understanding of a health problem and the ability to comply with prescribed action to remedy the problem

Functional – involves more advanced knowledge and skills to function in everyday society and the ability to seek out information in order to respond to changing needs.

Critical – advanced level of health literacy implies a significant level of knowledge, personal skills and confidence to manage ones health and the ability to take action to change the determinants of health in the environment.

Basic health literacy should be the aim for all members of society and ideally patients with chronic conditions should be supported to have critical health literacy in order to make the decisions needed for them to participate in their long-term health management.

Health literacy is also defined as "the degree to which individuals have the capacity to obtain, process and understand basic health information and services for appropriate health decisions" by Healthy People 2010 (National Centre for Health Statistics 2010). Health illiteracy has been made a government priority in the US as reportedly 90 million Americans struggle to understand basic health information (Kirsch et al 1993). This is a major obstacle to providing high quality care, as long-term and chronic diseases require self-management skills and the ability to negotiate complex treatments and health services. The British government identified their commitment to improving health literacy in the 'saving lives: our healthier nation'

policy (DH 1999). The policy identified a range of social determinants of health and inequalities in health with the identification and connection between educational status, literacy and health. A health literate individual is likely to have sufficient knowledge and skills to handle the information demands of the health system, communicate with health professionals, make appropriate use of health services, and contribute to optimizing the management of their own disorders. Patients with good health literacy skills can also act as advisers and mentors for other patients with long-term diseases and thus help spread best practice and improve disease management. However, rates of non-compliance may be as high as 50% in chronic conditions (Ross et al 2004 & Dunbar-Jacob et al 2001). Non-adherence in chronic disease has been associated with misunderstanding of the condition, perceived improvement in health, worsening in health, general disapproval of medications and concern over side-effects (Dunbar-Jacob et al 2004 & Svensson et al 2000). Hypertensive patients are clearly an example of a chronic disease population at high risk of non-adherence as they generally have no symptoms and therefore may perceive no benefit in feelings of well-being associated with their medication and side-effects from medications for a condition which is asymptomatic may be unacceptable to some of these patients (Ross et al 2004).

To patients, adherence may suggest the relief of symptoms and to providers more increasingly it may suggest the achievement of therapeutic goals and targets (Kennedy 2000), however adherence is not restricted to the act of taking medications, it is also related to the patient actively making changes in their lifestyle and behaviours such as smoking cessation, nutrition, and activities as well as attending medical appointments and making changes in response to new diagnosis and changes in their condition.

1.20 Conclusions

This thesis aims to go some way to increasing the body of knowledge to understanding risk awareness as a tool to improve secondary stroke prevention. An initial systematic review and meta-analysis was performed in order to gain a thorough understanding of risk of stroke in the presence of vascular disease. A systematic approach was taken to the literature review and search strategies were used when searching databases such as PubMed, Google scholar, Embase and Medline. Search terms such as ‘risk awareness in secondary prevention’, ‘stroke

prevention', 'stroke risk factors' and 'recurrence', 'adherence', 'health literacy' and 'risk perception' were all used to identify the literature. The literature identified in the review was used as a basis of information gathering and informed the general framework for the studies within this thesis.

Several theoretical frameworks were identified in order to inform questions for a population based study (chapter 3) to understand knowledge of stroke, signs and symptoms, behaviours and risk perceptions in a high risk stroke survivor population. The Health Belief Model and The Illness Perceptions Questionnaire (IPQ) were the main theoretical frameworks used and modified for the development of the sections investigating patient perceptions of the causes, consequences and timelines of their condition.

Chapter 4 describes a survey study of the general public population regarding their understanding of Blood Pressure. The participants were asked about their knowledge of blood pressure in order to understand whether awareness of BP affects control of BP in the healthy and hypertensive populations. Finally the knowledge gained from the previous studies described in chapters 1-4 informed a randomised controlled trial (RCT) aimed to identify if increased awareness of risk improves adherence to secondary prevention strategies and impacts on risk factor control as part of secondary stroke prevention.

The literature used throughout this work has identified risk perception theories and adherence measures such as HBM, IPQ, BMQ, however, these measurement frameworks have not been used specifically in the RCT, and they informed the general direction of the work. Specific medication adherence to cardiovascular secondary prevention medication was not measured as part of the RCT and therefore the BMQ (Horne et al 1999) was not used, however the theoretical framework behind the measurement tool was useful in understanding the relationship between health beliefs and health behaviour. The literature surrounding health literacy, adherence and the perception of medicine beliefs questionnaire was useful in the development of the intervention for the RCT to understand how to influence patients' behaviours and how best the researcher could communicate the intervention to the participant. In summarising the findings of the RCT the theoretical frameworks were useful during discussions surrounding human behaviour.

1.21 Chapter 1: Tables and Figures

Figure 1.1: Risk of Stroke recurrence (Mohan et al 2011)

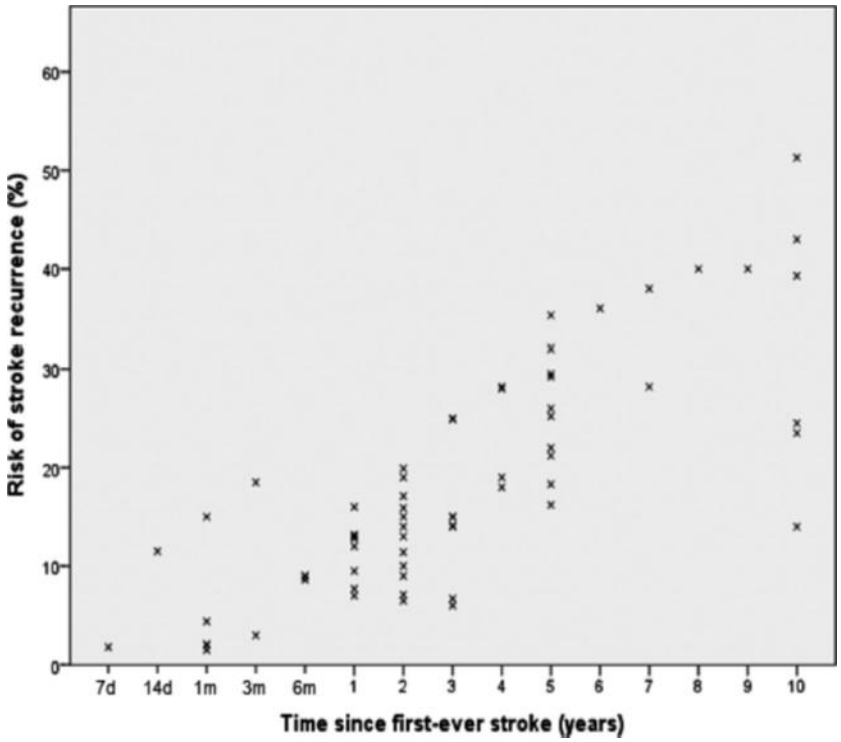


Figure 1.1 shows the estimates of risk of stroke recurrence across all the included studies (Mohan et al 2011). The risk of stroke recurrence was reported to range from 1.1% in South London, UK (Mohan et al 2009) to 15% in Oxfordshire, UK (Coull et al 2004) by 1 month, from 7.0% in Lisbon, Portugal (Salgado et al 1996) to 20.6% in Nanjing, China (Xu et al 2007) by 1 year and from 16.2% in South London, UK (Mohan et al 2009) to 35.3% in Hisayama, Japan (Hata et al 2005) by 5 years; and from 14% in Rome, Italy (Prencipe et al 1998) to 51.3% in Hisayama, Japan (Hata et al 2005) by 10 years after initial stroke.

Chapter two: Silent brain infarction in the presence of systemic vascular disease: a systematic review and meta-analysis

2.1 Introduction

It is now recognised that systemic vascular disease is part of a larger family of atherothrombotic diseases which are predicted to be the leading cause of death worldwide by 2020 (WHO 2011) However, despite receiving contemporary evidence-based preventative drug therapy, patients with established arterial disease and those with multiple risk factors for atherothrombosis both experience high cardiovascular (CV) event rates (Steg et al 2007) and are at a high risk of secondary stroke. People with symptomatic atherosclerosis in 1 vascular bed are at a higher risk of subsequent events in other beds, e.g. patients who suffer a stroke are at a high risk of going on to suffer a coronary event, with a 10 year CV event risk of 42.8% (Barnett et al 2007). These findings support the need for increased awareness among physicians and patients for the amount of vascular cross-risk that is related to the overlap between the various beds of atherothrombosis.

Stroke is the second most common manifestation of atherothrombotic vascular disease after coronary artery disease (Fuster and Moreno 2005). There is a need to identify and understand the risk factors and vascular disease risk markers for silent brain infarction, so that stratification of risk of an individual patient or population can be established (Gallego et al 2005). The aim of this study is to identify the prevalence of asymptomatic brain ischaemia in the presence of vascular disease in other locations to add to the field of knowledge. To highlight the importance of investigating and treating other vascular diseases in the presence of silent or asymptomatic cerebrovascular disease, this review will investigate studies which have identified the presence of silent brain infarction in the presence of coronary artery disease (CAD), peripheral vascular disease (PAD) and in acute ischaemic stroke. A number of studies have investigated and evaluated the relationship between stroke and MI, supporting the positive predictors for either event, yet shows varying results on the rate of subsequent cardiovascular events (Lichtman et al 2009 and Witt et al 2006). A previous meta-analysis synthesising the incidence of stroke after MI found 21.4 strokes occurred per 1000 MI at 1 year (Witt et al 2006). Conversely, there is an average annual incidence of 1% for MI after TIA (Burns et al 2011), and a 2.2% annual risk has been shown through meta-analysis for MI after stroke/TIA (Touze et al 2005).

Ischaemic stroke occurs predominantly as the result of a complex accumulation of atherosclerotic plaque which ultimately results in an atherothrombotic occlusion of the large or small vessels, followed secondly by cardio embolic stroke and less frequently by venous thrombosis or hypo-perfusion. Coronary artery disease (CAD) encompasses both ischaemic heart disease (IHD) and acute coronary syndromes including ST or non-ST elevation myocardial infarction (MI) or unstable angina. This is usually due to ischaemia from vulnerable plaque or coronary thrombosis and less frequently embolism (Anderson et al 2011)

Silent brain infarction (SBI) is an independent risk factor for stroke (Vermeer et al 2003) and if risk of SBI in other vascular diseases can be established also, then appropriate assessment and therapeutic treatments could be initiated to reduce the incidence of stroke in this high risk population. SBI's are known to be associated with a vascular origin and are reportedly seen frequently in asymptomatic elderly people (Longstreth et al 1996, Howard et al 1998, Vermeer et al 2002). Those with SBI are generally considered to be a high-risk group for clinical stroke. Several studies have examined the incidence of SBI and its relation to risk factors for stroke. Two recent studies (Vermeer et al 2003 and Bernick et al 2001) both found that risk of stroke increased 2-3 fold in the presence of SBI's on MRI in an elderly population. Vermeer et al (2003) stated an absolute risk of stroke within 4 years was 11.7% for participants with SBI compared to 2.3% for those without SBI. The majority of these studies (Vermeer et al 2003) demonstrated that age and hypertension, strongly and independently correlated with SBI's which would highlight an association with cerebrovascular disease as both age and hypertension are the largest modifiable risk factors for stroke. Patients with stroke caused by atherosclerotic disease of the large artery have a higher risk than those with stroke caused by small vessel disease (Hara et al 1994).

2.1.1 Silent brain infarction

Silent brain infarcts by definition are asymptomatic and frequently go unnoticed, however the presence of silent infarcts can as much as double the risk of subsequent stroke. Vermeer et al (2007) suggest future studies should investigate whether screening and treating high risk patients can effectively reduce the risk of further infarcts and stroke.

Most SBI's observed in acute stroke patients are small and deep (Ong et al 2009). Bokura (2008) found SBI to be the most significant independent risk factor for clinical stroke onset in a prospective cohort study. SBI was found in 380 of 2684 participants (14%). 102 subjects went on to have a clinical stroke (3.8%) during the follow-up period which suggests an increased risk of clinical stroke in patients with SBI. The Rotterdam scan study (Vermeer 2002), identified a prevalence of 20% of SBI in a normal healthy population aged 60-90 years. The prospective Rotterdam scan study showed that the presence of silent infarcts more than doubled the risk of dementia. Risk factors for SBI are considered to be comparable to those for stroke. The presence of SBI in stroke patients is associated with increasing age, hypertension, cigarette smoking, internal carotid artery stenosis and atrial fibrillation (Corea et al 2001).

The objectives of the study by Giele et al (2004) were to investigate the prevalence of silent infarcts in a high–risk population of patients with clinically manifest vascular diseases (coronary artery disease, peripheral vascular disease, abdominal aortic aneurysm (AAA) and to investigate its determinants. In this study patients with silent infarcts were older and more often had hypertension. Silent infarcts were found in 17% (51) of the 308 patients included in the study (mean age 58.4 years). Giele (2004) concluded that patients with manifest vascular disease especially AAA, are at risk of silent infarcts at a younger age and identified significant risk factors for the presence of silent infarcts were age, hypertension, systolic and diastolic BP, AAA, elevated creatinine, renal failure, elevated homocysteine and increased Intimal Medial Thickness (IMT).

The Rotterdam scan study (Vermeer et al 2002) showed of 1077 patients, 24% had 1 or more infarcts on MRI, of these, 217 (20%) had only silent infarcts, 26 (2.4%) had symptomatic infarcts and 16 (1.5%) had both. The majority of silent brain infarcts are lacunar infarcts found in the basal ganglia, one third of the patients with symptomatic infarcts had cortical lesions. Kobayashi et al (1997) go on to suggest a strong association of SBI with hypertension and suggests the underlying mechanism to be small vessel vasculopathy. This study showed that subjects with SBI showed significant association for clinical subcortical stroke, hypertension, age, diabetes, alcohol habits and retinal artery sclerosis were significant and independent risk factors. Annual incidence of clinical stroke was higher in the subjects with SBI than in

those without focal lesions (10.1% versus 0.77%). Vermeer et al (2007) performed a systematic review of the frequency, causes and consequences of MRI-defined SBI's. They examined 105 original papers which described the frequency, risk factors and consequences of silent brain infarcts detected on MRI imaging in a variety of adult populations.

The Northern Manhattan Study (Prabhakaran et al 2008) found SBI prevalence increased with age (<65years: 9.7%, 65-75years: 16.4%, >75years: 26.1%), was increased among men (21.3% in men, 15.2% in women) and was increased amongst blacks (24% Vs 18.1 in Europeans and 15.8 in Hispanics). They concluded age, male sex and hypertension were independently associated with SBI. Hypertensive and Diabetic small vessel disease are thought to be the main causes of most infarcts which are found within the basal ganglia (Vermeer 2007). These Lacunar infarcts are small infarcts occurring in the deeper parts of the brain (Basal Ganglia, Thalamus, Brain stem). They are caused by occlusion of the deep penetrating branches of major cerebral arteries (Vermeer 2007). The association with hypertension and diabetes is due to severe atherosclerosis of the small vessels, known as small vessel disease. In hypertension and diabetes, these vessels become thickened, and the normal components of their walls are replaced by a homogeneous substance composed of collagen and other proteins (Agamanolis and Adams 2011). In hypertension, it is caused by endothelial injury and leakage of plasma proteins in and around vessels, in diabetes, it has to do with glycation of proteins and diffuse basement membrane thickening. The overall effects are narrowing of the lumen and tortuosity, which lengthens the distance blood has to travel to perfuse its targets. Ischaemia resulting from these processes, causes small infarcts (lacunar infarcts) and diffuse loss of tissue density in the white matter (Agamanolis and Adams 2011).

2.1.2 Silent brain infarction in healthy populations

SBI have been found in healthy populations also and have been detected in 20% of healthy elderly populations and up to 50% in specific patient populations. The Rotterdam scan study (Vermeer et al 2002) found a prevalence of 20% of SBI in a normal, healthy population aged between 60-90years. The prevalence was strongly affected by age (Giele et al 2004) and increased from 8% in the participants aged 60-64 years to 35% in the oldest group (85-90years). The Framingham offspring

cohort were investigated for SBI with no history of stroke or TIA and 10.7% had at least 1 SBI which were largely located in the basal ganglia (52%) (Das et al 2008). A population based autopsy series found that nearly 13% of asymptomatic subjects had pathological evidence of SBI (Shinkawa et al 1995). There is therefore, a need to identify and understand risk factors and vascular disease risk markers for SBI, so that the stratification of risk of an individual patient or in a specific population can be established, appropriate cerebrovascular assessments conducted and appropriate therapeutic interventions initiated (Gallego J et al 2005).

To detect silent infarcts, MR images were made in 308 participants of the Second Manifestations of ARTerial disease (SMART) study (mean age, 58 years) without prior stroke or transient ischemic attack (Giele et al 2004). These are patients referred because of atherosclerotic vascular disease. Silent infarcts were found in 51 patients (17%). Most infarcts (62%) were located in white matter, 20% in the basal ganglia, 14% in the brain stem and cerebellum, and 4% in the cortical area. Categorical determinants for presence of silent infarct(s) that remained (borderline) significant after adjustment for age were hypertension (odds ratio [OR]=2.2; 95% CI, 1.2 to 4.2), abdominal aortic aneurysm (OR=2.4; 95% CI, 0.9 to 6.4), severe renal failure (OR=7.3; 95% CI, 2.1 to 25.2), and hyperhomocysteinaemia (OR=2.6; 95% CI, 1.1 to 5.9).

2.1.3 Impact on outcome in stroke patients

Silent brain infarctions are thought to be associated with a higher mortality, however no significant difference in mortality has been found between two groups with and without SBI (p=0.26) (Ong et al 2009). Mortality has been shown to be related to the subtype of stroke and is higher in patients with cardio embolic and large artery atherosclerosis as opposed to reports that most SBI are small and located in small arteries in the subcortical areas. Ong et al (2009) found SBI did not influence functional or vital outcomes among acute stroke patients and outcome has not been affected in patients with and without SBI at 2 year follow-up (Corea et al 2000 and Minn et al 2005).

2.1.4 Silent brain infarction in the presence of acute ischaemic stroke

Silent brain infarction is a common finding in asymptomatic elderly populations (Vermeer et al 2002), however, the frequency of SBI found in patients with first ischemic stroke has been previously reported with large variations between 10-40%

(Brainin et al 1992, Chodosh et al 1988, Herderschel 1992 et al and Ricci et al 1993). However, little is known about it as an independent risk associated with recurrent stroke or indeed its impact on stroke outcome in stroke survivors. Ong et al (2009) performed a study to evaluate the prevalence, risk factor and impact of SBI on the outcome of stroke patients. The frequency of SBI in the presence of first ever ischemic stroke or TIA was 20%. This study confirmed the majority of SBI to be small and deep. They also identified age, hypertension, diabetes mellitus, hypercholesterolaemia, hypertriglyceridaemia, alcohol use, smoking habits and AF did not significantly differ between patients with or without SBI. The mortality rate was higher in the patients without SBI than those with. The study concluded that first-ever stroke patients with SBI should be considered at a high risk for recurrent stroke.

2.1.5 Silent brain infarction in the presence of coronary artery disease

Vascular disease is a systemic, diffuse condition involving the coronary and peripheral arteries and is the most common cause of death and disability worldwide Fuster and Moreno 2005). Ikram et al (2008), showed that both clinical and subclinical cerebrovascular disease have been shown to be closely associated with each other and share similar risk factors, silent Myocardial Infarction and silent brain infarction present in patients with dementia. Kurl et al (2003) performed a study investigating the association of exercise-induced silent ST-segment depression with the risk of stroke and cardiovascular diseases in men and found that silent myocardial ischaemia is an important indicator of increased risk of stroke. Men with silent ischaemia during exercise had a 2.2 fold increased risk of stroke and a 3.5 fold increased risk of cardiovascular death compared with men without silent ischaemia. Prosser et al (2007) suggested that in the first 3 months after acute stroke 2-6% of patients die from cardiac causes. They found that from 846 patients with ischaemic stroke, 35 (4.1%) died from cardiac causes and 161 (19%) suffered at least one serious cardiac adverse event (SCAE).

It is well known that coronary artery disease and cerebrovascular disease (CVD) coexist and have similar risk factors. One third of patients with ischaemic stroke already have clinical manifestation of CAD such as angina or a history of ischaemic heart disease or myocardial infarction (Sandercock et al 1989). Alternatively CAD and ischaemic heart disease are well known as independent risk factors for

cerebrovascular disease (Pardo et al 1998). Patients with a history of ischaemic heart disease or coronary atherosclerosis have a higher risk for silent brain infarction than those who don't (Tanaka et al 1993). CAD is the most common manifestation of atherothrombosis (Fuster and Moreno 2005) and therefore patients with CAD may have increased risk of SBI, resulting in increased (2-3 fold) risk of stroke. This review identified studies which looked at populations with symptomatic coronary artery disease and investigated the relationship between CAD and the presence of SBI on either CT or MRI imaging. Giele et al (2004) concluded that patients with manifest vascular disease are at risk of SBI at a younger age and Hoshide et al (2001) performed a study to clarify differences in the progression and characteristics of SBI in patients with CAD. They concluded SBI were more advanced in patient with multi-vessel CAD than in patients with hypertension alone. Coronary atherosclerosis was independently associated with SBI in these patients (Hoshide et al 2001).

2.1.6 Silent brain infarction in the presence of peripheral artery disease

Peripheral artery disease (PAD) is a common manifestation of arthrosclerosis affecting an estimated 27 million people in Europe and North America (Berger et al 2009). PAD is associated with increased risk of cardiovascular events due to CAD and CVD. There is a 20-60% increased risk of MI, a two-six fold increased risk of cardiovascular death and a 40% increased risk of stroke in patients with PAD (Hirsch et al 2006). Antiplatelet therapy reduces the risk of MI, stroke and vascular death in patients with PAD (Cacoub et al 2005).The prevalence of PAD has increased from 0.5% in 1970 to 3.6% in 2002 (Fuster and Moreno 2005). The outcome in the CHARISMA study (Berger et al 2009) for patients with asymptomatic or symptomatic PAD showed the overall rate of cardiovascular death, MI or stroke was 8.2% compared to 6.8% in patients without PAD during mean follow up of 27.6 months (Bhatt et al 2007).

This systematic review and meta-analysis has been undertaken to identify the prevalence of silent brain infarction in the presence of acute ischaemic stroke, heart disease and peripheral artery disease, in order to attempt define the associated risk of future vascular events in the presence of silent brain infarction. The method of identifying and combining specific results from studies of SBI in the presence of systemic vascular diseases aims to summarize the existing evidence available from previous studies performed.

2.2 Aims and Objectives

1. To perform a comprehensive systematic review of silent brain infarction in the presence of acute ischaemic stroke, coronary artery disease and peripheral artery disease as the 3 main aspects of vascular disease

2. Summarize the existing evidence from previous studies performed.

3. To undertake a meta-analysis and identify the prevalence of SBI in order to define the associated risk of future vascular events.

2.3 Methodology

Data Sources Studies dating from 1988-January 1st 2011 were identified through searches in PubMed, Google scholar, Embase and Medline. The following search terms were used in each search engine: “silent brain infarction in stroke” and/or “asymptomatic stroke and cerebral infarction” and/or “silent cerebral infarction in stroke” and then separate searches were performed looking specifically at terms linking silent brain infarction with other vascular diseases locations, such as: “silent brain infarction in peripheral vascular disease”, “silent brain infarction in coronary artery disease” and “silent brain infarction in vascular disease”. The retrieved studies were examined thoroughly to assess their appropriateness for inclusion in the study. The references of all identified publications were manually reviewed for additional studies and the PUBMED ‘relevant articles’ function was used to ensure comprehensive use of this database.

2.3.1 Meta-analysis

Meta-analysis is the combination of results from multiple independent studies. The earliest specific example of meta-analysis as a tool to inform clinical practice was by Karl Pearson in 1904 when he looked at the effectiveness of Typhoid vaccines. There has always been a need and a desire for medical and clinical evidence to inform practice, however, evidence based research has increased more so in recent years and the use of meta-analysis has grown enormously (Sutton 2007). It is now been identified as the most cited type of research paper found in journals (Patsopoulos et al 2005). The process of systematic review which is usually undertaken in most studies does to some extent reduce bias due to selective inclusion of studies for analysis. Meta-analyses are generally undertaken for a variety of reasons, however, the broad aim is to summarize existing evidence but the

method can be used to inform specific decisions in clinical practice. The specific breakdown and explanation of analysis of this meta-analysis are described in-depth in section 2.4.1.

This method has been selected to investigate the presence of SBI in systemic vascular disease as it involves reviewing all existing literature and summarizing it appropriately. This process provides a systematic approach to performing the research synthesis whilst being able to indicate where more research in the topic is necessary (Stroup et al 2000).

2.3.2 Search strategy and selection criteria

The search strategies identified thousands of studies relating to SBI in vascular disease (Figures 2.4, 2.5, 2.6). Reference lists were searched of relevant studies, resulting in another 17 for SBI in ischaemic stroke, 12 for SBI in coronary artery disease and 7 in SBI in peripheral artery disease. Studies were included if they were on patients with symptomatic stroke, peripheral artery disease and ischaemic heart disease. The studies included were published in English, had imaging using either CT or MRI. SBI lesions were recorded in some studies and defined in size between 3-5mm in diameter. The cardiac studies used a variety of techniques to identify CAD such as ECG, SPECT, troponin, echo, scintography. As with studies using troponin as a measure of heart disease, Jespersen et al (2008) explain that a rise in cardiac troponin (cTn) is not necessarily due to coronary thrombosis as seen in patients with severe physical or mental stress which is often the case when someone is having or has just suffered a stroke and may not be an indication of CAD, therefore studies using troponin as a measure of CAD have been excluded from the analysis.

2.3.3 Study selection

Study selection was performed independently by two reviewers and disagreements were resolved by consensus and by the opinion of a third reviewer when necessary. Inclusion criteria included: (1) studies in populations of acute ischaemic stroke, coronary artery disease and peripheral artery disease; (2) studies where the presence of silent brain infarction was measured using CT and/or MRI imaging; (3) subjects were >18 years of age. Exclusion criteria included: (1) subjects were <18 years age; (2) studies which focussed on populations with no history of any vascular disease; (3) studies where cases of stroke had a background of metabolic disease or other non-vascular origin. Tables 2.1, 2.2 and 2.3 provide detail about the studies

included in the meta-analysis including author, year, sample size, mean age (where listed in the studies) and percentage of SBI found in patients.

2.4 Results

2.4.1 Data extraction and analysis

Data for analysis were extracted independently from each study by two reviewers, results compared, and disagreements resolved by consensus. The following information was extracted from each study: first author, journal, and year of publication, stroke sub-type, and the number of cases and evidence of SBI for each subgroup. Data was analysed using Review Manager v5.0. For each paper a pooled odds ratio (OR) and 95% confidence interval (CI) was calculated using a fixed (Mantel-Haenszel) and random effects (Mantel-Haenszel) analysis model. The strength of presence of SBI versus no presence of SBI was considered statistically significant with an OR greater than 1 and p-value of <0.05. For each meta-analysis an I^2 test for heterogeneity was performed, with significance set at $p<0.05$. Visual funnel plot inspection and Egger regression intercept p-value (two-tailed) were performed to identify probability of publication bias.

The meta-analysis was performed using excel and Review manager software systems. Three separate analyses were performed for silent brain infarction in the presence of AIS, CAD and PAD. As this was a one-sided investigation without a comparison group, an arcsine transformation was used for the meta-analyses (Kulinskaya et al 2008). This consists of taking the arcsine of the square root of a number. The square-root transformation is commonly used when the variable is a count of something as in this study, the variable is the count of SBI found in the different populations examined (McDonald 2009). Full formulae used for arcsine formatting are outlined in Appendix 1. For each study, the percentage proportion of stroke patients who were positive for silent brain infarction from the total population of patients was recorded. The standardised mean difference and standard error for each proportion was then calculated and the results combined using the generic inverse variance approach in Review Manager Version 5.1.1 (Cochrane Collaboration 2011). Pooled data was first analysed with a fixed-effects model and if heterogeneity was detected by T^2 tests for heterogeneity, including visual inspection of forest plots, a random-effects model was used. This produced a standardised

mean difference (SMD) with 95% confidence interval (CI) for each study and a pooled effect size for all studies with 95% CI that was weighted to the size of the individual studies. The results are presented representing the prevalence of SBI in vascular patients is interpreted as a percentage (Kulinskaya et al 2008).

2.4.2 Silent brain infarction in the presence of acute ischaemic stroke

Figure 2.4 shows the PRISM statement and search strategy, including all the studies identified in the course of the systematic review and reasons for inclusion and exclusion from the meta-analysis. Initial search produced 10487 potential studies. The majority of papers were excluded because they were not population specific, there was no measurement of SBI or SBI was measured in a non-stroke population (p=<0.01).

The Forest plot in figure 2.1 suggests there is a relative risk of SBI in the presence of acute ischaemic stroke is 23% with a standard mean deviation of 0.99 (CI 95% 0.88 - 1.10).

2.4.3 Silent brain infarction in the presence of coronary artery disease

Figure 2.5 shows the search strategy and reasons for inclusion and exclusion from the Meta analysis for the presence of SBI in patients with CAD. Much exclusion was due to studies focussing on asymptomatic CAD in stroke patients, no relevant data or measurement of SBI, papers identifying risk factors for CAD or SBI and non-CAD populations. The final 11 papers were identified for the meta-analysis out of a total of nearly 600 which were identified in the search.

The Forest plot in figure 2.2 suggests there is a 35% relative risk of SBI in patients with CAD with a standard mean difference of 1.26 (CI 95% 0.95, 1.58).

2.4.4 Silent brain infarction in the presence of peripheral artery disease

Figure 2.6 shows the search strategy and reasons for inclusion and exclusion from the meta-analysis for the presence of SBI in patients with PAD. Much of the exclusion was due to studies focussing on asymptomatic PAD in stroke patients, no data or measurement of SBI in patients with PAD. From 162 papers only 2 papers were able to provide data of patient population numbers with a diagnosis of PAD and a measure of the presence of SBI observed in that population.

The Forest plot in figure 2.3 suggests there is a 14% relative risk of a patient with peripheral artery disease having silent brain infarction. The standard mean difference is 0.48 (CI 95% 0.42, 0.54). There is significant heterogeneity in the population (p=0.0002).

2.5 Discussion

This systematic review and meta-analysis provides an up-to-date understanding of the burden of SBI in vascular disease, as well as highlighting independent risk factors associated with SBI in asymptomatic populations. SBI significantly increases the risk of stroke in all vascular groups examined and is particularly high in patients with CAD (35%). This review confirms that age and hypertension are the most consistent determinants for SBI (Vermeer 2007, Giele et al 2004, Ong et al 2009), however systemic vascular disease including CAD, CVD and PAD share similar cardiovascular risk factors and the risk of suffering these diseases, increases with age, therefore increasing the risk of SBI in all populations.

This study provides further evidence to concur that physicians need to approach all manifestations of atherothrombotic vascular disease whether clinically symptomatic or silent, as one pathologic entity that intermittently affects different vascular territories (Fuster and Moreno 2005). A global and aggressive approach to vascular disease control and management may result in appropriate risk stratification and therapy, reduction in future events and a better quality of life for patients. Patients with vascular disease are at risk of SBI at a younger age (Giele et al 2004), this is an important consideration for health professionals when instigating prevention strategies in this population and it should be suggested that thresholds should be reduced for commencing therapeutic regimes for the prevention of stroke.

It is important to mention SBI appears frequently in relation to vascular dementia. As recurrent stroke is a known cause of vascular dementia and disability (Ong et al 2009) it is important to associate SBI in stroke patients with an increased risk of dementia and poorer outcome. Although SBI does not produce neurological symptoms the risk of dementia is increased in a population with multiple SBI's (Masuda et al 2001). Multi-infarct dementia (MID) is the second most common cause of dementia after Alzheimers disease (Brewer 2007).

MID is caused by a series of SBI which occur over time causing a gradual increase in brain damage which eventually presents as a series of symptoms:

- Difficulty performing tasks that used to come easily, such as balancing a chequebook, playing games (such as bridge), and learning new information or routines
- Getting lost on familiar routes
- Language problems, such as trouble finding the name of familiar objects
- Losing interest in things you previously enjoyed, flat mood
- Misplacing items
- Personality changes and loss of social skills

The symptoms can present individually and the patient may improve in between occurrences but then worsen again in response to another SBI or they may go on to suffer a larger symptomatic stroke (Brewer 2007).

Silent brain infarction also adds to the burden of risk for patients with symptomatic atherosclerosis. This study highlights another aspect of vascular disease which expands the level of risk for patients with vascular disease in one arterial bed as they are at risk of having silent brain infarction also. We know that patients who suffer a stroke are at a high risk of going on to suffer another stroke or heart attack, with a 10 year risk of 42.8% (Jenkinson et al 2007). These reports have been supported by the findings from the REACH (REduction of Atherothrombosis for Continued Health) registry which evaluated the long term risk of atherothrombotic events in an at risk population. REACH has already demonstrated that a significant proportion of people with PAD, CVD or IHD will have disease in more than 1 vascular location. In 1 year follow-up 8.29% of patients with CVD went on to have a further vascular event while CV event rates increased significantly with the number of symptomatic locations ($p=0.0043$) (Morrell et al 2007). 40% of patients with CVD demonstrated multi-vascular involvement with many of these affected beds being clinically silent yet ultimately exposing patients to increasing risk profiles with each bed involved. This study supports the risk of vascular disease as a multi-organ condition.

SBI is an independent risk factor for stroke and heart disease which are the most common manifestations of vascular disease. PAD is the most commonly under-treated vascular disease and therefore, the need to stratify the risk of SBI in these diseases was important for the prevention of disease progression and management. SBI as an independent risk factor for stroke is key to management, however, prevalence of SBI identified in the populations examined was varied, the percentage of SBI found in the stroke studies varied from 14%-24%, in healthy, asymptomatic populations the prevalence varied from 8%-35%, increasing markedly with age. In CAD prevalence varied from 10%-55% and in PAD it was between 5%-21%. The study sizes and populations varied greatly, increasing the heterogeneity, however, SBI existed in all vascular manifestations examined and is therefore a real risk for patients with manifest vascular disease as well as the ageing population.

Fortunately it seems the prognosis of stroke and outcome is not influenced by the presence of SBI (Brainin et al 1995, Jorgensen et al 1994), however, the risk of stroke for people with 1 or more silent infarcts does increase by 2-10 fold during a mean follow-up time of 2-4 years (Giele et al 2004, Bernick et al 2001). Therefore, patients with vascular disease are at an increased risk of SBI and are therefore at increased risk of stroke and dementia and subsequently should be treated with primary prevention therapies to reduce their risk of stroke and other vascular events.

There was substantial heterogeneity found across all meta-analyses, although not entirely unexpected. Not only was there variation in the methods used to detect the symptomatic disease e.g. in some studies computed tomography (CT) has been used to diagnose stroke and in other studies they have used either CT or magnetic resonance imaging (MRI) for diagnosis of SBI. MRI is significantly superior in identifying cerebral infarcts than CT and therefore the studies may not be comparable. The variations in the cardiac studies for identifying CAD suggest these cohorts may also not be comparable. Also the size and location of acute ischaemic stroke may be varied and was not specified in some studies and therefore may not be comparable. It is possible, the difference in clinical and methodological diversity could explain the statistical heterogeneity found between the studies. Despite this, the use of a random-effects model provided a pooled estimate of the average effect of all the included studies. In addition, besides strict inclusion and exclusion criteria,

there were similar mean ages and proportion of males to females across all studies, allowing reliable comparison.

To conclude this study highlights the risk associated with stroke in the presence of SBI in all vascular diseases studied. The literature within the review has also highlighted the presence of SBI more than doubles the risk of subsequent dementia. Screening and treating high-risk patients can effectively reduce the risk of further infarctions, stroke and dementia (Vermeer 2007). This meta-analysis quantifies the risk associated with silent brain infarction in the presence of other vascular diseases both peripheral artery disease, coronary artery disease and symptomatic cerebrovascular disease and therefore we can suggest patients presenting with any form of vascular disease should be treated as high risk for stroke and dementia.

2.6 Chapter 2: Tables and Figures

Figure 2.1: SBI in the presence of acute ischaemic stroke

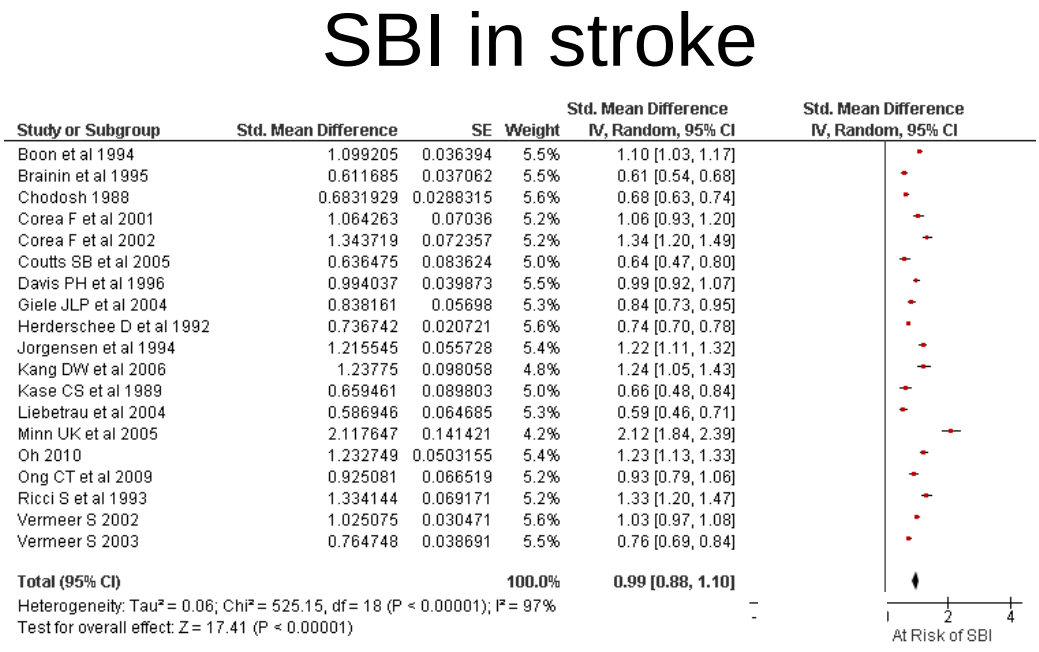


Figure 2.2: SBI in the presence of coronary artery disease

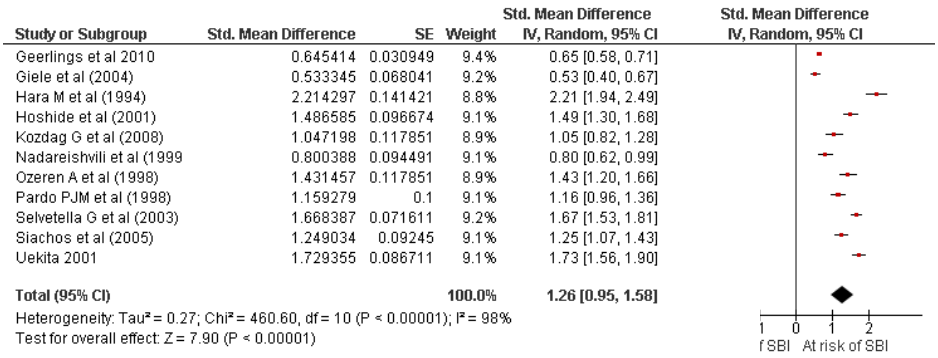


Figure 2.3: SBI in the presence of peripheral artery disease

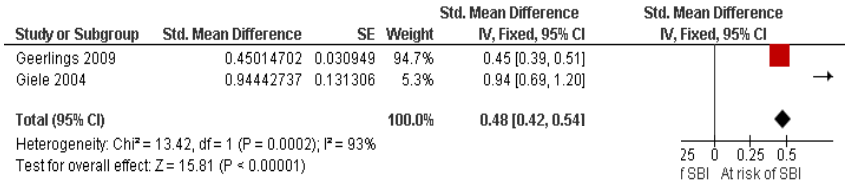


Figure 2.4: Search strategy flow chart - silent brain infarction in stroke

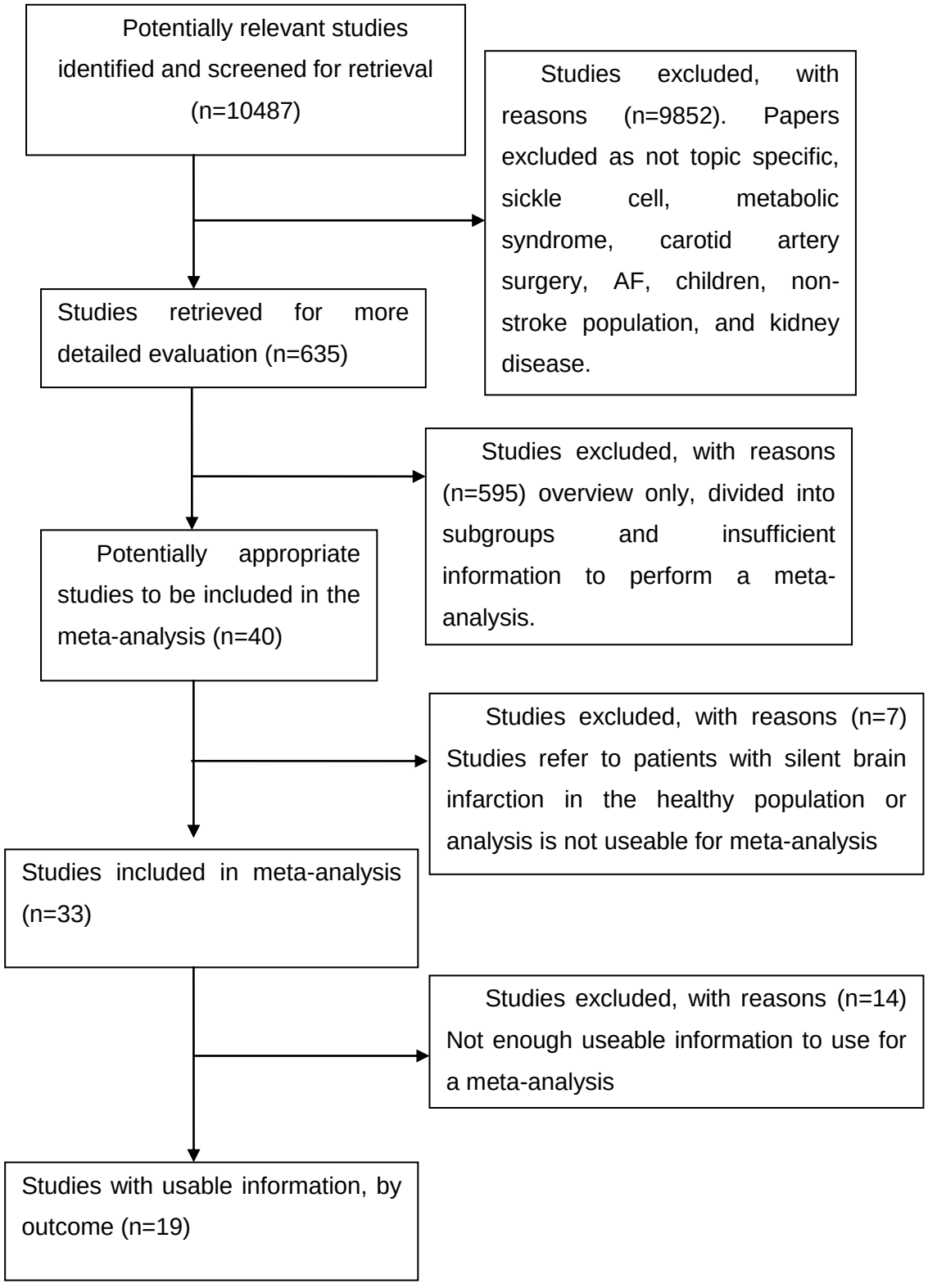


Figure 2.5: Search strategy flow chart – silent brain infarction in coronary artery disease (CAD)

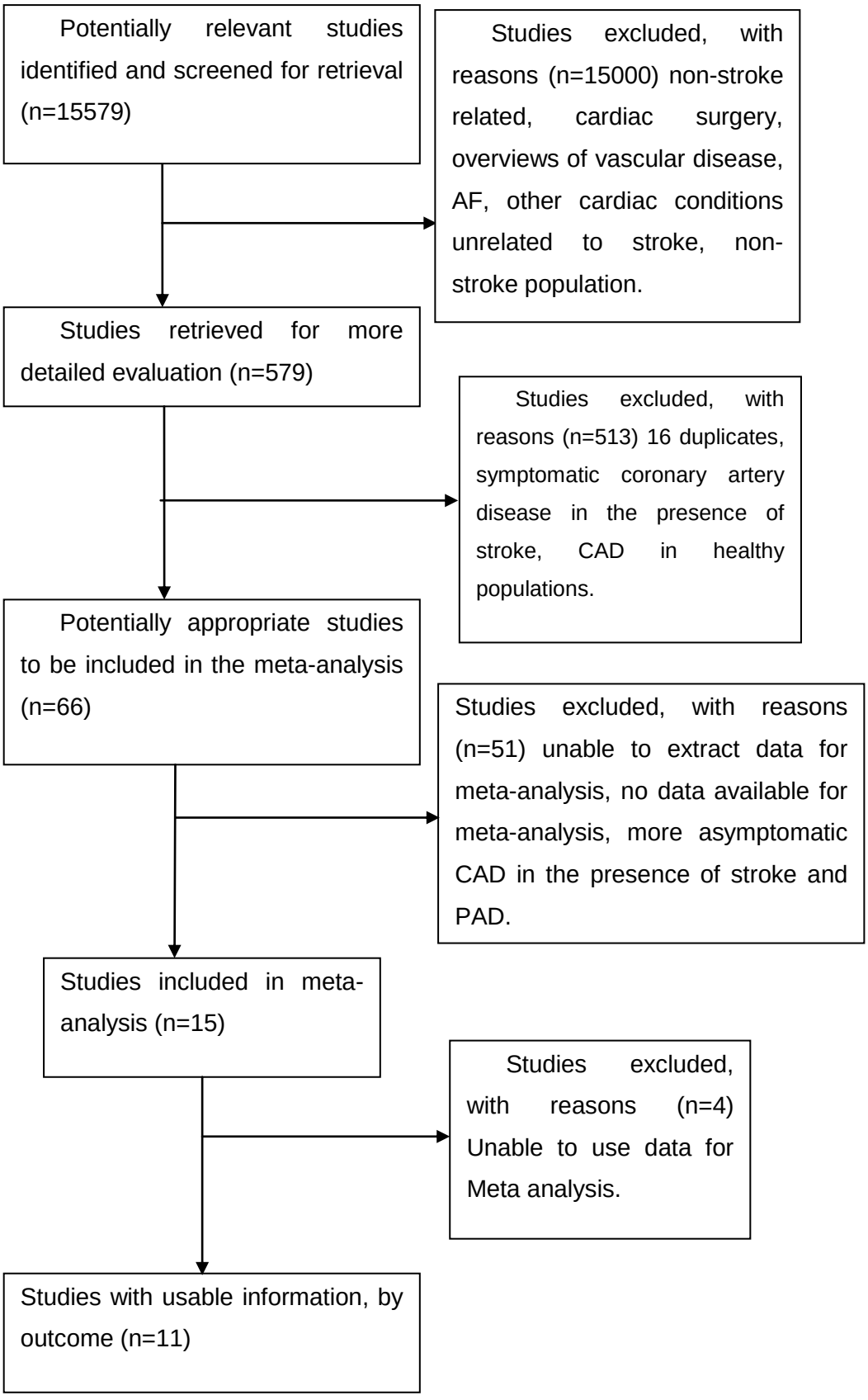


Figure 2.6: Search strategy flow chart – silent brain infarction in peripheral artery disease (PAD)

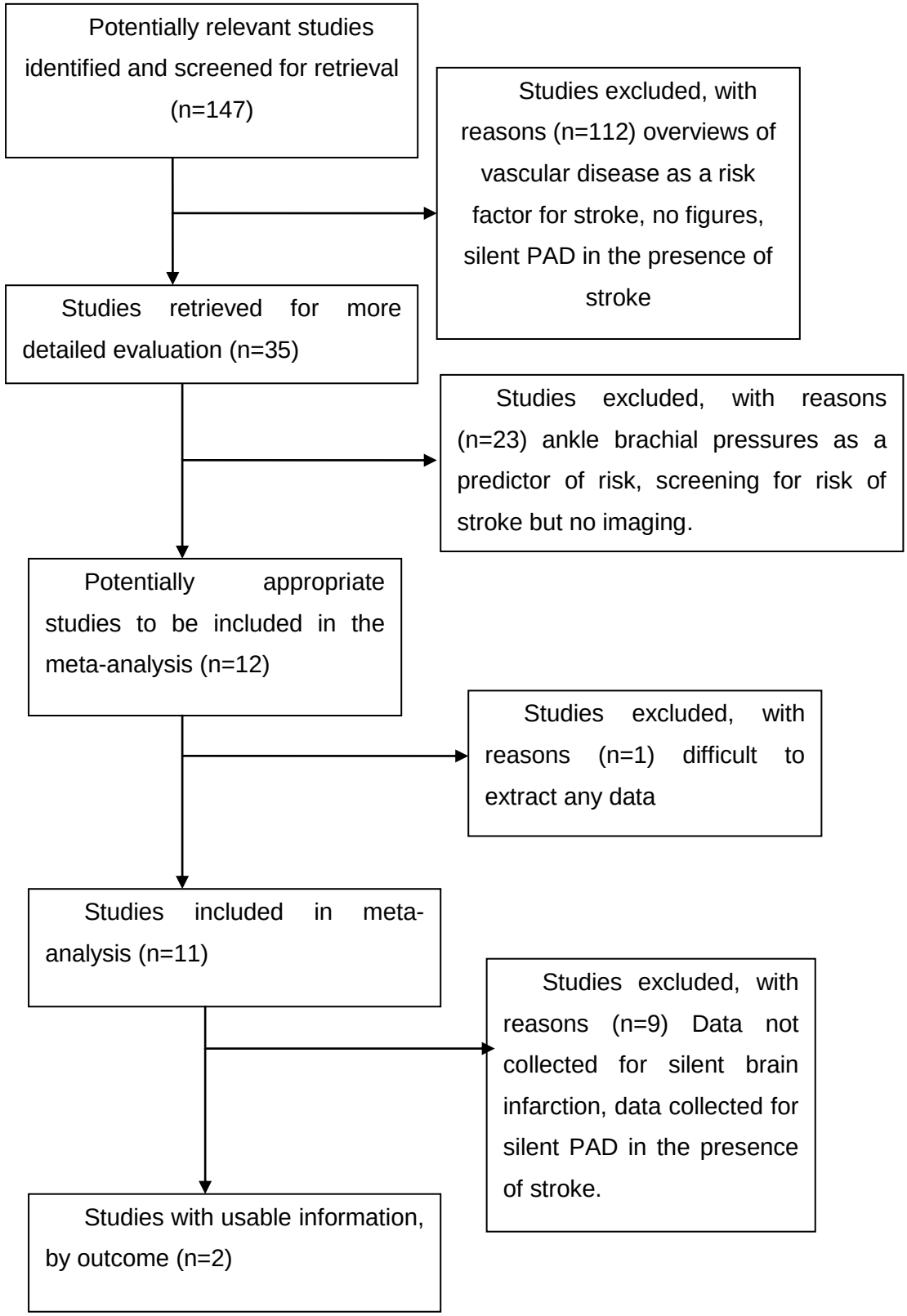


Table 2.1. Silent brain infarction in acute ischaemic stroke.

Study	Study population – SBI in AIS	n	Mean age range years	%
Boon A et al (1994)	Silent brain infarcts in 755 consecutive patients with first ever supratentorial stroke	755	71	27
Brainin A et al (1995)	Silent brain infarcts and TIA: a 3 year study of first ever ischemic stroke patients	728	68±10	11
Chodosh et al (1988)	Silent stroke in the NINCDS stroke data bank	1203	69.1	11
Corea F et al (2001)	Silent infarcts in stroke patients: patient characteristics and effect on 2 year outcome	202	70.05	25.7
Corea F et al (2002)	Brain CT scan in acute stroke patients: silent infarcts and relation to outcome	191	76	37.8
Coutts SB et al (2005)	Silent ischemia in minor stroke and TA patients identified on MR imaging	143	-	9.8
Davis PH et al (1996)	Silent cerebral infarction in patients enrolled in the TOAST study.	629	65	22.7
Giele JLP et al (2004)	Silent cerebral infarctions in patients with manifest vascular disease	308	58	17
Herderschee D et al (1992)	Silent stroke in patients with TIA or minor ischemic stroke	2329	-	13
Jorgensen et al (1994)	Silent infarction in acute stroke patients	322	73±12	32.5
Kang DW et al (2006)	Silent ischemic lesion recurrence on MRI predicts subsequent clinical vascular events	104	-	33.7
Kase CS et al (1989)	Prevalence of silent stroke in patients presenting with initial stroke: the Framingham study	124	46	10
Liebetrau (2004)	Silent and symptomatic infarcts on cranial computerized tomography in relation to dementia and mortality	239	85	8.6
Minn UK et al (2005)	Significance of silent infarcts in acute ischaemic stroke patients aged 80 years and older	50	>=80	76
Oh SH et al	The prevalence and risk factor analysis of silent brain infarction in patients with first-ever	395	63.8	33.4

Study	Study population – SBI in AIS	n	Mean age range years	%
(2010)	ischemic stroke			
Ong CT et al (2009)	Impact of silent infarction on the outcome of stroke patients	226	68±13	20
Ricci S et al (1993)	Silent brain infarctions in patients with first-ever stroke. A community based study in Umbria, Italy	209	71	38.3
Vermeer S et al (2002)	Prevalence and risk factors of silent brain infarcts in the population-based Rotterdam Scan Study	1077	75	24
Vermeer et al (2003)	Silent brain infarcts and white matter lesions increase stroke risks in the general population: The Rotterdam scan study	668	71±7	14

Table 2.2: Silent brain infarction in coronary artery disease

Study	Study population - SBI in CAD	n	Mean age range years	%
Geerlings et al (2010)	Brain volumes and cerebrovascular lesions on MRI in patients with atherosclerotic disease. The SMART study.	1044	58±10	10
Giele et al (2004)	Silent brain infarcts in patients with manifest vascular disease.	308	18-79	17
Hara et al (1994)	Silent cerebral infarction associated with coronary artery disease.	50	-	80
Hoshide et al (2001)	Different patterns of silent cerebral infarct in patients with coronary artery disease or hypertension.	107	62	46
Kozdag et al (2008)	Silent cerebral infarction in chronic heart failure: ischemic and non-ischemic dilated cardiomyopathy.	72	50-74	39
Nadareishvili et al (1999)	Cerebral micro embolism in acute myocardial infarction. Stroke.	112	68±11	15
Ozeren A et al (1998)	Silent cerebral lesions on magnetic resonance imaging in subjects with coronary artery disease.	72	-	43
Pardo PFM et al (1998)	Silent brain infarctions in patients with coronary heart diseases. A Spanish population survey.	100	34-82	30
Selvetella G et al (2003)	Left ventricular hypertrophy is associated with asymptomatic cerebral damage in hypertensive patients.	195	67±1	55
Siachos et al (2005)	Silent stroke in patients with heart failure.	117	51	34
Uekita et al (2003)	Cervical and intracranial atherosclerosis and silent brain infarction in Japanese patients with coronary artery disease.	133	-	58

Table 2.3: Silent brain infarction in peripheral artery disease

Study	Study population – SBI in PAD	n	Mean age range years	%
Geerlings et al 2010	Brain volumes and cerebrovascular lesions on MRI in patients with atherosclerotic disease. The SMART-MR study.	1044	58±10	5
Giele et al 2004	Silent brain infarcts in patients with manifest vascular disease.	58	18-79	21

Chapter three: Knowledge of stroke and risk perception in a stroke population.

3.1 Introduction

Recurrence of stroke carries an increased risk of death, additional disability and/or dependence on health care (Jorgensen et al 1997). Long-term determinants of survival and risk of vascular events following minor ischaemic stroke or TIA have been studied and approximately 10 years after a first event 54% of participants had experienced at least 1 new vascular event (Van Wijk et al 2005). Of the 130,000 annual new stroke occurrences in the UK this year, one third will go on to have a further stroke. Therefore improving secondary stroke prevention is a fundamental challenge for health providers. It is well known that risk factor control can reduce morbidity and mortality and improve survival (Chaudhry et al 2008). However, studies have shown that secondary risk factor management is not optimal (Qureshi 2001, Chaudhry et al 2008). In reality fewer than 20% of patients with cardiovascular disease are reaching their target lipid levels (Chaudhry et al 2008) despite clear recommendations that implementation and adherence to secondary risk reduction strategies are important for reducing the risk of recurrent stroke (RCP 2008). At least 2 to 3 years of consistent LDL cholesterol lowering are needed to see significant reduction in CVD events and atheroma burden (Goldenberg & Glueck, 2009). Patient non-adherence is suggested as one of the reasons for this, however, a greater understanding of what people understand about their stroke and how they perceive their risk of having a further stroke, may provide information which can enable health professionals to develop interventions to improve adherence to secondary prevention.

Comprehensive approaches to the control of cardiovascular diseases have resulted in a 60% decline in mortality rates over a 25-year period (WHO 2002), however, despite the general trend in reduction in stroke occurrence globally, the ageing population in the West continues to challenge healthcare due to the strong relationship between increasing age and stroke incidence (Asplund et al 2009).

Low knowledge of risk factors and warning signs in high risk patients and the general public have been well documented in large scale surveys (Pancioli et al 1998, Sug Yoon et al 2001, Schneider et al 2003, Kraywinkel 2007). Dearborn et al (2001) found knowledge of warning signs is lacking in many at-risk populations, however, Kraywinkel et al (2007) found knowledge of a risk factor was higher in those affected by it, but Dearborn and McCullough (2001) found conflicting results in their cohort as patients with AF and carotid stenosis did not identify those conditions as risk factors for stroke. They also reported there remains confusion between stroke and heart

attack knowledge as women identified chest pain as a warning sign for stroke, however stroke knowledge did not predict risk perception suggesting risk perception is a separate entity to knowledge and may not be affected by educational level or social status. A review of 15 studies of knowledge of stroke warning signs and risk factors in low and high risk populations (Nicol and Thrift 2005) showed a generally low knowledge in both populations. Using free re-call between 20%-30% could not name a single risk factor for stroke. Poor knowledge was associated with lower education level and older age, similar to other studies (Kraywinkel et al 2007, Samsa et al 1997).

There is still debate that individual healthcare professionals are responsible for the education of patients in a format which aids understanding, pitched at a level to optimise the transfer of information regarding level of risk and the need for lifestyle behaviour changes and adherence to medical interventions (Rothwell 2007), however more work is needed to identify the best strategies to provide the most accurate and effective education and information to patients which can positively affect their behaviour post-stroke. Increasing our understanding of stroke survivor's knowledge of stroke and perceptions of risk, may provide us with more information about behaviour and insight about adherence to secondary prevention strategies after stroke.

The health belief model proposes that patients weigh up a health-related behaviour, such as adherence, by considering their perceived susceptibility to an illness and the seriousness of the illness, as well as the benefits of the action. The model includes the concept of barriers to performing an action and cues which might prompt it. The theory of planned behaviour, on the other hand, describes action as secondary to intention. In turn, intention is derived from attitude, perceived control over the behaviour and the views of others. The self-regulatory model is a useful model in assessing specific health beliefs and how they influence medication-taking behaviour in particular. The self-regulatory model proposes that health related behaviour is strongly influenced by ideas around certain themes (termed illness representations). There are five themes: identity, time-line, cause, consequences and cure/control. Beliefs about these components of illness determine coping strategies. Compliance is regarded as a specific problem focused coping strategy; patients weigh up whether the proposed treatment is in line with what they believe about their illness in order to decide whether or not to comply with it. Patients will also assess the success of their treatment and may not continue with it if they perceive it to be

unsuccessful. Many studies have considered one or two aspects of the model, but few have examined the whole picture. The production of a new questionnaire allows for a more complete assessment. Since the publication of the Illness Perception Questionnaire (IPQ-R), a number of studies have utilised it to look at a range of diseases. Horne and Weinman (1999) have proposed that beliefs about treatment are also important and can be added into this model.

It has been suggested that there is a gradual rise in risk of recurrence after the 3 year period following stroke and one of the suggested reasons for this has been the possible decline in drug compliance and reduced attention to lifestyle factors in follow-up (Van Wijk et al 2005). It has also been suggested that follow-up is markedly reduced at three years, however, further research should be performed to look at assessment and care patterns for secondary prevention to determine whether there are gaps between actual care and the evidence based recommendations (Vickrey et al 2002). Young stroke survivors are an interesting population to focus on due to their long-term risk of stroke from the perspective of an aging population. They will need their risk factors modified and controlled for a longer period of time bearing in mind the increased risk as they age.

This study aims to gain an understanding of stroke survivor's knowledge of stroke and their perception of their risk of further stroke and heart disease and how this knowledge and understanding affects their behaviours post stroke, including how they adhere to lifestyle changes and medication taking. Studies have shown that the provision of information may improve knowledge but has not been found to improve perceived health status (Rodgers et al 2001, Forster 2001) therefore, more information is required to understand stroke survivor's perception of their illness with particular attention to their understanding of risk. It has been suggested that patient's own perspectives about stroke illness and recovery are important as they may influence emotional adjustment and adherence to medical recommendations (Townend et al 2006). Through gaining a more thorough knowledge of stroke survivor's behaviours after stroke it might be useful to predict how other, future stroke survivors will adhere to the secondary prevention advice after stroke.

3.2 Aims and objectives

1. To investigate stroke survivors' knowledge of stroke, risk factors, signs and symptoms and causes of stroke
2. To identify stroke survivors' understanding of risk and its influence on their life

3. To identify stroke survivors' perceptions of their risk of future stroke and other vascular events.
4. To identify if any particular finding influences stroke survivors behaviours post-stroke which improve their adherence to secondary stroke prevention.

3.3 Methodology

A detailed, face-validated questionnaire (Appendix 2) containing 57 questions divided into 4 sections was sent to members of a stroke survivor's charity. The aim of the questionnaire was to gain insight and understanding into stroke survivor's knowledge of stroke and risk factors and perception of their risk of future stroke and heart disease. With this insight it was an important aim to generate questions to identify the behaviours of this population to ascertain if knowledge of stroke and perceptions of causes and consequences affect behaviours after stroke. Theories from the health belief model, theory of planned behaviour and the IPQ-R were all used to generate items for the questionnaire. The frameworks were used to inform the methodology of this study and the questionnaire in order to ask the right questions to get the most useful answers. Perception was measured using aspects of the illness perception questionnaire (IPQ) (Weinman et al 1996) to identify the participants perceptions of the causes, consequences and a combination of time-line and cure-control were used to develop section 2 of the questionnaire (Appendix 2).

The study used qualitative, quantitative and longitudinal designs to gain a breadth of knowledge from the cohort. A combination of styles were used in the questionnaire including open and closed-ended questions. Open-ended questions provide the resarcher with the most accurate estimation of the partiicpants knowledge, understanding or perception through the use of free re-call, however these questions produce large volumes of text which can be difficult and time-consuming to compile and analyse. Mulitiple choice closed-ended questions are simpler to analyse however the act of asking the question and providing a list of possible answers may influence the participants responses. Therefore a combination of the two questions styles was used. The questions were divided in to four main sections; (1) General information and demographics, (2) stroke knowledge and perception of illness, consequences and recovery, (3) experience of stroke and understanding of prevention (4) perception of risk of future stroke and heart disease.

The host charity took responsibility for the distribution of the questionnaires to their members, this secured anonymity of the participants from the researcher. The questionnaire contains no identifiable data. The questionnaire was delivered to approx. 2,000 active members on the charity database in both paper format and to those who were members electronically, the questionnaire (Appendix 2) was formatted into a pdf to enable them to complete and return the questionnaire electronically. The questionnaires were only sent out once and a deadline was given for return of completed questionnaires.

Ethical approval was granted by Hammersmith and Queen Charlotte's & Chelsea Research Ethics Committee.

Content face validity was produced via a pilot study using 20 individual volunteers with a history of stroke in order to gain feedback on the design and question content. Relevant healthcare professionals were also consulted including medical, nursing and allied health professionals who were all specialists in stroke patient care. Subsequent validity and reliability testing took place in approximately 100 participants Test-retest reliability was undertaken using volunteers who were given two questionnaires, two weeks apart and correlation between the sub-scales was assessed. Subscale reliability was achieved using Cronbach alpha (0 - unreliable, 1 – perfect reliability) which was examined within each relevant section/sub-scale. Construct validity was achieved through a comparison of questionnaire scores using an alternative questionnaire successfully utilised in a previous study which explored the impact of social and cultural influences upon perceptions of cardiovascular risk and long term lifestyle changes amongst first time MI patients (Murray et al 2000). Discriminant validity used comparison of scores on perception and knowledge of risk of secondary cardiovascular events sub-scales taken between those participants who engaged in some degree of secondary prevention measures and those who did not. The data obtained from the validation study was used to identify any problems with the questions and was also used to test the method of analysis for the main data set to identify any potential problems (McGibbon 1997).

In response to the pilot, one question was removed as it elicited the same response as a previous question and some terminology was altered to ensure the question was understandable by the respondent. The pilot group were also asked to feed back on the length of time the questionnaire took to complete to ensure it was not

too time-consuming. The feedback was that it took approximately 10-12 minutes to complete and this was felt an acceptable amount of time to elicit a response.

Sample size is a particularly important consideration in population-based research (Nicol and Thrift 2005) as large numbers are needed to achieve adequate power. Therefore every effort was made to support the contribution and advertisement of this study to the members of the charity, however, electronic membership can be elusive and effective communication difficult to achieve despite support and enthusiasm from the administrators of the database for the charity.

3.4 Analysis

Over a two month period, a 31% response rate was achieved with over 600 responses received (n=626). Once the majority of expected questionnaires had been received, data was entered into Excel and 10% of questionnaires (60) were checked by an independent researcher to evaluate inter-rater reliability. Inter-rater discrepancy occurred in less than 1% of data-sheet entries.

Data generated from the closed questions was subjected to analysis using Excel and SPSS software. Multivariate analysis was used to identify which measures effect outcome. Bivariate associations between patient characteristics and behavioural risk factors were analyszed with chi-square tests.

3.5 Results

Analysis was performed on 622 responses aged 18-91 (mean age 55.4 years old; 309 males, 313 females). The overall gender specifics of the members of the charity was not available and it is therefore unknown if this is representative of the membership, however the equal numbers of male and female participants offers an equal distribution for this study. Four of the responses were excluded because they were completed by the mothers of young children with stroke. Table 3.1 summarizes the demographic characteristics of the population studied. The majority of respondents were Caucasian, of white European descent (n=556) and educated to secondary school and university level (76%). Subtype of stroke was self-reported as mainly ischaemic (n=316) with the majority (67%) having had their event more than 5 years previously (n=419).

3.5.1 Knowledge of stroke and heart attack

Knowledge of stroke and heart attack was demonstrated through free text responses (Q2.1-Q2.5). The respondents described stroke cause as due to clots (41%), blockages (10%) or bleeding (29%) in the brain (72%). Heart attacks were described as painful (26%) and blockages (16%) in the heart (69%). Most reported receiving health information from a professional (77%) following their stroke. Many thought they had a good knowledge of their cause of stroke (65%) while 72% thought they had a good understanding of how to prevent a further stroke. 70% of the respondents feared having another stroke, although 74% of the respondent's reported that they were unaware of 'having a stroke' at the time of the event.

3.5.2 Self-reported vascular risk factors

A diagnosis of hypertension was self-reported in over half (52%) of the population, diabetes in 11%, ischaemic heart disease in 14%, peripheral artery disease in 14% and renal disease in 4%. Smoking was self-reported in 9% (Table 3.2).

3.5.3 Hypertension

Over half of the population (52%) self-reported a diagnosis of hypertension. Of the hypertensive population 43% documented taking prescribed anti-hypertensive medications in the appropriate section. 83% of the hypertensive population accurately described taking antihypertensive medication as a form of stroke prevention; however, 17% did not associate anti-hypertensive medication with stroke prevention. Interestingly, 60% of the haemorrhagic stroke survivors self-reported a diagnosis of hypertension.

3.5.4 Smokers

Of the total population 9% (n=55) continue to smoke following their stroke. When asked directly only 19% of the ex-smokers reported that they gave up smoking in response to their stroke. Almost half of the smokers (n=25) reported that giving up smoking should be part of a secondary stroke prevention strategy despite continuing to smoke.

3.5.5 Knowledge of risk factors

The participants were asked to name, using free re-call, the risk factors they believed caused stroke and 48% of the respondents named both smoking and blood pressure as risk factors for stroke respectively. Stress was named as the next highest risk

factor with 35% of the respondents. Overweight, cholesterol and diet were also named as risk factors, 21%, 23%, and 18% respectively. (Figure 3.1)

Behaviours were unaffected by knowledge of stroke risk factors as opposed to awareness of secondary stroke risk. Analysis showed that those who named more than 3 risk factors for stroke (41%) were equally likely to make the same amount of behavioural changes as those who named 3 or less risk factors, 35% and 29% respectively.

3.5.6 Knowledge of stroke signs and symptoms

Symptom knowledge was measured using the FAST terminology (DH, 2009). One point being assigned each time Face, Arm or Limb or Speech was mentioned. When asked about their knowledge of signs and symptoms of stroke only 3.5% of the total population used the term FAST in relation to signs and symptoms. 34% did not mention any of the FAST signs or symptoms, 26% mentioned one, 26% mentioned two and only 14% mentioned all three of the FAST signs. There was no difference between gender in the use of FAST terms in describing signs and symptoms (Figure 3.2). A variety of terms were used to describe stroke signs and symptoms, including some which are not commonly associated with stroke such as pain, loss of consciousness and nausea.

3.5.7 Illness perception

Illness perception was measured using a five-point (1-5) scale ranging from ‘strongly agree (1) to strongly disagree’ (5) in response to statements which focussed on causes, consequences and future recovery from their stroke. Tables 3.4, 3.5 and 3.6 give the ‘rating of agreement’ median scores for the participant’s perceptions of their stroke including aspects of the illness perception questionnaire to understand more about aspects of the cause, consequences and future recovery from their stroke.

Overall, the population disagreed in the majority that a germ, virus or pollution caused their stroke (84% and 80%, respectively) (Table 3.4). However, almost half of the participants (44%) agreed with the statement; “it was just by chance that I had a stroke”. Stress was mentioned frequently in the responses as playing a role in the causation of stroke, 35% identified ‘stress’ as a risk factor for stroke and another 51% agreed with the statement, “Stress was a major factor in causing my stroke”. Interestingly, over half (51%) of these participants self-reported a diagnosis of hypertension. 30% of those who quoted stress as a risk factor for stroke were unable

to give one of the signs or symptoms for stroke (Face, Arm, Limb or Speech) used in the FAST campaign when asked to give a free text response (Figure 3.2).

The majority went on to agree that stroke is a serious condition which has a major consequence (Table 3.5) on the participant's life (90%) and that stroke has strongly affected the way the participant and others see them (61%). Two thirds (60%) of the participants agreed that their stroke had had serious economic and financial consequences (Table 3.5), this is significant for a younger population with the average age still a working age (median age 55 years).

Overall, the responses show a positive cohort who believe their stroke will improve in time (44%) and there is a lot they can do to control their symptoms (53%) and the same agree that treatment will be effective in preventing another stroke (Table 3.6). However, the results are not overwhelmingly positive and almost a quarter (22%) believed that recovery from their stroke was largely dependent on chance or fate. (Table 3.6)

When asked, 70% of the respondents said they feared having another stroke, however only 41% believed they were at risk of a future event, nevertheless a massive 74% of the respondent's reported they were unaware that they were 'having a stroke' at the time of the event.

3.5.8 Risk Perception

Respondents were asked if they had been diagnosed with any of the established vascular risk factors for stroke such as hypertension, diabetes, ischaemic heart disease, peripheral vascular disease and/or renal disease; over half of all respondents self-reported a diagnosis of hypertension (Table 3.2). Analysis was performed looking at whether the people who self-reported a diagnosis of a risk factor accurately responded positively to having a risk factor later on in the questionnaire, almost half (45%) denied having a recognised risk factor for stroke.

Over half (54%) identified that they were more likely to have a further stroke or heart attack compared with other possibilities such as winning the lottery or getting run over by a bus. This question was added to ensure the majority of the population were able to understand a basic level of their risk of stroke. 84% of 18-75 age group of the population were able to correctly calculate a percentage question in order to assess their ability to calculate risk.

3.5.9 Lifestyle changes since stroke

Personal risk awareness appears to influence life-style changes after stroke as those who didn't think they were at risk were more likely to make no changes at all in response to their stroke (P=0.02) (Figure 3.3).

Lifestyle changes were not influenced by education level or gender. The number of lifestyle changes made by each participant was disappointing with only 1% making all seven lifestyle changes (Figure 3.4). The participants were given a choice of lifestyle changes to choose from and they could select either none or all seven changes. However, 19% of the participants admitted making no lifestyle changes since their stroke. A small number of 9% (n=55) were still smoking and 18% gave up smoking in response to suffering a stroke. 43% have started a low fat diet since their stroke, 51% eat less salt, 43% eat more fruit and vegetables and 40% take more exercise. However 19% made no lifestyle changes at all since their stroke. Also 36% and 27% have taken less alcohol and lost weight since their stroke respectively.

Behaviour was not influenced by the length of time since stroke. There were no differences in the type or amount of lifestyle changes made depending on whether the stroke had been less than 1 or more than 5 years ago. The cohort is well educated with 77% being educated to secondary school level and above.

3.5.10 Medication taking

The self-reported results for medication taking as a secondary stroke prevention strategy was disappointing in that only 66% of participants with ischaemic stroke reported they were still taking antiplatelet therapy, 45% taking a statin and 44% taking antihypertensive medication. Of those who self-reported a diagnosis of hypertension, 83% reported taking anti-hypertensive medication as a way to prevent a further stroke. However, 17% of the hypertensive population did not associate taking antihypertensive medication with stroke prevention (Table 3.3).

20% of the respondents when asked did not put stroke prevention medication down as stroke prevention drugs, most put Aspirin down but statins, anti-hypertensive and anti-hypoglycaemic drugs were put in the 'other medications' box. This gives an indication that some respondents are unaware that they are taking specific stroke prevention medications.

3.6 Limitations

This work has a number of important limitations which include the sample selection of members of a stroke survivor's charity, which may not be representative of the entire stroke population of stroke survivors as one can presume they are well informed as they actively sought out information and support from this source. The questionnaire was only available in English language and therefore reduced the generalisability of results as non-English speakers and anyone with a communication problem would have been excluded from participating in the study unless they had an interpreter which was suggested as a possibility in the information section provided. The cohort is a young selection (mean age 55.4yrs) which is not representative of the ageing population. There is a lack of ethnic diversity in the responses which is largely European in its representation. Reporting bias is another major limitation of this study as we are reliant on the population giving truthful responses to the questions, particularly in lifestyle and behavioural changes since stroke. However this is a common limitation and has been recorded in other studies (Silcock et al, 2007, Bushnell et al 2009).

3.7 Discussion

Gaining an understanding of stroke survivors' knowledge, perceptions and behaviours post stroke is important for the development of strategies for improving adherence to secondary prevention measures. The key findings from this study concur with previous findings in that generally knowledge of stroke and risk factors is low and perceptions of future risk is low amongst high risk stroke survivor populations (Samsa et al 1997, Forster et al 2001, Townend et al 2006).

Studies have shown there is a lack of a sense of control over causes of stroke and many stroke survivors have fears associated with idiosyncratic and fatalistic beliefs (Townend et al 2006). The findings from this study support the concept that many stroke survivors' fear recurrence despite the fact they didn't realise they were having a stroke at the time of the event. The majority of respondents said they received their stroke information from a health professional, this informs us that information is being provided but it may not be effective in increasing knowledge of signs and symptoms or personal risk factors for future stroke and vascular events and therefore the type of information health professionals provide may need investigating further.

Low knowledge of risk factors has been recorded in other studies (Dearborn & McCullough 2009, Kraywinkel et al 2007) and in one study, knowledge of a risk factor was shown to be superior in those affected by it (Kraywinkel et al 2007). However, this was not seen in this population and their behaviours were unaffected by knowledge of stroke risk factors as those who could name more than 3 risk factors for stroke were equally likely to make the same amount of behavioural changes as those who named 3 or less risk factors. Therefore we can conclude in this population of younger stroke survivors that there was no relationship between knowledge of risk factors and adherence to secondary prevention behaviours.

Knowledge of stroke signs and symptoms was low in the context of a recent national campaign which was aimed at improving the public's awareness of stroke and it is more surprising in this cohort which has already suffered a stroke. However, stroke knowledge has been shown to be poorest in groups at highest risk (Pancioli et al 1998). Indeed, many patients (72%) in this study did not realise their symptoms were indicative of stroke, although with the proposed repetition of the media campaign this figure may improve.

Aalto et al (2005) showed that patients with cardiac disease believed that psychosocial problems contributed to their risk of future disease and over half the respondents in this study who quoted stress as a risk factor, self-reported a diagnosis of hypertension. This may show some similarities between the two groups of patients. A quarter of the respondents who quoted stress as a risk factor for stroke also felt that there was little to be done to improve their symptoms from stroke. This finding may play a role in identifying patients who have a more fatalistic attitude to their recovery from stroke and may therefore not actively make behaviour changes in response to their stroke.

These results show that perception of risk is poor in this high risk population of stroke survivors. Despite the poor understanding of 'risk' in this population, studies have shown that additional risk factor advice provision has shown disappointing results for lifestyle change after stroke (Ellis et al 2005) Therefore, it may be important to take into account patients personal experience, beliefs and fears when developing secondary prevention programmes.

In this study 40% of the participants' self-reported taking more exercise since their stroke, however, Rand et al (2009) reported levels of physical activity in adults with

mild motor impairment after stroke are half those of healthy older people. Although physical activity is encouraged post stroke, Boysen et al (2009) went on to report that repeated encouragement and verbal instruction did not result in a measureable increase in physical activity in a cohort of stroke survivors following mild ischaemic stroke, although professional advice and guidance with continued support encouraging sedentary people without previous stroke to be more physically active was effective in a previous trial (Foster et al 2005). Therefore 'stroke specific' rehabilitation programmes may be beneficial to stroke survivors although understanding how the population behaves is the key to developing such programmes and perception may provide insights into activities. This study population may perceive they are taking more exercise but may not be in reality therefore, joint research into perceptions of stroke survivors may provide us with more information regarding their beliefs about their condition and action related behaviours.

Obesity is a risk factor for stroke and maintaining a stable weight and weight reduction are key secondary prevention behaviours. Towfighi and Ovbiagle (2009) assessed the independent association between body mass index (BMI) and mortality among stroke survivors and found that stroke survivors were more likely to be overweight (BMI 25 to 29 kg/m2) or obese (BMI >30 kg/m2) than those without stroke. They concluded that higher BMI after stroke is associated with a greater risk of all-cause and cardiovascular death among younger individuals. Younger stroke survivors may especially benefit from more vigorous efforts to monitor and treat obesity (Towfighi & Ovbiagle 2009). A quarter of the participants in this study self-reported weight loss, this is difficult to validate in an unseen cohort, however, self-reporting a positive behaviour even if it is an exaggeration indicates an awareness of the need for that behaviour in this context.

The population of younger stroke survivors showed a mixed response to their stroke and outlook on the future. Almost equally half are positive about their future and half are pessimistic about what can be done to improve their symptoms and are fatalistic about recovery. Over half (53%) agreed that treatment will be effective in preventing a future stroke. It has been shown in older adults that optimism may play a protective role against stroke, as higher optimism was associated with a lower risk of stroke (Kim et al 2011) and Nabi et al (2010) identified low pessimism is linked to reduced risk of stroke in adults under 54 years. Kim et al (2011) recognise that optimism is related to other positive psychological constructs such as positive affect, positive

emotions and feelings of joy and happiness, however they suggest optimism is conceptually distinct and measures an individual's positive perception and expectations. Further work in this interesting area may be effective in gaining further insight into reasons for behaviour in stroke survivors.

The risk of a vascular event has been found to be at its highest shortly after the ischaemic event and at its lowest point at about 3 years and then gradually rises again afterwards (Van Wijk et al 2005). One explanation for the gradual rise of increased risk after the 3 year period was the possible decline in drug compliance and from reduced attention to lifestyle factors in follow-up. In light of the substantial risk of recurrence of subsequent ischaemic events and advances in therapeutic treatments which have demonstrated to be effective for secondary prevention, it has been suggested (Vickrey et al 2002) that further research should be performed to look at assessment and care patterns for secondary prevention to determine whether there are gaps between actual care and the evidence based recommendations. Interestingly, the majority of participants in this study had their stroke more than 5 years ago (67%) and the results could be seen positively as they suggests these high risk patients are still aware of secondary prevention in the long term following stroke, although, Qureshi et al (2001) reported actual risk factor control in 1252 survivors of MI and stroke from the National Health and Nutrition Examination Survey 3 was poor in the long-term. Qureshi et al (2001) reported risk factors were poorly controlled with only 35% of hypertensives BP controlled and blood glucose in diabetes was controlled in only about 50% and cholesterol was poorly controlled in 46%. About 18% of individuals were also still smoking cigarettes. Health professionals should be mindful that secondary prevention involves monitoring treatments as well as prescribing them to ensure ultimate control of risk factors is obtained.

In this study fewer than half of stroke patients reported taking a statin (45%), consistent with other studies (Jacobson et al 2004) despite widespread acknowledgement of the need for this. Interestingly, 66% of respondents' reported taking an antiplatelet. Thus, the lack of statin therapy may be due to health professionals either not realising their overall benefits or under-estimating their risk reduction benefits to a relatively younger stroke population. This outcome is similar to other studies that report lower levels of control and compliance with stroke prevention (Hillen et al 2000, Marini et al 1999, Sappok et al 2001). However, younger patients are less likely to adhere to statin therapy (Goldenberg et al, 2009).

Notwithstanding this observation, fewer than 20% of patients with cardiovascular disease are known to reach their target lipid levels (D'Agostino et al 2000) despite clear recommendations that implementation and adherence to secondary risk reduction strategies are important for reducing the risk of recurrent stroke then our findings are an indictment against current public health strategies to improve cardiovascular outcome.

Some of the population with a haemorrhagic stroke reported taking antiplatelet medication (37%) this is most likely due to multiple risk factors for ischaemic stroke in a small section of the population who are at risk of both ischaemic and haemorrhage stroke. This combined with the majority of stroke survivors in this study, who suffered their stroke more than five years ago may be the clinical reason for antiplatelet medication. 43% of the haemorrhagic strokes had other risk factors such as, diabetes (14%), ischaemic heart disease (11%), peripheral artery disease (14%) and renal disease (8%).

The information obtained from this study highlights the importance for health professionals to understand and be aware of the poor level of risk perception in this high risk population, when developing secondary prevention programmes. This population identified 'stress' as a key risk factor in stroke causation and prevention, therefore stress should be addressed in secondary prevention discussions to ensure patients understanding of stress reduction as part of their secondary prevention is realised to avoid them concentrating on relieving the stress alone and neglecting other aspects of secondary prevention such as medication taking and behaviour modification. It is important to ensure strategies are investigated to measure patient's perception of risk to guarantee stroke prevention can be effective in the future.

By allowing the participants to complete the questionnaires in their own homes and without any health professional contact has created a unique example of unbiased information about this stroke population. However, it clearly suggests day to day knowledge and appreciation of future risk of stroke and cardiac events is poor, and the lack of understanding of established and pre-existing risk factors to cardiovascular disease in the population of stroke survivors suggests on-going information provision is low. The majority of patients were unaware that their stroke was the consequence of their long standing risk factors. The key finding suggests that those who are more aware of their risk of future vascular events are more likely

to perform lifestyle behaviour changes in response to stroke than those who are unaware and regardless of their knowledge of stroke risk factors. These findings have important implications for those developing secondary prevention strategies as well as for the on-going high profile FAST campaign that aims to reduce the burden of stroke.

3.8 Chapter 3: Tables and Figures

Table 3.1: Population demographics

Population characteristics	**n=622**	**%**
Mean age, years Range	55 (18-91)	
Male	309	48
Ethnicity		
White British	556	89
White other	40	6
Black British	7	1
Asian British	2	0.3
Marital Status		
Married	352	56
Single/divorced	157	25
Widowed	20	3
Educational level		
Secondary school education	216	35
University	260	42
Stroke sub-type Ischaemic Haemorrhagic Both Unknown	 316 189 12 105	 51 30 2 17
Time since stroke:		
< 1 year	76	12
1-5years	111	18
> 5 years	419	67

Table 3.2: Self-reported stroke risk factors

Stroke Risk Factor	n	%
Smoking	55	9
Hypertensive	325	52
Diabetic	67	11
Ischaemic Heart Disease	85	14
Peripheral Arterial Disease	90	14
Renal Disease	25	4

Table 3.3: Medications

Medications	n	%
Antiplatelet therapy	414	66
Statin therapy	279	45
Antihypertensive therapy	272	44
Warfarin	63	10

Figure 3.1: Risk factors for stroke

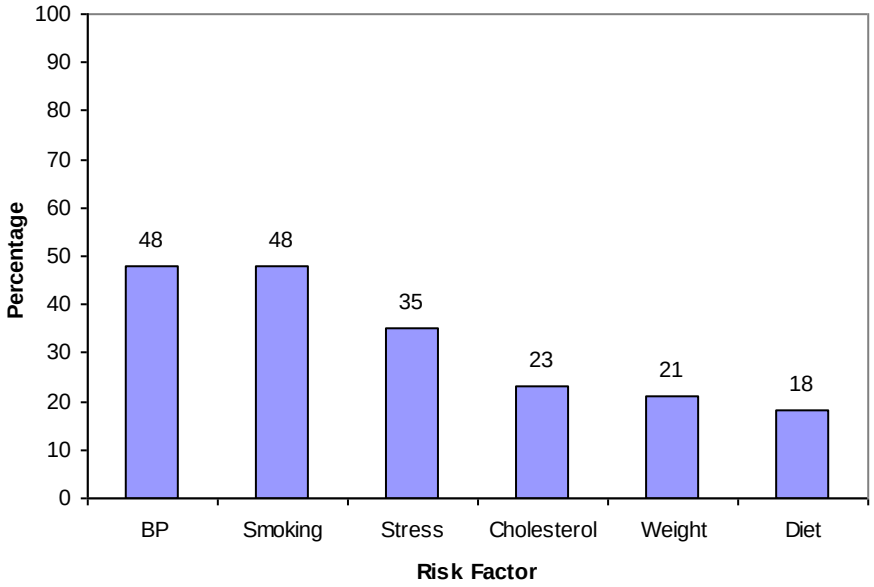


Figure 3.2: Knowledge of stroke using modified FAST

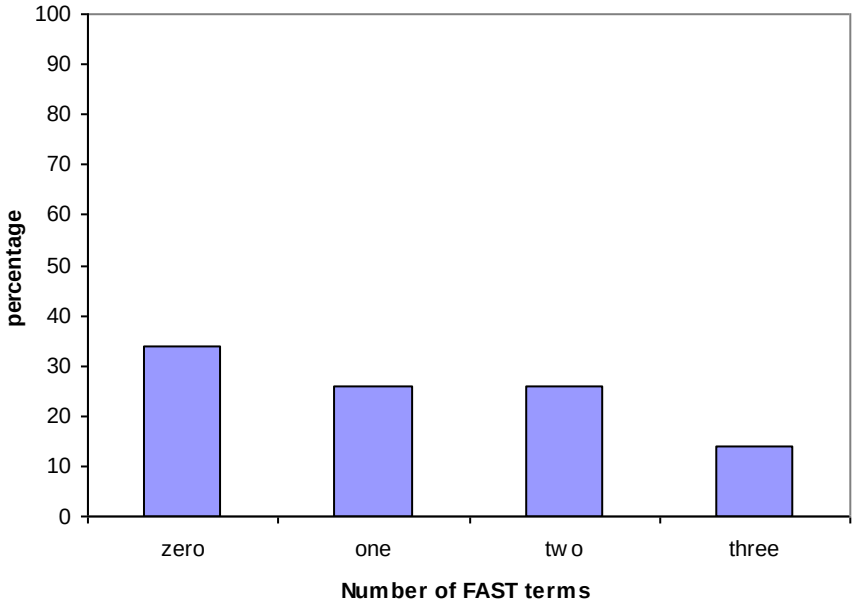


Table 3.4: Perception of stroke: Cause

Cause

Rating of agreement.	Median	*Range
1. A germ or virus caused my stroke	5	1-5
2. Pollution of the environment caused my stroke	5	1-5
3. My stroke was caused by hereditary factors, it runs in my family	**4**	1-5
4. It was just by chance that I had a stroke	3	1-5
5. Stress was a major factor in causing my stroke	2	1-5

*Range: 1-strongly agree to 5-strongly disagree

Table 3.5: Perception of stroke: Consequence

Consequence

Rating of agreement	**Median**	***Range**
1. My stroke is a serious condition	**1**	**1-5 1-strongly agree 5-strongly disagree**
2. My stroke has had a major consequence on my life	**1**	**1-5**
3. My stroke has become easier to live with.	**2**	**1-5**
4. My stroke has had little effect on my life *reverse scoring	**5**	**1-5**
5. My stroke has strongly affected the way others see me	**2**	**1-5**
6. My stroke has serious economic and financial consequences	**2**	**1-5**
7. My stroke has strongly affected the way I see myself as a person	**2**	**1-5**

*Range: 1-strongly agree to 5-strongly disagree

Table 3.6: Perception of stroke: Future perspective

Future perspectives

	Median	*Range
1. My stroke will improve in time	3	1-5
2. There is a lot which I can do to control my symptoms	2	1-5
3. There is very little that can be done to improve my symptoms *reverse scoring	4	1-5
4. My treatment will be effective in preventing a future stroke	2	1-5
5. Recovery from my stroke is largely dependent on chance or fate *reverse scoring	4	1-5

*Range: 1-strongly agree to 5-strongly disagree

Figure 3.3: Awareness of risk and effects on behaviour

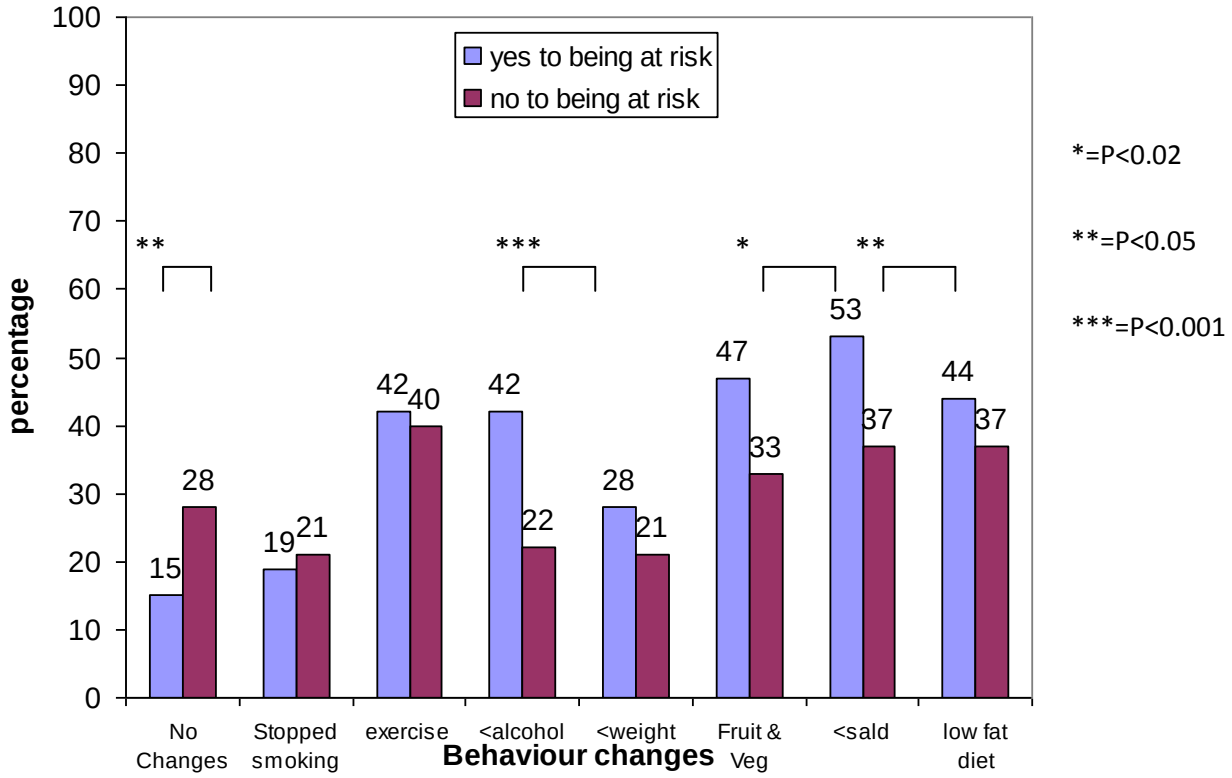
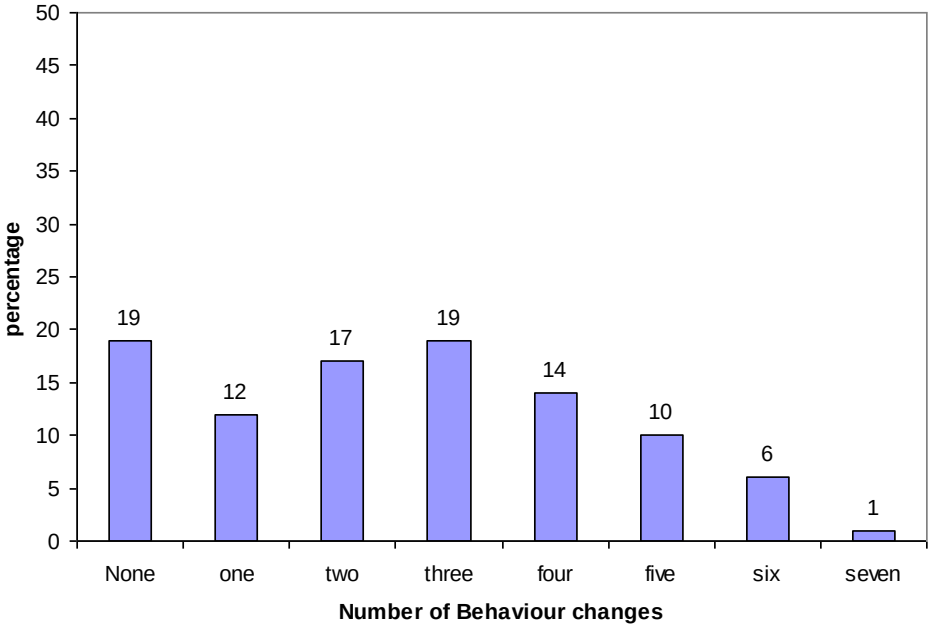


Figure 3.4: Number of lifestyle behaviour changes



Chapter four: Understanding knowledge of blood pressure in the general public

4.1 Introduction

Hypertension is the most common treatable risk factor for stroke (Volpe & Dedhiya 2006, Bosworth et al 2006). Multiple studies including randomized, controlled trials have demonstrated a reduction of between 30-40% of stroke by blood pressure lowering (Chalmers 2000, Yusuf et al 2000, Lawes et al 2004). In secondary stroke prevention only a minimal reduction of BP (10mmHg) is needed to reduce the risk of recurrent stroke by as much as 28% (Rodgers et al 1996). However, it has been estimated that nearly half (45%) of all strokes in patients who are on treatment for hypertension could be attributed to poorly controlled hypertension (Li et al 2005). It has been estimated that for the population as a whole worldwide, 75% of strokes occur in 90% of individuals with a blood pressure greater than 155/95 (McMahon and Rogers 1994). Therefore control of BP in secondary prevention is of great importance and in order to achieve this goal, understanding why BP is so poorly controlled in the hypertensive population is key.

Recent studies have shown that patients and public are aware of the link between hypertension and stroke but do not appreciate the consequences of uncontrolled hypertension (Volpe and Dedhiya, 2006), however it has been suggested that patients who recognize their increased risk for stroke are more likely to engage in stroke prevention practices than those who do not (Samsa et al 1997). Similar findings were found as a result of the questionnaire study (Chapter 3) in this thesis where stroke survivors who reported being 'at risk' of a future event were more likely to make behaviour changes (less alcohol, more fruit and 'veg', less salt) than those who said 'no', however Dedhiya (2006) found that public and hypertensive patients alike did not consider hypertension as a serious health problem and only a third of the respondents in their study knew that hypertension could be asymptomatic.

Looking at a hypertensive population, Oliveria et al (2005) found that hypertensive patients had a general understanding of 'hypertension' but were less knowledgeable about specific factors related to their condition and specifically their own level of BP control. There is no standardized tool available to assess knowledge or awareness of hypertension (Oliveria 2005) however, this study aims to go some way to adding to the field of knowledge using a large population sample of the general population to gain a breadth of understanding of their perception and knowledge of BP.

Individuals with pre-hypertensive levels of BP, as defined by 120/80 to 139/89 mmHg, also have an increased risk of developing cardiovascular disease and stroke

compared with those with optimal BP <120/80 mmHg. The association is among blacks, those with diabetes mellitus and those with a high BMI (Kshirsagar et al 2007). Cohort studies now indicate that in the Asia Pacific region as well as in North America and Western Europe, each 10 mmHg lower systolic BP is associated with a decrease in risk of stroke of approximately one third in subjects aged 60-79 years (Lawes et al 2004). The association is continuous down to levels of at least 115/75 mmHg and is consistent across sexes, regions, and stroke subtypes and for fatal and nonfatal events. The proportional association is age dependent but is still strong and positive in those aged 80 years. Data from randomized controlled trials, in which mean age at event was approximately 70 years, indicate that a 10 mmHg reduction in systolic BP is associated with a reduction in risk of stroke of approximately one third. Per mmHg systolic BP reduction, the relative benefits for stroke appear similar between agents, by baseline BP levels, and whether or not individuals have a past history of CVD. There is, however, evidence of greater benefit with a larger BP reduction. Epidemiologically expected benefits of BP lowering for stroke risk reduction are broadly consistent across a range of different population subgroups with greater benefits from larger BP reductions (Lawes et al 2004).

There is little knowledge or understanding of blood pressure and its role as a major risk factor for stroke and heart disease in the general public (Samal et al 2007, Celentano 2004, Volpe and Dedhiya 2006). Samal et al (2007) found that despite 77% of the patients stated they knew that hypertension was a risk factor for stroke, only 30% felt at an increased risk of stroke. Other studies have shown that patients and public are aware of the link between hypertension and stroke but do not appreciate the consequences of uncontrolled hypertension (Volpe and Dedhiya, 2006). Volpe and Dedhiya (2006) found that the public and hypertensive patients alike did not consider hypertension as a serious health problem and only a third of the respondents in their study knew that hypertension could be asymptomatic.

4.2 Quality and outcomes framework

The significance of achieving better BP control has increased since 2003 with the release of new clinical practice guidelines for the prevention, detection and treatment of high BP and more recently the introduction of Quality and Outcomes Framework (QOF 2004). Variations in the quality of healthcare have been extensively documented in the UK and US and continue to persist despite considerable investment (Crawley et al 2009). Pay for performance programmes were first

initiated in the UK in 2004 with the introduction of QOF. This provides financial rewards to G.P's for achieving large numbers of evidence-based quality indicators and places considerable emphasis on the management of common cardiovascular conditions of which hypertension is the most treatable. The study by Crawley et al (2009) looked at impact of pay for performance on quality of chronic disease management by social class group in England. The study was performed to compare the 2003 and 2006 surveys which focused on cardiovascular disease risk factor management. They found no difference in usage of anti-hypertensive or achievement of BP target following the implementation of the QOF. However, further QOF analysis is showing more promising results in a 2005-2007 comparison study of General Practitioner records (Ashworth et al 2008) 82.3% of adults in England had an up-to-date BP recording in 2005 and this increased to 88.3% in 2007. The proportion of patients reaching a target BP level ranged from 71-85% in 2005, rising to between 78.6-89.4% in 2007. These results show an improvement in base levels of one CVD risk factor, however, Wolfe et al (2010) argue QOF payments have only been evaluated in relation to BP control and have not been evaluated in a RCT. Variations still exist despite the opportunities to improve BP control and the financial rewards that are now available. It appears that despite regular monitoring, BP control is still reported as suboptimal in the hypertensive population (Ashworth et al 2008) in Europe, which inadvertently puts this population at increased risk of stroke and cardiovascular disease.

Physicians worldwide appreciate the importance of managing hypertension to avoid future complications such as stroke, however Volpe & Dedhiya (2006) suggest they do not conform to the recommendations in various hypertension guidelines and have higher thresholds than guideline recommendations for defining and categorizing hypertension and need to engage in patient communication regarding hypertension (Volpe & Dedhiya 2006). A study looking at lifestyle modification knowledge among health professionals and students resulted in only 10% achieving the desired scores of 80% or higher. The majority of health professionals in this study promoted the theoretical concept of lifestyle modification but had difficulty in providing practical advice to patients. Lack of time, lack of patient adherence and language barriers were given as the main barriers to providing lifestyle counselling (Parker et al 2009).

4.3 Relation between knowledge and BP control

It has been suggested that knowledge about hypertension and its control can influence blood pressure control in patients with hypertension (Samal et al 2007). Samal et al (2007) performed a study which looked at the relation between knowledge about hypertension and education in hospitalized patients with stroke in Vienna. They found that patients without a basic school education had a significantly lower frequency of blood pressure measurements than the others ($P<0.05$ compared with the reference category). Three fourths (76%) of the patients stated they owned a blood pressure meter, but only 63% used it. Knowledge of other possible consequences of hypertension, namely myocardial infarction, nephropathy, peripheral vascular disease, and retinopathy, were significantly associated with educational attainment. Knowledge about these consequences ranged from 64% for myocardial infarction to 11% for peripheral vascular disease. Concerning non-pharmacologic options for lowering blood pressure, there were significant differences defined by educational level as well; the higher the educational level, the more patients were likely to know about physical activity, reduction of salt intake, reduction of caloric intake, and relaxation techniques. Knowledge about these options ranged from 17% (relaxation techniques) to 54% (reduction of salt intake). When asking about adherence to these lifestyle modifications, 37% to 66% affirmed to do so. Samal et al (2007) concluded that knowledge in their population was insufficient and partly associated with educational level, leaving much room for improvement by educational campaigns.

The importance of education programmes has been reported and patients who are aware that elevated BP levels can lead to reductions in life expectancy have been reported to have a higher compliance level with medication use and follow up visit than patients without this awareness (Balazovjech 1993). Oliveria et al (2005) found that many patients did not know their BP level nor could they accurately classify their level as elevated or normal. 41% of patients in this study reported that their BP values were in the normal range but in fact they were elevated. This highlights the need for investigation into perceptions of blood pressure in the community and identification of appropriate educational systems to inform people about the importance of adequate blood pressure control to prevent vascular events such as stroke and myocardial infarction.

4.4 Health literacy in long term conditions

Most measures of health literacy have been developed in the US, where approximately 40% of the population have inadequate health literacy. In the UK prevalence is unknown but at least 20% of UK adults have literacy and numeracy skills insufficient to read simple written information, these people are therefore at risk of having inadequate health literacy. The prevalence of low health literacy places a bigger responsibility on health professionals to ensure patient comprehension and health information is relayed appropriately to patients (Colledge et al 2008). This is a major obstacle to providing high quality care, as long-term and chronic diseases require self-management skills and the ability to negotiate complex treatments and health service needs with health professionals. Patients require sufficient knowledge and skills in order to handle the complex information demands of the health system, to communicate in order to make appropriate use of health services available to them and contribute to optimising the management of their own care.

Stroke survivors are at a high risk of repeated vascular events and therefore their self-management is crucial to their long-term care, however, due to the complex communication difficulties sustained by most stroke patients, this makes health literacy a particular challenge in this population, but still a goal to aim for. Also patients with good health literacy skills can act as advisers and mentors for other patients with long-term diseases and thus help spread best practice and improve disease management.

The United Kingdom White Paper (2004) 'better information, better choices and better health' sets out a strategy to provide improved access to high quality health education and information and suggests health professionals should communicate more effectively with patients. They also suggest a nationally coordinated process to deliver and produce information. There have been improvements in information provision via many approaches such as telephone and internet access, however, many patients still don't have access to the information they need or want in the format they can understand.

4.5 Adherence as a tool to controlling BP

It is well known in population studies, higher educational level and income positively influences BP control (Egan et al 2003, Muntner et al 2004, Mendez et al 2003). Higher education influences a persons ability to become health literate and this factor may influence adherence to both medication taking and lifestyle modifications

in the context of BP control. It has been estimated only 30%-50% of patients with hypertension regularly take their anti-hypertensive medication (Stephenson 1999, cited by O'Carroll et al 2010). Improving adherence to medications prescribed for hypertension and secondary stroke prevention has the potential to have a major impact on cardiovascular disease prevention (Silcock & Standage 2007). However, lack of knowledge about BP or understanding of risk is associated with non-adherence as patients do not believe the expected behaviour such as medication taking, may reduce their risk or they do not perceive they are at risk in the first instance. Dearborn and McCullough's (2009) study found women who were high-risk still perceived their risk to be the same as their peers and a study of 1502 American adults over the age of 50 (Egan et al 2003) identified 46% of the hypertensives did not know their own BP. This study concluded limited awareness of systolic BP was a barrier to control. This continued lack of perceived risk and lack of knowledge of risk factors has considerable consequences for health professionals working with first time stroke survivors to ensure high risk individuals adhere to stroke prevention strategies.

Patient-centred strategies may lead to the identification of better tools to improve control of long-term conditions (Schedlbauer et al 2004, Silcock & Standage 2007) while randomized controlled trials have shown specific health behaviour modification interventions can be successful, such as advice to give up smoking (Law et al 1995) and healthy eating in nurse-led cardiovascular disease (CVD) follow-up programmes (Wood et al 2008). Specifically targeted programmes may be beneficial to the stroke population if they are individually designed. Notwithstanding these successes, studies to examine if improvements have been made to long-term management of chronic vascular diseases such as coronary heart disease, diabetes and hypertension with the formal introduction of pay-for-performance targets have shown no improvement in blood pressure control (Crawley et al 2009). Indeed, even improved patient knowledge has failed to guarantee higher levels of adherence supporting the opposite view that poor knowledge does not necessarily lead to low adherence (Silcock and Standage 2007). Studies investigating interventions to improve adherence have been unable to identify advantages in any one type of intervention (Schedlbauer et al 2004, Horne et al 2005). The provision of medically accurate information may improve knowledge but may not improve mood or perceived health status and therefore the patient's own perspectives about stroke and their recovery. Preliminary studies of additional risk factor advice provision have

produced disappointing results for lifestyle change following stroke (Townend et al 2006).

4.6 Physician approaches to BP control

Patient non-adherence is certainly one possible reason for low levels of BP control in hypertensive populations, however, some studies have investigated how physicians make decisions about initiating and modifying pharmacologic treatments for hypertension (Oliveria et al 2002, Andrade et al 2004). These studies have found that many physicians have a high tolerance despite guidelines stating levels at which treatment regimens should be commenced or altered.

Many patients with hypertension have inadequate BP control and often BP thresholds for diagnosis and treatment of hypertension are substantially higher than recommended (Berlowitz et al 1998, Andrade et al 2004, Hyman et al 2000). This is despite evidence suggesting that primary care physicians are aware of the existence of treatment guidelines for hypertension (Oliveria et al 2002). Several studies have shown suboptimal BP control in specialist hypertension clinics (Andrade et al 2004, Berlowitz et al 1998, Knight et al 2001). In one study 40% of patients with a diagnosis of hypertension who visited a hypertension clinic more than six times in a year still had a BP of >160/90mmHg (Berlowitz et al 1998). This study focused on a selected population of older men, however those who received more intensive therapy had better controlled BP, despite this, the study showed that many physicians are not aggressive enough in their approach to the management and treatment of hypertension. Andrade et al (2004) found that physicians were significantly more likely to intensify the antihypertensive regimen only when the systolic BP reached 160mmHg or greater.

Among the cohort examined in the 2003–2004 National Health and Nutrition Examination Surveys (NHANES) that gather information about health and diet from households in the United States, the overall prevalence of hypertension was 29.3%. In the 2005–2006 NHANES, the overall prevalence of hypertension was slightly less at 29.0%. In both studies, hypertension was defined as a blood pressure of ≥140/90 mmHg or as taking antihypertensive medication. Interestingly in the Health Survey for England (2003), of those with hypertension (BP ≥140/90 mmHg) 61.7% were aware of their diagnosis and only 21.8% had adequate BP control (BP ≤140/90 mmHg).

Ashworth et al (2008) identified from National surveys between 12-25% of the population of 5 European countries had a systolic BP of ≥160mmHg compared with 7.4% in Canada and 5.2% in the US. Under-treatment with antihypertensive medications was identified as a probable cause for the disparity with only 41-52% of those in European countries being treated compared to 62% and 78% in Canada and the US respectively. Although the number of patients treated for hypertension has increased gradually over time (Ashworth et al 2008), blood pressure is not controlled in all patients with hypertension. In NHANES 2003–2004, hypertension was controlled in only 37% of all patients with hypertension and in 57% of those treated for it. In NHANES 2005–2006, the rate of hypertension control had improved to 43.5% of all patients with hypertension and to 64.0% of those patients who were taking medication to control it.

4.7 Local population

The Hammersmith and Fulham (pop 170,000) borough has a population which has a highly diverse culture and ethnic mix. 22.2% of the Hammersmith and Fulham population is made of an ethnic group other than white. Poor blood pressure control remains a common problem that contributes to significant morbidity and mortality particularly among ethnic minority groups (Bosworth et al 2006) such as south Asians and Black African and Caribbean groups. 18% of adults aged between 16 and 74 years of age have no formal qualifications in the borough. The influence of educational level and poorer outcomes and levels of care delivery for ethnic minority groups are a consideration for this local population, therefore a random study would include a large number of low education level and ethnic minority groups although this was not specifically studied as part of this project. The literature informs us that there is little knowledge or understanding of blood pressure and its role as a major risk factor for stroke and heart disease in the general public (Samal et al 2006, Celentano 2004, Volpe and Dedhiya 2006). In another study it was found that the public and hypertensive patients alike did not consider hypertension as a serious health problem and only a third of the respondents knew that hypertension could be asymptomatic (Volpe and Dedhiya 2006).

The aim of this survey is to gain insight into the knowledge and perceptions of blood pressure in a convenience sample of the local population of predominantly Hammersmith and Fulham residents in London. This will allow us to gain further information regarding BP awareness in the local population and also gain some

insight into the knowledge of BP in an asymptomatic hypertensive section of the population who are at high risk of vascular disease. This information may be able to inform the development of primary and secondary prevention strategies to inform the public in a way that ensures an adequate understanding of the risk factors for stroke and how blood pressure prevention can play a major role in its prevention.

4.8 Aims and Objectives

1. To gain an understanding of the local population's perception of blood pressure:
   - Perception of what is a normal blood pressure
   - Knowledge of their own blood pressure measurement
2. Identify the level of knowledge that hypertensive patients taking medication have of 'normal' blood pressure and their own measurements.

4.9 Methodology

As part of an awareness campaign about stroke, members of the public were offered blood pressure testing and were asked relevant questions to identify their perception and understanding of blood pressure. Performing a BP reading is an important element of this study as it provides clinical data in order to compare the participants perception and knowledge of their own BP level and what they perceive to be a 'normal' level. All BP's in this study were undertaken by a trained health professional with clinical experience enough to perform the measurement and training to provide written and verbal information about BP, hypertension and risk factors for stroke.

Members of the public were approached to participate from within the local borough at selected venues such as the Town Hall, local shopping centre, coffee shop of a local hospital and an exhibition hall during a careers convention.

A joint approach to blood pressure recording was used with a combination of sphygmomanometry and wrist BP devices used to measure the participants BP. The wrist BP devices were the Omron 637IT. Individuals were asked the following questions:

1. Gender
2. Age
3. Postcode and London borough in which they reside
4. Whether they have ever been diagnosed with hypertension (high BP)

5. Whether it has been treated with medication
6. If they had knowledge of what a ‘normal’ BP was and if so to give an example
7. If they had knowledge of what their own BP was when it was last recorded

The British Hypertension society classification (2005) of a ‘normal’ BP equates to that of the European Society of Hypertension (2003) and that of the World Health Organisation – International Society of Hypertension (1999) states that the systolic BP should be <130mmHg and the diastolic should be <85mmHg (Table 4.1).

4.9.1 Study design

This is a quantitative study using a survey approach to obtain information of participant perception of blood pressure and demographic information such as Age, Gender and drug therapy history for hypertension and post code information.

4.9.2 Power Calculation

The power was calculated using an earlier study (Wizner et al 2003) which reported perception and knowledge of normal blood pressure among the general population. The reported difference among normotensive and hypertensive members of that population was 47%, with 95% confidence and with a 3.15 bond on error of estimation. Therefore a sample of 965 patients was required to gain an understanding of the local population’s perception of blood pressure. Allowing for a 5% non-response rate our final sample size was 1019.

4.9.3 Validation of the Omron 637IT

The Omron 637IT used for this study passed according to the International Protocol criteria and is recommended for use in adults and obese adults. The standard location for BP measurement is the upper arm, however monitors that measure BP at the wrist are becoming increasingly popular as the monitors are smaller and lighter than upper arm devices and in the context of this study doing BP recordings in public places require less invasive removal of external clothing to reach the wrist rather than upper arm. Owing also to population trends of increasing body weight, most BP machines are sold in the market with inappropriate cuff sizes, however wrist diameter is little affected by obesity and therefore can be used on obese adults.

4.9.4 Consent

Verbal consent to participate was obtained prior to asking any of the questions and performing a blood pressure recording.

4.9.5 Professional responsibility

Participants with a blood pressure recording of >140-90mmHg on three consecutive recordings on both OMRON and sphygmomanometer testing, (according to British Hypertension guidelines on blood pressure measurement) were advised to see their G.P or Practice nurse for further investigation and advice.

4.9.6 Analysis

The results were obtained using Excel and SPSS software in order to answer questions relating to a person's knowledge and understanding of blood pressure. Chi-squared test was used to compare healthy and hypertensive populations and multiple logistic regression was used to adjust for differences in the groups associated with age.

4.10 Results

4.10.1 Population Characteristics

Table 4.2 provides the demographic information of the 1019 participants who took part in the survey. The mean age for the total population was 54 years (range 16-92). In total 194 people (19%) who participated in the survey had consistently high readings on the day and were advised to see their GP service or practice nurse within one week in accordance with the professional responsibilities set out for the study (Section 4.9.5).

Of the total population, 313 participants self-reported hypertension and 299 reported taking medications for BP, however 334 (33%) were clinically hypertensive according to BHS coding from optimal to severe hypertension. Of the 334 who had a SBP of ≥140mmHg, 182 (54%) were from the self-reported hypertensive group and 152 (45%) were from the 'healthy' group. In further analysis of those who were clinically hypertensive with either a SBP of ≥ 140mmHg or a DBP of ≥90mmHg, 58.7% had no idea and were unable to guess what a 'normal' BP is.

4.10.2 Knowledge of a 'normal' BP

Of the total population, 52% of the participants had no idea what a normal blood pressure should be, they either guessed incorrectly outside of the normal values or were unable to give an answer (Table 4.3) The majority of the hypertensive population (77%) were unable to give a correct value for a 'normal' BP and 63% of the healthy population were also unable to give an accurate report of a 'normal' BP reading (Chi Square test P=0.03) (Figure 4.1).

4.10.3 Knowledge of own BP

When asked to guess their own BP, 58% of the overall population either had no idea or did not report their own BP correctly (Table 4.3). Of the healthy population 67% guessed incorrectly and 89% of the hypertensive population guessed incorrectly or couldn't guess at all (Chi Squared test P=<0.001) (Figure 4.2). Only 11% of the hypertensive population were able to guess their own BP of ≤140/≤90mmHg, however, this may be due to hypertensives believing their BP to be higher than that. Despite this 30% (306) of the hypertensives continued to have a SBP of ≥140 mmHg.

4.10.4 BP recordings

Only 31% of the total population in this survey had an optimal BP (<120/80 mmHg) recording on the day and 33% had mild-severe hypertension on BP recordings (>140/90mmHg). Mean blood pressure for the total population was 130/77 mmHg. The mean SBP for the hypertensive population was 150/87. Those with a SBP of more than 155mmHg were 334 (33%) which may put them at increased risk of stroke according to McMahon and Rodgers (1994). Of the people who self-reported a diagnosis of hypertension, 32% had a systolic BP recording of >140mmHg.

4.10.5 Hypertensive Vs Healthy populations

Healthy is defined as a BP of ≤139/89mmHg and hypertensive is defined as a BP of ≥140/90mmHg (Table 4.1). Of the self-reported hypertensive population 77% guessed a normal BP incorrectly compared with 63% in the healthy population. There was no significant difference in participants understanding of systolic and diastolic BP as both were either guessed or both were not guessed at. Age of pre-diagnosed hypertensives that had no idea or guessed incorrectly was significant higher. Independent T-Test calculated a significant difference between mean age for the hypertensive population as 63yrs and the healthy population 50yrs (P<0.001)

(Figure 4.1).There was a significant association between the differences between control of BP in the hypertensive population which corresponded with their knowledge of a normal BP. Chi-squared test identified the hypertensive group had less knowledge of a 'normal' BP (P=0.03) (Figure 4.1) and a highly significant difference in knowledge of their own BP (P=<0.001) (Figure 4.2). Independent T-Test calculated mean BP in participants who guessed normal correctly as SBP 147 mmHg and those who guessed incorrectly as SBP 150 mmHg which had a significant p-value of p=<0.047 (Std 9.3 and 12.6 respectively) (Table 4.3).

The results suggest that there is poor understanding of blood pressure in the general public and of particular importance people who are known to be hypertensive and who take medication for blood pressure have little knowledge of their own blood pressure and what is 'normal' blood pressure.

4.11 Limitations

Random selection of BP recording could be higher due to recent activities but this would be the same if recorded in a busy clinic environment. Possible 'white coat' phenomenon although still away from the clinical environment but nevertheless a health professional took the BP and therefore could have influenced a 'white coat' reaction from the participant. Ethnicity was not recorded as part of this study. Also the population is largely comprised of women. This may have occurred due to the method of using passing trade with a bias towards large numbers of females, however, this may also be because women are more likely to approach a health monitoring stand rather than men. Men generally are less likely to volunteer to get a health check and men are 20% less likely to go to their GP than women (WHO 2003). However, many couples approached the stand together in this study, which highlights the probability that women initiate the approach and bring their partners with them, where men did not approach alone but accompanied their female companions.

4.12 Discussion

With the increase in stroke and heart disease worldwide it becomes critical to define and measure patient perceptions of blood pressure. This project has been able to identify the perception and knowledge of a large sample of a local population of West London (1019 participants). A key finding from this project is knowledge of BP in a hypertensive population does appear to influence control. Patient's understanding of 'normal' BP may enable them to participate in the management of their care more

and the process of bringing their BP under control and they may be more likely to make behaviour changes to reduce their BP. Approximately one third of the population self-reported hypertension and were taking BP medications. The presumption could therefore be made that this group which made up 29% of the population studied, would have seen a health professional at one time to discuss their BP. Disappointing then that only 23% of the hypertensive group were able to guess a 'normal' BP correctly compared with 37% of the healthy group. One reason for this may have been because the hypertensive group were more familiar with higher BP readings and didn't recognise what a 'normal' BP should be. However, when asked about their own BP, only 13% were able to guess correctly and 30% of this population's BP was uncontrolled with a SBP of ≥ 140mmHg. This highlights the lack of BP management in this population despite QOF and is similar in outcome to results from the Health Survey for England (2003) where only 21.8% of hypertensives had adequate BP control. Increasing age has however, been a strong indicator for poorer knowledge and affected perceptions of BP in this survey. The hypertensive population were significantly older than the healthy population which may account for the poorer understanding however this issue should be highlighted to health professionals to ensure information is adequately tailored towards older people as they are the population most likely to have hypertension.

The lack of public and patient awareness of the importance of hypertension control for general good health and stroke prevention is well documented (Volpe & Dedhiya 2006, Oliveria et al 2005, Samsa et al 1997). The data from this project supports these findings and concurs with Egan et al (2003) who found nearly half (46%) their hypertensive population did not know their own BP. This therefore, highlights the need to investigate further how the provision of information by health professionals in both primary and secondary care is given to patients. It is vital that educational and awareness programs are developed to inform both patients and the general public of the importance of routine blood pressure monitoring and reducing high blood pressure effectively when it has been diagnosed. These results show there is a significant lack of understanding of blood pressure in the general public population and people have little knowledge of what a normal blood pressure should be and even less understanding of what their own blood pressure is. There is an identified need for greater information provision and education for the general public surrounding blood pressure with specific interest in understanding what blood pressure is in terms of defining systolic and diastolic differences. This is with the aim

to empower people to take responsibility for their own health needs and to encourage members of the public to understand the significance of blood pressure on their own health. More importantly health professionals should be aware that those members of the general public diagnosed with hypertension also show little knowledge of normal BP and this has shown to effect control of their hypertension. Therefore health professionals should not presume that patients with diagnosed hypertension on treatment have any knowledge of their condition and information and education should be repeated at every opportunity when in consultation with patients.

Although there is a large female sample in this population it is interesting that many couples had their BP checked at the same time and frequently if one partner didn't know what 'normal' was then the other also didn't know and vice versa if they did have an understanding. Therefore it could be suggested that if awareness can be raised in one person then this information and knowledge is likely to be passed on to their spouse and therefore improve the health and wellbeing of two people with one interaction.

The hypertensive population within this study demonstrated less knowledge of what a normal BP should be than that of the healthy population, this is associated with age, however age itself is the highest non-modifiable risk factor for stroke and hypertension is the highest modifiable risk factor for stroke, therefore health professionals should be made aware with a sense of urgency that older people with hypertension may benefit from extra time and education at consultation, regarding BP control. This study reinforces the concept that hypertensives within the general population are not well controlled as one third of the hypertensive population continued to have a SBP of ≥140mmHg. Knowledge of normal BP values may be a reflection of an individual's appreciation of the importance of BP control and the need to treat it and may therefore result in adherence to medication and behaviours which may improve control.

It could be argued that knowledge of one's own BP may reflect the frequency with which BP is taken (by self or doctor) as a result of poor BP control, however that was not an issue in this study as the hypertensives had poor knowledge of their own BP (77%). This is similar to Egan et al (2003) who found 46% of hypertensive adults over the age of 50 years did not know their own BP.

The results of this study have identified a significant lack of understanding and knowledge about blood pressure and a survey to explore the population in greater depth or by surveying a larger population may give valuable insight into public perceptions of health. This information can be developed and used in London-wide and national educational programmes and advertising campaigns in order to improve the overall public health and prevention of cardiovascular disease. To conclude this study has identified that those who guessed correctly had a lower BP, those who guessed incorrectly were significantly older and the healthy were more likely to guess correctly compared to the hypertensive groups. Therefore we can target information and education about BP control to older hypertensives within the community, however time should be spent to ensure the format of the information is targeted in such a way as to be effective in improving knowledge of BP and its relationship to stroke risk and awareness of individual risk to improve adherence to prevention strategies.

4.13 Chapter 4: Tables and figures

Table 4.1: British Hypertension Society Guidelines for Hypertension Management (2004)

Grades of hypertension				
Bp Category	Systolic Bp mmHg	Diastolic Bp mmHg	Lifestyle	Drug therapy
Optimal	<120	<80		
Normal	≥120 + <130	≥80 + <85	-	-
High normal	**≥**130 + <139	**≥**85 + <89	Yes	Consider *
Mild hypertension (grade 1)	140-159	90-99	Yes	Consider +
Moderate hypertension (grade 2)	160-179	100-109	Yes	Yes
Severe hypertension (grade 3)	>180	>110	Yes	Yes

*Drug therapy may be indicated for people with established cardiovascular disease, chronic renal disease or diabetes with complications at BP levels >130/80mmHg.

+ Drug therapy is recommended for people with established cardiovascular disease and Diabetes or evidence of target organ damage or a 10 year CVD risk > 20%.

Table 4.2: Population characteristics

Population characteristics	n=1019	%
Age **Range**	54 years 16-92	
Female	724	74
Self-reported hypertension	313	31
Self-reported taking medications for BP	299	29
No idea of normal BP or guessed incorrectly	259	52
No idea of own BP or guessed incorrectly	592	58
Total clinically hypertensive	334	33

Table 4.3: Blood pressure knowledge

Question	No idea or guessed incorrectly n=1019	%
What do you think is a 'normal' BP	529	52
What do you think your own BP reading is?	592	58
GP referrals	194	19

Table 4.4: Hypertensive coding results for study population

Code	n=1019	%
Optimal	316	31
Normal	167	16
High normal	202	20
Mild hypertension	256	25
Moderate hypertension	64	6
Severe hypertension	14	1

Figure 4.1: Knowledge of 'normal' BP

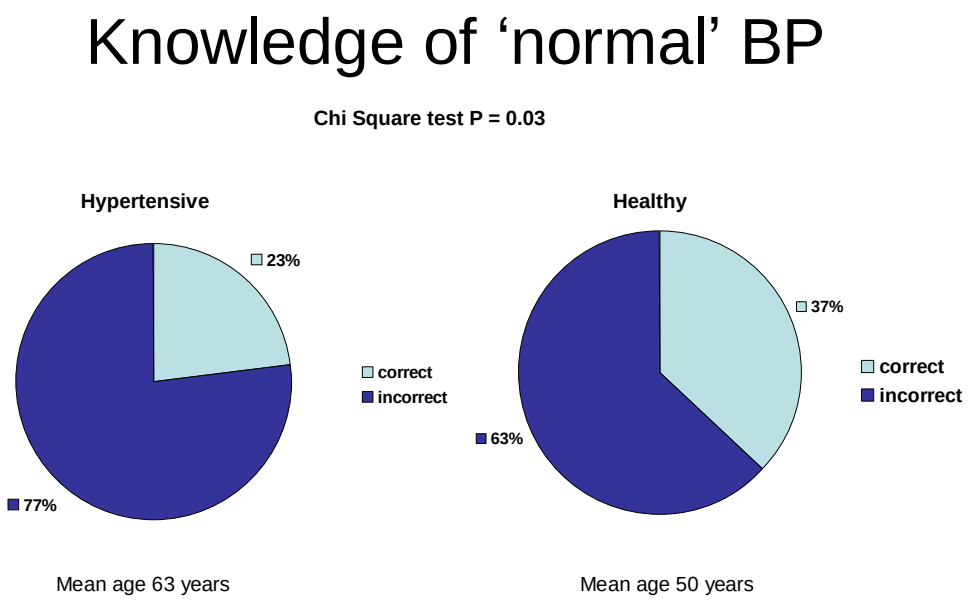


Figure 4.2: Knowledge of own BP

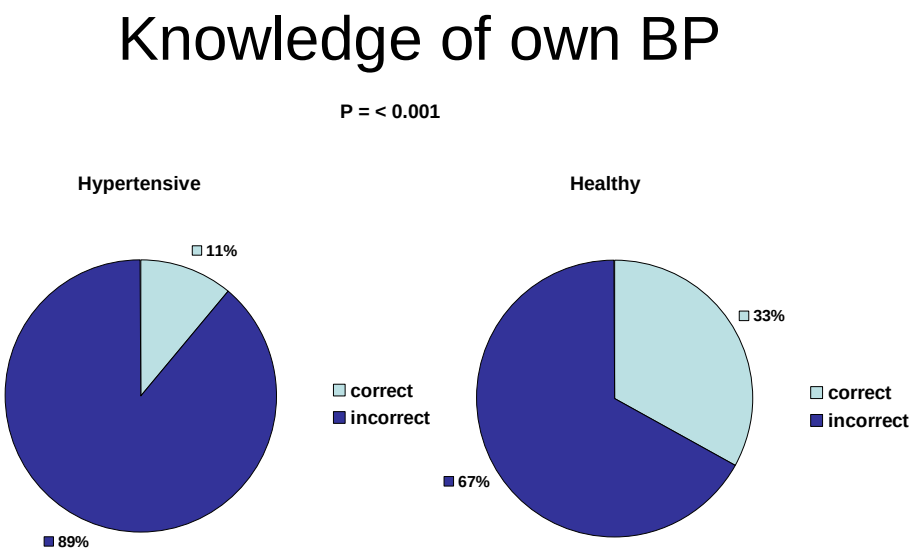
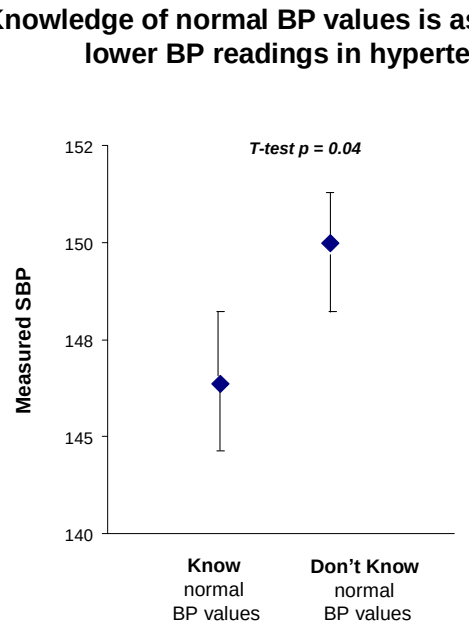


Figure 4.3: Knowledge of 'normal' BP in hypertensive group associated with lower BP readings



Chapter five: Individual risk awareness intervention in stroke (IRAIS) study

5.1 Introduction

Recurrent stroke occurs in up to 20% of patients (Talelli & Greenwood 2008) and is more likely to be fatal than first stroke and survivors are more likely to be left with major disability (Rothwell 2007). Secondary stroke prevention strategies and risk factor management as well as advances in medical care have been shown to reduce stroke recurrence (Chaudhry et al 2008) and improve survival following an acute vascular event, however, studies observing behaviours post stroke have identified sustained behaviour change is low.

From over 2,000 patients with ischaemic stroke followed up at 3 months, one quarter reported discontinuing 1 or more of their prescribed secondary prevention medications (Bushnell et al 2010). Redfern et al (2000) studied patients at one year post-stroke and reported 22% smoking, 36% obese and 4% drinking excessively. They suggest different behavioural risk factors are associated with specific socio-demographic groups within the stroke population, for example they found younger, white males were more likely to smoke and non-white women more likely to be obese. Wang et al (2006) evaluated adherence to secondary prevention strategies within one year following ischaemic stroke and 69% were taking some sort of antithrombotic medication, however, only 36.4% were still taking the same antithrombotic therapy they had been discharged with. They concluded that adherence to secondary prevention was poor and identified income levels, categories of thrombotic agents and personal living ability as closely related to compliance. They suggested doctors should pay more attention to secondary stroke prevention and suggested providing patients with detailed medications instructions as a way of increasing the potential effectiveness of prevention treatments. In CAD, illness beliefs have been shown to contribute, as perceptions of more serious consequences have predicted better adherence (Stafford et al 2008).

Studies to identify characteristics of adherence and non-adherence are important in recognising strategies to improve lifestyle behaviours post-stroke, and there are more studies investigating behaviours in cardiac patients than stroke. To our knowledge no study to date has investigated if risk awareness has any influence on stroke survivors' behaviour.

It has been suggested, stroke survivors are less likely to adhere to secondary prevention strategies than patients following myocardial infarction (MI) (Lewis et al 2008 & Qureshi 2001). Pain at onset associated with MI has been suggested as one

factor which may contribute to adherence in cardiovascular patients, as an incentive to reduce the risk of experiencing the pain again (Agyeman et al 2006). Stroke is usually painless and often multi-factorial in its onset which is suggested as one of the possible reasons for the delay in presentation and poor knowledge of signs and symptoms in stroke patients. International studies have shown that patients are unlikely to call for urgent attention if they or a family member suffer a stroke (Segura et al 2003, Samsa et al 1997, Sug Yoon et al 2001, Pancioli et al 1998). This may go some way to explaining the disparity between behaviours in the two populations, however, studies have shown that attendance at cardiac rehabilitation programmes (French et al 2006) can be poor and long term adherence to medication in chronic disease groups is estimated as low as 50% (WHO 2003). Therefore, identifying the influences and causes of non-adherence are key questions which if answered may improve outcomes. However, diagnosis and management of cardiovascular disease is improving in response to the national targets set for GP's (QOF) and this may be one reason for reductions seen in cardiovascular events in the UK, despite reports of low levels of adherence.

The cognitive effects of stroke may be one cause of both delayed presentation to hospital and poor adherence. Stroke can severely affect a patient's memory sufficiently to result in 'unintentional non-adherence' (Silcock & Standage 2007, Croquelois & Bogousslavsky 2006) which is often due to physical and /or cognitive problems. Cognitive impairment has been associated with non-adherence (O'Carroll et al 2010), however physical disability and social isolation can cause barriers to adherence such as having no one to collect a prescription or due to physical disability which affects getting to a pharmacy to collect a prescription or lack of financial support to afford regular prescriptions (under 65 years) for what could easily be three or more medications. The complexities which influence adherence are all important issues which should be discussed during interactions with health providers in order to identify potential barriers as soon as possible.

5.2 Risk awareness

Studies addressing knowledge of future event risk have mainly focussed on the general public (and then predominantly the white population) but one study showed that only 42% of patients with a history of previous stroke were aware of their future stroke risk and only 27% recalled being informed of their risk by a physician (Samsa et al 1997). Chapters 3 and 4 of this thesis have identified low levels of risk

awareness in a high risk stroke population with only 41% reporting being at risk of a future event (Chapter 3) and low levels BP awareness in a general population where knowledge of a 'normal' BP also appears to influence control (Chapter 4). Failure by physicians to control cardiovascular risk factors following stroke is an on-going problem but signs of improvement are being seen, since 2004 and the introduction of QOF BP monitoring and control have shown signs of significantly improving (Ashworth et al 2008), however, other studies have suggested CVD risk factor management remains inadequate (Girot et al 2005, Wang et al 2006, Raine et al 2009, Wolfe et al 2010). The explanation for this may be related to poor patient awareness and knowledge (with older patients and those who have made an excellent recovery being at particular risk of poor awareness) and sub-optimal adherence to risk modifications (Crosquelois and Bogousslavsky 2006). Conversely, providing information about atherosclerosis may improve adherence to intervention protocols such as medications and lifestyle modifications (Kraywinkel et al 2007). Increases in public awareness of the signs and symptoms of stroke have improved early recognition and allowed new treatment advances such as thrombolysis for acute ischaemic stroke (RCP 2008).

Charitable organisations such as the Stroke Association have been responsible for improvements in public awareness with recent surveys suggesting an increase in knowledge of stroke signs and symptoms from 45% to 85% (Stroke Association 2010) mainly due to media campaigns such as F.A.S.T. (Face, Arm, Speech and Time). However, stroke patients are still slower than cardiac patients at attending hospital urgently with their symptoms and stroke patients may not recognise future signs and symptoms of stroke which differ from their original symptoms. However, an increase in general public awareness is useful for future generations of stroke sufferers.

5.3 Barriers to risk factor awareness and control

Barriers to risk factor control have been identified in various studies and include inadequate follow-up and monitoring of stroke survivors by health care professionals, inadequate prescribing of secondary prevention therapies, poor information provision and inadequate self-management of risk factors by patients (Jorgensen et al 1997, Rigler et al 2001, Bak et al 2002, Rudd et al 2004, Girot et al 2005, Kaplan et al 2005, Wang et al 2006). Raine et al (2009) studied general practice records between 1995-2005 and found only 25.6% of men and 20.8% of women received secondary

prevention. Wolfe et al (2010) suggest barriers to risk factor control include inadequate follow-up and monitoring by health care professionals, inadequate prescribing of secondary prevention medications, poor information provision and inadequate self-management of risk factors by patients. Therefore a multi-factorial approach is required to improve secondary prevention in this highly complex population. It is also important to consider an individual is not likely to initiate, change or maintain health behaviour in the face of barriers, unless they have a core belief they have the personal resources to do so (e.g. making the decision to stop smoking by not buying cigarettes, but sustaining smoking cessation when faced with the usual 'smoking-break' with work colleagues). Thus consideration of self-efficacy, an individual's motivational and self-regulatory skills, is imperative in any behaviour change intervention; such self-regulation will involve monitoring own behaviour, setting realistic goals to motivate and guide behaviour and enlisting social support to sustain behaviour (Bandura 2007).

Increased knowledge of stroke risk factors is significantly associated with younger age, a higher educational level and not living alone (Muller-Nordham at al 2006). Well educated patients from high social classes are known to be more knowledgeable and compliant with healthcare advice than those from less privileged backgrounds (Nutbeam 2000). Indeed, even knowledge about hypertension and its aetiological role as a risk factor for stroke is not only poorly realised but partly associated with educational background (Samal et al 2007). Therefore the challenge for health professionals is how to educate members of the public and patients about risk factors and other health messages, however, this challenge has been on-going for decades and is linked to health literacy. More research on patient behaviours post stroke will inform future campaigns to improve the effectiveness of health messages to all members of society particularly those at high risk from vascular disease.

5.4 Risk management

'Risk management' has been described in a number of ways, including a way of controlling future uncertainty (Giddens 1991, Beck 1992) and for allocation or apportioning of blame (Sachs 1996). However both the Department of Health (DH 2001) and The Royal College of Physicians (RCP 2004) have taken risk management to mean a specific clinical construct defined in health policy by the National Service Framework for Older people (2001) and the National Clinical

Guidelines for stroke (2008). Risk management in this context is used to design strategies to prevent both primary and secondary stroke. These strategies have largely relied upon health professionals providing information, support and monitoring of patients conditions and control of individual risk factors for stroke such as BP, cholesterol, diabetes and smoking status. However, Redfern et al (2006) remind us that studies have identified failures in putting these strategies into practice. They suggest this failure is due to conflict between providing a patient centred approach and the goals of public health, but go on to offer social influences as key to risk factor management. Social influences impact on patient beliefs, adherence to medication and lifestyle advice as well as the socio-economic challenges of low economic status and educational levels as well as ethnicity and cultural disparities.

5.5 Ethnicity

Studies to identify specific risk differences in varying ethnic populations are useful to understand which groups are at high risk from certain vascular risk factors, for example, it has been suggested that men born in South Asia are 50% more likely to have an MI or Angina and Bangladeshi's have the highest rates. In contrast men born in the Caribbean are 50% more likely to die of a stroke than the general population (POST 2007). Despite the biological differences, ethnicity also involves cultural and religious variables which effect behaviour of patients and it appears health professionals. Recent evidence implicates racial origin as a determinant of the type and level of healthcare received, suggesting that inequalities exist as a function of ethnic or social background (Bourke et al 2006). It is well known that patient's values and beliefs influence behaviour (Smedley et al 2002, Hunt el al 2005) and this is of particular importance to Black Minority Ethnic (BME) groups when in consultation with health professionals from different ethnic backgrounds and should be taken into consideration during every interaction. Bentley et al (2008) found large variations in cultural diversity training for health care professionals across the country depending on profession and region. They called for National Guidelines to incorporate cultural competency training for all UK health care professional training bodies.

5.6 Raising risk awareness to change behaviour

Provision of information alone is rarely sufficient to affect health behaviour change (there are few, if any, smokers who are unaware of the message 'smoking kills'),

however it remains a crucial element of health education. Due to the challenge this presents and the rise in the need for communication of risk to patients and the general public in order to increase self-management of chronic health conditions, the communication of risk information has recently received increased attention (NICE 2010, WHO 2011). Research in the field of health psychology has demonstrated that individuals are more responsive to information about relative risk than absolute risk, and the former has greater influence over decision making (Edwards et al 2000). It has also been suggested that an individual's perceptions of severity of the targeted health threat are as influential as perceptions of risk in relation to motivating behaviour change (Milne et al 2000, Witte & Allen 2000). Provision of risk information should also be accompanied by a personally tailored action plan of where and how the risk reducing behaviour may be implemented within the context of that individual's current lifestyle (Sheeran 2002). Explicit in any risk communication should be an explanation of the process whereby the risk leads to the disease and the process through which that risk is reduced when health behaviour is altered or undertaken.

Studies have shown that the provision of information may improve knowledge but has not been found to improve perceived health status (Forster et al 2001). It has been suggested that patient's own perspectives about stroke illness and recovery are important as they may influence emotional adjustment and adherence to medical recommendations (Townend et al 2006). Wolf et al (1991) suggested that information about ones' risk of stroke may provide the impetus for risk factor modification. The dissemination of risk information is indeed necessary if reductions in risk are to be achieved (Edwards et al 2000) and studies which include interventions to communicate risk, are useful to identify if risk awareness can improve adherence to secondary prevention strategies or the likelihood that patients will participate in behaviour changes to reduce risk.

A review of the literature was performed in order to identify other relevant studies performed in order to improve adherence to secondary prevention and no directly specific risk awareness interventional studies were identified. However, other studies have been performed using strategies such as, enhanced educational programmes to impact on behaviour and improve adherence to secondary prevention strategies following stroke specifically (Gillham et al 2009, McManus et al 2009, Wolfe et al 2010). From other reviews of interventions to improve adherence or alter behaviours, few have had significant results and of the 5 randomised controlled trials performed

specifically in stroke the most effective study used an integrated care model of multiple components and an integrated management system to demonstrate improved effects on risk factor management (Joubert et al 2009). This whole team commitment is an example of a ‘gold standard’ of stroke care, however, the multiple intervention components would be costly and difficult to coordinate in the long term and would require excellent communications between secondary and primary care. Although these elements should be expected, it would be challenging to implement these strategies across every stroke service in the country. Nevertheless, in-hospital initiation of secondary prevention therapies yielded high rates of adherence in the stroke PROTECT (Preventing Recurrence of Thrombo-embolic Events Through Co-ordinated Treatment) program. This project delivered 8 medication/behavioural secondary prevention measures known to improve outcomes in patients with cerebrovascular disease (Ovbiagele et al 2004). The 4 medication goals were:

- Antithrombotic
- Statin
- ACE
- Thiazide Diuretic

The 4 Behavioural goals were:

- Smoking cessation counselling
- Exercise counselling
- Diet counselling
- Education about personal risk factors

They found high rates of adherence to the measures at 3 months and suggest the inpatient setting provides a unique window of opportunity for the initiation of secondary prevention measures. The initiation of secondary prevention measures as an inpatient have been shown to be effective in other diseases such as coronary heart disease where good outcomes were demonstrated and led to a revision of national guidelines to endorse the approach as a national standard of care in patients with cardiac disease (Fonarow et al 2001). Currently stroke care guidelines provide evidence based treatment targets but do not suggest how secondary

prevention should be initiated or managed, however as the risk of stroke in the early days and weeks following initial event is so high the guidelines suggest prevention is initiated as soon as possible after the event (RCP 2008). Rothwell et al (2007) concluded urgent use of existing preventive treatments was associated with an 80% reduction in risk of early recurrent stroke following a prospective study with the primary outcome as risk of stroke within 90 days of first seeking medical attention following stroke. The urgent preventive treatments used in this study were:

- Antiplatelet therapy
- BP lowering medications (existing medications or Perindopril)
- BP lowering plus or minus Indapamide (Thiazide Diuretic)
- Anticoagulation as required

Further studies are required to identify if there is a long-term effect, however, this study clearly suggests the positive effect of acute, urgent preventive medical treatment for stroke and TIA.

Changing illness perceptions could improve behaviours. Petrie et al (2002) examined whether a brief hospital intervention designed to alter patients perceptions about their myocardial infarction (MI) would result in better recovery and reduced disability. The intervention caused significant positive changes in patient views of their recovery from their MI. It has also been suggested illness perception can influence attendance to the cardiac rehabilitation programmes (French et al 2006). French et al (2006) identified patients who viewed their condition as controllable, symptomatic and with severe consequences and who felt they understood their condition were more likely to attend than those who did not. This offers insight into how perceptions can influence behaviour following MI and may be useful in understanding how stroke survivors may react following their event.

Communicating risk information is a key element of the intervention of this study and Edwards et al (2000) offer strategies to improve the effectiveness of risk communications through including individual risk estimates rather than general risk information during a risk consultation. Edwards et al (2000) found that patients appeared to be more amenable to make behaviour changes with risk estimates

given during a discussion between the health professional and patient rather than attending screening sessions.

Leventhals model of common-sense self-regulation (Diefenbach and Leventhal 1996) is used as a premise that patients develop their own cognitive representation to make more sense of the threat to their health which therefore determines their behaviour in response to the threat. Theoretically the hypothesis for this study is, increasing individuals' awareness of future vascular risk including secondary stroke, will influence their appreciation of the threat to their health and therefore increase the likelihood of behaviour change and adherence to secondary preventions strategies which will reduce the threat or in this situation risk of future vascular events.

5.7 Aims and objectives

1. To study the characteristics, knowledge of stroke and perception of risk in a stroke population.

2. To investigate if a risk awareness intervention increases risk awareness in a stroke population using a RCT.

3. To identify if an increased risk awareness improves adherence to secondary prevention strategies such as medication taking and behaviour modification in the 3 months following discharge from hospital.

5.8 Methodology

This study will use a variety of methods to measure adherence including physiological measurement and patient self-reporting.

The MRC presents a step-wise approach to the implementation of complex interventions and suggests a randomised controlled trial is the optimal study design to minimise bias and provide the most accurate estimate of a complex intervention's benefits (MRC 2000). This study was developed using the MRC approach to complex interventions as a framework for the design and evaluation of the RCT.

The first step of the framework used was to establish the theoretical basis that suggests that the intervention should have the expected outcome. The literature review informed and identified stroke recurrence as a real risk and secondary prevention of stroke using strategies such as medication taking and lifestyle modification as key. The second step in evaluating a complex intervention is to

develop an understanding of the intervention and its possible effects. This involves delineating an intervention' components and how they inter-relate and how active components of a complex package may be related to either surrogate or final outcomes. 'Modelling' refers to the possibility that this phase is paper-based for example computer simulations or economic modelling. It may also include qualitative testing through focus groups, preliminary surveys case studies or small observational studies. The results from chapters 3 and 4 have been used to assume increased knowledge and awareness of personal risk improve control of hypertension and behaviours post stroke and have informed the development of the intervention to be tested. The third step in is the crucial stage prior to the main RCT. Evidence can be obtained to support the theoretically expected treatment effect, to identify an appropriate control group, outcome measures, estimates of recruitment for a main trial and other requirements of such a trial. The fourth phase and central step in the evaluation of a complex intervention is the main RCT and required attention to standard issues of adequate power, adequate randomisation and blinding appropriate outcomes measures, informed consent of participants and other standard features of well designed trials.

It has been suggested that a multiple assessment approach to the measurement of adherence is the most accurate way to measure all the aspects of secondary prevention advice. Using a mix of physiological and psychological measurements can provide a more robust understanding. Cummings et al (1981) employed a multi-method design to assess the construct validity of 3 commonly used methods for assessing compliance, physiological assessment such as blood chemistry, ratings by health professionals and patient self-reports. They concluded multiple assessments are the best way to ensure accuracy in gauging levels of patient adherence and behaviour to medical instructions and therefore this study will aim to use similar methods of assessment.

5.8.1 Trial design

A pre and post open labelled RCT intervention trial design was used to measure stroke risk factor control and patients perception of their risk of future stroke and heart disease as well as measuring their understanding of stroke risk factors, likely cause and intended behaviour modifications at baseline and at follow-up. Following the Medical Research Council Framework for the development and evaluation of complex health service interventions (Craig et al 2008) work was performed to inform

the development of this novel intervention to improve adherence to secondary prevention strategies and influence risk factor control in a stroke population. This work is detailed in chapters 2-4. The results from the studies performed as part of this PhD have informed the researcher in order to identify the intervention and the variables to be measured as part of the RCT. Awareness of BP improved control in hypertensive members of the public and awareness of risk resulted in more stroke survivors making behaviour changes in response to their stroke even up to 5 years after the event. Clear, transparent and detailed reporting of RCT's are important aspects and this study uses the CONSORT convention (Hopewell et al 2008) as a guide to maintain a clear and transparent report of the design, methodology and results obtained from this study.

The study was registered as the Individual Risk Awareness Intervention in Stroke study with the International Standard Randomised Controlled Trial Number register (ISRCTN67999605) as part of the quality standard process for this study. Figure 5.1 is a flow chart of the process of the study including number of participants approached about the study, those recruited and randomised, the intervention and controls and the final numbers at follow-up for endpoint data collection.

5.8.2 Risk modelling for secondary stroke risk

The Framingham study risk models have been used to identify cross-risk for IHD, stroke and diabetes (D'Agostino et al 2000 and Wolf et al 1991). This and other models have been found to be useful tools to gain a better understanding of the relationship between risk factors and the occurrences of cardiovascular events in subjects who are free of systemic vascular disease, as well as individuals who have had a prior event or are at particularly high risk of an event (D'Agostino et al 2000). Risk assessment is now a well-established tool for health professionals to identify patients at a higher risk of stroke, however the concept of risk has not been broadly taught to patients following a first vascular event to control factors affecting the risk of further events.

Logistic regression (Appendix 3) was used in the development of a risk modelling tool to produce a risk score for secondary stroke. The regression was used to create a predictive model based on the development dataset which included 300 subjects from the British Repository of DNA in Stroke (BRAINS) database. BRAINS is a platform for several arms for collecting DNA in patients with different cerebrovascular diseases including TIA, Arterio Venous Malformations (AVM),

ischaemic and haemorrhagic stroke. Using uni-variate analysis, we evaluated a range of covariates as potential determinants of secondary score risk including age, gender, history of hypertension, diabetes, ischemic heart disease, peripheral artery disease (PAD), atrial fibrillation, smoking history and any drug history (statin/antiplatelets/antihypertensive). Baseline parameters significant on uni-variate analysis ($p<0.25$) were used in step-wise multi-variable logistic regression analysis to determine independent predictors of secondary stroke. Once the final model had been defined, an equation (listed below) was constructed using beta co-efficients of variables significant in multivariable logistic regression analysis to derive a score which would predict risk of secondary stroke (Appendix 3).

5.8.3 Independent variables

Independent variables were identified to measure adherence and effectiveness of the intervention to control risk factors and influence patient's lifestyle modification. The independent variables measured were:

- Blood Pressure
- Blood sugar
- HbA1c
- Weight
- Waist
- Cholesterol
- National Institute of Health Stroke Scale (NIHSS)
- C - reactive protein (CRP)

In stroke patients with hypertension the absolute risk reduction is 2.2% after 2 years of treatment for an average diastolic BP reduction of 5-6mmHg and for an average systolic BP reduction of 10-12 mmHg (Collins et al 1990). Treatments to produce a BP lowering effect are numerous, the HOPE trial (2000) showed that Ramipril, an Angiotensin Converting Enzyme (ACE) inhibitor reduced the risk of vascular events and PROGRESS (2001) showed that a combination of an ACE and a diuretic (Indapamide) reduced the risk of a new vascular event after an ischemic or

haemorrhagic stroke. For patients with a history of ischaemic heart disease or hypercholesterolaemia, treatment with a statin leads to approximately 25% relative risk reduction in stroke (Di Mascio et al 2000) and the Heart Protection Study (2002) showed a benefit for patients with previous ischemic stroke if treated with statins regardless of their cholesterol levels. Both blood glucose and HbA1c were measured to reflect current diabetes control, the HbA1c measurement was particularly useful in that it measures glycaemic control over the 3 month period.

Few weight loss studies have been powered to detect differences in mortality and morbidity or followed patients up for sufficient time, however low fat diets in the overweight and obese have been shown to reduce type 2 diabetes, improve blood pressure control and reduce hypertension medication for up to 3 years. However, it is important to consider dietary change should be feasible financially and should fit within the patient's lifestyle as well as appealing to ones tastes in order to be sustainable over time (Singh et al 2002). Waist was measured in order to identify weight loss but also as a way of measuring potential cardiovascular risk reduction as waist measurement is an indicator for cardiovascular risk (Zhu et al 2002). Janssen et al (2002) reported that increased visceral fat, as measured by magnetic resonance imaging (MRI) in 341 whites, had a stronger correlation with waist circumference than with body mass index (BMI; in kg/m^2). Using the third National Health and Nutrition Examination Survey data in 9019 Europeans, Zhu et al (2002) reported that waist circumference is more closely linked to cardiovascular disease risk factors than BMI. Cholesterol was measured to indicate effective secondary prevention with medication and to support self-reports of medication taking. Severity of stroke was assessed using the National Institute of Health Stroke Scale (NIHSS) (Brott et al 1989). This NIHSS is a standardized method used by physicians and other health care professionals to measure the level of impairment caused by a stroke. The scale serves several purposes, but its main use in recent years is during the assessment of whether or not the degree of disability caused by a given stroke merits treatment with thrombolysis (Bradley et al 2004). The NIHSS is also commonly used in research, where it allows for the objective comparison of efficacy across different stroke treatments and interventions.

The NIHSS (Brott et al 1989) measures several aspects of brain function, including consciousness, vision, sensation, movement, speech, and language. A certain number of points are given for each impairment identified during a focused neurological examination. A maximal score of 42 represents the most severe and

devastating stroke and a score of 0 reflects no measureable impairment. Current guidelines as of 2008 (RCP) allow thrombolysis to be given to patient with a diagnosis of stroke with scores of greater than 4 points (Bradley et al 2004).

C - reactive protein (CRP) was measured in order to provide a scientific control of the study as CRP is a critical component of the immune system, a complex set of proteins that are made when faced with a major infection or trauma. CRP is an 'acute-phase reactant' and goes up during the acute period and then goes down again, however it has also been recognised as a risk for cardiovascular disease (Ridker 2003). Studies have demonstrated that baseline levels of CRP in apparently healthy men and women are highly predictive of future risk of heart attack, stroke, and the development of peripheral arterial disease (Libby et al 2002). CRP levels predict recurrent coronary events among patients who already suffer from heart disease and that the prognosis of patients in the acute phase of a heart attack is tightly linked to CRP levels. Individuals with elevated levels of CRP have a risk of stroke, about 2 to 3 times higher than the risk of those with low levels (Ridker 2003).

Self-reported behaviours measured at follow-up were:

- Smoking cessation
- More exercise
- Less alcohol
- Weight loss
- Low fat diet
- Less salt
- Taken medications
- Smoking cessation was self-reported as well as alcohol intake.

Weight loss was self-reported in conjunction with weight and waist measurements. Low fat diet as a secondary prevention strategy was included in the intervention and therefore measured as a behaviour change at follow-up. High salt intake is associated with significantly increased risk of stroke and total cardiovascular disease (Strazzullo et al 2009). Reducing sodium intake is also known to reduce BP (Sacn

2003) and a small reduction from 9g to 6g (teaspoon) per day is significant to produce an effect. Moderate levels of activity (30 mins per day) have been associated with a significant reduction in stroke risk of 20% (Wendel-Vos et al 2004). It has also been suggested the addition of exercise to diet can reduce the risk of metabolic syndrome in men (Brown et al 2009). However, Brooke et al (2009) found only half of the stroke survivors in their study were participating in physical activity at 12 months post stroke and were less likely to perform physical activity to lose weight.

5.8.4 Power calculation

Group sample sizes of 48 in group one and 48 in group two achieve 80% power to detect a difference between the group proportions of 0.28. The proportion in group one (the treatment group) is assumed to be 0.4 under the null hypothesis and 0.68 under the alternative hypothesis. The proportion in group two (the control group) is 0.4. The test statistic used is the two-sided Z test with pooled variance. The significance level of the test was targeted at 0.05. The significance level actually achieved by this design is 0.05.

5.8.5 Inclusion criteria

- All patients with a diagnosis of ischaemic stroke who are being treated as inpatients at Imperial College Healthcare NHS Trust.
- All patients who are able to participate in a one to one risk awareness intervention session or who have a spouse willing to engage and participate in the study.
- Patients who are able to consent both verbally and sign a written consent form.

5.8.6 Exclusion criteria

- Patients who are unlikely to live as a consequence of the stroke
- Patients who are unlikely to be able to attend follow-up consultation at 3 months.
- Patients who are unable to participate in the intervention due to cognition and memory difficulties following their stroke or pre-morbidly.

5.8.7 Randomisation and blinding

Subjects were randomised using computer-generated random codes. The researcher was blind to randomisation until after recruitment of each participant to avoid selection bias. The trial is an open-labelled design with blinding of the researcher only at randomisation. This was achieved through sealing each random code in an envelope prior to commencing the trial, which was only selected after the participant had been recruited.

5.8.8 Intervention

Early initiation of prevention strategies has been shown to improve sustained adherence and good outcomes in stroke patients (Ovbiagele et al 2004) therefore the intervention was given whilst the patient was still an inpatient, however with a discharge date set.

Those patients randomised to receive the intervention underwent a 30 minute risk awareness intervention session with the researcher. An intervention proforma (Appendix 5) was used to ensure all intervention participants received similar information regarding specific risk factors. The proforma was divided into sections:

1. Smoking
2. Exercise and Activity
3. Medications
4. Blood pressure
5. Cholesterol
6. Diet
7. Alcohol
8. Salt
9. Follow-up

The participant was informed with medication information specific to their individual risk factors to ensure they were given an understanding of which medications were for which risk factor and how the medication affects and controls each risk factor in

order to reduce overall stroke risk. This has been shown to be successful where a relationship was found between regimen persistence of stroke prevention medications in those with an understanding of why prevention medications were prescribed and how to refill the prescriptions (Bushnell et al 2010). The intervention group received enhanced risk factor awareness information, comprising further information about stroke pathology specific to their current condition and diagnosis, explanation of their individual stroke risk factors with particular focus on how lifestyle change and medication could influence modification of risk factors for future stroke and vascular disease (Appendix 5). Relatives were invited to be present during the intervention sessions. The intervention group were also given a percentage risk score for future stroke stratified by current smoking status which was developed using logistic regression modelling. The risk score was presented to the participants in a percentage format to provide them with an element of numerical understanding of their personal risk of future stroke (Appendix 3).

The control group received usual practice and no further risk awareness information and were followed up for data endpoint collection at 3 months. All participants completed the study proforma (Appendix 4) prior to randomisation to obtain baseline data such as age, gender, ethnicity, educational level and marital status and baseline dichotomised risk perceptions were also recorded for both study arms prior to the intervention.

All the stroke survivors invited to participate in the study had suffered an acute ischaemic stroke confirmed on imaging. This subgroup of stroke was chosen as the risk factors for ischaemic stroke are most affected by control, management and behaviour change, however BP is a risk factor for both ischaemic and haemorrhagic stroke and reduction and management benefits both equally.

A favourable ethical opinion was given to the study by the East London Research Ethics Committee (REC 10/H0701/9) on 8th April 2010.

5.8.9 Analysis

Data collected from the proforma completed for each participant was double-entered into Epidata and exported to STATA-11.1 for statistical analysis (StataCorp 2007).

5.9 Results

Population characteristics and demographics are found in Table 5.1. The study reached power with 96 participants recruited. Of the 96 participants, 47 were randomised to the intervention and 49 randomised to control group. Two participants were lost to follow-up from the control group, therefore 94 patients data were analysed with 47 in both arms of the study. No one suffered a further ischaemic stroke event during the 3 month study period. Mean age was 65 years in the intervention group and 66 years in the control group (95% CI 12.1-12.7, P=0.56). There was an equal gender split in both groups (Male n= 30 in intervention arm and n=26 in control arm). The majority of participants were white in both groups with 29 (61.7%) in the intervention group and 33 (67.3%) in the control group. Black Ethnic Minority (BME) groups made up 13% of the total cohort. The majority of participants were married in both groups with 27 (57.4%) and 27 (55.1%) respectively. All the participants had at least a secondary school education and 19 (40.4%) had a university education in the intervention group and 9 (18.3%) in the control group (P=0.06). NIHSS showed minimal deficit at discharge for both groups with a mean score of 1.2 and .73 (P=0.42) respectively which was not significantly different. Length of stay on the stroke unit was longer in the intervention group with 14 days compared to 5 days in the control group however this was statistically insignificant (P=0.06) and can be explained by the inclusion of a single outlier in the intervention group of 67 days, this is further demonstrated by the Median length of stay which for the intervention group was 3 days compared to 2 for the control. Results for perception and knowledge questions asked at discharge were prior to the intervention and therefore any impact of the intervention will be seen in the analysis of the responses given at follow-up to ensure any significance is related specifically to the intervention. Mean length of follow-up was 89 days.

Interventions during admission were recorded to identify if a medical intervention had any effect on behaviour, however medical interventions for the entire group were low with 5 patients undergoing a carotid endarterectomy (Intervention arm n=2, control arm n=3), only one patient underwent a hemi-craniectomy from the intervention arm, none from the control arm. Eight patients from the intervention arm received thrombolysis compared to two patients in the control arm. The majority of patients in the study received no advanced medical interventions beyond usual care (intervention arm n = 36, control arm n = 44) (Figure 5.2).

5.9.1 Past medical history

Hypertension was self-reported as the most common risk factor in both groups (n=39 intervention group and n=26 in the control group, P=0.09), followed by hypercholesterolaemia with 19 (40%) and 12 (25%) respectively. A previous stroke was reported in 16 (34%) of participants in the intervention group and 13 (28%) of the control group (Table 5.2).

5.9.2 Medication taking

Medications on admission were recorded and only cardiovascular disease related medications were recorded for the purpose of this study. The medications were divided into groups for, 1) any antiplatelet, 2) any statins, 3) any hypertensive medications, 4) anticoagulation (Warfarin), and 5) any diabetes medication. The discharge medications were recorded and follow-up medications were then recorded at the 3 month consultation. On admission a moderate amount of the participants were admitted to hospital taking no medication (intervention n=12, control n=17), however at discharge all patients were taking either antiplatelet or anticoagulation medication in both groups, and nearly all were taking statins (intervention n=47, control n=43). Of the intervention group at baseline 94% (n=44) were discharged with an antiplatelet and 96% (n=45) of the control group, 6% (n=3) and 4% (n=2) were discharged with warfarin medication respectively and 51% (n=24) of the intervention group were taking anti-hypertensive medication and 68% (n=32) of the control group. At discharge 98% (n=46) of the intervention group and 91% (n=43) of the control group were prescribed a statin. At follow-up 89% (n=42) in the intervention and 94% (n=44) in the control group self-reported they were prescribed and were taking an antiplatelet medication. At follow-up 91% (n=43) of the intervention group and 87% (n=41) of the control group self-reported being prescribed and taking a statin, 47% (n=22) reported taking hypertensive medication in the intervention group compared to 64% (n=30) in the control group and 13% (n=7) and 17% (n=8) respectively reported taking medications for diabetes (Table 5.3).

5.9.3 Pre-stroke behaviours

Smoking frequency was measured as never, past or current/recently quit. Alcohol intake was measured recording none, recommended (21units for men, 14 units for women) or more than recommended. Both smoking and alcohol history was self-reported. Current or recent smoking was found in 16 participants at discharge in the

intervention group and 8 of the control arm (P=0.17). At follow-up 9 participants from the intervention arm self-reported quitting and 2 from the control arm reported the same. Alcohol intake at discharge was high in both groups but especially the intervention arm with 13 participants drinking more than the recommended amount of alcohol per week and 8 in the control group reporting the same, at follow-up 11 from the intervention group self-reported drinking less alcohol compared to only 3 in the control arm (P=0.06).

5.9.4 Risk awareness and perception

Risk perception was measured by asking patients at baseline and then follow-up, whether they perceived themselves to be at risk of a future stroke. They had the opportunity to answer either, yes, no or don't know. At discharge both groups answered similarly, 30% of the intervention arm and 31% of the control arm answered yes, 19% of the intervention arm and 18% of the control arm answered no and the majority in both groups answered don't know (51% intervention group and 51% in control group). However at follow-up 51% of the intervention group compared to 33% of the control group answered yes to being at risk, 23% and 15% respectively answered no and 25% and 51% respectively answered don't know (P=0.041) showing a significant difference in perception of risk in the intervention group. There was a similar result when asked about their risk of a heart attack with a significant difference in perception between the two groups at follow-up (P=0.039).

5.9.5 Knowledge of cause and type of stroke

Overall knowledge of the cause of stroke was poor with 82% of the total population unable to name in free-text any cause of their stroke at baseline and 70% unable to name a cause of their stroke at follow-up. As part of the inclusion criteria all patients recruited into the study had a diagnosis of ischaemic stroke and knowledge of stroke type was seen in both groups with 60% (28) of the intervention group responding to the question with either clot or ischaemia and 41% (20) in the control arm (P=0.141) at discharge, however at follow-up the intervention group showed significantly higher knowledge of stroke type with 80% (28) able to answer clot or ischaemia compared with 47% (17) from the control group at follow-up (P=0.001) (Figure 5.3).

5.9.6 Knowledge of risk factors

At baseline and then at follow-up participants were asked if they had any risk factors for stroke, they were given the option to answer yes and provide information about

their risk factors or to answer no. At baseline 49% (23) of the intervention arm answered yes to having risk factors compared to 61% (30) of the control arm. At follow-up 70% (33) of the intervention arm answered positively to having risk factors for stroke compared to 51% (23) of the control arm which suggests a trend (P=0.061) towards greater awareness in the intervention group. Risk factors identified at discharge included Blood Pressure (Intervention 36%, control 50%), previous stroke (intervention16%, control 16%), stress (intervention 8%, control 0) and smoking (intervention 12%, control 8%). At follow-up more participants generally cited appropriate risk factors and in the intervention group BP was cited as a risk factor by 48% compared to 47% in the control arm.

5.9.7 Behaviour changes after stroke

The participants were asked if they planned to make any lifestyle or behaviour changes in response to their stroke at the initial interview prior to the intervention and were asked if they made any of those changes at the follow-up interview. The number of behaviour changes self-reported at follow-up was divided into three groups for the analysis, none, 1-2 changes or 3 or more changes. The results (figure 5.5) for the intervention group showed 8% (n=4) made no lifestyle changes, 56% (n=26) made 1-2 changes and 36% (n=17) made 3 or more changes. For the control group 46% n=21) made no changes, 46% (n=22) made 1-2 changes and only 8% (n=4) made 3 or more changes. This suggests a highly significant difference in the number of lifestyle changes made between the two groups (P<0.001) (Figure 5.4).

Analysis of the types of behaviour change made identified medication taking as the most frequent behaviour change in both groups. The intervention group made more lifestyle changes in all categories and the most reported changes following medication (70%) taking were more exercise (34%), less alcohol (23%), followed by low fat diet (21%), smoking cessation (19%), weight loss (15%) and less salt (4%) in the intervention group, however in the control group only 29% self-reported taking medications, 11% reported taking more exercise, 8% a low fat diet, 6% less alcohol and 2% reported weight loss. No one reported taking less salt in their diet and only 4% stopped smoking in response to their stroke (Figure 5.5). T-test analysis identified the intervention group made overall more lifestyle changes in all categories of behaviour compared to the control group (P=0.03) (Figure 5.5).

5.9.8 Risk factor control

Risk factors were measured at baseline and again at follow-up. Data was collected and analysed for Blood pressure, cholesterol, weight, waist, blood glucose and CRP. Mean measurements were calculated and entered into STATA for analysis. There was no statistical difference between blood glucose at discharge for the intervention group (6.2mmols; 2.0Std dev, P=0.12) versus the control group (6.9mmols; 2.6Std dev) with a P=0.12 and follow-up for the intervention group (5.8mmols; 1.5Std dev) and controls (6.3mmols; 1.67Std dev) and a P=0.23, weight at discharge and follow-up didn't significantly alter for both groups (intervention at discharge 79.3kgs; std dev 18.5 and control 78.7kgs;std dev 11.92), waist at discharge was lower in the control group but not significantly (intervention 37.1 inches and 36.5 inches for the control) or cholesterol in both the intervention and control groups at discharge (4.7mmols intervention; 4.3mmols control) going down to 4.1mmols in the intervention group and 4.06 in the control, however CRP measurement at discharge and follow-up for the intervention group was significantly different P=0.05 and systolic BP at follow-up was shown to be significantly different for the intervention group compared with the control group (P=0.01). The reduction of SBP was shown to be 3 mmHg in the intervention group but this was not significant (P=0.25) (Table 5.4).

5.10 Limitations

The control group received conventional treatment, however it might be possible that by being involved in the study awareness of risk was inadvertently raised and may have influenced their behaviours and improved adherence and lifestyle behaviours. This is known as the Hawthorne effect, by potentially tainting the 'control' status though involvement in the study information sheet.

The researcher conducted all the assessment and interventions as well as the follow-up assessments therefore it is important to discuss the limitation of lack of blinding of the researcher throughout the totality of the project, however it is important to highlight that blinding at the time of recruitment was upheld rigorously with randomisation numbers (1=intervention, 2=control) sealed in envelopes until recruitment had been made.

5.11 Discussion

The results suggest the intervention was successful in increasing risk awareness in this population of stroke survivors. It also suggests that increasing risk awareness has an impact on knowledge and behaviour during the first 90 days after stroke. The

majority of both participants in both groups were married, which suggests a level of support after discharge, however spouse input was not measured at follow-up but approximately 25% of participants had a family member present during the intervention. Social support has been documented as a valuable resource affecting health and health behaviours (Conn 1991) and low NIHSS scores describe a population with minimal to mild disability and deficits following their stroke. The acute medical interventions were minimal and did not affect behaviour, however, the thrombolysis rate was 12.5% which is representative of current thrombolysis rates in London (RCP 2010) which supports the reliability of the cohort and is representative of current stroke practices in London. Researcher bias is avoided through using independent variables and data collection was specifically chosen to avoid any subjective elements, however this may have been introduced at the time of endpoint data collection because the researcher was not blinded to the intervention group.

The evidence for medication taking in this population provides an example of good clinical prescribing of secondary prevention medications at discharge and generally suggests high levels of adherence at 3 months, however, on further analysis it was noted that despite the high numbers of self-reported medication taking in both groups at follow-up across the five secondary prevention drug groups (antiplatelet, warfarin, statins, hypertensive and diabetes medications), at follow-up four out of the five medication groups showed a small reduction. The intervention group taking antiplatelet therapy went from 94% at discharge to 89% at follow-up, this is a small reduction of 5%, however it occurred over a short period of time. This reduction in medication taking may be the result of non-adherence or poor repeat prescribing over time but could end up in a significant loss of risk factor management for secondary prevention. The reduction of antihypertensive medication taking at discharge compared to admission (Table 5.3) may be due to specialist knowledge of drug treatment regimens which enable a reduction in the overall amount of antihypertensive medications through the introduction of a more effective drug. The only drug which saw an increase over the 3 month period was warfarin which may have indicated the slight drop in participants taking antiplatelet medications, however the reduction in statin therapy went from 98% to 91% in the intervention group and 91% to 87% in the control group. This result suggests there is a need for medication focussed follow-up to ensure patients continue to take prescribed medications, it is understandable for medication prescriptions to change if there are side-effects, however, the long-term risk reduction benefits of these medications should be

explained at discharge to ensure patients are aware of the need to take them for the foreseeable future and health professionals in the specialist areas should ensure other health care colleagues are aware of the long-term needs of patients to be prescribed the medications.

The number of BME participants in this study was low (13%), however, the results are representative of the ethnic diversity across the country, despite this the importance of risk and ethnicity should be discussed with regard to how health professionals manage secondary stroke prevention strategies. Few studies have focussed on knowledge of stroke risk factors in BME populations in the UK. Due to the low uptake of BME groups in this study knowledge of behaviour and risk awareness remains low. Studies from overseas looking at knowledge of high risk populations have shown knowledge of risk factors for cardiovascular disease is low (Khan MS et al 2006), this raises concerns regarding populations living in the UK and how health information messages are shared to ensure knowledge of risk is increased in all sectors of society and ethnicities. Further studies of BME groups in stroke are needed to increase the body of knowledge regarding knowledge and behaviour.

Perception of risk was poor at baseline, prior to the intervention. Interestingly both cohorts answered similarly at discharge with only one third in each group perceiving they were at risk of a further stroke and half of both groups answered they did not know about their risk. The results remained the same for the control group at follow-up but an increase was seen in the intervention group response at follow-up of 21%. The number of participants in the intervention group who went from ‘don’t know’ at discharge to ‘at risk’ at follow-up went from 51% down to 20% which suggests a shift in perception of risk. These results mirror similar studies which found risk perception low (42%) in a cohort of patients who have a history of stroke (Samsa et al 1997). Interestingly, the REACT study (Erhardt & Hobbs 2002), of attitudes and behaviours of the general public in 5 major European Countries, found that risk awareness and knowledge was poor in all groups studied and the presence of cardiovascular risk factors had no influence on risk perception when compared with members of the public with no risk factors. Similar results were found in the level of knowledge of stroke risk factors in this study, with a trend (P=0.069) for the intervention group as, half (49%) believed they had risk factors for stroke and this went up to 69% at follow-up whereas in the control group the figure went down at follow-up from 61% to 47% who believed they had risk factors for stroke. This suggests an improvement in

knowledge of stroke risk factors in the intervention group and the retention of information throughout the 3 months after the intervention.

Stock (2009) found a perceived lack of consistent secondary prevention advice from health professionals was a cause of stroke survivors being uncertain about implementing guidance in their daily lives. However, both groups answered highly to receiving enough information about their stroke, with only 2 participants answering no to the question. However, a future study might involve asking patients about how they perceive the information they are provided to understand if they believe they receive consistent information and if they understand what the information is trying to convey.

The results show low levels of knowledge overall relating to the cause of stroke, however, knowledge of stroke sub-type was good in both cohorts but significantly better in the intervention group at follow-up (P=0.001) (Figure 5.3). This result is interesting as the initial data at discharge showed the intervention group had less knowledge of the type of stroke than the controls, therefore indicating the intervention significantly increased their knowledge of the type of stroke and they retained that information at 3 months. It would be interesting to understand why the results for knowledge of stroke cause were low compared with knowledge of stroke subtype, however this may be a direct reflection on the information provided regarding cause of stroke as an inpatient in hospital as it can be difficult to find the cause of stroke in as many as 25% of patients during the acute phase of their admission. The identification of the subtype of stroke is done early as part of the urgent treatment and this is communicated to patients as part of routine practice. However, the results at the time of discharge were actually low for knowledge of stroke sub-type and they remained quite low in the control arm of the study, therefore this result might suggest that communication of stroke subtype may not be effective during the acute phase or it may not be highlighted as an important factor for secondary prevention for patients unless it is communicated in the form of a risk awareness intervention. As during the intervention the reasons for medications to prevent clot formation were discussed and reinforced to the participants as part of the intervention.

This may also be a reflection of the individualisation of the intervention, through personalising their stroke, they were more likely to retain the information at follow-up. They showed a significant learning and retention of information through the

intervention as they had less knowledge than the control group at discharge, however at follow up the intervention group showed a significant difference in their awareness of having vascular risk factors. However, it is also important to suggest the simple increase in attention and professional interaction may have been enough to increase learning and retention of information in the intervention group.

Knowledge of risk factors was significantly higher in the intervention group who were more aware of their risk of future stroke at follow-up than the control group. They were also more aware of their individual risk factors for stroke as 60% compared to 47% of the control group, at follow-up answered yes to having a risk factor for stroke. An increase in their risk awareness and having risk factors was hypothesised as likely to influence behaviour and increase participant's reaction to the threat of suffering a recurrent stroke and may be the reason for the intervention group's significant increase in behaviour changes at follow-up.

Behaviour modification overall was poor in the control group with only 29% reporting taking medications as a modified behaviour at follow-up in response to their stroke. The intervention group made significantly more lifestyle changes than the control group, however the changes reported were generally most common in the difficult to measure behaviours such as exercise, less alcohol and a low fat diet. Weight loss was reported in 13% of the cohort however, there was no significant difference in weight loss in the analysis (P=0.9). Studies have been performed to measure psychological reaction to information about increased risk of coronary heart disease in general practice (Christensen 2004) which showed no difference was found between any of the groups at baseline or at 1 or 5 year follow-up whether they were receiving information about being a low, moderate or high risk of CVD. Cooper (2007) alternatively offers the potential response to a false reassurance when receiving a low/minimal risk feedback, however, in this population of stroke survivors the risk is already moderate.

Smoking results were disappointing in this study as 13 of 24 smokers were still smoking (54%) at follow-up overall. In the intervention group 7 of 16 were still smoking (43%) and only 2 of the 8 participants in the control group reported smoking cessation. This suggests smoking at 3 months is still a problem for stroke survivors who smoke, however the intervention group does appear to have been more likely to stop smoking, however this was not statistically significant.

Drinking excessive alcohol was high in the overall stroke population with 19% drinking more than the recommended levels of alcohol for men and women, however there was a significant response to reducing alcohol intake at follow-up for the intervention group which indicates an influence on behaviour change for lifestyle changes. However, drinking alcohol is high across the country, in England in 2008, 71 per cent of men and 56 per cent of women reported drinking an alcoholic drink on at least one day in the week and eleven per cent of men and 6 per cent of women reported drinking every day (DH 2010), however 40% of the total population of this study didn't drink at all according to self-reports which is reassuring.

The overall results suggest behaviour was influenced by the intervention, however, the exact details of how behaviour was influenced is still unclear as just increased time and attention may have been equally responsible for the greater number of behaviour changes in the intervention group. However, one could responsibly report that an intervention involving increased risk perception is a useful tool to changing health behaviour in stroke survivors. The intervention group made significantly more self-reported behaviour changes than the control group and this may be related to participant bias in self-reporting, however in the presence of the other positive findings throughout the study this is unlikely. Increased risk awareness may be the factor which encourages patients to participate in lifestyle changes in response to their stroke and their perceived health threat. Therefore early initiation of a risk awareness intervention tool effects health behaviours at 3 month follow-up, however, whether this has any long-term impact is still unknown, however, as risk is highest during the first 90 days following stroke, these health behaviours to reduce risk are exciting outcomes for this study.

The significance of a physiological impact on systolic blood pressure management is an exciting outcome of this study as any reduction in BP has an impact on reducing stroke recurrence. The reduction of 3mmHg does have significance for secondary stroke prevention as studies have shown even a small decrease in BP can reduce stroke risk by as much as 25-40%. This reduction may be the result of better adherence to medication taking but also as a result of the increase in behaviour changes made by the intervention group. They reported making more changes which would influence BP, such as weight loss, less alcohol, low fat diet and more exercise. These behaviours together with better adherence to medication taking may be the reason for the significant improvement in this most important part of risk factor management with BP being the highest modifiable risk factor for stroke.

Certainly the positive results from this study for medication taking is of interest as there was high self-reported results for all medications, the majority of participants in both groups were taking similar drugs to what they were discharged with at 3 months. It has been reported that adherence is improved by regular follow-up and this is probably reflected in this cohort with such an early follow-up from discharge which reflects the high levels of adherence, also being part of a research study improved adherence (Benner 2004) and as the researcher ensured patients received contact at 3 months where possible, this may have positivity influenced both groups as they were guaranteed a follow-up consultation with a health professional by being part of a research study. Therefore as a recommendation it would be reasonable to suggest that it would be useful for all patients admitted to stroke units across the country to be invited to participate in research studies as a way of increasing adherence and improving long-term care and follow-up of these high risk patients. It was encouraging to see that all patients were discharged home with anti-platelet and statin therapy. However, 3 months may not have been long enough to impact cholesterol levels, but it is disappointing not to have seen a larger reduction in cholesterol levels considering the high self-reporting for taking medications at follow-up, this may be a sign that in-fact self-reporting of medication adherence is not as reliable as one would like. Studies have suggested adherence to statins is as low as 50% (Jacobson 2004) so it would be unrealistic to expect the high levels of self-reported adherence to be completely accurate in this study. However, longer-term follow-up may allow a better opportunity to identify reductions in cholesterol levels and adherence to medication taking. Longer-term follow-up would also be useful as some studies have suggested although early initiation of secondary prevention strategies have been successful, long-term persistence may not occur (Bushnell et al 2009).

Stroke is a chronic condition, symptoms are usually physical and on-going rehabilitation is actively encouraged. However, from a secondary prevention perspective, many risk factors for secondary stroke remain silent or asymptomatic, making control and management more complex. Patients require high levels of health literacy to understand new medications to take and choose behaviours which might reduce their risk of stroke recurrence. Prior to discharge from hospital is the ideal opportunity to communicate important information while the perception and the disease consequences are high in this group, may be the most opportune time to communicate a long-lasting message of risk awareness for secondary prevention.

In conclusion, this study has resulted in enhanced patient care, and increased risk factor awareness for the stroke patient population studied. The intervention is simple and inexpensive to implement but looks at information and education provision in a more useful, patient centred way that seems to be effective in communicating the accurate risk information to the most high risk patients. In light of these findings it would be reasonable to suggest National Guidelines may be modified to include more specific directions regarding the provision of individualised patient information about secondary prevention strategies and risk of future events in order to improve adherence rates. The communication of appropriate risk information was a key element of the intervention of this study and increasing risk awareness is an effective strategy to increase patient knowledge of risk which improved lifestyle behaviours after stroke to reduce risk and improved adherence to secondary prevention strategies at 3 month follow-up after discharge from hospital after stroke.

5.12 Chapter 5: Tables and Figures

Figure 5.1: IRAIS Study design flow chart

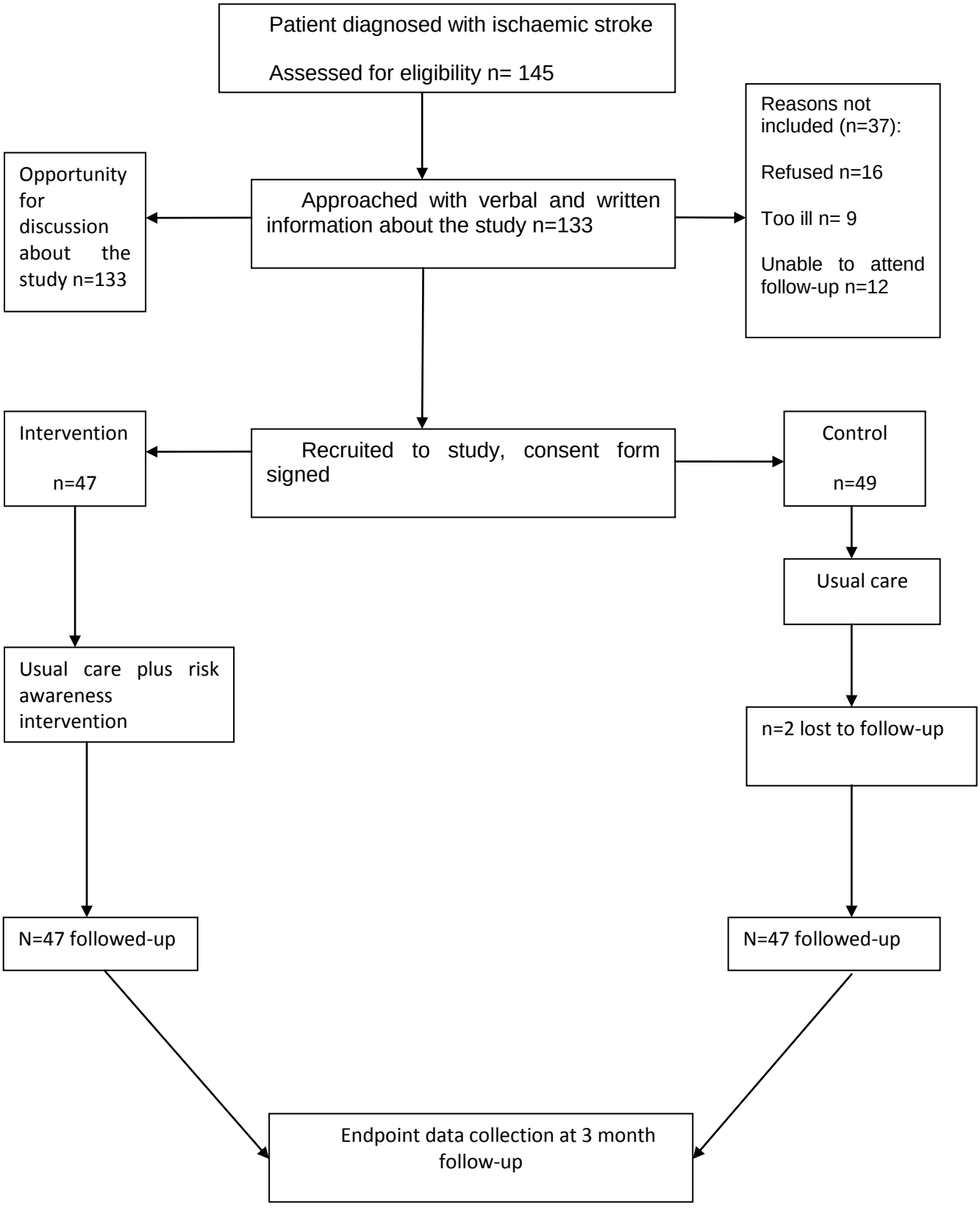


Table 5.1: Population characteristics for IRAIS

Characteristic	Intervention n=47 (%)	Control n=47 (%)	P Value T-test
Age **Mean (SD)**	65 (12.1)	66 (12.7)	0.56
Male	30 (63.8)	26 (53.1)	0.29
European ethnicity	39 (61.7)	43 (67.3)	0.56
Married	27 (57.4)	27 (55.1)	0.96
University education	19 (40.4)	9 (18.3)	0.06
Length of stay on stroke unit **Range** **Median**	14 days 1-67 3	5 days 1-7 2	0.06
Mean NIHSS at D/C	1.2	.73	0.42
Mean NIHSS at follow-up	0.92	0.61	0.36

Figure 5.2: Medical interventions performed

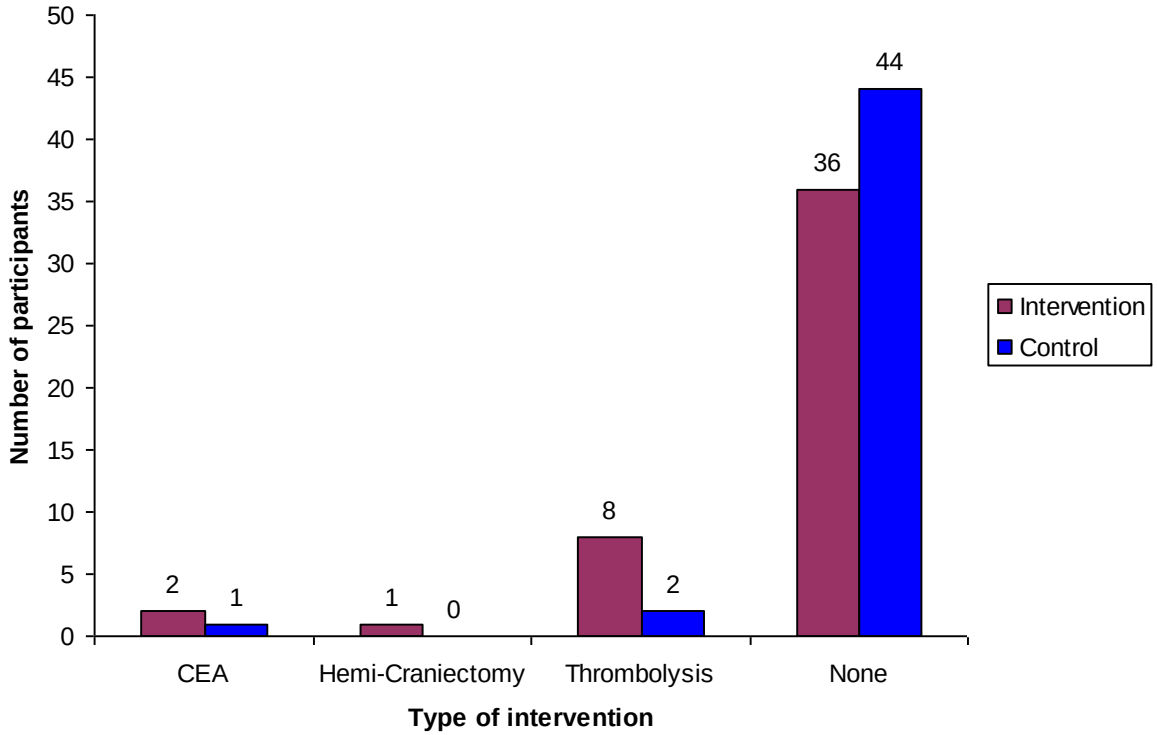


Table 5.2: Past medical history

Risk Factor	Intervention n=47	Control n=47	P Value
All Risk Factors			T-test 0.09
No Past Medical History	5	12	
Stroke	16	13	
IHD	12	10	
DM	14	8	
PAD	1	1	
AF	7	8	
HTN	39	26	
Carotid stenosis	0	1	
High Cholesterol	19	12	

Figure 5.3: Knowledge of stroke sub-type at follow-up

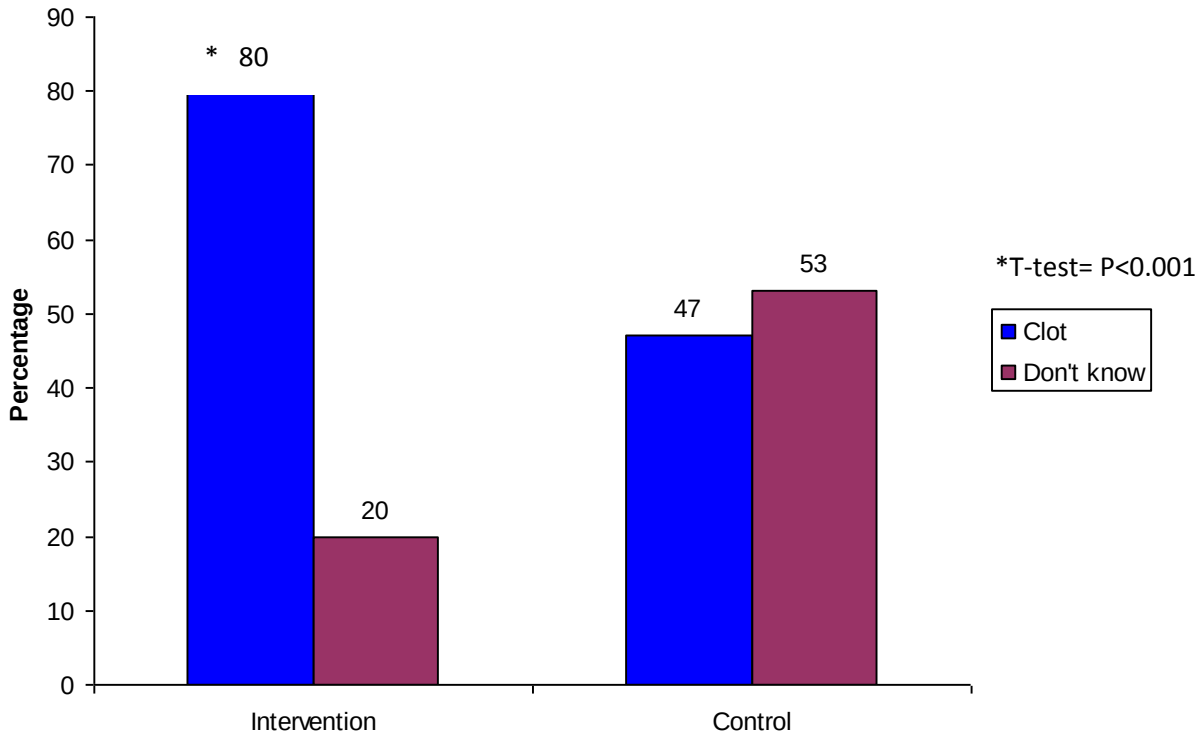


Table 5.3: Medication taking behaviours

Medications on admission	Intervention n=47 (%)	Control n=47 (%)	P Value
Medications			T-test 0.10
None	12 (25)	17 (36)	
Antiplatelet	22 (47)	19 (40)	
Warfarin	0	0	
Statin	24 (51)	21 (45)	
Hypertensive treatment	29 (62)	19 (40)	
Diabetes treatment	12 (25)	6 (13)	
At baseline	**n=47 (%)**	**n=47 (%)**	
Medications			0.60
None	0	0	
Antiplatelet	44 (94)	45 (96)	
Warfarin	3 (6)	2 (4)	
Statin	46 (98)	43 (91)	
Hypertensive treatment	24 (51)	32 (68)	
Diabetes treatment	8 (17)	10 (21)	
At Follow-up	**n=47 (%)**	**n=47 (%)**	
Medications			0.35
None	0	0	
Antiplatelet	42 (89)	44 (94)	
Warfarin	5 (11)	4 (8)	
Statin	43 (91)	41 (87)	
Hypertensive treatment	22 (47)	30 (64)	
Diabetes treatment	7 (15)	8 (17)	

Figure 5.4: Number of behaviour changes made at 3 months

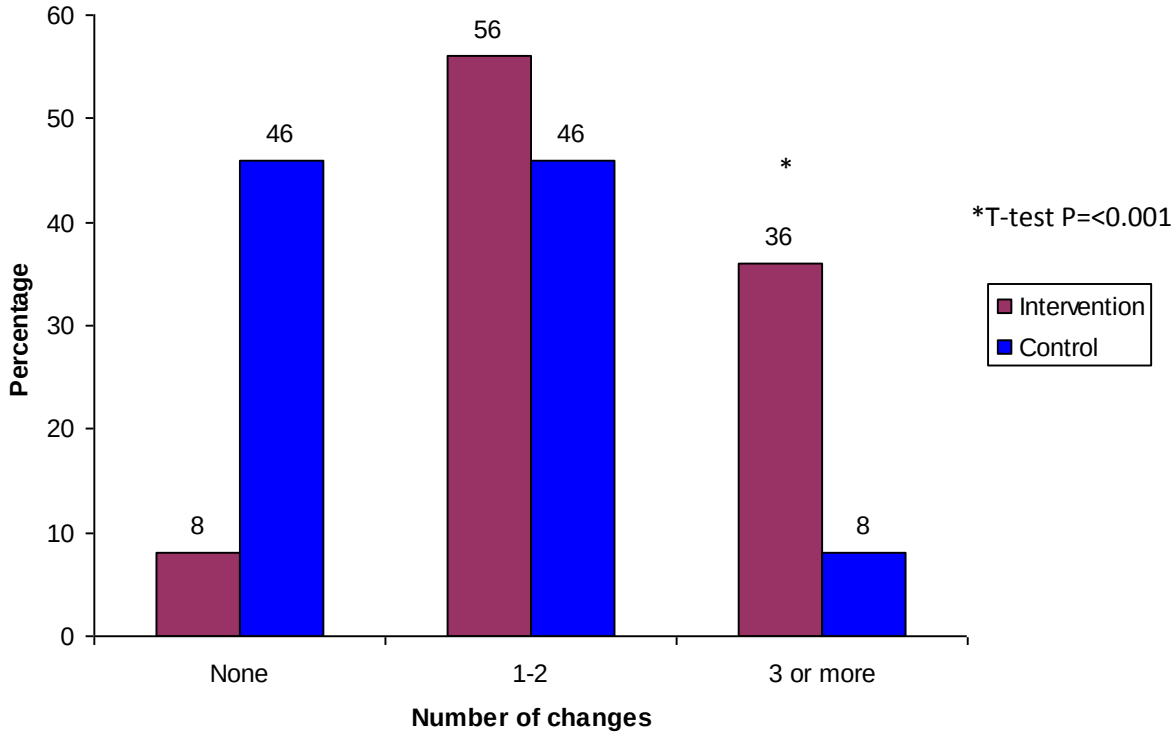


Figure 5.5: Breakdown of behaviour changes at 3 months

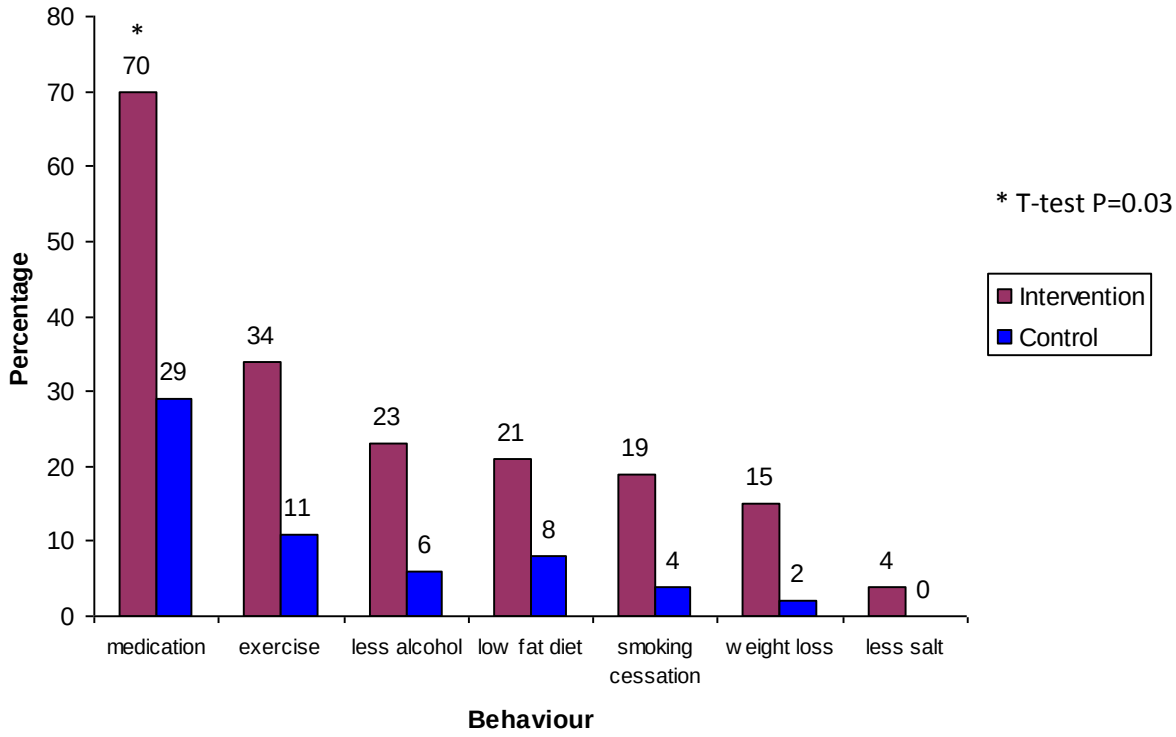


Table 5.4: Risk factor control

Variable	Intervention Mean (SD)	Control Mean (SD)	P value
CRP mg/l			
Discharge	7.93 (16.05)	17.5 (27.1)	0.04
Follow up	3.33 (4.06)	6.66 (10.9)	0.07
Weight Kg			
Discharge	79.3 (18.5)	78.7 (11.9)	0.84
Follow up	78.8 (18.7)	78.4 (12.4)	0.90
Waist inches			
Discharge	37.1 (5.55)	36.5 (4.4)	0.57
Follow up	36.8 (5.35)	36.3 (4.5)	0.59
Cholesterol mmol/l			
Discharge	4.7(1.35)	4.4 (0.99)	0.22
Follow up	4.1 (0.75)	4.0 (0.79)	0.85
Blood glucose mmol/l			
Discharge	6.2 (2)	6.9 (2.6)	0.12
Follow up	5.8 (1.5)	6.3 (1.6)	0.23
Systolic BP mmHg			
Discharge	131 (17.8)	136 (14.7)	0.158
Follow up	128 (12.1)	134 (10.4)	0.01
Diastolic BP mmHg			
Discharge	77 (10.4)	78 (7.7)	0.78
Follow up	74 (11)	73 (12.6)	0.91

Chapter six: Conclusions and Discussion

6.1 Introduction

Advances in stroke medicine such as thrombolysis are seeing more people surviving their first stroke and with less disability. Effective secondary prevention is the ultimate goal to reduce recurrence and this will become more evident in the future as stroke services continue to expand and require further investment and investigation to ensure evidence based high quality care is sufficiently applied to clinical practice.

Vascular disease is the number one cause of death and disability on a global scale. Stroke alone is responsible for approximately 5.7 million global deaths worldwide (WHO 2011). Therefore, the impact of vascular disease on health care in the UK is devastating. The Health Survey for England (2005) stated in that year, 40% of deaths in the UK were caused by vascular diseases (CAD, IHD, PAD, CV disease). Currently more than 4 million people in the UK are affected by CVD and it costs the UK alone £30 billion annually (Pennant et al 2008). Rates of cardiovascular disease and many cancers are heavily influenced by lifestyles and behaviours which in turn are influenced by a variety of social, economic and demographic structures (NICE 2010). Pennant et al (2008) concur and suggest variations in incidence of CVD related illness in the UK are caused by geographical, ethnic and social aspects, however they go on to suggest CVD death rates are 3 times higher among lower socioeconomic groups than among more affluent groups. Nevertheless, Bunker (2001) suggests the provision of medical care, the development of healthier personal habits and the creation of a more just social environment each contribute to the potential to improve health. Just as vascular disease is a multi-factorial physiological syndrome which needs a whole systems approach, improving overall health through a variety of systems is a concept of health care for the future. Stroke alone costs the NHS £7 billion per year on direct and indirect health costs for acute care, on-going rehabilitation as well as informal carer costs and loss of earnings and productivity. 13% of strokes occur in people of working age which impacts further on the economy as well as devastating the lives of individuals and their families. The cost and loss of productivity is one reason for recent Government legislative interest in primary and secondary stroke prevention. Stroke and vascular disease has many complex components including genetic and physiological causes, however the severity of disease progression can be affected by healthy lifestyle behaviours and we know stroke mortality and morbidity can be reduced through risk factor modification (Chaudhry and McDermott 2008). The need for risk factor management is important as individual risk factors alone increase the risk of CVD, however patients with

multiple risk factors are three to five times more likely to die or suffer a major vascular event such as a heart attack or stroke than those without such risk factors (Cooper 2007).

Risk factors identified for CVD highlight the lifestyle behaviours which influence disease progression such as smoking, alcohol, poor diet and inactivity and it has been suggested half the deaths and disability caused by CVD could be reduced through the minimisation of major risk factors (WHO 2002). NICE (2009) discuss producing guidance on public health interventions and programmes based on fit-for-purpose, high quality evidence from research and practice concerned with changing behaviours of individuals, communities and populations in order to improve health. It has been suggested the cost of treating disease that could be prevented through lifestyle or behaviour change represents a considerable burden on Western budgets (NICE 2009) and this is one of the precursors to producing national guidance for public health interventions and programmes to improve overall health of the nation as well as specific population targeted guidance such as the RCP national clinical stroke guidelines (updated 2008). The need to improve services is also reflected in national frameworks to monitor and measure care, with the implementation of the RCP Sentinel Stroke Audit in 2004 a framework to measure equity of care was produced and this is now embedded in stroke care services to ensure treatment, care and prevention is of the highest standard across the country.

6.2 Risk of recurrence

Stroke recurrence adds significantly to stroke-related disability, increasing the disease burden on individuals and health care systems. Mohan et al (2011) identified the disparity in reported stroke recurrence and suggested real differences in the populations as one possible cause, as well as differences in stroke management and secondary prevention techniques. It has been identified that different ethnic groups have higher incidences of risk factors for CVD which might reflect in the recurrence figures, however despite the variations, stroke recurrence is a genuine health risk and secondary prevention studies are important for the success of long-term management of risk factors. National and International guidelines are in place to provide evidence for effective secondary prevention to reduce recurrence (RCP 2004, NICE 2008, EUSI 2003) and the Quality and Outcomes Framework (QOF) information is providing encouraging data for the UK, which suggests risk factor control in general practice is improving with rates of target BP control being achieved

and levels increasing from 71%-85% in 2005 to 78.6%-89.4% in 2007 (Ashworth et al 2008).

6.3 Risk factors

Established risk factors for stroke and CVD have been identified as well as other consequences of vascular disease which add to the relative risk of stroke. The main risk factors identified and discussed are:

- Age
- SBI
- Hypertension
- Diabetes
- AF
- Smoking
- Alcohol
- Poor diet
- Inactivity
- Obesity
- Hypercholesterolaemia
- Ethnicity
- Carotid stenosis

The review of the literature of stroke risk factors provides an up-to-date overview and clear understanding of stroke risk in the presence of individual risk factors as well as quantifying the risk benefits and risk reductions possible with modifications such as healthy lifestyle behaviour changes. Other risk factors which are consequences of vascular disease have been discussed and are of importance when discussing CVD as a global physiological syndrome. Both renal artery disease and retinal artery disease are less common forms of vascular disease and are often the results of

multiple vascular conditions and result in the same physiological process of inflammation which increases stroke risk, so should be treated aggressively with the same preventative measures.

Risk factors which are less common include PFO and genetic factors and research continues to identify the absolute risk of stroke and how if treated the risk can be reduced. With regard to genetic factors, high risk genes cannot be removed or treated, however, knowledge of genetic risk can inform us who is at greatest risk so that medical treatments and lifestyle modifications can be targeted specifically at high risk groups and may be useful to reduce risk from environmental and social factors. As part of this research SBI, an established vascular risk factor has been quantified to identify stroke risk in the presence of the two other members of the vascular disease family, CAD and PAD.

The systematic review and Meta-analysis provided an up-to-date review of the literature surrounding SBI and the risk of stroke and highlighted the risk of multi-infarct dementia in patients with SBI as a key finding. SBI as an independent risk factor for stroke is key to management, however, prevalence of SBI identified in the populations examined was varied, the percentage of SBI found in the stroke studies varied from 14%-24%, in healthy, asymptomatic populations the prevalence varied from 8%-35%, increasing markedly with age. In CAD prevalence varied from 10%-55% and in PAD it was between 5%-21%. However, the studies clearly identified that patients with systemic vascular disease are at increased risk of stroke and MI and treatment should be initiated swiftly if prevention is to be effective.

6.4 Stroke and risk factor knowledge

Individual studies performed throughout this project have highlighted poor knowledge of primary stroke risk factors and secondary stroke risk and stroke signs and symptoms. BP awareness in a low risk general population was poor as well as among high risk stroke survivors. Stroke survivors had poor risk awareness and were unaffected by large scale, media information campaigns to improve knowledge of stroke signs and symptoms. Although surveys suggest the campaigns are effective for members of the general public, impact on current presentation to emergency department figures still suggests stroke patients are slow to present to hospital despite decades of research and public awareness campaigns (Moser et al 2006). The delay for stroke patients is 2-3 times longer than for patients with acute coronary syndromes (Libman et al 2001) and of the stroke deaths that occur each

year almost half occur before the patient reaches hospital (Ayala et al 2003). Therefore knowledge of signs and symptoms influence stroke occurrence at every stage and the need to improve public awareness is of paramount importance.

Low levels of knowledge of stroke warning signs and risk factor awareness have been identified for decades (Samsa et al 1997, Nicol and Thrift 2005, Dearborn et al 2009). Many patients described symptoms they themselves had been affected by but which are not commonly associated with stroke such as pain at onset and loss of consciousness, this does not suggest the patient was not affected by those symptoms but does inform us that patients knowledge of general, well known signs and symptoms of stroke is poor in this context. The observational study identified low knowledge of risk factors for stroke similar to the Nicol and Thrift study (2005) when a third of patients could not name a single risk factor using free-recall in both high and low risk populations, the observational study found 45% of patients self-reported a well-known stroke risk factor and then later in the questionnaire denied having any risk factors for stroke, this highlights a lack of awareness of established stroke risk factors. The same results were found initially in the RCT, as at baseline prior to any intervention, risk factor knowledge was poor and increased in the intervention group at follow-up but nevertheless it suggests generally knowledge of risk factors for stroke specifically, is poor in the stroke population.

6.5 Risk perception

Risk perception is a subjective judgement made on a background of previous personal, social, geographic, ethnic and cultural experiences (Slovic 1987). Theory of risk perception has been identified and categorised into 3 main domains as the degree to which risk is understood, the degree to which the risk evokes a feeling of dread and the number of people exposed to the risk (Slovic 1987). Risk interventions to influence behaviour can be directed by knowledge of the relevant risk (the disease), what constitutes a ‘risky’ behaviour (smoking in the presence of a stroke), how the patient responds to the risk information (whether they think they should stop smoking since suffering a stroke) and having an understanding of what happens when they respond to the risk information (giving up smoking reduces the risk of stroke recurrence) (Slovic 1987). Therefore perception of risk clearly influences decision making regarding health behaviour and patient’s responses to the consequences of their decisions.

The Social Amplification of Risk Framework's (SARF) theory states that risk events interact with individual's psychological, social and cultural factors to either increase or decrease a populations perception of risk (Kasperson 1988). According to the theory, different groups may react differently to a single risk event. As health professionals, knowledge of this theory is useful when trying to influence reactions at the initial stages of communication during transfer of information about risk. The response mechanism of the patients has already been influenced by that individual's psychological, social and cultural make-up and background, however by individualising risk at the time of the acute, often life-changing event, may be useful for influencing the patient's response to their risk.

Risk perception is key to understanding how a person becomes motivated to change health behaviours. Studies have shown high risk groups perceive to be at the same level of risk as their low risk peers (Dearborn et al 2009) and that has been mirrored in the control group of the IRAIS study. However, the risk awareness intervention in this study effectively increased risk perception which in turn increased the amount of health behaviour changes made.

The Health Belief Model (HBM) (Lewin 1951, Glanz 2002), the theory of planned behaviour (Azjen and Fishbein 1980), the theory of social behaviour (Bandura 1986) and the transtheoretical model of behaviour change (Prochaska and Velicer 1997) emphasise the perceived value of a patients' response to a consequence. The transtheoretical model (Pochaska and Velicer 1997) with its "stages of change" is another model in which interpretation of the likelihood of behaviour change is understood in terms of an individual's readiness to change, and interventions may be targeted accordingly. Readiness to change (Pochaska et al 1983) was not measured throughout this project, however it would be a useful tool to understand and interpret a patients likelihood of change in response to their stroke in order to plan further programmes of education. These theoretical models have been discussed extensively throughout this project and were used as the basis of the theoretical framework for planning the risk communication intervention. In general, the models seek to provide an understanding of how individuals perceive risk and how this influences their behaviour and may go some way to developing a way of predicting behaviour change. These models frequently attribute consequences in behaviour change to two underlying dimensions: an individual's perception of the value of an outcome presented in a health recommendation and the perceived threat presented by the outcomes in the recommendation. This was understood for the development

of the risk awareness intervention as a way of increasing a patients understanding of the threat to their health so that the health recommendation had an increased value by reducing the risk of a recurrence of the unwanted event i.e. another stroke. The observational study identified stroke survivor's strong sense of consequence following their stroke (90%) and two thirds said they felt their stroke had had a major consequence on their life, this may certainly impact on perception, however this study also highlighted many of the participants believed their stroke happened by chance and suggests a lack of control over their condition which compared with cardiac studies suggesting patients who feel in control have better adherence (Townend 2006) this may be one reason for the differences in stroke and cardiac patient behaviours.

6.6 Risk awareness

Important factors which reflect individual risk awareness have been identified as adherence, behaviour and lifestyle modification. The theoretical models of understanding risk perception and influences on health behaviours have been investigated to identify how the intervention in the RCT could improve health behaviours to reduce risks that have been discussed. Improving adherence to secondary prevention strategies by increasing both health literacy and self-efficacy in targeted patient populations are recognised in the literature, however interventions to achieve this have been lacking in stroke.

Understanding the concept of 'risk' has been key to developing the theoretical frameworks required to develop the risk awareness intervention and the potential impact on patient's perception and behaviours. 'Risk' has many definitions which mainly consist of the concept of a potential loss or undesirable outcome. The notion implies, a choice can have an influence on the outcome and this is true of risk in health care and secondary stroke prevention as the patient makes a choice or a decision to perform a health behaviour action to reduce risk. Patients with an awareness of risk have behaved differently compared to controls as part of this thesis, an observational study of stroke survivors up to 5 years later identified those with a greater understanding of their risk being more likely to make more healthy lifestyle choices compared to those who had no risk awareness. In the RCT study in the first 3 months following discharge from hospital, those who had greater risk awareness made more lifestyle changes in direct response to their stroke compared with those with a low risk awareness.

6.7 Medication taking

Results from the two studies investigating behaviours of stroke survivors identified differences in medication taking. Adherence for secondary stroke prevention was poor in the observational study with only 66% taking antiplatelet appropriately and 45% taking statins. These results differed from the RCT data where medication taking was very well reported with 89% taking an antiplatelet and 87% taking a statin appropriately. The major difference between the two populations is length of time since stroke. Therefore these results support the concept of adherence dropping off over time and should be an argument for long-term follow-up with a focus on medication taking. Interestingly behaviour was not influenced by time since stroke in the observational study which would suggest once health behaviour is in place, it remains so in the long-term, however, a possible explanation might be changes in medication prescriptions' disrupt a pattern of adherence as a change in routine might interrupt lifestyle behaviour. Also the identification of a small reduction in medication taking at follow-up in the RCT is noteworthy as the reduction was seen in all four of the major secondary prevention medications prescribed at discharge. It would be very interesting to investigate if this group continued to reduce medication taking over time and a follow-up at one year would be most useful.

It is also important to highlight, it has been documented that patient compliance with treatment is usually substantially better in closely monitored and motivated research trial populations than in routine clinical practice (Sappok 2001), this suggests either all patients participate in a clinical research trial, which is unrealistic, or all patients receive better, more closely monitored follow-up at discharge from hospital.

6.8 Methodology challenges

A variety of study designs were used throughout this thesis including, a systematic review and Meta-analysis, observational study, population survey and a RCT. Several qualitative and quantitative methods were used to obtain and analyse the data including thematic analysis and statistical software packages such as SPSS and STATA. The challenges were in learning new techniques of data collection and analysis for every new study. The observational study involved the development and implementation of a questionnaire which was sent out to stroke survivors both in paper form and electronically so there were practical barriers to overcome regarding delivery of and collection of the completed questionnaires, however these were overcome through networking with the charity organisation which eventually took

responsibility for the entire distribution of questionnaires to their members. Analysis of the questionnaires was challenging as so much data was generated in a variety of formats which required both thematic analysis and data entry into excel for statistical analysis.

The population survey consisted of a straightforward design format however, more data could have been obtained. This was a response to the volumes of data obtained during the observational study so the population survey was made as simple as possible to aid analysis. However, thought went in to what data information should be collected and the aim of the survey was that it would be quick and non-intrusive to enhance recruitment numbers. However, ethnicity and educational level would have been really useful variables to include in the survey to identify if those factors had an impact on awareness of BP in the general public and it would have also been useful epidemiological information about the local population.

The RCT used a proforma to obtain demographic information and risk perception at the time of recruitment and then again at follow-up. The risk perception questions were developed in a short form from the observational questionnaire, however it would have been useful to include similar illness perception questions to identify in further depth the participant's perceptions of the consequences and causes of their stroke, however, it was clear at the time of developing the proforma that due to the time constraints of the academic process there would be limited time for in-depth analysis, however considering the interesting results of the intervention RCT further analysis of perception would be really useful.

The lack of ethnic diversity in all studies was disappointing considering the multiplicity of the populations London and the UK. Despite approaching patients from all cultures and ethnicities to participate in the studies, uptake was limited except from those of European descent. We therefore, have little knowledge of the impact of the risk awareness intervention on BME groups as a result of the low uptake and further work to identify effective interventions in this group would be useful.

6.9 Overall significance

The initial systematic review identified stroke and SBI as part of the family of vascular diseases and clarified the risk posed by stroke and the impact it has on individuals and populations at local, national and globally was important to put the thesis in to context. The observational study of stroke survivors understanding of risk

produced initial data suggesting risk awareness may play a role in lifestyle and risk factor modification behaviours. Stroke survivors who still thought they were at risk of another stroke, up to five years later, self-reported more health behaviours than those who did not think they were at risk. This finding informed the development of the RCT to investigate if through increasing risk awareness during the acute stages of stroke, influences health behaviours up to 3 months following discharge from hospital. Another interesting finding from the initial studies prior to the RCT were that hypertensive members of the general public who were aware of what a 'normal' BP should be had a significantly lower and therefore better controlled BP than those who had no knowledge. This result had the potential to impact on risk factor control and management and was based on information provision and knowledge improvements which require high levels of health literacy throughout a population.

The results from the BP study concurred with other studies of awareness in the general population with low levels of knowledge of BP in the overall population surveyed and even more so in the hypertensive population. Surprisingly it was hypothesised that knowledge of BP would be greater in the hypertensive population as it was expected they would have had interactions with health professionals directly related to BP. This result suggests a poor general impact from the provision of information about BP to hypertensive populations. In the BP survey the hypertensive population were significantly older than the healthy population, this finding is useful for health professionals to understand that elderly patients with hypertension may not have the cognitive ability to retain the information or the information needs to be configured in a way which communicates the risk effectively to this population in a way which influences their behaviours in regard to BP control.

The studies within this thesis have added to the body of knowledge through the examination of patient perceptions of their illness and information has been gathered in order to investigate further, patients decision making and coping processes related to long-term disease management within the field of stroke as a member of the CVD family, adding to the work performed around CAD and IHD.

6.9.1 Clinical significance and changes to practice

The RCT identified several areas where a focussed risk awareness intervention may influence knowledge of risk factors and behaviours post stroke. However, it is important to mention that it is unclear whether the intervention itself resulted in

increased knowledge and behaviour change or whether simply the increased interaction with participants resulted in the changes. However, the results do suggest significant differences between the two groups and risk awareness may be a way forward to improve patient's perceptions of risk and attitudes to health care recommendations. Focussed attention at discharge to inform patients of the importance of risk reduction for secondary prevention and systematic education about risk factors is suggested with attention geared towards how medication taking and lifestyle modification can reduce risk may be effective. Information aimed at increasing health literacy for this patient population should be the ultimate goal, to enable patients and their families to participate in the management of their condition in the long term and understand the importance of risk factor control through adherence to medications and improved health behaviours to reduce risk of secondary stroke is the strongest recommendation from this thesis.

6.10 Future research

As an academic study the RCT follow-up data endpoint collection had to take place at 3 months, however, on-going investigation of behaviour in the months and years beyond 3 month follow-up would be useful to identify if behaviour change is sustained in this high risk population as studies have suggested long-term adherence to change is low in chronic conditions and it might be as follow-up becomes less regular and therefore discussion regarding risk factors less frequent which effects behaviour and risk awareness particularly if discussion of lifestyle continues to be low as it was recorded in only 37% of consultations in the Royal Colleague of Physicians sentinel audit for stroke (RCP 2004). Future work should concentrate on ways to increase risk awareness effectively in all high risk groups. The intervention could also be examined when applied in different settings such as in TIA/minor stroke and outpatient settings.

The development of a RCT to investigate the effectiveness of a stroke rehabilitation programme to increase risk awareness and health behaviour change in order to reduce recurrence and improve risk factor control would be a potential post-doctoral research plan. There are few structured stroke rehabilitation programmes despite the evidence from cardiac rehabilitation programmes which suggest good outcomes (Devereaux et al 2005). The Transtheoretical Model of Health Behaviour Change would be a useful tool to structure the study, using the six measures of readiness to change as framework to collect data at recruitment and the processes of change as

the theoretical basis for the interventions throughout the rehabilitation programme. The goal of the initial study would be to develop a programme based on the processes of change:

1. Consciousness raising
2. Dramatic relief
3. Self-re-evaluation
4. Environmental re-evaluation
5. Self-liberation
6. Social liberation
7. Counter conditioning
8. Stimulus control
9. Contingency management
10. Helping relationships

The Transtheoretical model has been used in cardiac rehabilitation with positive outcomes, Devereaux et al (2005) found the framework improved readiness to change outcomes in the short term with 84% in the action stage at completion of the programme. The model has also been used to investigate stroke patient behaviours, Gillham (2010) most recently used the framework to study readiness to change in minor stroke and TIA patients, however no differences were seen in readiness to change but some behaviours were improved significantly in the intervention group. A study of mainly African Americans (Miller & Spilker 2003) were recruited from a family practice clinic, each with multiple risk factors and were assigned to one of 3 interventions: 1. Control, 2. Simple advice, 3. Brief intervention. Findings showed significant differences in the number of newly initiated health behaviours and stroke knowledge among the 3 groups with the best outcomes from the intervention group. Although a small pilot study, the results support the effectiveness of the brief intervention. However these studies have all been performed in outpatient settings on participants with minor stroke, TIA or asymptomatic community dwelling populations. It would be interesting to investigate if this framework would be useful during an inpatient hospital stay or on patients recently discharged from hospital. The main goals of the project would be to investigate if the framework is effective for the development of a stroke rehabilitation programme and whether the programme itself is effective in reducing recurrence of stroke and improving health behaviours to improve secondary stroke prevention.

Finally further research to identify how risk factor information is communicated to and received by ethnic minorities and in patients and families where English is not the first language would be useful. Health inequalities for ethnic minority groups have been identified, however specific interventions to improve health literacy in these minority groups is limited which may impact on their ability to participate fully in their health care which may be one of the reasons for their worse outcomes compared to Europeans in the West. Also further research into recruitment into research trials would be interesting in ethnic minority groups, as a European researcher the majority of patients recruited into the RCT were of European decent also and it would be very interesting to investigate further if ethnic background of researchers influences the type of ethnic groups recruited into research trials.

References

References

Aalto AM, Heijmans M, Weinman J, Aro AR. Illness perception in coronary heart disease: sociodemographic, illness-related and psychosocial correlates. Journal of Psychosom Res. 2005; 58: 393-402.

Adams R, Chimowitz M, Alpert J, Awad I, Cerqueria M, Fayad P and Taubert K. Coronary risk evaluation in patients with TIA and Stroke. A Scientific statement for healthcare professionals from the stroke council and the council on clinical cardiology of the American Heart Association/American Stroke Association. Circulation 2003; 108: 1278-1290

Agamanolis D, Adams J. Cerebral arterial stenosis and stroke. Proc Natl Acad Sci. 2011;108:5372-7

Agyeman O, Nedeltcher K, Arnold M, Fischer U, Remonda L, Isenegger J. Time to admission in acute ischaemic stroke and TIA. Stroke.2006;37:963-66

Air EL & Kissela BM. Diabetes, the metabolic syndrome and ischaemic stroke. Diabetes care. 2007;30:3131-3140

Albert NM. Improving medication adherence in chronic cardiovascular disease. Critical Care Nurse. 2008; 28: 54-64

Altunkan S, Oztas K and Altunkan E. Validation of the OMRON 637IT wrist blood pressure measuring device with a position sensor according to the international protocol in adults and obese adults. Blood Pressure Monitoring. 2006; 11: 79-85

Amarenco P, Benavente O, Goldstein LB, et al. Results of the Stroke Prevention by Aggressive Reduction in Cholesterol Levels (SPARCL) trial by stroke subtypes. Stroke. 2009;40:1405–1409.

Andersen KK, Andersen ZJ, Olsen TS. Age and gender-specific prevalence of cardiovascular risk factors in 40,102 patients with first-ever ischaemic stroke: A Nationwide study. Stroke. 2010; 41: 2768-2774

Anderson JL, Adams CD, Antman EM, Bridges CR, Califf RM, Casey DE Jr, Chavey WE 2nd, Fesmire FM, Hochman JS, Levin TN, Lincoff AM, Peterson ED, Theroux P, Wenger NK, Wright RS, Smith SC Jr. 2011 writing group members; ACCF/AHA Task force members. Guidelines for the management of patients with unstable angina/non-ST elevation myocardial infarction: a report of the American college of Cardiology Foundation. Circulation. 2011; 123: e426-579

Anderson RT, Camacho F, Iaconi AI, Tegeler CH, Balkrishnan R. Enhancing the effectiveness of community stroke risk screening: a randomised controlled trial. Journal of Stroke and Cerebrovascular Diseases. 2010;20: Epub 2010. Aug 7

Armstrong D. The rise of surveillance medicine. Sociology of Health and Illness. 1995;17:393-404

Ashworth M, Medina J, Morgan M. Effect of social deprivation on BP monitoring and control in England: a survey of data from the quality and outcomes framework. BMJ. 2008; 337:a2030

Asplund K, Karranen J, Giampaoli S, Jousilahti P, Niemela M, Broada G, Cesana G, Dallongeville J,Ducimetriere P, Evans A, Ferrieres J, Haas B, Jorgensen T, tamosiunas A, Vanuzzo D, Wiklund PG, Yarnell J, Kuulasmaa K, Kulathinal S, for the MORGAM project. Relative risks for stroke by Age, Sex and populations based on follow-up of 18 European populations in the MORGAM project. Stroke. 2009; 40:2319-2326

Ayala C, Croft JB, Keenan NL, Neff LJ, Greenlund KJ, Donehoo RS, Zheng ZJ, Mensah GA. Increasing trends in pre-transport stroke deaths—United States, 1990–1998. *Ethn Dis.* 2003;13:S131–S137.

Azjen I and Fishbein M. Understanding attitudes and predicting social behaviour. 1980. Prentice-Hall, Englewood Cliffs, NJ

Azjen I. Attitudes, personality and behaviour. 1988. Milton Keynes, England: Open university Press and Chicago, IL. Dorsey Press

Bak S, Sindrup SH, Alsler T, Kristensen O, Christensen K, Gaist D. Cessation of smoking after first-ever stroke – a follow up study. Stroke. 2002;33:2263-69

Balarajan R. Ethnic differences in mortality from ischaemic heart disease and cerebrovascular disease in England and Wales. BMJ. 1991;302:560-4

Balazovjech I, Hnilica P Jr. Compliance with antihypertensive treatment in consultation rooms for hypertensive patients. J Hum Hypertens. 1993;7:581-3

Bandura A. Social Foundations of Thought and Action: A social cognitive theory. 1986. Prentice Hall, Englewood Cliffs, NJ

Barnett A, Begg A, Bradbury A, et al. Panel of the Atherothrombosis clinical faculty group. Clopidogrel in the modern management of atherothrombosis. Br J Cardiol. 2007; 14: supplement 5; S3-S10.

Barnett HJM and Feasby TE. Improving the appropriateness of Carotid Endarterectomy. Neurology. 2007; 68: 172-3.

Beck U. Risk Society: towards a new modernity. 1992. Sage. London

Becker MH. The health belief model and personal health behaviours. Health educ Monographs. 1974;2:324-473

Becker MH, Shumaker SA, Eleanor B. Theoretical models of adherence and strategies for improving adherence. In: Schron JK, Ockene CT, Parker JL, et al, eds. The handbook of health behaviour change. New York: Springer, 1990: 5-43.

Beckett NS, Peters R, Fletcher A, Staessen JA, Liu L, Dumitrascu D, Stoyanovsky V, Antikainen R, Nikitin Y, Anderson C, Belhani A, Forette F, Rajkumar C, Thijs L, Banya W, Bulpitt C; for the HYVET study group. The New England Journal of Medicine. 2008; 358:1-12

Benner JS, Tierce JC, Ballantyne CM. Follow-up lipid tests and physician visits are associated with improved adherence to statin therapy. Pharmacoeconomics. 2004; 22 (suppl 3): 13-23

Bentley P, Janovic A, Sharma P. Cultural diversity training for UK healthcare professionals: a comprehensive nationwide cross-sectional survey. Clin Med. 2008;120:431-441

Bentley P, Peck G, Smeeth L, Whittaker J, Sharma P. Causal relationship of susceptibility genes to ischemic stroke: comparison to ischemic heart disease and biochemical determinants. PLoS One. 2010; 5:e9136

Berger K. Light to moderate alcohol consumption and the risk of stroke among U.S. male physicians. The New England Journal of Medicine. 1999; 341: 1557-1564

Berger JS, Bhatt DL, Steinhubl SR, Shao M, Steg PG, Montalescot G, Hacke W, Fox KA, Lincoff AM, Topol EJ, Berger PB; CHARISMA investigators. Smoking, Clopidogrel and mortality in patients with established cardiovascular disease. Circulation. 2009;120:2337-44

Bernick C, Kuller L, Dulberg C, Longstreth WT, Manolio T, Beauchamp N, Price T. Silent MRI infarcts and the risk of future stroke: the Cardiovascular Health Study. Neurology. 2001; 57: 1222-1229

Berlowitz DR, Ash AR, Hickey EC, Friedman R, Glickman M, Kader B, Moskowitz MA. Inadequate management of Blood Pressure in a hypertensive population. The New England Journal of Medicine. 1998; 339:1957-1963.

Bevan S and Markus H. The Genetics of Stroke. ACNR. 2004; 4: 8-11

Bhatt D and Steg PG. REACHing for new heights in disease management. The British Journal of Cardiology. 2007; 14: 190.

Bhatt D, Flather MD, Hacke W, Berger PB, Black HR, Boden WE, Cacoub P, Cohen EA, Creager MA, Easton JD et al: CHARISMA investigators. Patients with prior myocardial infarction, stroke or symptomatic PAD in the CHARISMA trial. J AM Coll Cardiol. 2007; 49: 1982-8

Boden-Albala B, Sacco RL, Lee H-S, Grahame-Clarke C, Rundek T, Elkind MV, Wright C, Giardina E-G, DiTullio MR, Homma S and Paik MC. Metabolic syndrome and ischaemic stroke. Northern Manhattan Study. Stroke. 2008; 39: 30-35.

Bokura H, Yamaguchi S, Iijima K. Metabolic syndrome is associated with silent ischaemic brain lesions. Stroke. 2008;39:1607-1609

Boon A, Lodder J, heuts-Van Raak L, Kessels F. Silent brain infarction in 755 consecutive patients with first-ever supratentorial ischemic stroke. Relationships with index-stroke subtype, vascular risk factors and mortality. Stroke. 1994;25:2384-90

Bosworth HB, Dudley T, Olsen MK, Voils CI, Powers B, Goldstein MK, Oddone EZ. Racial differences in Blood Pressure control: Potential explanatory factors. Am J Med. 2006;119: 70. E9-15

Bourke J, Sylvester R, Sharma P. Ethnic variations in the management of patients with acute stroke. Postgrad Med J. 2006;82:13-15

Boysen G, Drarup LH, Zeng X, Oskedra A, Dorv J, Andersen G, Gluud C, Pedersen A, Lindahl M, Hansen L, Winkel P, Truelsen T, for the ExStroke Pilot Trial Group. ExStroke Pilot Trial of the effect of repeated instructions to improve physical activity after ischaemic stroke: a multinational randomised controlled clinical trial. BMJ. 2009; 339: b2810; 273-275.

Bradley WG, Daroff RB, Fenichel MG, Jancovic J. Neurolgoy in clinical practice. Principles of diagnosis and management. Philadelphia. Elsevier. 2004.

Brainin M, McShane LM, Steiner M, Dachenhausen A, Seiser A. Silent brain infarcts and transient ischemic attacks: a three year study of first ever ischemic stroke patients: the Klosterneuburg stroke data bank. Stroke. 1995; 26: 1348-1352

Brewer NT, Chapman GB, Brownlee S, Leventhal EA. Cholesterol control, medication adherence and illness cognition. Br J Health Psychol. 2002;7:433-448

Brewer JB, Gabrieli JDE, Preston AR, Vaidya CJ, Rosen AC. Memory. In: Goetz CG, ed. Textbook of Clinical Neurology. 3rd Ed. Philadelphia. Pa: Saunders Elsevier. 2007; Chapter 5

British Heart Foundation (BHF). What makes us tick. Annual Review. 2003. www.bhf.org.uk/plugins/publicationssearchresults/idoc?docid=8fb4dbfe-684d

British Hypertension Society Guidelines for Hypertension Management. Classification of Blood Pressure levels of the British Hypertension Society. BMJ. 2004; 328:634-640

Brott T, Adams HPJ, Olinger CP, Marler JR, Barsan WG, Biller J, Spilker J, Holleran R, Eberle R, Hertzberg V, Rovick M, Moomaw CJ, Walker M. Measurements of acute cerebral infarction: a clinical examination scale. Stroke. 1989; 20: 864-870

Brown T, Avenell A, Edmunds LD, Moore H, Whitaker V, Avery L, Summerbell C for the PROGRESS team. Systematic review of long-term lifestyle interventions to prevent weight gain and morbidity in adults. Obesity reviews. 2009;10:627-38

Bunker J. Medicine matters after all. Measuring benefits of medical care, a healthy lifestyle and a just social environment. 2001. Nuffield Trust Series no.15. London. The Stationary Office.

Burns J. Transient Ischaemic Attack doubled MI. Stroke. 2011;doi:10.1161/StrokeAHA.110.593723. Accessed online 27.08.2011.

Bushnell C, Zimmer L, Schwamm L, Goldstein LB, Clapp-channing N, Harding T, Drew L, Zhao X, Peterson E; AVAIL registry. The adherence eValuation After Ischemic Stroke Longitudinal (AVAIL) registry: design, rational and baseline patient characteristics. American Heart Journal. 2009; 157: 428-435.e2.

Cacoub P, Cambou JP, Belliard JP, Beregi JP, Branchereau A, Carpentier P, Kownator S, Leger P, Luizy F, Maiza D, Mihci E, Herrmann M-A, Priollet P. Prevalence of peripheral artery disease in general practice using ankle brachial pressure index in high risk patients: The Ipsilon Study. Circulation. 2006;114:11-378

CAPRIE Steering Committee. A randomised, blinded, trial of clopidogrel versus aspirin in patients at risk of ischaemic events (CAPRIE). Lancet. 1996; vol 348:1329-39.

Cellentano A, Palmeiri V, Arezzi E, Sabatella M, Guillaro B, Brancati C, Piccinocchi G, Minichiello S, Russo C, Pezzullo S, Tufano A, Finelli L, Panico S, and Di Minno G. Cardiovascular secondary prevention: patient's knowledge of cardiovascular risk factors and their attitude to reduce the risk burden, and the practice of family doctors. The "help your heart stay young" study. Italian Heart Journal. 2004; 5: 767-773.

Chalmers J, Castaigne A, Morgan T, Chastang C. Long-term efficacy of a new fixed, very low-dose angiotensin enzyme inhibitor/diuretic combination as first-line therapy in elderly hypertensive patients. J Hypertens. 2000;18:327-37

Chaudhry HJ and McDermott B. Recognizing and improving patient non-adherence to statin therapy. Curr Atheroscler Rep. 2008; 10: 19-24

Chi Y-W and Jaff MR. Optimal risk factor modification and medical management of the patient with peripheral arterial disease. Catheterization and Cardiovascular Interventions. 2008; 71: 475-489.

Chin MH, Walters AE, Cook SC, Huang ES. Interventions to reduce racial and ethnic disparities in health care. Med Care Res Rev. 2007;64 (suppl 5):7s-28s

Chobanian AV, Bakris GL, Black HR et al, for the National High Blood Pressure Education Program Coordinating Committee. The seventh report of the Joint National Committee on prevention, detection, evaluation and treatment of high blood pressure, detection, evaluation and treatment of high BP: the JNC report. JAMA. 2003; 289: 2560-2572

Chodosh EH, Foulkes MA, Kase CS, Wolf PA, Mohr JP, Hier DB, Price TR, Furtado JG Jr. Silent stroke in the NINCDS stroke data bank. Neurology. 1988;38:1674-9

Choo PW, Rand CS, Inui TS. Validation of patient reports, automated pharmacy records and pill counts with electronic monitoring of adherence to antihypertensive therapy. Med Care. 1999;37:845-57

Christensen B, Engberg M, Lauritzen T. No long-term psychological reaction to information about increased risk of coronary heart disease in general practice. Eur J Cardiovasc Prev Rehabil. 2004;11:239-43

Cole J. The relationship between smoking and stroke risk in women: breaking the habit. Women's Health. 2011;7:261-264

Colledge A, Car J, Donnelly A and Majeed A. Health information for patients: time to look beyond patient information leaflets. Journal of the Royal Society of Medicine. 2008; 101: 447-453.

Collins R, Peto R, MacMahon S. Blood Pressure, Stroke and Cardiovascular disease, part 2: short term reductions in BP: overview of randomised drug trials in their epidemiological context. Lancet. 1990;335:827-38

Collins KS, Huges DL, Doty M, Ives BL, Edwards JN, Tenney K. Diverse communities, common concerns: Assessing health care quality for minority Americans. 2002. Report No 523. The Commonwealth Fund. New York

Collins R, Armitage J, Parish S. Effects of cholesterol lowering with simvastatin on stroke and other major vascular events in 20536 people with cerebrovascular disease or other high risk condition. Lancet. 2004;363: 757-67

Conn VS, Taylor SG, Abele PB. Myocardial infarction survivors: age and gender differences in physical health, psychosocial state and regimen adherence. Journal of Advanced Nursing. 1991; 16: 1026-1034.

Conner M and Sparks P. The Theory of Planned Behaviour and Health Behaviours, In: Connor M (ed) and Norman P. Predicting Health Behaviour. 2003. Kinder Scout. Open University Press, Buckingham, England and Philadelphia, PA.

Cooper A. Attitudes and perceptions in cholesterol management. Int J Clin Pract. 2007; 61: 1067-9

Corea F, Henon H, Pasquier F, Leys D and the Lille Stroke/Dementia study group. Silent infarcts in stroke patients: patient characteristics and effect on 2 year outcome. Journal of Neurology. 2001; 248:271-278

Corea F, Tambasco N, Luccioli R, Ciorba E, Parnetti L, Gallai V. Brain CT scan in acute stroke patients: silent infarcts and relation to outcome. Clin Exp Hypertension. 2002;24:669-76

Coull AJ, Lovett JK, Rothwell PM, Oxford Vascular Study. Population based study of early risk of stroke after transient ischaemic attack or minor stroke: implications for public education and organisation of services. BMJ. 2004;328:326 –328.

Coull AJ, Rothwell PM. Underestimation of the early risk of recurrent stroke: evidence of the need for a standard definition. Stroke. 2004;35:1925–1929.

Coutts SB, Hill D, Simon JE, Sohn C-H, Scott JN, Demchuk AM for the VISION group. Silent ischemia in minor stroke and TIA patients identified on MR imaging. Neurology. 2005;65:513-17

Craig P, Dieppe P, MacIntyre S, Michie S, Nazareth I, Petticrew M. Developing and evaluating complex interventions: the new MRC guidance. BMJ. 2008;337:a1655

Crawley D, Ng A, Mainous AG, Majeed A, Millett C. Impact on pay for performance on quality of chronic disease management by social class group in England. Journal of the Royal Society of Medicine. 2009;102: 103-7

Croquelois A and Bogousslavsky J. Risk awareness and knowledge of patients with stroke: results of a questionnaire survey 3 months after stroke. J Neurol Neurosurg Psychiatry. 2006;77:726-8

Cummings KM, Becker MH, Kirscht JP, Levin NW. Intervention strategies to improve compliance with medical regimens by ambulatory haemodialysis patients. J Behav Med. 1981;4:111-27

Curb JD, Abbott RD, MacLean CJ, et al. Age-related changes in stroke risk in men with hypertension and normal blood pressure. Stroke 1996;27:819–24.

Das R, Seshadri S, Beiser A, Kelly-Hayes M, Au R, Himali JJ, Kase C, Benjamin EJ, Polak J, O'Donnell C, Yoshita M, D'Agostino R, DeCarli C and Wolf P. Prevalence and Correlates of Silent Brain infarction in the Framingham Offspring Study. Stroke. 2008; 39:2929-2935

Davis PH, Bendixen BH, Adams HP, Woolson RF, Culebras A. Silent cerebral infarction in patients enrolled in the TOAST study. Neurology. 1996;40(4):942-48

Dearborn JL and McCullough LD. Perception of risk and knowledge of risk factors in women at high risk for stroke. Stroke. 2009; 40: DOI: 10.1161/STROKEAHA.108.543272. Accessed online 03.10.2009.

D'Agostino RB, Russell MW, Huse DM, Ellison RC, Silbershatz H, Wilson PW and Hatz Sc. Primary and subsequent coronary risk appraisal: New results from the Framingham study. American Heart Journal. 2000; 139: 272-281.

De Becker G. The Gift of Fear. New York. Dell. 1997.

Deo R, Wassel-Fyr C, Fried L, Newman A, Harris TB, Angleman S, Green C, Kritchersky S, Chertow G, Cummings SR, Shlipak M. Kidney dysfunction and fatal cardiovascular disease: an association independent of atherosclerotic events: Results from the Health, Ageing and body composition study. Am Heart J 2008; 155: 62-8.

Department of Health. Saving Lives: our healthier nation. 1999. http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH. Accessed online 22.06.2011.

Department of Health. The NHS Plan. 2001. http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4010198. Accessed online 10.03.2009

Department of Health National Service Framework for Older People (Stroke-Standard 5. Department of Health. 2001. http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4003066. Accessed online 22.06.2011

Department of Health NHS information centre. Alcohol Statistics. 2010. www.dh.gov.uk. Accessed online 05.09.2011.

Department of Health. Health survey for England. 2003; http://www.dh.gov.uk/PublicationsAndStatistics/PublishedSurvey/HealthSurveyForEngland/fs/en. Accessed online 05.09.2011.

Department of Health. White Paper; Better information, Better Choices, Better Health. 2004. http://www.dh.gov.uk/PublicationsAndStatistics/PublishedSurvey/HealthSurveyForEngland/fs/en. Accessed online 05.09.2011

Department of Health. Health survey for England. 2005; http://www.dh.gov.uk/PublicationsAndStatistics/PublishedSurvey/HealthSurveyForEngland/fs/en. Accessed online 06.09.2011

Department of Health. Stroke Campaign. FAST. Feb. http://www.hospitalhealthcare.com/default.asp?title=DHlaunchstrokecampaign&page=article.display&article.id=15601. 2009. Accessed online 06.09.2011

Devereaux M, Pauly MA, Fietek T, Bigelow S, Shores K. Use of Transtheoretical Model improves adherence to several health behaviour changes in a cardiac rehabilitation setting. J Cardiopulmonary Rehab Prevention. 2005; 25: 301

Diabetes UK. 2007; http://www.diabetes.org.uk/Professionals/Publications-reports-and-resources/Reports-statistics-and-case-studies/Reports/Diabetes-prevalence-2007/. Accessed online 15.06.2011

Diener HC, Bogousslavsky J, Brass LM, Cimminiello C, Csiba L, Kaste M, Leys D, Matias-Guiu J, Rupprecht HJ. Aspirin and Clopidogrel compared with Clopidogrel alone after recent ischaemic stroke or TIA in high risk patients. (MATCH): randomised, double blind, placebo-controlled trial. Lancet. 2004; 364: 331-337.

Di Matteo MR, Giordiani PJ, Lepper HS. Patient adherence and medical treatment outcomes: a meta-analysis. Med care. 2002;40:794-811

Di Pasquale G, Andreoli A, Pinelli G. Cerebral Ischaemia and asymptomatic coronary artery disease: a prospective study of 83 patients. Stroke 1986; 17: 1098-1101.

Djousse L, Ellison C, Beiser A, Scaramucci A, D'Agostino R, Wolf PA. Alcohol consumption and risk of ischaemic stroke. The Framingham Study. Stroke. 2002;33:907-912

Dunbar-Jacob J, Burke LE, Rohay JM. Comparability of self-report, pill count and electronic monitored adherence data. Control Clin Trials. 1996;12 (suppl 2):80s

Eccles M, Freemantle N, Mason J. North of England evidence based guideline development project: guidelines on the use of Aspirin as secondary prophylaxis for vascular disease in primary care. North of England Aspirin Guideline Development Group. BMJ. 1998;316:1303-1309

Edwards A, Hood K, Matthews E, Russell D, Russell I, Burnard P, Covey J, Pill R, Wilkinson C, Stott N, Barker J, Bloor M. The Effectiveness of One-to-one Risk-communication Interventions in Health Care : A Systematic Review. Med Decis Making. 2000; 20: 290.

Egan BM, Lackland DT, Cutler NE. Awareness, knowledge and attitudes of older Americans about high BP. Arch Intern Med. 2003; 163: 681-687

Eichar DM. Occupation and class consciousness in America. Number 27 Green wood Press. New York, Westport, Connecticut, London. Accessed online at www.questia.com on 12.08.2011.

Ellis G, Rodger J, McAlpine C, Langhorne P. The impact of stroke nurse specialist input on risk factor modification: a randomised controlled trial. Age Ageing. 2005; 34: 389-392.

Elsayed E, Tighiouart H, Griffith J, Kurth T, Levey A, Salem D, Sarnak M and Weiner D. Cardiovascular Disease and subsequent kidney disease. Arch Intern Med 2007; 167: 1130-1136.

Elsawy B and Higgins KE. Physical Activity for older adults. Am Fam Physician. 2010;81:55-9

Erhardt L & Hobbs FD. Public perceptions of Cardiovascular Disease risk in five European Countries: the react survey. Int J Clin Pract. 2002;56: 638-44

European Atrial Fibrillation Trial (EAFT) study group. Stroke prevention in Atrial Fibrillation. Lancet. 1993;342:1255-1262

European Society of Hypertension Guidelines. 2003; http://www.eshonline.org/Guidelines/ArterialHypertension.aspx. Accessed online 15.06.2011

European Stroke Initiative Executive Committee and the EUSI writing Committee. European Stroke Initiative Recommendations for Stroke Management – Update. Cerebrovascular Diseases. 2003;16:311-337

Ezekowitz MD, Connolly S, Parekh A, Reilly PA, Varrone J, Wang S, Oldgren J, Themeles E, Wallentin L, Yusuf S. Rationale and design of RE-LY: Randomised evaluation of long-term anticoagulant therapy, warfarin compared with Dabigatran. Am Heart J. 2009;157:805-810

Five-year findings of the hypertension detection and follow-up program.II. Mortality by race-sex and age. Hypertension Detection and Follow-Up Program Cooperative Group. JAMA. 1979;242:2572–2577.

Feasby TE & Barnett HJ. Improving the appropriateness of carotid endarterectomy. Neurology. 2007;16: 172-173

Feinberg WM, Blackshear JL, Laupacis A, Kronmal R, Hart RG. Prevalence, Age distribution and Gender of patients with atrial fibrillation. Arch Intern Med. 1995:469-473

Fisher M. Stroke and TIA Epidemiology, risk factors and the need for early intervention. Am J Manag Care. 2008;14 (suppl 2): S204-11

Fonarow GC, Gawlinski A, Moughrabi S, Tillisch JH. Improved treatment of coronary heart disease by implementation of a cardiac hospitalisation atherosclerosis management program (CHAMP). Am J Cardiol. 2001;87:819-22

Foster C, Hillsdon M, Thorogood M. Interventions in promoting physical activity. Cochrane Database SSyst Rev. 2005; CD003180. Accessed online 16.08.2011

Forster A. Information provision for stroke patients and their caregivers. Cochrane Database Systematic Reviews. 2001;3:CD0091919. Accessed online 17.07.2011

French DP, Cooper A, Weinman J. Illness perceptions predict attendance at cardiac rehabilitation following acute MI: A systematic review and meta-analysis. Journal of Psychosomatic Research. 2006; 61:757-67

Fuster V and Moreno PR. Atherothrombosis(Vermeer, Longstreth Jr et al. 2007) as a systemic, often silent disease. Nature Clinical Practice Cardiovascular Medicine. 2005; 2: 431

Gallego J, Martinez-Vila E. Asymptomatic cerebrovascular disease and systemic diagnosis in stroke, atherothrombosis as a disease of the vascular tree. Cerebrovascular Diseases. 2005; 20 suppl 2: 1-10

Geerlings MI, Appelman AP, Vincken KL, Algra A, Witkamp TD, Wali WP, Van der Graaf Y: SMART study group. Brain volumes and cerebrovascular lesions on MRI in patients with atherosclerotic disease. The SMART study. Atherosclerosis. 2010; 210: 130-6 Epub 2009.

Giele, JLP, Witkamp TD et al. Silent brain infarcts in patients with manifest vascular disease. Stroke. 2004; 35: 742-746.

Gillham S and Endacott R. Impact of enhanced secondary prevention on health behaviour in patients following minor stroke and transient ischaemic attack: a randomised controlled trial. Clinical Rehabilitation. 2010; DOI: 10.1177/0269215510367970.
http://cre.sagepub.com/content/early/2010/07/15/0269215510367970. Accessed online 17.06.2011

Giorda CB, Avogaro A, Maggini M, Lombardo F, Mannucci E, Turco S, Alegiani SS, Raschetti R, Velussi M, Ferrannini E: The Dai study group. Incidence and risk factors for stroke in type 2 diabetic patients. Stroke. 2007;38:1154-1160

Girot M, Kowiak-Cordonoliani MA, Deplanque D, Henon H, Lucas C, Leys D. Secondary prevention after ischaemic stroke – evolution over time in practice. J Neurol. 2005;252:14-20

Glanz K, Rimer BK, Lewis FM. Health behaviour and health education. Theory, Research and Practice. 2002. San Francisco: Wiley and Sons.

Go AS, Chertow GM, Fan D, McCulloch CE and Chi-Yuan Hsu. Chronic Kidney Disease and the Risks of Death, Cardiovascular Events, and Hospitalization. New England Journal of Medicine 2004; 351:1296-305.

Goldenberg N and Glueck C. Efficacy, effectiveness and real life goal attainment of statins in managing cardiovascular risk. Vasc Health Risk Manag. 2009; 5: 369-76

Goldstein LB, Amarenco P, Zivin J, Messig M, Altafullah I, Callahan A, Hennerici M, MacLeod MJ, Sillesen H, Zweifler R, Welch MA on behalf of the SPARCL investigators. Statin Treatment and Stroke outcome in the Stroke Prevention by Aggressive Reduction in Cholesterol Levels (SPARCL) Trial. Stroke. 2009;40:3526-3531

Gould AL, Davies GM, Alemao E, Yin DD and Cook JR. Cholesterol reduction yields clinical benefits: meta-analysis including recent trials. Clinical Therapy. 2007; 29: 778-94.

Granger BB, Ekman I, Granger CB. Adherence to medication according to sex and age in the CHARM programme. Eur J Heart Fail. 2009;11: S.1092-8

Gretarsdottir S, Thorleifsson G, Reynisdottir ST, Manolescu A, Jonsdottir S, Jonsdottir T, Gudmundsdottir T, Bjarnadottir SM, Einarsson OB, Gudjonsdottir HM, Hawkins M, Gudmundsson G, Gudmundsdottir H, Andrason H, Gudmundsdottir AS, Sigurdardottir M, Chou TT, Nahmias J, Goss S,Sveinbjornsdottir S, Vladimarsson EM, Jakobsson F, Agnarsson U, Gudnason V, Thorgeirsson G,Fingerle J, Gurney M,Gudbjartsson D, Frigge ML, Kong A, Stefansson K, Gulcher JR. The gene encoding phosphodiesterase 4D confers risk of ischaemic stroke. Nat Gen 2003;353:131-138.0

Guidelines Subcommittee. World Health Organization– International Society of Hypertension Guidelines for the Management of Hypertension. Journal of Hypertension. 1999; 17: 151–183.

Guidelines Committee European Society of Hypertension–European Society of Cardiology Guidelines for the Management of Arterial Hypertension. Journal of Hypertension. 2003;21: 1011–1053.

Hackam D and Spence D. Combining multiple approaches for the secondary prevention of vascular events after stroke. Stroke 2007; 38: 1881-1885.

Hajat C, Tilling K, Stewart JA, Lemic-Stojevic N and Wolfe CDA. Ethnic differences in risk factors for ischaemic stroke: a European case-control study. Stroke. 2004;35:1562-1567

Hakim AA, Curb JD, Petrovitch H, et al. Effects of walking on coronary heart disease in elderly men: the Honolulu Heart Program. Circulation 1999;100:9–13.

Hale ED, Treharne GJ, Kitas GD. The Common-sense Model of Self-regulation of health and illness: how can we use it to understand and respond to our patients' needs? Rheumatology. 2007; 46: 904-906

Hankey GJ and Warlow CP. Treatment and secondary prevention of stroke: evidence, costs and effects on individuals and populations. The Lancet. 1999; 354: 1457-1463

Hanson SO. Risk. The Stanford Encyclopaedia of Philosophy. 2007. Edward N. Zalta (Ed).

Hara M, Ito K, Nawata T, Shiraiwa H, Urakami S, Tsunematsu Y, Kusakabe T, Ooga M, Niwa H, Maeda T et al. Silent cerebral infarction associated wiht coronary artery disease. Cardiology. 1994; 85: 171-174.

Hata J, Tanizaki Y, Kiyohara Y, Kato I, Kubo M, Tanaka K, Okubo K, Nakamura H, Oishi Y, Ibayashi S, Iida M. Ten year recurrence after first ever stroke in a Japanese community: The Hisayama study. J Neurol Neurosurg Psych. 2005;76:368 –337.

Hatano S. Experience from a multicentre stroke register: a preliminary report. Bulletin of the World Health Organisation. 1976; 54: 541–53.

Haynes RB, Ackloo E, Sahota N, McDonald HP, Yao X. Interventions for enhancing medication adherence. Cochrane Database of systematic reviews. 2008; 2 Art No:CD000011. Accessed online 18.08.2011

Heart Protection Study Collaborative Group. MRC/BHF Heart Protection Study of Cholesterol lowering with Simvastatin in 20536 high risk individuals: a randomised placebo-controlled trial. The Lancet. 2002; 360: 7-22.

Herderschee D, Hijdra A, Algra A, Koudstaal PJ, Kappelle LJ, Van Gijn J. Silent stroke in patients with TIA or minor ischemic stroke. Stroke.1992;23:1220-4

Heron M, Hoyert DL, Murphy SL, JXu J, Kochanek KD, Tejada-Vera B. Deaths: final data for 2006. National Vital Stat Rep 2009;57:1–135.

Hiatt WR. Medical treatment in peripheral arterial disease and claudication. New England Journal of Medicine. 2001; 344: 1608-1621.

Hillborn M, Numminen H and Juvela S. Recent heavy drinking of alchohol and embolic stroke. Stroke. 1999;30:2307-2312

Hillen T, Dundas R, Lawrence E, Steward J, Rudd A, Wolfe CDA. Antithrombotic and antihypertensive management 3 months after ischemic stroke. Stroke. 2000; 31: 469-475.

Hillen T, Coshall C, Tilling K, Rudd AG, McGovern R, Wolfe CDA. Patterns, risk factors and outcomes of stroke recurrence in the South London Stroke Registry. Cause of stroke recurrence is multifactorial. Stroke. 2003; 34: 1457-1463

Hirsch AT, Criqui MH, Treat-Jacobson D, Regensteiner JG, Creager MA, Olin JW, Krook SH, Hunninghake DB, Comerota AJ, Walsh ME, McDermott MM, Hiatt WR. Peripheral arterial disease detection, awareness and treatment in primary care. JAMA. 2001; 286: 1317-1324.

Hirsch AT et al. ACC/AHA Guidelines for the management of patients with peripheral artery disease. J AM Coll Cardiol. 2005;47:1-192

Homma S, Sacco RL, Di Tullio MR et al. Effect of medical treatment in stroke patients with Patent Foramen Ovale. Patent Foramen Ovale in Cryptogenic Stroke Study. Circulation. 2002;105:2625-2631

Hong KS, Saver JL, Kang DW, Bae HJ, Yu KH, Koo J, Han MK, Cho YJ, Park JM, Lee BC. Years of optimum health lost due to complications after acute ischaemic stroke. Disability-Adjusted Life Years Analysis. Stroke. 2010; 41: 1758-1765

Hopewell S, Clarke M, Moher D, Wager E, Middleton P, Altman DG, Schulz K and the CONSORT Group. CONSORT for Reporting Randomised Controlled Trials in Journal and Conference Abstracts: Explanation and Elaboration. PLoS Medicine. 2008;5: e20 1-9

Horne R and Weinman J. Patients beliefs about prescribed medicines and their role in adherence to treatment in chronic physical illness. Journal of Psychosomatic Research. 1999; 47: 555-567

Horne R, Weinman J, Barber N, Elliott R, Morgan M. Concordance, adherence and compliance in medicine taking. 2005: Report for the National Co-ordinating Centre for NHS service delivery and organisation. NCCSDO, London. http://www.sdo.nihr.ac.uk/files/project/76-final-report.pdf. Accessed online 18.08.2011

Horne R, Parham R, Driscoll R, Robinson A. Patients attitudes to medicines and adherence to maintenance treatment in inflammatory bowel disease. Inflammatory Bowel Disease. 2009; 15:837-844

Hoshide S, Kario K, Mitsuhashi T, et al. Different patterns of silent cerebral infarct in patients with coronary artery disease or hypertension. American Heart Journal. 2001;14:509–15

Hostetter T. Chronic kidney disease predicts cardiovascular disease. New England Journal of Medicine. Sept 2004; 351: 1344-46.

Houslay M, Adams D. PDED4 cAMP phosphodiesterases: modular enzymes that orchestrate signalling crosstalk, desensitisation and compartmentalisation. Biochem J. 2003;370:1-18.

Howard G, Wagenknecht LE, Cai J, et al. Cigarette smoking and other risk factors for silent cerebral infarction in the general population. Stroke. 1998;29:913–17

Hubbard D. How to Measure Anything: Finding the Value of Intangibles in Business. 2007; 46. John Wiley & Sons, 2007

Hubbard D. The Failure of Risk Management: Why It's Broken and How to Fix It. 2009. John Wiley & Sons.

Hunt KA, Gaba K, Larizzo-Moray R. Racial and ethnic disparities and perceptions of health care: does health plan type matter? Health Services Research. 2005;40 :551-76

Husted S. Evidence-based prescribing and adherence to antiplatelet therapy – how much difference do they make to patient's with Atherothrombosis? Int J Cardiol. 2009;134:150-9

Hyman D, Pavlik VN. Self-reported hypertension treatment practices among primary care physicians. Arch Intern Med. 2000; 160:2281-2286.

Ikram A, Vernooij MW, Hofman A, Niessen WJ, van der Lugt A and Breteler MB. Kidney function is related to cerebral small vessel disease. Stroke. 2008; 39: 55-61.

Ikram MK, Hofman A, Breteler MM, De Jong FJ, Van Dijk EJ, Prins ND and De Jong PT. Retinal vessel diameters and cerebral small vessel disease: the Rotterdam Scan Study. Brain 2006; 129: 182-188.

International Organization for Standardization (ISO). Risk Management. ISO/IEC Guide 73:2002.

International Society of Hypertension. 2011; http://www.ish-world.com/default.aspx?BackgroundInformation. Accessed online 11.09.2011

Ivers RQ, Mitchell P and Cumming RG. Sensory impairment and driving: the blue mountains eye study. Am J Public Health. 1999;89:85-87

Jacobs BS, Birbeck G, Mullard AJ, Hickenbottom S, Kothari R, Roberts S, Reeves MJ. Quality of hospital care in African American and White patients with ischaemic stroke and TIA. Neurology. 2006;66:809-814

Janes S, West J, Hopkinson B and Walsh J. Pharmacological secondary prevention in people with peripheral arterial disease compared to those with coronary artery disease: a missed opportunity. The British Journal of Cardiology 2008; 15;: 48-50

Janssen I. Morbidity and mortality risk associated with an overweight BMI in older men and women. Obesity. 2007;15:1827–1840.

Janssen I, Heymsfield SB, Allison DB, Kotler DP, Ross R. Body mass index and waist circumference independently contribute to the prediction of non-abdominal, abdominal subcutaneous, and visceral fat. Am J Clin Nutr. 2002;75:683-8.

Janz NK, Becker MH. The health belief model: a decade later. Health education Q. 1984;11:1-47

Jenkinson D. Implications of REACH for stroke physicians. Br J Cardiol 2007; 14: supplement 3.

Jespersen CM and Hansen JF. Myocardial stress in patients with acute cerebrovascular events. Cardiology. 2008; 110: 123-128.

Johnston SC, Rothwell PM, Nguyen-Huynh MN et al. The ABCD, California and unified ABCD2 risk scores predicted stroke within 2, 7 and 90 days after TIA. Validation and refinement of scores to predict very early stroke risk after transient ischaemic attack. Lancet. 2007;369:283-92

Joint British Societies' guidelines on prevention of cardiovascular disease in clinical practice. Prepared by British Cardiac society, British Hypertension society, Diabetes UK, HEART UK, Primary Care Cardiovascular society, The Stroke Association. Heart. 2005; 91: 1-52.

Jorgensen HS, Nakayama H, Raaschou HO, Gam J, Olsen TS. Silent infarction in acate stroke patients: prevalence, localization, risk factors and clinical significance: the Cophenhagen stroke study. Stroke. 1994; 25: 97-104

Jorgensen HS, Nakayama H, Reith J, Raaschou HO, Olsen TS. Stroke recurrence: predictors, severity and prognosis. The Copenhagen Stroke Study. Neurology. 1997;48:891-95

Joubert J, Reid C, Barton D, Cumming T, McLean A, Joubert L, Barlow J, Ames D, Davis S. Integrated care improves risk factor modification after stroke: Initial results of the integrated care for the reduction of secodnary stroke model. J Neurol Neurosurg Psychiat. 2009;80:279-84

Kalaria RN, Low WC, Oakley AE, Slade JY, Ince PG, Morris CM, Mizuno T. CADASIL and genetics of cerebral ischaemia. J Neural Transm Suppl 2002;63:75-90.

Kane SV. Systematic review: adherence issues in the treatment of ulcerative colitis. Aliment Pharmacol Ther. 2006;23:577-85

Kang DW, Latour LL, Lattimore SU, Warach S. Silent ischemic lesion recurrence on MRI predicts subsequent clinical vascular events. Arch Neurol. 2006;63:1730-33

Kannel WB, Wolf PA, Verter J. Manifestations of coronary artery disease predisposing to stroke. The Framingham study. JAMA. 1983; 250: 2943-2946

Kaplan RC, tirchwell DL, Longstreth WT, Manolio T, Heckbert SR, Lefkowitz D, El-Saed A, Psaty BM. Vascular events, mortality and preventive therapy following ischemic stroke in the elderly. Neurology. 2005;65:825-42

Kario K, Shimada K, Schwartz JE, Matsuo T, Hoshide S, Pickering TG. Silent and clinically overt stroke in older Japanese subjects with white coat and sustained hypertension. J Am Coll Cardiolol. 2001; 38: 238-245.

Kase CS, Wolf PA, Chodosh EH, et al. Prevalence of silent stroke in patients presenting with initial stroke: the Framingham study. Stroke. 1989;20 : 850–2

Kasperson JX, Roger E. Kasperson RE. The Social Contours of Risk. Volume I: Publics, Risk Communication & the Social Amplification of Risk. Earthscan, Virginia. 2005

Kasperson RE, Renn O, Slovic P, Brown H, Emel J, Goble R, Kasperson J, l Ratick S. The Social Amplification of Risk: A Conceptual Framework. Risk Analysis. 1988; 8: 177–187.

Kent D and Thaler D. Is Patient Foramen Ovale a modifiable risk factor for stroke recurrence? Stroke. 2010; 41 (Suppl 1): S26-S30

Khan MS, Jafary FH, Jafar TH, Faruqui AM, Rasool SI, Hatcher J, Chaturvedi N. Knowledge of modifiable risk factors of heart disease among patients with acute myocardial infarction in Karachi, Pakistan: across sectional study. BMC Cardiovascular Disorders2006, **6**:18-27

Kim ES, Park N, Peterson C. Dispositional optimism protests older adults from stroke: the health and retirement study. Stroke. 2011; Doi:10.1161/STROKEAHA.111.613448. Accessed online 09.09.2011

Kinlay S, Libby P and Ganz P. Endothelial function and coronary artery disease. Current Opinion Lipidology 2001; 12: 383-389.

Kirsch IS, Jungleblut A, Jenkins L, Kolstad A. Adult literacy in America: a first look at the results of the national adult literacy survey. 1993; Princeton, NJ: Educational Testing Centre

Kissela BM, Khoury J, Kleindorfer D, Woo D, Schneider A, Alwell K, Miller R, Ewing I, Moomaw CJ, Szaflarski JP, Gebel J, Shukla R, Broderick JP: Epidemiology of ischemic stroke in patients with diabetes: the Greater Cincinnati/ Northern Kentucky Stroke Study. Diabetes Care. 2005; 28:355–359

Knight El, Bohn RL, Wang PS, Glynn RJ, Mogun H, Avorn J. Predictors of uncontrolled hypertension in ambulatory patients. Hypertension. 2001; 38:809-814.

Knight FH. Risk, uncertainty and profit. Hart, Schaffner, and Marx Prize Essays, no. 31. Boston and New York: Houghton Mifflin. 1921; 31: 19

Kobayashi S, Okada K, Koide H, Bokura H, Yamaguchi S. Subcortical silent brain infarction as a risk factor for clinical stroke. Stroke. 1997; 28: 1932-1939.

Kozdag G, Ciftci E, Ural D, Sahin T, Selekler M, Agacdiken A, Demirci A, Somsuoghu S, Somsuoghu B. Silent cerebral infarction in chronic heart failure: ischemic and nonischemic dilated cardiomyopathy. Vasc Health Risk Manag. 2008;4:463-69

Kraywinkel K, Heidrich J, Heuschmann P, Wagner M, Berger K. Stroke risk perception among participants of a stroke awareness campaign. BMC Public Health. 2007; 7:39.

Kritsonis A. Comparison of change theories. International Journal of Scholarly Academic Intellectual Diversity. 2004-2005; 8: 1-7

Kshirsagar AV, Carpenter M, Bang H. Blood pressure usually considered normal is associated with an elevated risk of cardiovascular disease. Am J Med 2007; 119: 133-41.

Kulinskaya E, Morgenthaler S, Staudte R. Meta Analysis: A guide to calibrating and combining statistical evidence. Wiley and Sons, Ltd. 2008.

Kurl S, Laukkanen JA, Tuomainen TP, Rauramaa R, Lakka TA, Salonen R, Eranen J, Sivenius J, Salonen JT. Association of exercise-induced silent ST-segment depression with the risk of stroke and cardiovascular diseases in Men. Stroke. 2003; 34: 1760-1765.

Kurth T, Gaziano JM, Berger K, Kase CS, Rexrode KM, Cook NR, Buring JE, Manson JE. Body mass index and the risk of stroke in men. Arch Intern Med. 2002;162:2557–2562.

Kurth T, Kase CS, Berger K, Schaeffner E, Buring JE, Gaziano JM. Smoking and risk of haemorrhagic stroke in men. Stroke. 2003; 34: 1151-1155

Kwon HM, Kim BJ, Oh JY, Kim S, Lee S, Oh B and Yoon BW. Retinopathy as an indicator of silent brain infarction in asymptomatic hypertensive subjects. Journal of Neurological Science, 2007; 252: 159-62.

Law M and Tang JL. An analysis of the effectiveness of interventions intended to help people stop smoking. Arch Intern Med. 1995; 155:1933-41

Law MR, Morris JK, Wald NJ. Use of Blood Pressure lowering drugs in the prevention of cardiovascular disease. Meta-analysis of 147 randomised controlled trials in the context of expectations from prospective epidemiological studies. BMJ.2009;338:b1665. Accessed online 15.03.2011

Lawes CM, Bennett DA, Feigin VL. Blood pressure and stroke: an overview of published reviews. Stroke 2004; 35: 2237-8.

Lee CD, Folsam AR, Blair SN. Physical activity and stroke risk: a meta-analysis. Stroke. 2003; 34: 2475-81

Leventhal H, Benjamini Y, Brownlee S. Illness representations: theoretical foundations. In: Petrie KJ, Weinman JA, eds. Perceptions of Health and Illness. Amsterdam: Harwood Academic. 1997: 19-45

Leventhal H, Brissette I. Leventhal EA. The Common-sense Model of Self-regulation of health and illness behaviour. In: Cameron LD, Leventhal H, eds. The Self-regulation of health and illness behaviour. London. Routledge. 2003: 42-65

Lewis WR, Peterson ED, Cannon LP, Super DM, LaBresh KA, Quely K, Lian L, Fonarow GC. An organised approach to improvement in guideline adherence for acute MI. Arch Intern Med. 2008;168:1813-19

Li C, Engstroem G, Hedblad, B, Berglund G, Janzon L. Blood pressure control and risk of stroke: a population-based prospective cohort study. Stroke. 2005; 36: 725-730

Libby P, Ridker, PM, Maseri A. Inflammation and atherosclerosis. Circulation. 2002; 105:1135–43.

Libman RB, Kwiatkowski TG, Hansen MD, Clarke WR, Woolson RF, Adams HP. Differences between anterior and posterior circulation stroke in TOAST. *Cerebrovasc Dis*. 2001;11:311–316.

Lichtman JH, Allen WB, Wang Y, Watanabe E, Jones SB, Goldstein LB. Stroke patient outcomes in US hospitals before the start of the joint commission primary stroke centre certificate programme. Stroke. 2009;40:3574-9

Liebetrau M, Steen B, Hamann GF, Skoog I. Silent and symptomatic infarcts on cranial CT in relation to dementia and mortality: a population-based study in 85 years olds. Stroke. 2004;34:1816-20

Lip GY, Kamath S, Jafri M, Mohammed A, Bareford D. Ethnic Differences in patient perceptions of AF and anticoagulations therapy: the West Birmingham Atrial Fibrillation Project. Stroke. 2002;33:238-42

Lloyd-Jones D, Adams RJ, Todd M, et al. Heart disease and Stroke statisctics-2010 update: A report from the American Heart Association. Circulation. 2010; 121: e46-121. Accessed online 15.06.2011

Longstreth WT, Jr, Dulberg C, Manolio TA, et al. Incidence, manifestations, and predictors of brain infarcts defined by serial cranial magnetic resonance imaging in the elderly: the Cardiovascular Health Study. Stroke. 2002;33:2376–82

Lumpton D. Perspectives on power, communication and the medical encounter: implications for nursing theory and practice. Nursing Inquiry. 1995;2:157-163

Lynch GF, Washington J, Gorelick PB. Lacunar stroke in black patients. In Gillum RF, Gorelick PB, Cooper ES, eds. Stroke in Blacks. Basel, Switzerland: Karger; 1999.

Mann JFE, Gerstein HC, Pogue J, Bosch J and Yusuf S for the HOPE investigators. Renal insufficiency as a predictor of cardiovascular outcomes and the impact of Ramipril: The HOPE Randomized Trial. Annals of Internal Medicine 2001; 134: 629-636.

Marini C, Totaro R, Carolei A. Long-term prognosis of cerebral ischaemia in young adults. Stroke. 1999; 30: 2320-2325.

Martin SC, Butcher A, Martin N, Farmer J, Dobson PM, Bartlett WA and Jones AF. Cardiovascular risk assessment in patients with retinal vein occlusion. British Journal of Ophthalmology. 2002; 86: 774-776.

Marteau TM, Kinmouth AL, Pyke S, Thompson SG and Group FHS. Readiness for lifestyle advice: self-assessments of coronary risk prior to screening in the British family heart study. British Journal of General Practice. 1995;45: 5–8.

Masuda J, Nabika T and Notsu Y. Silent stroke: pathogenesis, genetic risk factors and clinical implications as a risk factor. Current Opinions in Neurology. 2001; 14:77-82

Matchar DB, Samsa GP, Cohen SJ, Oddone EZ and Jurgelski AE. Improving the quality of anticoagulation of patients with atrial fibrillation in managed care organizations: results of the Managing Anticoagulation Services Trial. Am J Med. 2002; 113:42-51

Mavrakanas T and Bounameaux H. The potential role of new oral anticoagulants in the prevention and treatment of thromboembolism. Pharmacol Ther. 2011;130:46-58.

McAlister F, Wilkins K, Joffres M, Leenan FHH, Fodor G, Gee M, Tremblay MS, Walker R, Johansen H, Campbell N. Changes in the rates of awareness, treatment and control of hypertension in Canada over the past two decades. Canadian Medical Association Journal. 2011. 0:cmaj.101767. Accessed online 08.2011

McDonald JH. Handbook of Biological Statistics. 2009; http://udel.edu/~mcdonald/statintro.html. Accessed online 17.08.2011

McGibbon C. How to make a questionnaire work. Nursing Times. 1997;93:46-8

McMahon S and Rogers A (1994). Blood pressure, antihypertensive treatment and stroke risk. Journal of Hypertension; 12 (SUPP 10): S5-S14.

McManus RJ and Mant J. Blood pressure lowering treatment should be offered to all patients regardless of their blood pressure. The Journal of clinical Hypertension. 2009;11:698-701

McManus JA, Craig A, McAlpine C, Langhorne P, Ellis G. Does behaviour modification affect post-stroke risk factor control? Three-year follow-up of a RCT. Clinical Rehabilitation. 2009;23:99-105

Mead G, Lewis S, Wardlaw JM and Dennis MS. Comparison of risk factors in patients with transient and prolonged eye and brain ischaemic syndromes. Stroke. 2002; 33: 2383-90.

Medical Research Council (MRC). A framework for development and evaluation of RCTs for complex interventions to improve health. MRC. 2000.

Mendez MA, Cooper R, Wilks R, Luke A, Forrester T. Income, education and BP in adults in Jamaica, a middle-income developing country. International Journal of Epidemiology. 2003; 32: 400-408

Miller ET and Spilker J. Readiness to change and brief educational interventions: successful strategies to reduce stroke risk. Journal of Neuroscience Nursing. 2003;35: 215-22

Milne S, Orbell S, Sheeran P. Combining motivational and volitional interventions to promote exercise participation: protection motivation theory and implementation intentions. British J Health Psychology. 2002;7:163-84

Minn Y-K, Cho S-J, Lee J-H, Kim S-Y, Kim C-H, Kwon K-H, Lee B-C. Significance of silent infarcts in acute ischaemic stroke patients aged 80 years or older. Cerebrovascular Diseases. 2005;20 DOI:10.1159/0000086512. Accessed online 15.06.2011

Mitchell P, Wang JJ, Wong T, Smith W, Klein R and Leeder SR. Retinal microvascular signs and risk of stroke and stroke mortality. Neurology. 2005 Oct 11; 65: 1005-9.

Mohan KM, Crichton SL, Grieve AP, Rudd AG, Wolfe CD, Heuschmann PU. Frequency and Predictors for the Risk of Stroke Recurrence up to 10 years after stroke: The South London Stroke Register. J Neurol Neurosurg Psych. 2009; 80:1012–1018.

Mohan KM, Wolfe CDA, Rudd AG, Heuschmann PU, Kolominsky-Rabas PL, Grieve AP. Risk and cumulative risk of stroke recurrence: A systematic review and meta-analysis. Stroke. 2011; 42: 1489-1494

Morales LS, Elliot MN, Weech-Maldonado R, Spritzer KL, Hays RD. Differences in CAHPS adult survey reports and ratings by race and ethnicity: an analysis of the National CAHPS benchmarking data. Health Service Research. 2001;36:595-617

Morrell JM and Kassianos GC. One-year data from the UK arm of the REACH Registry. The British Journal of Cardiology 2007; 14:215–18.

Moser D, Kimble LP, Alberts MJ, Alonzo A, Croft JB, Dracup K, Evenson KR, Go AS, Hand MM, Kothari RU, Mensah GA, Morris DL, Pancioli AM, Reigel B, Zernic JJ. Reducing delay in seeking treatment by patients with Acute Coronary Syndrome and Stroke. A Scientific statement from the American Heart Association Council on Cardiovascular Nursing and Stroke Council. Circulation. 2006;114:168-182

Mouradian M, Majumdar SR, Senthilselvan A, Khan K, Shuaib A. How well are hypertension, hyperlipidaemia, diabetes, and smoking managed after a stroke or transient ischemic attack? Stroke. 2002;33:1656–1659. 12.

Muller-Nordhorn J, Nolte CH, Rossnagel K. Knowledge about risk factors for stroke: a population based survey of 28090 participants. Stroke. 2006;37:946-50

Muntner P, Gu D, Wu X, Duan X, Wenqi G, Whelton PK, He J: for the InterASIA Collaborative group. Hypertension. 2004; 43:578-585

Nabi H, Koskenvuo M, Singh-Manoux A, Korkeila J, Suominen S, Korkeila K. Low pessimism protects against stroke: the health and social support (HESSUP) prospective cohort study. Stroke. 2010;41:187-90

Nadareishvili Z, Choudary Z, Joyner C, Brodie D, Norris JW. Cerebral microembolism in Acute Myocardial Infarction. Stroke. 1999;30:2679-82

National Audit Office. Reducing Brain Damage: Faster access to better stroke care. DH. 2005.

National Center for Health Statistics. Healthy People 2010. Centers for Disease Control and Prevention. Atlanta. USA. http://www.cdc.gov/nchs/healthy_people/hp2010.htm. Accessed online 15.09.2011

National Cholesterol Education Program Adult Treatment Panel III guidelines. Third report of the expert panel on detection, evaluation and treatment of high blood cholesterol in adults (ATP III). 2004; http://www.nhlbi.nih.gov/guidelines/cholesterol/index.htm. Accessed online 08.2011

National Health and Nutrition Examination Survey 2003-2004. http://www.cdc.gov/nchs/nhanes/nhanes2003-2004/nhanes03_04.htm. Accessed online 18.09.2011

National Health and Nutrition Examination Survey 2005-2006. http://www.cdc.gov/nchs/nhanes/nhanes2005-2006/nhanes05_06.htm. Accessed online 18.09.20111

National Institute for Health. Consensus Development Panel on Physical Activity and Cardiovascular Health. Physical activity and cardiovascular health. JAMA. 1996;276:241–246.

National Institute for Health and Clinical Excellence. Medicines Adherence clinical guideline 76. 2009. www.nice.org.uk/nicemedia/pdf/PH076guidance.pdf Accessed online 18.09.2011

National Institute for Clinical Excellence (NICE). Behaviour change at population, community and individual levels. NICE public health guidance no.6. London. National Institute for Clinical Excellence. www.nice.org.uk/nicemedia/pdf/PH006guidance.pdf

National Institute for Clinical Excellence (NICE). Health systems and health-related behaviour change: a review of primary and secondary evidence no.2. London. National Institute for Clinical Excellence. 2010. www.nice.org.uk/nicemedia/pdf/evidence.pdf. Accessed online 15.09.2011

Newby LK, LaPointe NM, Chen AY, Kramer JM, Hammill BG, DeLong ER, Muhlbaier LH, Califf RM. Long-term adherence to evidence based secondary prevention therapies in coronary artery disease. Circulation. 2006:113:203-212

Nicol MB and Thrift AG. Knowledge of risk factors and warning signs of stroke. Vasc Health Risk Manag. 2005;1:137-47

Ninios I, Bogossian H, Zarse M, Lazaridou F, Dimitiadis K, Ninios V, Lemke B, Louridas G. Prevalence, clinical correlates and treatment of permanent atrial fibrillation among the elderly: insights from the first prospective population-based study in rural Greece. J Thromb Thrombolysis. 2010;30:90-6

Nutbeam D. Advancing Health literacy: a global challenge for the 21st Century. Health Promot Int. 2000;15:183-184

Oates DJ, Berlowitz DR, Glickman ME, Sullivan RA, Borzecki AM. Blood Pressure and survival in the oldest old. J Am Geriatr Soc. 2007;55:383-388

O'Carroll R, Dennis M, Johnston M, Sudlow C. Improving adherence to medication in stroke survivors (IAMSS): a randomised controlled trial: study protocol. BMC Neurology. 2010;10-15

Ogata M, Hino SC, Scito A, Moikawa K, Kando S, Karemoto S, Murakani M et al. Autophagy is activated for cell survival after ER stress. Mol Cell Biol. 2006;DOI:10.1128/MCB01453-06

Ogawa S, Korestune Y, Yasaka M, Aizawa Y, Atarashi H, Inoue H, Kamakura S, Kumagai K, Mitamura H, Okumera K, Sugi K, Yamashita T. Antithrombotic therapy in Atrial Fibrillation. Circulation Journal. Official Journal of the Japanses circulation society. 2011; 75: 1539-47

Oh SH, Kim NK, Kim SH. The prevalence and risk factor analysis of silent brain infarcts in patients with first-ever stroke. J Neurol Sci. 2010;293:97-101

O'Hare AM, Glidden DV, Fox CS and Hsu CY. High prevalence of peripheral arterial disease in person with renal insufficiency: results from the National Health and Nutrition Examination survey 1999-2000. Circulation 2004; 109: 320-3.

Oliveria S, Lapuerta P, McCarthy BD, L'Italien GJ, Berlowitz DR, Asch SM. Physician-related barriers to the effective management of uncontrolled hypertension. Arch Intern Med. 2002; 162:413-420.

Oliveria S, Chen R, McCarthy B, Davis C and Hill M. Hypertension knowledge, awareness and attitudes in a hypertensive population. Journal of General Internal Medicine. 2005; 20: 219-225.

Ong CT, Sung KC, Sung SF, Wu CS, Hsu YC, Su YH. Impact of silent infarction on the outcome of stroke patients J Formos Med Assoc. 2009; 108: 224-230

Ong KL, Cheung BMY, Man YB, Lau CP, Lam KSL. Prevalence, awareness, treatment and control of hypertension among United States adults. 1999-2004. Hypertension. 2007; 49: 69-75.

O'Regan C, Wu P, Arora P, Perri D and Mills EJ. Statin therapy in stroke prevention: meta-analysis involving 121,000 patients. American Journal of Medicine. 2008 Jan; 121: 24-33.

Osterberg L and Blaschke T. Adherence to Medication. N Engl J Med. 2005; 353: 487-497

Ostchega Y, Yoon SS, Hughes J, Louis T, for the centres for disease control and prevention division of health and nutrition examination surveys. Hypertension awareness, treatment and control – continued disparities in adults: United States, 2005-2006. NCHS data. 2008; 3:1-8

Ovbiagele B, Saver JL, Fredieu A, Suzuki S, Selco S, Rajajee V, McNair N, Razinia T, Kidwell CS. In-hospital initiation of secondary prevention therapies yields high rate of adherence at follow-up. Stroke. 2004; 35:2879-2883

Oxford English Dictionary. Oxford University Press. 2011. Accessed online at www.oed.com. Accessed online 25.07 2011.

Ozeren A, Acarturk E, Koc F, Demir M, Sarica Y, Eroghu H. Silent cerebral lesions on MRI in subjects with CAD. Jpn Heart J. 1998;39:611-618

Pancioli AM, Broderick J, Kothari R, Brott T, Tuchfarber A, Miller R, Khoury J, Jauch E. Public perception of stroke warning signs and knowledge of potential risk factors. JAMA. 1998;279:1288-1292.

Parikh N, Hwang S-J, Larson M, Meigs J, Levy D, and Fox C. Cardiovascular disease risk factors in chronic kidney disease: overall burden and rate of treatment and control. Archive of internal medicine 2006; vol 166: 1884-1891.

Parliamentary Office of Science and Technology (POST). Postnote: Ethnicity and Health. 2007; 276: 1-9

Pandian JD, Jaison A, Deepak SS, Kalra G, shamsher S, Lincoln D, Abraham G. Public awareness of warning signs, risk factors and treatment in stroke in Northwest India. Stroke. 2005;36:644-48

Pardo M, Fuster L, Nuez T. Silent brain infarctions in patients with coronary artery disease. A Spanish population survey. J Neurol. 1998;245:93-97

Patsopoulos NA, Analatos AA, Ioannidis JP. Relative citation impact of various study designs in the health sciences. Journal of the American Medical Association. 2005; 18:2362–2366.

Pearson T and Kopin L. Bridging the Treatment Gap: Improving compliance with lipid-modifying agents and therapeutic lifestyle changes. Preventive Cardiology. 2007;6:204-213

Pedersen T, Kjekshus J, Pyorala K, Olsson A, Cook T, Musliner T, Tobert J and Haghfelt T. Effect of Simvastatin on ischaemic signs and symptoms in the Scandinavian Simvastatin survival study. American Journal of Cardiology. 1998; 81; 3:333-335.

Pendlebury ST, Giles MF, Rothwell PM. Transient Ischaemic Attack and Stroke. Diagnosis, Investigation and Management. Cambridge University Press.2009; 2.

Pennant M, Davenport C, Bayliss S, Greenheld W, Marshall T, Hyde C. Community Programs for the Prevention of Cardiovascular Disease. A systematic review. Am J Epidemiol. 2010;172:501-516

Perett-Watel P, Constance J, Guilbert P, Moatti J. Smoking too few cigarettes to be at risk? Smokers perceptions of risk and risk denial, a French survey. Tob Control. 2007;16:351-356

Petrea RE, Beiser AS, Seshadri S, Kelly-Hayes M, Kase CS, Wolf PA. Gender differences in stroke incidence and post-stroke disability in the Framingham Heart Study. Stroke. 2009;40:1032–1037.

Phatak HM, Thomas J 3rd. Relationships between beliefs about medications and non-adherence to prescribed chronic medications. Ann Pharmacother. 2006;40:1737-42

Poddar R, Deb I, Mukherjee S, Paul S. Journal of Neurochemistry. 2010; 115:1350-1362

Phatak HM, Thomas J 3rd. Relationships between beliefs about medications and non-adherence to prescribed chronic medications. Ann Pharmacother. 2006; 40:1737-42

Prencipe M, Culasso F, Rasura M, Anzini A, Beccia M, Cao M, Giubilei F, Fieschi C. Long-term prognosis after a minor stroke: 10-year mortality and major stroke recurrence rates in a hospital-based cohort. Stroke. 1998;29:126 –132.

Prochaska JO and Velicer WF. Transtheoretical Model of Health Change Behaviour. Am J Health Promo. 1997; 12: 38-48

PROGRESS Collaborative Group. Randomised trial of a perindopril-based blood pressure lowering regimen among 6,105 individuals with previous stroke or transient ischaemic attack. Lancet. 2001; 258: 1033-1041

Prosser J, MacGregor L, Lees K, Diener H-C, Hacke W, Davis S, on behalf of the VISTA investigators. Predictors of Early cardiac morbidity and mortality after ischemic stroke. Stroke. 2007; 38: 2295-2302.

Purroy F, Montaner J, Molina CA, Delgado P, Ribo M, Alvarez-Sabín J. Patterns and predictors of early risk of recurrence after transient ischemic attack with respect to etiologic subtypes. Stroke. 2007;38:3225–3229.

Qureshi A, Suri MFK, Guterman LR and Hopkins LN. Ineffective secondary prevention in survivors of cardiovascular events in the U.S population: report from the third national health and nutrition examination survey. Archives of Internal Medicine. 2001; 161: 1621-1628.

Qiao Q, Gao W, Zhang L, Nyamdorj R and Tuomilehto J. Metabolic syndrome and cardiovascular disease. Annals of Clinical Biochemistry. 2007; 44: 232-63.

Raine R, Wong W, Ambler G, Hardoon S, Petersen I, Morris R, Bartley M, Blane D. Examination of socio-demographic variations in the contribution of secondary drug prevention to stroke survival at middle and older ages. BMJ. 2009; 338:b1279

Rand D, Eng JJ, Tang PF, Jeng JS, Hung C. How active are people with stroke? Use of accelerometers to assess physical activity. Stroke. 2009; 40; 163-168.

Rasmussen N. WASH-1400. The Reactor Safety Study. The United States Nuclear Regulatory Commission. 1975. USA

Redfern J, McKevitt C, Dundas R, Rudd AG, Wolfe CDA. Behavioural risk factor prevalence and lifestyle change after stroke: a prospective study. Stroke. 2000;31:1877-81

Redfern J, McKevitt C, Wolfe CDA. Development of complex interventions in stroke care: A systematic review. Stroke. 2006;37:2410-19

Redfern J, Rudd A, Wolfe CDA, McKevitt C. Stop Stroke: Development of an innovative intervention to improve risk factor management after stroke. Patient Education and Counselling. 2008; 72: 201-209.

Reeves MJ, Hogan JG, Rafferty AP. Knowledge of stroke risk factors and warning signs among Michigan adults. Neurology. 2002; 59: 2547-1552

Reeves MJ, Bushnell CD, Howard G, Gargano JW, Duncan PW, Lynch G, Khatiwoda A, Lisabeth L. Sex differences in stroke: epidemiology, clinical presentation, medical care, and outcomes. Lancet Neurol. 2008; 7:915–926.

Reynolds K, Lewis B, Nolan JDL, Kinney GL, Sathya B, He J. Alcohol consumption and stroke: A Meta-analysis. JAMA. 2003;289:579-588

Rhodes RE and Plotnikoff RC. Can current physical activity act as a reasonable proxy measure of future physical activity? Evaluating cross-sectional and passive prospective designs with the use of social cognitive models. Prev Med. 2005; 40 : 547-55

Ricci S et al. Silent brain infarction in patients with first-ever stroke. A community based study in Umbria, Italy. Stroke. 1993;24:647-51

Rigler SK, Webb MJ, Patel AT, Lai SM, Duncan PW. Use of antihypertensive and antithrombotic medications after stroke in community-based care. Ann Pharmacother. 2001;35:811-16

Rodgers A, McMahon S, Gamble G, Slattery J, Sandercock P and Warlow C. Blood pressure and risk of stroke in patients with cardiovascular disease. BMJ. 1996;313:147.

Rodgers H, Bond S, Curless R. Inadequacies in the provision of information to stroke patients and their families. Age and Ageing. 2001;30:129-33

Rokey R, Harati Y and Rolak LA. Coronary artery disease in patients with cerebrovascular disease: a prospective study. Annals of Neurology 1984; 16: 50-53.

Rosenstock IM. Historical origins of the health belief model. In: Becker MH, ed. The Health Belief Model and Personal Health Behaviour. Health education Monographs. 1974; 2:324-473

Ross S, Walker A and MacLeod MJ. Patient compliance in hypertension: role of illness perceptions and treatment beliefs. Journal of Human Hypertension. 2004; 18:607-613

Rothwell P. Making the most of secondary prevention. Stroke 2007; 38: 1726.

Rothwell P, Coull AJ, Silver LE, Fairhead F, Giles MF, Lovelock CE, Redgrave J, Bull LM, WelchS, Cuthbertson FC, Binney LE, Gutnikov SA, Anslow P, Banning AP, Mant D, Mehta Z, for the Oxford Vascular Study. Population-based study of event-rate, incidence, case fatality and mortality for all acute vascular events in all arterial territories. Lancet. 2005; 366: 1773-1783.

Ross R. The pathogenesis of Atherosclerosis: A perspective for the 1990's. Nature. 1993; 362:801-809.

Royal College of Physicians Intercollegiate Stroke Working Party. National Clinical Guidelines for Stroke. 3rd Edition. 2008.

Royal College of Physicians. The National Clinical Guidelines for Stroke. Royal College of Physicians.2004. London. Updated 2008.

Rudd AG, Lowe D, Hoffman A, Irwin P, Pearson M. Secondary prevention for stroke in the UK: results from the National Sentinel Audit of Stroke. Age Ageing. 2004;33:280-86

Sacco RL, Boden-Albala B, Abel G, Lin I-F, Elkind M, Hauser WA, Paik MC, Shea S. Race-ethnic disparities in the impact of stroke risk factors. The Northern Manhattan Stroke Study. Stroke 2001; 32: 1725-1731

Sacco RL. Risk factors for TIA and TIA as a risk factor for Stroke. Neurology. 2004;62 (8 suppl 6): S7-11

Sacco RL et al. Guidelines for Prevention of Stroke in Patients with Ischemic stroke or Transient Ischaemic Attack. A Statement for healthcare professionals from the American Heart/Stroke Association Council. Stroke. 2006;37:577-617

Sachs L. Causality, responsibility and blame: core issues in the construction and subtext of prevention. Sociology of Health and Illness. 1996;18:632-52

Scientific Advisory Committee on Nutrition (SACN). Salt and Health. 2003. http://www.sacn.gov.uk/pdfs/sacn_salt_final.pdf. Accessed online 11.09.2011

Sandercock PG, Warlow CP, Jones LN, Starkey I. Predisposing factors for cerebral infarction: The Oxfordshire community stroke project. BMJ. 1989; 298:75-80

Salgado AV, Ferro JM, Gouveia-Oliveira A. Long-term prognosis of first-ever lacunar strokes. A hospital-based study. Stroke. 1996;27: 661– 666.

Samal D, Greisenegger S, Auff E, Lang W and Lalouschek W. The Relation between knowledge about hypertension and education in hospitalized patients with stroke in Vienna. Stroke.2007; 38: 1304-1308.

Samsa G, Cohen S, Goldstein L, Bonito A, Duncan P, Enarson C, DeFriese G, Horner R, Matchar D. Knowledge of risk among patients at increased risk of stroke. Stroke. 1997; 28: 916-921.

Sappok T, Faulstich A, Stuckert E, Druck H, Marx P and Koennecke HC. Compliance with secondary prevention of ischemic stroke: A prospective evaluation. Stroke. 2001; 32: 1884-1889.

Schedlbauer A, Schroeder K, Peters TJ, Fahey T. Interventions to improve adherence to lipid lowering medication. Cochrane Database of Systematic Reviews. 2004;4: CD 004371. DOI: 10.1002/14651858

Schedlbauer A, Schroeder K, Fahey T. How can adherence to lipid-lowering medication be improved? A systematic review of randomised controlled trials. Family Practice. 2007;24: 380-387

Schiffrin EL, Lipman ML and Mann JF. Chronic Kidney Disease: Effects on the Cardiovascular System. Circulation 2007;116:85-97

Schneider AT, Pancioli A, Khoury J, Rademacher E, Tuchfarber A, Miller R, Woo D, Kissela B, Broderick JP. Trends in community knowledge of the warning signs and risk factors for stroke. JAMA. 2003;289:343-47

Sconocchini C, Racco F, Pratillo G. Patients with carotid stenosis and clinical history negative for coronary disease: usefulness of the ergometric test for the identification of ischemic myocardial disease. Minerva Med 1997 ;88:173–181.

Segura T, Vega G, Lopez S, Rubio F, Castillo J on behalf of the cerebrovascular diseases study group of the Spanish society of neurology. Public perception of stroke in Spain. Cerebrovascular Diseases. 2003;16:21-26

Seliger SL, Gillen DL, Longstreth WT Jr, Kestenbaum B and Stehman-Breen CO. Elevated risk of stroke among patients with end-stage renal disease. Kidney International. 2003; 64: 603-609.

Seliger SL and Longstreth WT Jr. Lessons about brain vascular disease from another pulsating organ, the kidney. Editorial. Stroke 2008; 39: 5-6.

Selvetella G, Notte A, Maffei A, Calistri V, Scamardella V. Left ventricular hypertrophy is associated with asymptomatic cerebral damage in hypertensive patients. Stroke. 2003;34:1766-70

Shah R and Cole JW. Smoking and stroke: the more you smoke, the more you stroke. Exp Rev Cardiov Ther. 2010;8: 917-932

Shantsila E and Lip G. ‘Aspirin Resistance’ or treatment non-compliance: which is to blame for cardiovascular complications?. J Transl Med. 2008;6:47

Sheeran P and Abraham C. The Health Belief Model. In: Connor M and Norman P (Eds) Predicting Health Behaviour. 2nd ed. Buckingham, UK: Open University press. 2005; 2: 23-61.

Sheeran P. Intention-behaviour relations: A conceptual and empirical review. European Review of Social Psychology. Chichester Wiley. 2002;12:1-30

Shi L and Stevens GD. Disparities in access to care and satisfaction among US children: the roles of race/ethnicity and poverty status. Public Health Rep. 2005;120:431-41

Shinkawa A, Ueda K, Hasuo Y, Kiyohara Y, Fujishima M. Silent cerebral infarction in a community based autopsy series in Japan. Stroke. 1995;26:380-385

Shlipak MG, Heidenreich PA, Noguchi H, Chertow GM, Browner WS, McClellan MB. Association of renal insufficiency with treatment and outcomes after Myocardial infarction in elderly patients. Annals of Internal Medicine. 2002; 137: 555-562.

Siachos T, Vanbakel A, Feldman DS. Silent strokes in patients with heart failure. J Card Fail. 2005;11:485-90

Sienkiewica-Jarosz H, Zatorski P, Baranowska A, Ryglewicz D, Bienkowski P. Predictors of smoking abstinence after first ever ischemic stroke. A 3-month follow-up. Stroke. 2009;40:2592-2953

Silcock J and Standage C. Exploring patient adherence to cardiovascular medicines. British Journal of Cardiac Nursing. 2007;2:223-228

Singh RB, Dubnov G, Niaz MA, Ghosh S, Singh R. Effect of Indo-Mediterranean diet on progression of cardiovascular disease in high risk patients: a randomised single blind trial. Lancet. 2002;360:1455-61

Slovic P. Perception of risk. Science. 1987;236: 280-285

Slovic P. Perceived risk, trust and democracy. Risk Analysis. 1993;13: 675-682

Smedley BD, Stith AY and Nelson AR. Unequal Treatment: Confronting Racial and Ethnic Disparities in Healthcare. Eds. 2002. Washing D.C: National Academy Press

Stafford L, Jackson H, Berk M. Illness beliefs about heart disease and adherence to secondary prevention regimens. Psychosomatic Medicine. 2008; 70: 942-948

Starr C. Risk management, assessment and acceptability. Risk Analysis. 1985;5:97-102

StataCorp. 2007. Stata Statistical Software: Release 10. College Station, Texas: StataCorp LP

Steg PG, Bhatt DL, Wilson PWF, et al. One year cardiovascular event rates in outpatients with atherothrombosis. JAMA 2007; 297: 1197–1206

Strazzulo P, D'Elia L, Kandala N, Cappucio F. Salt intake, stroke and cardiovascular disease: meta-analysis of prospective studies. BMJ.2009;339:b4567

Strippoli GF, Navaneethan SD, Johnson DW, Perkovic V, Pellegrini F, Nicolucci A and Craig JC. Effects of statins in patients with chronic kidney disease: meta-analysis and meta-regression of randomised controlled trials. BMJ. 2008; Mar 22; 336: 624-625.

Stroup DF, Berlin JA and Morton SC. Meta-analysis of observational studies in Epidemiology: A proposal for reporting. JAMA. 2000; 283: 2008-2012

Sudlow CL and Warlow CP. Comparable studies of the incidence of stroke and it's pathological types: results from an international collaboration. International Stroke Incidence Collaboration. Stroke. 1997;28:491-9

Sug Yoon S, Heller RF, Levi C, Wiggers J, Fitzgerald PE. Knowledge of stroke risk factors, warning signs and treatment among an Australian urban population. Stroke.2001;32:1926-30

Sullivan K and Waugh D. Toward the development of the Cerebrovascular Attitudes and Beliefs Scale (CABS): A measure of stroke-related beliefs. Top Stroke Rehab. 2007;14: 42-51

Sutton JA and Higgins JPT. Recent developments in meta-analysis. Statistics in medicine. 2008; 27: 625-650

Svensson S, Kjellgren KI, Ahlner J, Saljo R. Reasons for adherence with antihypertensive medications. Int J Cardiol. 2000;76:157-163

Talelli P and Greenwood RJ. Recurrent stroke: where do we stand with the secondary prevention of non-cardio embolic ischaemic strokes? Ther Adv Cardiovasc Dis. 2008; 2: 387-405.

Tanaka H, Sueyoshi K et al. Silent brain infarction and coronary artery disease in Japanese patients. Arch Neurol. 1993;50:706-709

Tapiero C. *Risk and Financial Management: Mathematical and Computational Methods*.2004. John Wiley & Son.

The Stroke Association Manifesto. 2010-2015. http://www.stroke.org.uk/campaigns/stroke_policy/manifesto_20102015.html. Accessed online 25.07.2011

Towfighi A and Ovbiagle B. The impact of Body Mass Index on Mortality after stroke. Stroke. 2009; 40; 2704-2708.

Townend E, Tinson D, Kwan J and Sharpe M. Fear of recurrence and beliefs about preventing recurrence in persons who have suffered a stroke. Journal of Psychosomatic Research. 2006; 61; 747-755.

Townsend RR. Stroke in chronic kidney disease: prevention and management. Clinical Journal of the American Society of Nephrology: 2008 Jan; 3; suppl 1: S11-6.

Touze E, Varenne O, Chatellier G, Peyrard S, Rothwell P and Mas JL. Risk of Myocardial infarction and vascular death after TIA and Ischaemic stroke. A systematic review and meta-analysis. Stroke 2005;36: 2748-2755.

Tuttolomondo A, Pedone C, Pinto A, Di Raimondo D, Fernandez P, Di Sciacca R, Licata G, Gruppo Italiano di Farmacoepidemilogia dell 'Anziano (GIFA) Researchers. Int J Cardiol. 2008;125:391-6 epub 2007 May 08

Uekita K, Hasebe N, Funayama N. Cervical and intercranial atherosclerosis and silent brain infarction in Japanese patients with CAD. Cerebrovascular Diseases. 2003;16:61-68

Urbinati S, Di Pasquale G, Andreoli A. Frequency and prognostic significance of silent coronary artery disease in patients with cerebral ischaemia undergoing carotid endarterectomy. American Journal of Cardiology. 1992; 69:1166–1170.

U.S. Department of Health and Human Services 2006 national healthcare disparities report. Agency for Healthcare Research and Quality; Rockville, MD: 2006. Publication No. 07-0012

Van Wijk I, Kappelle LJ, Van Gijn J, Koudstaal PJ, Franke CL, Vermeulen M, Gorter JW, Algra A, for the LiLAC study. Long-term survival and vascular event risk after transient ischaemic attack or minor ischaemic stroke: a cohort study. The Lancet. 2005; 365: 2098-2104.

Vermeer S, Koudstaal P, Oudkerk M, Hofman A, Breteler M. Prevalence and risk factors of silent brain infarcts in the population-based Rotterdam scan study. Stroke. 2002; 33: 21-25.

Vermeer S, Hollander M, Van Dijk E, Hofman A, Koudstaal and Breteler M. Silent brain infarcts and white matter lesions increase stroke risks in the general population: The Rotterdam scan study. Stroke. 2003;34:392-396 .

Vermeer, S. E., W. T. Longstreth Jr, et al. Silent brain infarcts: a systematic review. The Lancet Neurology. 2007; 6: 611-619.

Vickrey B, Rector T, Wickstrom S, Guzy P, Sloss E, Gorelick P, Garber S, McCaffrey D, Dake M and Levin R. Occurrence of secondary ischaemic events among person's with atherosclerotic vascular disease. Stroke: Journal of the American Heart Association. 2002; 33: 901-906.

Volpe M and Dedhiya SD. Physicians, patients and public knowledge and perception regarding hypertension and stroke: a review of survey studies. Curr Med Res Opin. 2006;22:1319-30

Wang Y, Wu D, Yilong W, Ma R, Wang C, Zhao W. A Survey on adherence to secondary prevention to secondary ischemic stroke prevention. Neurological Research. 2006;28: 16-20

Wang R. Critical health literacy: a case study from China. Health Promot Int. 2000;15:269-274

Wei L, McDonald TM, Watson AD, Murphy MJ. Effectiveness of 2 statin prescribing strategies with respect to adherence and cardiovascular outcomes: observational study. Pharmaco-epidemiology Drug Safety. 2007;16:385-392

Weinman J, Petrie KJ, Moss-Morris R, Horne R. The Illness Perception Questionnaire: A new method for assessing illness perceptions. Psychology and Health. 1996; 11: 431-446

Wendel-Vos GCW, Schuit AJ, Tijhuis MAR, Kromhout D. Leisure time physical activity and health-related quality of life: cross-sectional and longitudinal associations. Qual Life Res. 2004;13:667-77

Wenger NK. Physical inactivity and coronary heart disease in elderly patients. Clin Geriatr Med. 1996;12:79-88

Williams B, Poulter NR, Brown MJ, Davis M, McInnes GT, Potter JP, Sever PS and Thom S McG; The BHS Guidelines Working Party Guidelines for Management of Hypertension: Report of the Fourth Working Party of the British Hypertension Society, 2004 - BHS IV. Journal of Human Hypertension 2004; 18: 139-185.

Wilson P, D'Agostino RB, Sullivan L, Parise H, Kannel WB. Overweight and obesity as determinants of cardiovascular risk. The Framingham experience. Arch Intern Med. 2002; 162:1867-1872.e1-9

Witt BJ, Ballman KV, Brown RD, Meverden RA, Jacobsen SJ, Roger VL. The incidence of stroke after myocardial infarction: a meta-analysis. Am J Med. 2006; 119:354

Witte K and Allen M. A meta-analysis for fear appeals: Implications for effective public health campaigns. Health Edcu Behav. 2000;27:591-615

Wizner B, Gryglewska B, Gasowski J, Kocemba J, Grodzick T. Normal Blood Pressure values as perceived by normotensive and hypertensive subjects. Journal of Human Hypertension. 2003; 17:87-91

Wolfe CDA, Redfern J, Rudd AF, Grieve AP, Heuschmann PU, McKevitt C. Cluster Randomisation Controlled Trial of a Patient and General Practitioner Intervention to improve the management of multiple risk factors after stroke: Stop Stroke. Stroke. 2010; 41: 2470-2476

Wolf PA, Cobb JL, D'Agostino RB. Epidemiology of Stroke. In: Barnett HJM, Mohr JP, Stein BM, Yatsu FM (eds). Stroke: Pathophysiology, diagnosis and management. 1992; 2nd edn; Churchill Livingstone, New York.

Wolf PA, Abbott RD, Kannel WB. Atrial fibrillation as an independent risk factor for stroke: the Framingham Study. Stroke. 1991; 22: 983–7.

Wolf PA, Benjamin EJ, Belanger AJ, Kannel WB, Levy D, D'Agostino RB. Secular trends in the prevalence of atrial fibrillation: the Framingham Study. Am Heart J. 1996;131:790 –795.

Wolf PA, D'Agostino RB, Belange AJ and Kannel WB. Probability of stroke: a risk profile from the Framingham Study. Stroke. 1991; 22: 312-318.

Wonderling D, McDermott M, Buxton AL, Kinmouth S, Pyke S, Thompson S and Wood D. Costs and cost effectiveness of cardiovascular screening and intervention: the British family heart study. BMJ. 1996;312:1269-1273

Wood DA, Kotseva K, Connolly S et al. Nurse co-ordinated multidisciplinary, family based cardiovascular disease prevention programme (EUROACTION) for patients with chronic heart disease and asymptomatic individuals at high risk of cardiovascular disease: a paired, cluster randomised controlled trial. Lancet. 2008;371: 1999-2012

World Health Organisation (WHO). Integrated Management of Cardiovascular Risk: Reducing Risks, Promoting Healthy Life. Geneva, Switzerland: World Health Organisation; 2002.

World Health Organisation (WHO). Adherence to Long-term therapies: evidence for action. Geneva, Switzerland: World Health Organisation; 2003.

World Health Organisation (WHO). 2011. Fact sheet No. 311. http://www.who.int/mediacentre/factsheets/fs311/en/. Accessed online 17.08.2011

World Health Organisation (WHO). Cardiovascular Diseases Fact Sheet No 317. Geneva. 2011. http://www.who.int/mediacentre/factsheets/fs317/en/index.html. Accessed online 15.09.2011

Wu JR, Moser DK, Lennie T, Burkhat P. Medication adherence in patients who have heart failure: a review of the literature. Nurs Clin North Am. 2008; 43: 133-353.

Xu G, Liu X, Wu W, Zhang R, Yin Q. Recurrence after ischemic stroke in Chinese patients: impact of uncontrolled modifiable risk factors. Cerebrovasc Dis. 2007;23:117–120.

Yusuf S, Sleight P, Pogue J, Bosch J, Davies R, Dagenais G. Effects of an angiotensin-converting-enzyme inhibitor, ramipril, on cardiovascular events in high-risk patients: the Heart Outcomes Prevention Evaluation Study Investigators. N Engl J Med. 2000; 342: 145–153

Zhu S, Wang Z, Heshka S, Heo M, Faith MS, Heymsfield SB. Waist circumference and obesity-associated risk factors among whites in the third National Health and Nutrition Examination Survey: clinical action thresholds. Am J Clin Nutr. 2002;76:743-9.

Appendices

Appendix 1: Arcsine transformation formulae

Arcsine transformation formulae & methodology (Kulinskaya et al 2008, Cochrane Collaboration 2011)

n = number of patients with positive silent brain infarction in the presence of

1. AIS
2. CAD
3. PAD

Calculate: Proportion (P) = number of positive events / n

Transform data: Standardised Mean Difference (SMD) = 2 x arcsin (√P)

Standard Error (SE) = 1 / √n

Enter SMD and SE into Review Manager using Generic Inverse Variance data type and statistical method, with random-effects analysis model (DerSimonian and Laird) to produce pooled effect measure SMD = (A)

Transform data back to original scale to give pooled percentage prevalence.

% Prevalence = $(\text{Sin } x\ (A/2)^2) \times 100$

Appendix 2: Population-based study questionnaire

1.1 Age				
1.2 Gender	1.Male □		2.Female □	
1.3 Your ethnic background 1. White British □ 2. White Irish □ 3. White Other □	4. Caribbean □ 5. African □ 6. Indian □ 7. Pakistani □ 8. Bangladeshi □		9. Any other Asian □ 10. Other ethnic group □ please state……	
1.4 Your educational background 1. No basic school education □ 2. Secondary school education □ 3. Apprenticeship □	4. Upper secondary school education □ 5. University or college graduation □			
1.5 Marital status: please circle	Single/Married/Divorced/ Separated/Widowed	Co-habiting/Civil partnership		
1.6 Do you smoke?	1. Yes □	2. No □		
1.6a If you have given up smoking, how long ago?	Months	Years		
1.7 Have you been diagnosed with high blood pressure?	1. Yes □	2. No □		
1.8 Have you ever been diagnosed with diabetes?	1. Yes □	2. No □		
1.9 Have you ever been diagnosed with heart disease?	1. Yes □	2. No □		
1.10 Have you ever been diagnosed with circulation problems in your legs?	1. Yes □	2. No □		
1.11 Have you ever been diagnosed with kidney disease?	1. Yes □	2. No □		
2.1 In your own words what do you think is a stroke?				
2.2 In your own words what do you think is a heart attack?				
2.3 What do you think are the risk factors for stroke?				
2.4 What do you think are the signs and symptoms of stroke?				
2.5 What ways do you think you can prevent a further stroke?				

Illness perception: Cause	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
A germ or virus caused my stroke					
Pollution of the environment caused my stroke					
My stroke was caused by hereditary factors, it runs in my family					
It was just by chance that I had a stroke					
Stress was a major factor in causing my stroke					

Illness perception: Consequence					
My stroke is a serious condition					
My stroke has had a major consequence on my life					
My stroke has become easier to live with					
My stroke has had little effect on my life					
My stroke has strongly affected the way others see me					
My stroke has serious economic and financial consequences					
My stroke has strongly affected the way I see myself as a person.					

Illness perception: Future					
My stroke will improve in time					
There is a lot which I can do to control my symptoms					
There is very little that can be done to improve my symptoms					
My treatment will be effective in preventing a future stroke					
Recovery from my stroke is largely dependent on chance or fate					

3.1 What type of stroke did you have?	1. Bleed □ 3. Small /TIA □ 4. Don't know □ 2. clot □
3.2 How long ago did you have your stroke?	1. < 1 year □ 2. 1-5 years □ 3. > 5 years □
3.3 At the time do you think you knew you were having a stroke?	1. Yes □ 2. No □
3.4 Do you fear having another stroke?	1. Yes □ 2. No □
3.5 Do you take any medication to prevent a further stroke?	1. Yes □ 2. No □ please list below:
3.5a Please list all other medications.	
3.6 Do you think you have any risk factors for stroke?	1. Yes □ 2. No □
3.7 Do you have your blood pressure monitored? *If yes please state where:*	1. Yes □ 2. No □ *a.) Home* □ *b.) G.P* □ *c.) Hospital* □
3.8 Besides medication have you undertaken any lifestyle changes following your stroke? *Please tick all that apply.*	1. None □ 5. Weight loss □ 2. Stopped smoking □ 6. Eat 5 fruit/veg per day □ 3. More exercise □ 7. Reduced salt intake □ 4. Less alcohol □ 8. Low fat diet □
3.9 Do you think you have a good knowledge of the cause of your stroke?	1. Yes □ 2. No □
3.10 Do you think you have a good understanding of how to prevent a further stroke?	1. Yes □ 2. No □
3.11 Where did you get your stroke information from? Please tick all that apply.	1. Media □ 3. Family and friends □ 2. Health professional □ 4. None received □
3.12 What format was the information in?	1. Internet □ 3. Verbal face to face □ 2. Written booklet □ 4. None received □ 5. Telephone □

4.1 Do you think you are at risk of having another stroke?	1. Yes □ 2. No □ 3. Don't know □	
4.2 Are you still employed?	1. Yes– what do you do? □ 2. No □ 3. Retired before stroke □ 4. Retired due to stroke □	
4.3 To help us assess your ability to calculate risk please answer this question	**A restaurant bill is £25, what amount is a 10% tip?**	£
4.4 Please rank the following in order of the most likely to happen to you. Please rank the suggestions 1-4 in the boxes, 1 being the most likely thing to happen and 4 being the least likely.	Survive a plane crash Have a heart attack Win the lottery Get struck by lightening	☐ ☐ ☐ ☐
4.5 Please rank the following in order of the most likely to happen to you. Please rank the suggestions 1-4 in the boxes, 1 being the most likely thing to happen and 4 being the least likely.	Get a hole-in-one in a Golf game Have another stroke Get run over by a bus Get struck by a falling plane	☐ ☐ ☐ ☐

4.6 Do you think that having *heart disease* would increase your risk of having a *heart attack*?	**Least 1 2 3 4 5 6 7 8 9 10 Most**
4.7 Do you think that having *diabetes* would increase your risk of having a *heart attack*?	**Least 1 2 3 4 5 6 7 8 9 10 Most**
4.8 Do you think having *kidney disease* would increase your risk of having a *heart attack*?	**Least 1 2 3 4 5 6 7 8 9 10 Most**
4.9 Do you think that having *circulation problems in your legs* would increase your risk of having a *heart attack*?	**Least 1 2 3 4 5 6 7 8 9 10 Most**
4.10 Do you think that having a *stroke* would increase your risk of having a *heart attack*?	**Least 1 2 3 4 5 6 7 8 9 10 Most**

Appendix 3: Model formula for Logistic Regression Modelling for RCT design

xi:logisticoutcome age gender antiplats statin antiplatsdis antihtndish statdish htn dm ihd i.smoking pvd sbpadm af

adjust age=XX gender=XX antiplats=XX statin=XX antiplatsdis=XX antihtndish=XX statdish=XX htn=XX dm=XX ihd=XX pvd=XX sbpadm=XX af=XX, by(smoking)pr

Example ID 036

adjust age=50 gender=1 antiplats=0 statin=1 antiplatsdis=1 antihtndish=1 statdish=1 htn=1 dm=1 ihd=0 pvd=0 sbpadm=143 af=0, by(smoking)pr

Smoking	**pr**
Never	.133104 (13%)
Ex-smoker	.144045 (14%)
Current smoker	.22331 (22%)

Appendix 4:IRAIS Measurement Tool

ID STUDY NUMBER:		**Consent form signed:** 1. Participant ☐ 2. Consultee ☐		**Name:**	**Date recruited:**
GENDER:	1.MALE ☐	2. FEMALE ☐	**AGE:**	**Date of Birth:**	**Hospital Number:**
MARITAL STATUS:	1. Single ☐ 2. Married/Civil partnership ☐ 3. Divorced/separated ☐ 4. Widowed ☐		**ETHNIC BACKGROUND: Corresponding number:** ☐	1. White British 2. White other – please specify 3. Asian British 4. Asian other – please specify 5.Chinese British 6.Other ethnic background – please specify	7. Black other – please specify 8. Mixed race British 9. Mixed race other – please specify 10 Black British 11.Chinese other – please specify
EDUCATIONAL LEVEL:	1. No basic education ☐ 2. secondary school ☐		3. Apprenticeship ☐ 4. University ☐		
NIHSS ON DISCHARGE:			**NIHSS AT 3 MONTHS:**		
LENGTH OF TIME ON STROKE UNIT	Days		**Dysphasia:**	1. yes ☐	2. no ☐
DRUGS ON ADMISSION	1.	2.			3.
	4.	5.			6.
	7.	8.			9.
DRUGS ON DISCHARGE	1.	2.			3.
	4.	5.			6.
	7.	8.			9.
TYPE OF STROKE	1. Ischaemic ☐	2. Haemorrhagic ☐			3. Cardio – embolic ☐
INTERVENTIONS DURING ADMISSION	1. Carotid Endarterectomy ☐	Neurosurgery – Hemi-craniectomy ☐			Thrombolysis ☐
PAST MEDICAL HISTORY	1. Stroke ☐	2. Ischaemic heart disease/angina/coronary artery disease/MI ☐			3. Diabetes mellitus ☐
	4. Peripheral arterial disease ☐	5. AF ☐	6. Hypertension ☐		7. Carotid stenosis ☐
ALCOHOL	1.More than recommended units for gender per week ☐	2. Recommended units per week for gender ☐	3. No alcohol at all. ☐		
SMOKING STATUS	1. Never ☐	2. Past ☐	3. Current/quit recently ☐		Carbon dioxide at discharge:

				Carbon dioxide at follow-up:
Knowledge of stroke and perception of risk of future vascular events at RECRUITMENT				
Do you think you are at risk of a future stroke?		1. yes ☐	2. no ☐	3. don't know ☐
Do you think you are at risk of a future heart attack?		1. yes ☐	2. no ☐	3. don't know ☐
Do you think you have any risk factors for future stroke or heart disease?		1. Yes ☐ **If yes what are they?**		2. no ☐
What caused your stroke?	1.		2. don't know ☐	
What type of stroke did you have?	1. infarct/clot ☐	2. bleed ☐	3. don't know ☐	4. other ☐
Do you think you have received adequate information about your stroke?	1. yes ☐		2. no ☐	
What lifestyle changes if any do you plan to make? Choose from this list.	1. None ☐	2. stop smoking ☐	3. more exercise ☐	4. less alcohol ☐
	5. lose weight ☐	6. low fat diet ☐	7. less salt ☐	8. take medications ☐
Knowledge of stroke and perception of risk of future vascular events at 3 MONTH FOLLOW-UP				
Do you think you are at risk of a future stroke?		1. yes ☐	2. no ☐	3. don't know ☐
Do you think you are at risk of a future hear attack?		1. yes ☐	2. no ☐	3. don't know ☐
Do you think you have any risk factors for future stroke or heart disease?		1. Yes, ☐ **if yes what are they?**		2. no ☐
What caused your stroke?	1.		2. don't know ☐	
What type of stroke did you have?	1. infarct/clot ☐	2. bleed ☐	3. don't know ☐	4. other ☐
Do you think you have received adequate information about your stroke?	1. yes ☐		2. no ☐	
What lifestyle changes, if any, have you made since your stroke? Choose from this list.	1. none ☐	2. stopped smoking ☐	3. more exercise ☐	4. less alcohol ☐
	5. lost weight ☐	6. low fat diet ☐	7. less salt ☐	8. taken medications ☐

Physiological monitoring								
BP	Discharge	Follow-up	**WEIGHT**	Discharge	Follow-up	**Hip/Waist**	Discharge	Follow-up
BM	Discharge	Follow-up	**HbA1c**	Discharge	Follow-up	**Total Cholesterol**	Discharge	Follow-up
CRP	Discharge	Follow-up	**Creatinine**	Discharge	Follow-up	**Homocysteine**	Discharge	Follow-up
SBP on admission			**Cognition/ MMSE**	Discharge	Follow-up	**New event in 3 months**	Yes	No
Drugs at follow-up		1.		2.		3.		
		4.		5.		6.		
DESTINATION AT DISCHARGE				**Follow-up date:**				
CVD risk score at discharge:				**CVD risk score at follow-up:**				

Appendix 5: Intervention Proforma

Secondary stroke risk score:		
Lifestyle Modifications	**Intervention**	**Initial when completed**
Smoking	1. Smoking cessation advice re: NHS systems to aid quitting.	
	2. Contact numbers for H&F smoking cessation team.	
	3. Written information on smoking cessation	
	4. Risk reduction score for smoking cessation: 20%	
Medication taking	1. Verbal information about individual drugs prescribed	
	2. Relate individual drug prescribed to risk factors for stroke and secondary prevention	
	3. Written information on medication taking	
	4. Aspirin reduces risk of further ischaemic stroke by 25%	
	5. Discuss specific secondary stroke prevention medications	
	• Blood pressure medications	
	• Statins	
	• Antiplatelets/Anticoagulants	
	• Diabetes medicines	
Low salt diet	1. Information about how salt affects health and BP	
	2. Provide written information on salt and the benefits of salt reduction	
	3. Salt reduction in the diet may help reduce BP which will reduce the risk of future stroke and vascular events.	
Low fat diet	1. Low fat diet may help weight loss and reduce cholesterol levels	
	2. Provide written information on low fat diet	
	3. Provide with a low fat , low cholesterol diet sheet	
	4. Explain how low fat healthy diet can reduce the risk of future stroke and vascular events	

Cholesterol Target =	5. Cholesterol reduction reduces the risk of future stroke and vascular events by %.	
Exercise	1. Exercise can aid weight loss	
	2. Exercise can help the heart muscle to gain strength	
	3. Provide written information on exercise	
Blood pressure Target =	1. By reducing your BP by 5-10mmgh you will reduce your risk of future stroke and vascular events by up to 23%. 2. Give written information on BP and stroke prevention.	
Alcohol	1. Reduce alcohol intake to the correct units for gender in order to reduce risk 2. Alcohol affects BP and with extreme alcohol intake it can affect the thickness of the blood **3.** Give written information on alcohol in stroke.	
Follow-up after stroke	Reiterate the importance of seeing the specialist in follow-up to ensure secondary prevention measures are working to reduce the risk of future stroke and other vascular events.	