Cost-effectiveness review of blood pressure interventions

A Report to the Blood Pressure System Leadership Board

November 2014

Final Report

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Executive Summary

Context

High blood pressure is one of the key risk factors contributing to premature death and disability in England.

Public Health England (PHE) established the Blood Pressure Systems Leadership Board (BPSLB), bringing together partners across national and local government, the health system, voluntary sector and academia, to develop a system-wide initiative to tackle high blood pressure. In developing this work the BPSLB has taken a systematic approach to considering the cost effectiveness of selected policies and interventions to inform the way forward.

Optimity Matrix was commissioned by PHE to support the BPSLB; specifically to deliver a short assessment of the cost effectiveness of selected interventions. A sub-group of the BPSLB was established to steer the work and work collaboratively with Optimity Matrix.

Aims & Objectives

The overall aim of the Optimity Matrix project is:

> To support the BPSLB by delivering a cost effectiveness analysis of interventions to tackle raised blood pressure.

Approach

The project was delivered collaboratively with a sub-group of the BPSLB.

Scope

The project scope sought to cover as wide a range of interventions to tackle raised blood pressure, relevant to England, as possible – covering prevention, detection and management. While the finer details of the scope were determined iteratively in partnership with the BPSLB sub-group, and fuller details are presented in the following chapters, the project scope is summarised below.

Consideration of interventions of key interest to the BPSLB and the available evidence base appropriate for modelling, resulted in the following system-wide interventions being modelled:

1. national dietary salt reduction.
2. healthy behaviour/lifestyle advice & change: diet, alcohol, exercise, and obesity.
3. blood pressure testing (general practice, community pharmacy, secondary care & community settings).
4. effective management of diagnosed raised blood pressure in primary care.

5. approaches to improving drug therapy adherence.
6. support for self-management.
7. Education & awareness raising initiatives.

These interventions were modelled in the following sub-populations in England.

- people with un-diagnosed pre-hypertension and hypertension.
- people with diagnosed pre-hypertension.
- people with diagnosed hypertension.

Methods

The key methodological components of the project were as follows.

- call for evidence to BPSLB and partners.
- workshops with BPSLB sub-group.
- targeted searches of relevant websites and bibliographic databases.
- selection of evidence sources appropriate for cost effectiveness modelling.
- data extraction from evidence and transformation for modelling.
- development of simple cost effectiveness model.
- cost effectiveness, burden and scenario modelling analysis.
- sensitivity analysis of model findings.

The following main measures were estimated by the model for individual interventions and scenarios, over four time horizons (1 year, 5 years, 10 years, 40 years):

- CVD (i.e. CHD, stroke, vascular dementia, kidney disease) mortality and disease events.
- NHS and social care costs.
- Incremental cost effectiveness ratios (ICERs).
- Burden of disease for raised blood pressure.

Findings

NHS cost of high blood pressure

Based on a brief literature review it is estimated that the total NHS cost of the burden of disease resulting from hypertension in England is £2.1bn (2014 prices). This estimate includes costs attributed to CHD (£750m), stroke (£850m), vascular dementia (£320m), and kidney disease (£220m). These are considered to be conservative estimates, as they exclude the costs of managing blood pressure as a condition in its own right.

Evidence review

83 studies were supplied by the BPSLB and its partners, and in addition, 11 studies were identified from relevant NICE guidance for initial study screening. From these, 72 were selected for full text review and as a result 18 selected for inclusion. 13 studies were added as a result of

additional literature searches. Consequently, a total of 31 studies were included as effectiveness evidence for development of the economic model.

In terms of setting, of these studies, 11 were multinational, 11 were from the US, and 4 the UK; and in terms of study type, 9 were systematic reviews, 8 observational studies, 7 RCTs, and 5 economic analyses. The included studies were considered to be high quality.

In terms of study population, 16 were in the general adult population and 15 were in adults diagnosed with high blood pressure.

Based on the category of intervention, the number of studies used in the model is as follows:

- national dietary salt reduction – 10 studies
- healthy behaviour/lifestyle advice & change: diet, alcohol, exercise, and obesity – 4 studies
- blood pressure testing (general practice, community pharmacy, secondary care & community settings) – 4 studies
- effective management of diagnosed raised blood pressure in primary care – 4 studies
- approaches to improving drug therapy adherence – 2 studies
- support for self-management – 6 studies
- Education & awareness raising initiatives – 1 study

Clearly the number (and quality) of studies are not necessarily evenly distributed across the modelled interventions; and in some cases the fit of studies to the interventions of interest has limitations.

The key effectiveness findings can be summarised as follows:

- There is good evidence that national dietary salt reduction interventions contributes a great deal to improvements in blood pressure outcomes, mostly from systematic reviews and economic analyses.
- Effectiveness of interventions aimed at identifying people with high blood pressure varies according to the setting of the intervention.
- Interventions that are aimed at improving a primary care systems management of high blood pressure were effective at controlling the blood pressure of patients.
- The interventions that increased an individual's capacity to self-manage their blood pressure were quite effective in achieving good blood pressure control.

Cost effectiveness

Based on commonly accepted thresholds of value for money for health investments, the key findings in relation to cost effectiveness are that:

- The ICERs for many of the included interventions increase substantially over longer time horizons.
- National interventions to reduce salt in food are cost saving across all time horizons, both in the general adult population and in adults diagnosed with high blood pressure.
- In the general adult population, health lifestyle changes are potentially cost-effective at 10 years and cost saving over the lifetime time horizon. Testing is more cost effective in GP and Pharmacy settings rather than in community settings. Education and awareness campaigns are cost effective over a lifetime time horizon.

- In adults with diagnosed high blood pressure health, lifestyle improvement interventions become cost effective within 5 years, and potentially cost saving within 10 years. Drug therapy adherence interventions become cost saving over a lifetime but are not cost effective in shorter time horizons. Similarly, self-management support programmes are only cost effective over the lifetime time horizon.
- Surprisingly primary care management programme interventions (over and above standard care) are not cost-effective at any time horizon. This appears to be due to their high cost in the studies found.
- Sensitivity analysis found that the vast majority of the ICER findings were robust when the costs and benefits were varied.

Implementation scenarios

Modelling of the impact of three implementation scenarios specified by the BPSLB found that in England, over 10 years:

1. A 5mmHg reduction in average population blood pressure would result in a gain of 45,000 QALYs and 140,000 life years, and a reduction of £800m in health care costs and £60m in social care costs.
2. A 15% increase in the proportion of adults who have had their high blood pressure diagnosed would result in a gain of 7,000 QALYs and 22,000 life years, and a reduction of £112m in health care costs and £11m in social care costs.
3. A 15% increase in the proportion of adults on treatment controlling their blood pressure to 140/90mmHg or less would also result in a gain of 7,000 QALYs and 22,000 life years, and a reduction of £112m in health care costs and £11m in social care costs.

Discussion

As set-out above in relation to methods, our project has entailed the development of a relatively simple cost effectiveness model, based on selected effectiveness evidence reporting blood pressure outcome metrics. While the work is robust to pragmatic standards and is ‘fit for purpose’, consideration of the summarised findings above needs to be given in the wider policy and delivery context and the stated technical limitations of the work.

Firstly, the categorisation of intervention types was developed before a full assessment of the literature had been undertaken. Thus, while the interventions assessed in the studies on which the modelling was based correspond as closely as possible to all relevant intervention categories, the limitations in the precision of this fit should be borne in mind.

For instance, the evidence base for the modelled impact of national dietary salt intake reduction is based on the general assumption that this can be achieved by a number of alternative interventions/mechanisms, including food industry product agreements and/or personal behaviour change in salt consumption behaviour by individuals. A more detailed description of the studies is presented in the appendices.

Secondly, the quantity of studies available for modelling varies across categories of intervention. For some categories of intervention, the literature we were able to consider was much more extensive than for others. Where a number of interventions are applicable to an intervention category, readers may be reassured that uncertainty around cost-effectiveness has been captured. At the same time, given the restrictions of our evidence gathering, we are unable to draw firm conclusions about the representativeness of the evidence base allocated to the different categories.

There are some aspects to the evidence base which need to be taken into account when interpreting the cost-effectiveness results. One is the design of individual studies, of which further details are given in appendices. The second is the generalisability of results to the decision maker's own context. For example, there may be reason for supposing that it is possible to deliver the more costly interventions we have identified using fewer or less expensive resources. It should also be noted that the current evidence base tends to focus on more established interventions than minor changes to established protocols. To assist the reader in interpreting the cost-effectiveness results, the tables below report the costs and effectiveness separately from the ratio. Within each intervention category, variation in the cost per QALY ratio will depend both on differences in unit costs (cost per recipient of the intervention) and in effectiveness expressed in terms of increased numbers controlling and the population targeted.

In both groups of interventions (all adults and adults with hypertension), our findings suggest that interventions to control blood pressure can be highly cost-effective and, in some cases, generate cost savings well in excess of their intervention costs. This is particularly the case for interventions to reduce dietary salt consumption, where wide variation was found in cost-effectiveness estimates; some studies suggested a cost-effectiveness ratio around the reference points used by NICE of £20,000 to £30,000 per QALY while others suggested that cost savings would be possible, and others gave cost per QALY ratios well above the normally accepted range. Variation between studies was particularly noticeable in the Category 6 (effective primary care management of hypertension), category 7 (drug therapy adherence interventions) and category eight (support for self-management). The study which gave the highest cost-effectiveness ratio in the effective primary care management category investigated an intervention which was intended to address a range of risk factors. Focussing solely on blood pressure-related benefits is therefore likely to underestimate the benefits of the programme as a whole.

For interventions among all adults, the testing categories showed wide variation in cost-effectiveness from cost saving to a cost per QALY well above the upper end of the range normally considered by NICE. Due the limited evidence available, the least cost-effective intervention across the testing categories was based on a study of testing in dental surgeries and therefore should be regarded with caution.

Conclusion

Consistent with other evidence, this project suggests that substantial improvements in health can be made through a range of blood pressure interventions across the system.

While our work has acknowledged limitations, for instance on precision of fit of some available evidence to the interventions of interest, it appears that most interventions considered are cost effective over the longer term. Also, savings result in both the health care and social care sectors.

1.0 Introduction

1.1 Context

High blood pressure is one of the key risk factors contributing to premature death and disability in England.

Public Health England (PHE) established the Blood Pressure Systems Leadership Board (BPSLB), bringing together partners across national and local government, the health system, voluntary sector and academia, to develop a system-wide strategy to tackle high blood pressure. In developing this strategy the BPSLB has taken a systematic approach to considering the cost effectiveness of selected policies and interventions to inform the way forward.

Optimity Matrix was commissioned by PHE to support the BPSLB; specifically to deliver a short assessment of the cost effectiveness of selected interventions. A sub-group of the BPSLB was established to steer the work and work collaboratively with Optimity Matrix.

1.2 Cost of raised blood pressure to the NHS

As part of the project, estimates were made of the costs of hypertension to the NHS. This was done by estimating the proportion of total NHS costs for the main hypertension-related conditions considered in this report, namely coronary heart disease (CHD), stroke, vascular dementia (VaD) and chronic kidney disease (CKD), attributable to hypertension.

These estimates were not based on a systematic review of the evidence, but were drawn from what were considered to be the best available sources given the constraints of our searches. The resulting cost estimates should therefore be treated with caution. As our estimate gives the annual NHS costs for CHD, stroke, VaD and CKD, it is a conservative estimate of the costs associated with hypertension as it excludes costs purely for the management of hypertension in the absence of any of these four conditions. For example, it has been estimated that hypertension-related medication costs amounted to £1 bn in 2006 and that hypertension accounted for 12% of primary care consultation episodes[1]. Including all these costs would involve some double counting since some will be incurred amongst those with disease consequent upon hypertension. For the purposes of this exercise, we have not attempted to separate out costs for managing hypertension in the absence of other conditions.

The NHS costs associated with the four conditions attributable to hypertension for England are estimated to be £2.1 bn at 2014 prices.

We also explored the option of using the model to estimate the burden of disease. However, several issues prevented this method producing a useable estimate. The model is designed to be an incidence model, calculating new cases of disease as a result of blood pressure. This excludes existing cases of CHD, Stroke, VaD and CKD as our interventions are designed to

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[1] http://www.nice.org.uk/news/press-and-media/nice-consults-on-new-hypertension-draft-quality-standard

prevent, rather than treat, these diseases. However, we estimate the numbers of new future cases and related costs. These estimates are presented in an Annex to this note.

CHD

The total burden per year for CHD in the UK has been estimated by the British Heart Foundation (BHF)[2] to be around £1.8 bn in 2009 based on the 2012 European Cardiovascular Disease Statistics[3] figure of €2 bn. This equates to approximately £2 bn at 2014 prices in the UK, or £1.7bn for England (adjusting for the share of the England population aged 18+ in the corresponding UK population). If we assume that 45% of this is attributable to hypertension[4], it is estimated that around £750 mn healthcare costs per year are caused by hypertension-related CHD.

Stroke

Based on the same source used for CHD, the BHF estimate that total NHS costs for stroke in the UK in 2009 were similar to those associated with CHD, at around £1.8 bn. For the purposes of consistency, we use this figure rather than the higher figure of £2.8 bn in NHS costs quoted by the National Audit Office[5] and also cited by NICE[6]. We therefore also estimate a cost of £1.7 bn in England at 2014 prices. As around 50% of strokes are attributed to hypertension[7], the economic value of the hypertension-related stroke burden per year to the health service is put at £850 mn.

Vascular Dementia

The overall burden of disease to the UK from dementia is around £4 billion[8][9]. We estimate that 17% of dementia is vascular dementia, giving an estimated cost to the NHS of £750 million per year. The cause of vascular dementia is overwhelmingly from stroke[10]. As around half of all strokes are caused by hypertension, we make an assumption here that half of the cases of vascular dementia are caused by hypertension. On this basis, the annual cost to the NHS of hypertension-related vascular dementia in England is around £320 mn.

Chronic Kidney Disease

The Wanless report estimated that NHS spending for the UK on late stage kidney disease might reach over £800mn by 2010/11[11]. Taking account of increased costs since then, and adjusting to England estimates, spending in England might be as much as £750 mn. It has been estimated that around 25% of end stage kidney disease is attributable to hypertension[12]. We therefore estimate that approximately £200 mn spent by the NHS in England is due to hypertension.

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[2] http://www.bhf.org.uk/research/heart-statistics/economic-costs.aspx
[3] http://www.escardio.org/about/Documents/EU-cardiovascular-disease-statistics-2012.pdf
[4] http://www.who.int/mediacentre/factsheets/fs317/en/
[5] http://www.nao.org.uk/wp-content/uploads/2005/11/0506452.pdf
[6] http://www.nice.org.uk/guidance/qs2/resources/qs2-stroke-cost-impact-and-commissioning-assessment2
[7] http://www.world-heart-federation.org/cardiovascular-health/stroke/stroke-and-hypertension/
[8] National Audit Office (2007) Improving services and support for people with dementia Available at: http://www.nao.org.uk/report/improving-services-and-support-for-people-with-dementia/ Last accessed: 23/10/14
[9] Value uprated to £2014. Original value £3.3 billion.
[10] http://www.nhs.uk/Conditions/vascular-dementia/Pages/Causes.aspx
[11] http://si.easp.es/derechosciudadania/wp-content/uploads/2009/10/4.Informe-Wanless.pdf
[12] American Kidney Fund (2012) Kidney Disease Statistics factsheet

1.3 Aims & Objectives

The overall aim of the Optimity Matrix project is:

> To support the BPSLB by delivering a cost effectiveness analysis of interventions to tackle raised blood pressure.

Specific objectives are to:

1. define and agree the blood pressure population interventions of interest;
2. work with the BPSLB sub-group to identify and review key sources of evidence, and where necessary undertake supplementary evidence searches;
3. design a simple cost effectiveness model able to consider a wide range of population and individual intervention types, and populate this with evidence selected from the evidence review; and
4. undertake and report the analysis from the model.

1.4 Methods

The key methodological components of the project were as follows.

- call for evidence to BPSLB and partners.
- workshops with BPSLB sub-group.
- targeted searches of relevant websites and bibliographic databases.
- selection of evidence sources appropriate for cost effectiveness modelling.
- data extraction from evidence and transformation for modelling.
- development of model.
- cost effectiveness, burden and scenario modelling analysis.
- sensitivity analysis of model findings.

1.5 Scope

The project scope sought to cover as wide a range of interventions, relevant to England, as possible. While the finer details of the scope were determined iteratively in partnership with the BPSLB sub-group, and fuller details are presented in the following chapters, the project scope is summarised below.

1.5.1 Interventions

A number of system-wide interventions were included for consideration. This initial list was further refined and categorised, as explained below. The interventions were:

1. national dietary salt reduction.
2. healthy behaviour/lifestyle advice & change: diet, alcohol, exercise, and obesity.
3. blood pressure testing (general practice, community pharmacy, secondary care & community settings).
4. effective management of diagnosed raised blood pressure in primary care.
5. approaches to improving drug therapy adherence.
6. support for self-management.
7. Education & awareness raising initiatives.

1.5.2 Populations

The project sought to consider the following sub-populations in England.

- people with un-diagnosed pre-hypertension and hypertension.
- people with diagnosed pre-hypertension.
- people with diagnosed hypertension.

1.5.3 Time horizons

Interventions to tackle raised blood pressure deliver short-term, medium-term and long-term health impacts. Consequently their respective cost effectiveness will vary over different time horizons, and the following four time horizons have been examined to illustrate these temporal impacts.

- 1 year.
- 5 years.
- 10 years.
- 40 years (lifetime).

1.5.4 Outcome measures

Outcome measures include:

- CVD (i.e. CHD, stroke, vascular dementia, kidney disease) mortality and disease events.
- NHS and social care costs.

1.6 Report structure

The remainder of the report is structured as follows:

- Chapter 2 outlines the methods adopted in collecting and reviewing evidence, and designing the cost effectiveness model.
- Chapter 3 reports the incorporation of the evidence and findings of the cost effectiveness modelling.
- Chapter 4 reports the outcomes of selected implementation scenarios.
- Chapter 5 discusses the overall findings.
- Chapter 6 outlines the conclusions.

2.0 Methods

This Chapter presents the methods adopted for the identification and reviewing of evidence, and the development and functionality of the economic model.

2.1 Evidence review

2.1.1 Introduction

The following activities were undertaken to examine the existing evidence on the effectiveness and cost effectiveness of interventions to tackle high blood pressure.

- Defining the characteristics of relevant studies and other potential evidence sources.
- Evidence search and collection:
  - Request for evidence to BPSLB and partners.
  - Search of relevant websites (NICE and Cochrane)
  - Filling of evidence gaps through targeted literature searching.
- Study selection.
- Data extraction.

Summaries of the methods adopted are outlined in the following sections.

2.1.2 Search strategy

A pragmatic search method was utilised to source evidence from internal PHE teams and specialists and relevant stakeholders identified by PHE. The components of this pragmatic search strategy are as follows.

Request for evidence

A 'Request for Evidence' was sent out to identified individuals from the audiences mentioned above, and via three workshops held with the BPSLB sub-group.

Website searching

Searches were conducted on the websites of the National Institute for Health and Care Excellence (NICE) for relevant guidance as well as on the Cochrane Library website for relevant systematic reviews. The references for effectiveness and cost-effectiveness evidence underpinning NICE evidence were searched for relevant studies using the study titles only. All relevant studies identified were added to those identified from the evidence call.

Electronic database search

Where evidence gaps existed following the evidence call, a narrow electronic database search was conducted to identify relevant material. This database search was limited to Medline and was conducted using simple structured search terms, with limits set for language and publication date. Titles and abstracts for the first 300 hits from the search, ranked according to relevance, were screened using the inclusion/exclusion criteria. Relevant full texts of studies included at this stage were obtained for full text screening as described below.

2.1.3 Study selection

A comprehensive set of inclusion and exclusion criteria consistent with the project scope were applied in the evidence review.

The titles and abstracts of all publication citations retrieved from the searches were screened by one reviewer using the inclusion and exclusion criteria. The full texts of publications selected from the searches as well as the texts obtained from the evidence call were reviewed by one reviewer against the same inclusion and exclusion criteria, with the opinion of a second reviewer sought in borderline cases.

Papers selected through the process of full text review were then subject to data extraction and quality assessment, as described later in this chapter. The inclusion and exclusion criteria are summarised below.

Date

Studies were included if they were published between 2005 and 2014. However, where relevant literature about an intervention was not identified for the studies available for this time period, studies published earlier were utilised.

Countries and territories

Studies were included if they were conducted in any OECD country. These include: Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Republic of Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, and the United States of America.

Language

Only studies in English were included.

Blood pressure interventions

Consistent with the project's scope and based on consideration of policy relevant interventions, studies of interventions related to the prevention of, identification of new cases, or management of high blood pressure, consistent with the working definition of high blood pressure adopted in the project, were included in the evidence review.

In addition, the relevance of interventions to the following two sub-populations was considered.

1. **Interventions targeted at all adults/general population –** These include interventions aimed at preventing the onset of high blood pressure, identification of individuals with high blood pressure and raising awareness about high blood pressure.
2. **Interventions targeted at individuals with diagnosed high blood pressure –** These include interventions the management of high blood pressure.

As a result the following two lists of interventions were agreed as the structure for evidence collation and review, and modelling.

Table 1: Intervention Categories – All adults

All adults: 'normal BP' & undiagnosed hypertension					
Category No	**Intervention title**	**Mode**	**Setting**	**Eligible Population**	**Actors**
1.	National dietary salt reduction	Reduced salt in food products and personal diets	Home and commercial products	All	Industry & individuals
2.	Healthy lifestyle advice and change	Improved lifestyle choices and brief advice to encourage behaviour change	Home, commercial, primary and secondary healthcare	All	Individuals, primary and secondary care clinicians
3. a. i	Testing	Opportunistic (including reference to NICE/QOF standards)	General practice	All attendees	General practice clinician
3. a. ii	Testing	Opportunistic (including reference to NICE standards)	Community pharmacy	All users	Pharmacy staff
3. b	Testing	Opportunistic (including reference to NICE/QOF standards)	Secondary care	All attendees	Secondary care clinicians
3. c	Testing	Opportunistic (including reference to NICE/QOF standards)	Community venues (e.g. place of work, sports club, W.I., faith venue)	All attendees	Outreach clinicians
3. d	Testing	Personal choice/purchased monitor or check	1.Home 2.Commercial setting	All	Individual
7.	Education & awareness raising initiatives	Patient & public networks and groups Media/marketing	All physical settings Media	All	PHE 3rd sector Commercial

Table 2: Intervention categories – Adults with diagnosed hypertension

Adults with diagnosed hypertension					
Category No	**Intervention title**	**Mode**	**Setting**	**Eligible Population**	**Actors**
1.	Dietary salt reduction	Reduced salt in food products and personal diets	Home and commercial products	All	Industry & individuals
2.	Healthy lifestyle advice and change	Improved lifestyle choices and brief advice to encourage behaviour change	Home, commercial, primary and secondary healthcare	All	Individuals, primary and secondary care clinicians
4.	Effective primary care management of hypertension	BP care plan/pathway in line with NICE/ professional guidelines influenced by QOF	General practice & community pharmacy	All diagnosed	Primary care clinicians
5.	Drug therapy adherence interventions		General practice & community pharmacy	All treated	Primary care clinicians & pharmacy staff
6.	Support for self-management	Defined programmes	Home	All treated/ selected	Numerous

In addition, studies of the following types of interventions or aspects of interventions were excluded:

- Interventions evaluating the effectiveness of medications
- Interventions comparing medication to another intervention type
- Interventions evaluating management of cardio-vascular events

Population

Studies that scrutinized blood pressure interventions, provided for and accessible to members of general populations (for preventions and identification interventions) or diagnosed populations (for management interventions) were included.

Study design

Publications of empirical studies or reviews of the effectiveness and cost effectiveness of blood pressure control interventions were included, such as RCTs, experimental, quasi-experimental, observational studies and economic analyses.

Publications of policy, opinion, discussion, and editorial and of non-comparative case-study series were excluded.

Setting

Any setting relevant to the UK public health environment was included in this study. However, some of the interventions we were asked to consider were specific to particular settings; in such cases only studies evaluating these interventions in the specified settings were included.

Outcomes

In light of the project's prime focus on blood pressure as the modifiable risk factor and the consequences of this for the design of the economic model, it was necessary for included studies to report an appropriate blood pressure outcome metric. These include but were not limited to changes in systolic and/or diastolic blood pressure, changes in high blood pressure prevalence and identification rates. Studies that did not have quantified outcomes were excluded.

2.1.4 Data extraction

A data extraction database was designed to capture a comprehensive range of study characteristics, population targeted, country of study, and findings on the effectiveness and cost effectiveness of blood pressure control interventions relevant to the needs of the economic model.

Consistent with the study inclusion criteria summarised above, the following data was extracted:

- Study characteristics: author, year, title of study, country or territory, study design.
- Population characteristics and sample sizes
- Blood pressure intervention type and characteristics
- Setting
- Outcome measure
- Results

2.1.5 Quality assessment

Due to the heterogeneity of the study types included in the model, a structured assessment of the quality of the studies using a standard quality assessment template was not conducted. However, a hierarchy of evidence table was used to establish the level of the quality of the included studies. This hierarchy can be found below.

Table 3: Hierarchy of evidence

Hierarchy of evidence	
Level 1	Systematic reviews and meta-analyses
Level 2	Randomised controlled trials and economic analyses
Level 3	Cohort studies
Level 4	Case-control studies
Level 5	Cross-sectional studies

Adapted from Guyatt 1995[13]

2.1.6 Assignment of evidence to intervention categories

Based on the review and extraction of data from included evidence judgements were made in collaboration with the BPSLB regarding the fit of evidence to the intervention categories, for instance in terms of type of intervention, setting and mechanism of delivery, and professionals or others delivering the intervention. These considerations are noted in the reporting and discussion of findings in the Chapters that follow.

2.2 Economic model & analysis

2.2.1 Introduction

The following sections set out the methods adopted in developing the economic model and associated analyses. In addition, the references used as the basis for the model parameters are set-out in Appendix 1.

2.2.2 Modelling – key features

The aim of the economic modelling was to estimate the cost-effectiveness of the interventions listed in the previous section, using a common methodology. In line with NICE methods, the objective was to assess the impact of each intervention in terms of its costs and cost offsets (savings associated with reductions in disease) as well as morbidity and mortality, these effects being combined to generate quality adjusted life years (QALYs) gained.

The perspective of NHS and Personal Social Services (PSS) costs was adopted, that is, we estimated the offsetting savings in terms of NHS and PSS costs for reductions in diseases attributable to hypertension following increases in the numbers of people whose blood pressure is controlled. The key value-for-money metric we report is the cost per QALY ratio, taking account of intervention costs and cost savings from cases of disease prevented. We assessed

[13] Guyatt GH, Sackett DL, Sinclair JC, Hayward R, Cook DJ, Cook RJ (1995). "Users' guides to the medical literature. IX. A method for grading health care recommendations. Evidence-Based Medicine Working Group". JAMA 274 (22): 1800–4. doi:10.1001/jama.1995.03530220066035. PMID 7500513.

each intervention against a 'do nothing' comparator. Thus, the interventions are treated as being mutually exclusive.

In general, the reference points used by NICE suggest that NHS/PSS expenditure is justified if it buys QALYs at a cost of around £20,000 to £30,000 per QALY gained. When considering the cost-effectiveness of the interventions included in our model, the results can be interpreted in this context. Where cost savings outweigh intervention costs, we report a negative cost per QALY ratio, indicating that the intervention generates both health gains and cost savings and is therefore unambiguously to be preferred over no intervention.

Using the data sources discussed above, we have attributed relevant individual papers to the intervention categories. For some categories of intervention, more than one study was relevant.

Where an intervention category was found not to have any effectiveness evidence in the evidence review, where appropriate, another relevant category has been used as a proxy for the results as shown in the table below.

Table 4– Proxy information for missing intervention categories

Category	Replacement category
General population interventions	
3b – Testing – secondary care	Category 3ai – testing – primary care
3d – Testing – home/commercial setting	Category 3aii – testing – Pharmacy

2.2.3 Basic modelling approach – the decision tree

A whole population approach has been adopted for the cost effectiveness analysis. The project's duration prevented the use of dynamic modelling approaches (simulating the trajectory of the population over time, with risks of disease and mortality applied in each time period depending on the characteristics of the projected future population). Rather, a static economic model was developed, in which a one-off change in blood pressure is converted into a change in disease risk, with costs and benefits projected over time on the basis of assumptions about, for example, average life expectancy and time lags between changes in blood pressure and the occurrence of disease (we return to this in the Discussion section). The economic model can be schematically represented by a decision tree structure, which incorporates chains of probabilities of related events together with the costs and health outcomes associated with those events. In essence, it sets out the way in which the different policy interventions, or the counterfactual (no intervention), affect the intermediate and final outcomes PHE and partners are interested in estimating. The simplified decision tree is shown in Figures 1 and 2.

Figure 1 – Prehypertensive population model (blood pressure measurement between 120/80 mmHg and 139/89 mmHg)

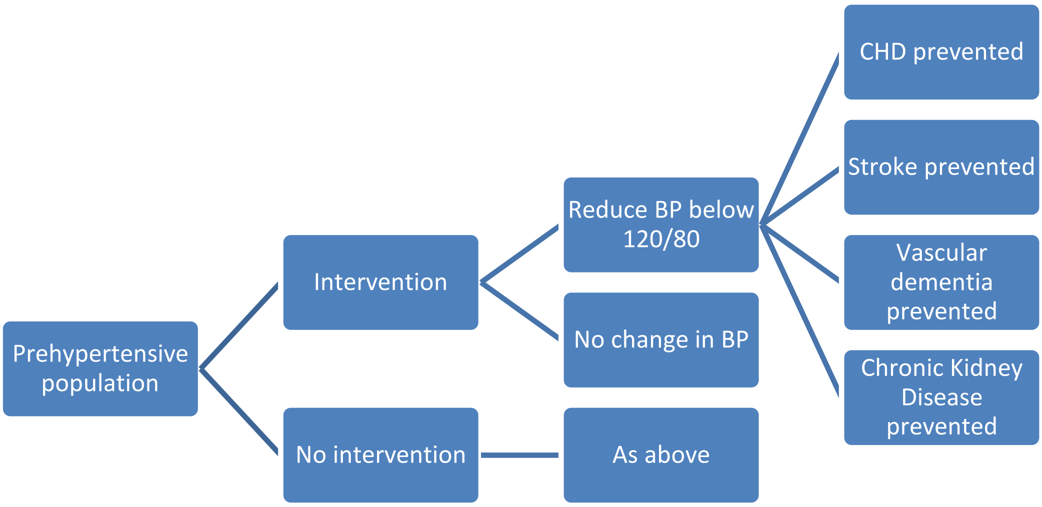
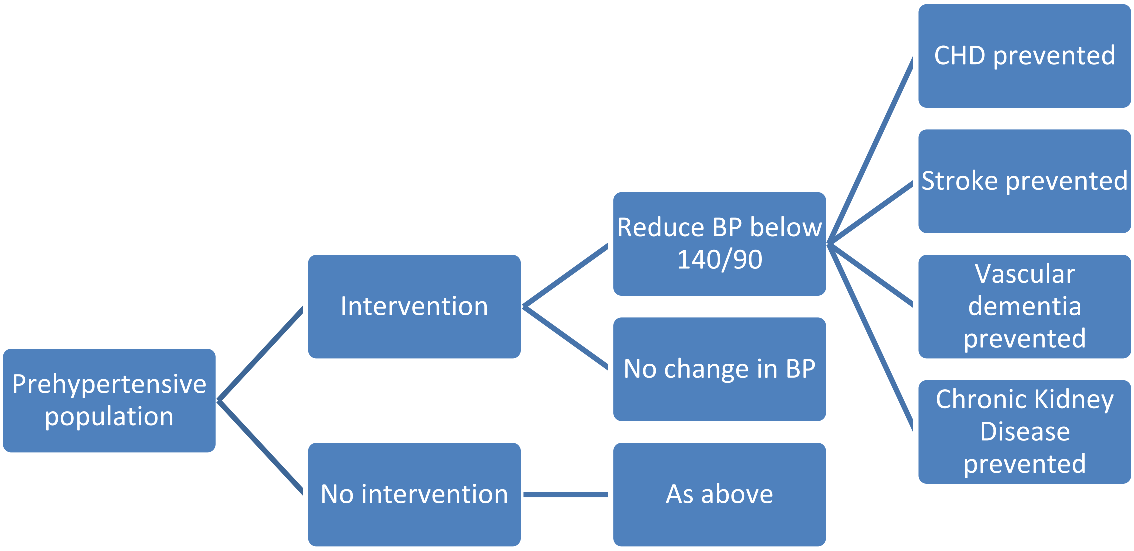


Figure 2 – Hypertensive population model (blood pressure measurement above 140/90 mmHg

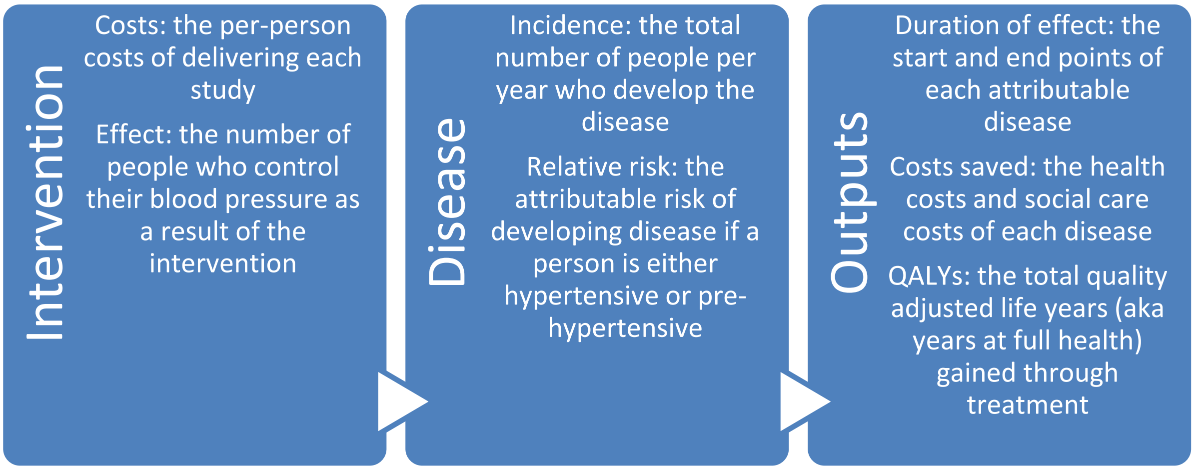


The conceptual model was designed based on the results of the parameter searching and data from the literature provided by PHE.

2.2.4 Model parameters

The outputs of the model, as illustrated by the decision trees above, are reliant on the parameters that underpin the calculations. The relationship between these groups of parameters is illustrated in Figure 3.

Figure 3 – Conceptual relationship between parameters in the model



2.2.5 Model functionality

Population distribution of blood pressure

Estimating the benefits generated from a reduction in blood pressure is key to an accurate representation of the impact on the population, from controlling hypertension. There is evidence that a small change in systolic blood pressure of 2 mmHg is enough to generate changes in risk factors for coronary heart disease and that disease risk may vary continuously with changes in blood pressure.

However, adopting continuous treatment of risk revealed several issues. Firstly, our intention in this model was to be as comprehensive as possible with regards to interventions included. Interventions for which outcomes are expressed in terms of people reaching their blood pressure goal or being screened tend to report their results in terms of a binary outcome i.e. people either have high blood pressure or do not have high blood pressure. Where intervention studies do not give their output in terms of improving blood pressure measurement (a continuous variable), it would not be possible to include these interventions in a model based on a continuous approach.

Secondly, while the risk function for CHD will respond to small changes in blood pressure of as little as 2 mmHg, the other diseases, especially vascular dementia and kidney disease, require greater reductions in blood pressure before they trigger disease savings. This leads to problems where interventions don't reach the threshold level of blood pressure change. For example, if the minimum change in blood pressure required to have an impact on kidney disease is a systolic blood pressure change of 5-10 mmHg, a typical salt intervention, which generates a reduction of only 2-4 mmHg, would yield no health benefits. Under a threshold approach, this effect size can be converted into an estimate of the numbers of people controlling their blood pressure, so that the effect of small changes in systolic and diastolic blood pressure can be calculated.

For the purposes of this project, we have therefore employed a threshold approach. This calculates the number of people in the population who control their blood pressure as a result of an intervention. The benefits of this are that all interventions can be compared on the same basis, and all desired diseases can be modelled. Changes in the controlled population are converted into changes in the occurrence of disease in the population, using information on relative risks of disease for the different levels of severity of hypertension and the proportions of the population in each category of hypertension severity.

As there is a significant difference in risk for the general population (including pre-hypertensives) and the hypertensive population on its own, the model was split into two component parts. One component looked at the effects of reducing blood pressure below 120/80 mmHg; this has been applied to the pre-hypertensive and hypertensive populations and looks at population salt, lifestyle, screening and media campaign interventions. The other component generates the benefits of blood pressure control among those with diagnosed hypertension above 140/90 mmHg who reduce their blood pressure below this threshold through targeted salt, lifestyle, adherence and monitoring interventions. We refer below to the two different components of the model as the 120/80 model and the 140/90 model, respectively.

Disease probabilities

Disease probabilities are calculated for each model in order to accurately capture the risk of disease in each population group. Using the individual annual risk of disease, calculated from the annual incidence of disease in the population, and relative risks of disease for each blood pressure category, the model calculates the incremental annual probability of developing each disease, entirely attributable to hypertension.

The 120 model is based on disease risks across the whole population and uses a population distribution by stage of hypertension of 39% pre-hypertensive, 18.3% stage 1 hypertensive and 12.2% stage 2+ hypertensive (with 30.5% of the population being normotensive). This breakdown can be seen in Figure 4. Definitions of the categories of hypertension are given in Box 1.

Box 1: Definitions of stages of hypertension

Normotensive (N-T) : <=120/80
Pre-hypertensive (P-HT) : >120/80, <=140/90
Stage 1 hypertension (S1 HT) : >140/90, <=160/100
Stage 2+ hypertension (S2+ HT) : >160/100

Figure 4 – Population distribution of blood pressure

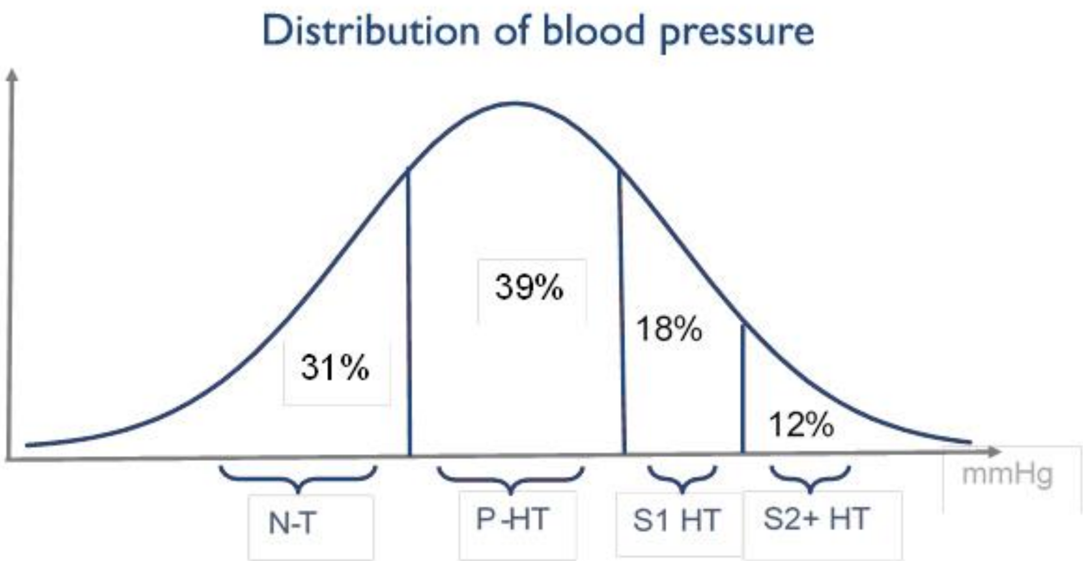


Table 5– Disease probability calculations for 120/80 model

Description	Individual annual risk of disease	RR for BP <120/80 mmHg	RR for BP 120/80 - 139/89 mmHg	RR for BP 140/90-159/99 mmHg	RR > 160/100 mmHg	Weighted average risk of disease if >120/80 mmHg	Probability of disease if <120/90 mmHg	Incremental probability of disease if hypertensive
P(CHD)	0.002628	1	1.31	1.70	1.98	0.29%	0.19%	0.10%
P(Stroke)	0.001585	1	1.00	1.35	1.52	0.17%	0.14%	0.03%
P(VaD)	0.002890569	1	1.03	1.05	1.05	0.29%	0.28%	0.01%
P(CKD)	0.00109	1	1.53	2.08	3.14	0.13%	0.07%	0.06%

The 140 model is based on the risks experienced by those with blood pressure above 140/80 mmHg and uses a split of 60% stage 1 hypertensive and 40% stage 2+ hypertensive.

Table 6– Disease probability calculations for 140/90 model

Description	Individual annual risk of disease	RR for BP <120/80 mmHg	RR for BP 120/80 - 139/89 mmHg	RR for BP 140/90 - 159/99 mmHg	RR > 160/100 mmHg	Weighted average risk of disease if >140/90 mmHg	Probability of disease if <140/90 mmHg	Incremental probability of disease if hypertensive
P(CHD)	0.002628	1	1.31	1.70	1.98	0.38%	0.21%	0.17%
P(Stroke)	0.001585	1	1.00	1.35	1.52	0.19%	0.13%	0.07%
P(VaD)	0.002890	1	1.03	1.05	1.05	0.30%	0.28%	0.02%
P(CKD)	0.00109	1	1.53	2.08	3.14	0.19%	0.07%	0.12%

Full details of the sources of data used to make these calculations can be found in the Appendices.

Calculation of effect

The effect of an intervention is calculated by transforming its blood pressure change outcome metrics to represent the number of people moving over the threshold from uncontrolled to controlled blood pressure.

To do this, a number of assumptions are made about the population.

- Blood pressure in the general population follows a normal distribution (bell-curve distribution) as illustrated in Figure 4.
- Effectiveness is not changed by the starting measurement – i.e. that if an intervention has an effect of reducing systolic blood pressure by 5 mmHg, this effect is experienced across all groups in the population, whether starting systolic blood pressure is 120 or 160.

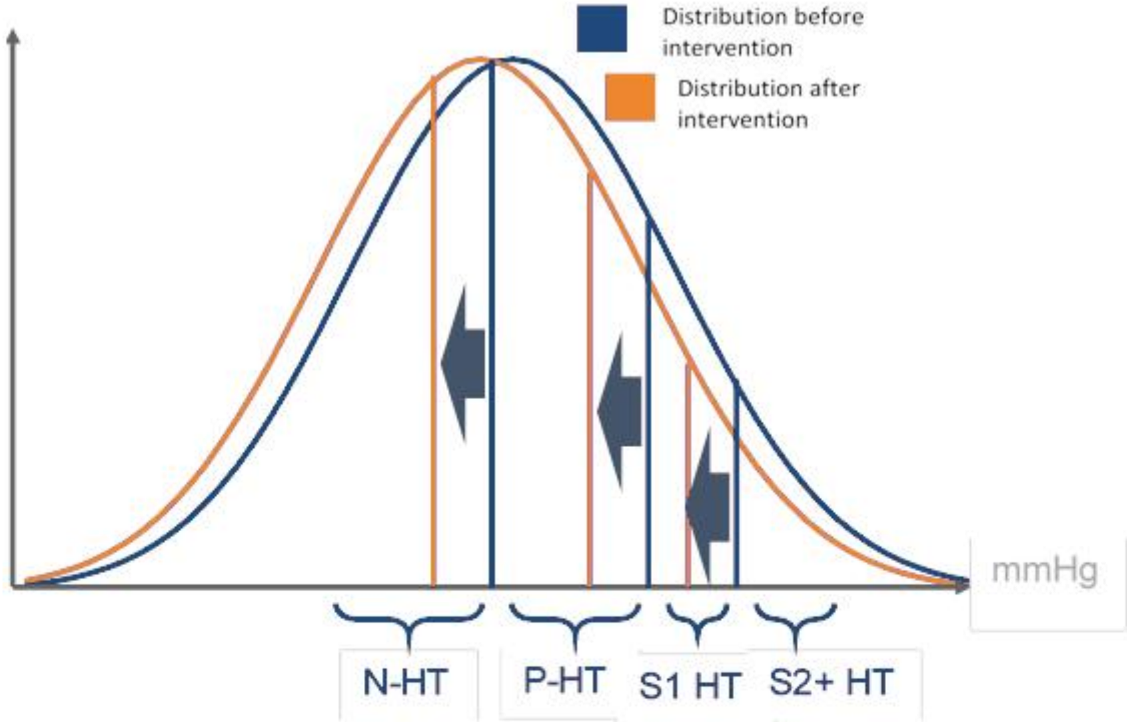
A method used in Joffres et al 2010 is used to calculate the effect of moving over the threshold using studies that give the results in terms of reduction in mmHg but do not give the baseline data we use This method calculates how many people would control their blood pressure purely by using the intervention being investigated (in this case dietary salt reduction). It uses a calculation of the average reduction in mmHg required to control blood pressure, and then calculates a new threshold of control using the difference between the average reduction to control and the reduction achieved in the study. Using the normal distribution, it is then possible to calculate how many people are controlling. The same approach is also used for lifestyle interventions that report reduction in systolic blood pressure.

Variations on this approached are used:

- To estimate how many people would control as a result of testing. Here, the number of people made aware of their hypertensive status is multiplied by the average rate of control in the adult population, which is 11%.

- Where studies that report before and after data are used. Here the normal distribution is used to calculate the number of people controlling both before and after, with the incremental effect measured.

Figure 5 – Population shift in the blood pressure distribution



Calculation of intervention costs

A bottom-up approach was taken to calculate intervention costs for 33 of the 57 interventions. Bottom up costing is a standard approach to estimating unit costs where they haven't been given by the original study, but the description of what was done is comprehensive enough to establish the major cost components. Taking for example, Reid et al (2010), this intervention involved time with pharmacist, nurse, screening for diabetes, and GP review. By comparison, the control arm involved periodic check-ups with the GP. These costs are set out in Table 7.

Table 7– Costing example for Reid et al (2010)

Control	Unit cost	Source	Intervention	Unit cost	Source
10 minute GP visit every 8 weeks	£189.58	PSSRU Unit Costs of health and social care 2013 - page 191 - per minute of patient contact	15 minute patient facing meeting with pharmacist	£86.67	PSSRU Unit Costs of health and social care 2013 - page 180 - per hour of patient contact
			10 minute nurse	£46.94	PSSRU Unit Costs of health and social care 2013 - page 183 - per hour of patient contact

Urine testing strip	£0.06	http://www.valuemed.co.uk/acatalog/urs-glucose-protein-100-strip-pack-supplies.html?gclid=Cj0KEQjwpvufBRCwzp_zyqfkhrcBEiQA8b-SHKWiiPe0rbSY7zKhfx5XLR0JZIQv_4F6LJ1IS0-XMxgaAvJI8P8HAQ
10 minutes GP time	£189.58	PSSRU Unit Costs of health and social care 2013 - page 191 - per minute of patient contact
10 minute pharmacist (non patient-facing)	£46.04	PSSRU Unit Costs of health and social care 2013 - page 180 - per hour
Total	£369.30	
Incremental cost	**£179.72**	

While bottom-up costing allows for local context, they still may miss some additional costs of infrastructure or administration.

For the interventions where a bottom up approach wasn't possible, published costs are used. As the evaluations of salt interventions are based on simulation, rather than direct observation, an average cost given in He et al 2013 is used.

For Robson et al 2014, a top-down approach was used. The total cost of the intervention was given as a grant to provide the service, and this was divided by the number of people who received the intervention to give an approximate cost of £200 per person.

The two interventions within Howard 2010 had unit costs, but they were in Australian dollars. First, these costs were converted to British pounds using historical exchange rates, and then the costs were up-rated to £2013.

2.2.6 Disease risks

In order to correctly estimate the risks of disease sequelae of blood pressure above 120/80 mmHg, PHE was keen to include a wider range of diseases than are usually modelled.

Coronary heart disease and stroke have been modelled extensively (as the summary of existing economic evaluations illustrates); however, this study also considers the disease risk of vascular dementia (VaD) or chronic kidney disease (CKD) which generally have not been included in previous studies.

Coronary heart disease

Coronary heart disease is the leading cause of both morbidity and mortality in the UK. CHD occurs when the heart's blood vessels are blocked by fatty deposits called atheroma, causing narrowing of the arteries and restricting the flow of blood to the heart. Coronary heart disease leads to heart attacks, angina and stroke.

Stroke

Stroke is one of the leading causes of death and disability in the UK. Caused by a disruption to blood flow to the brain, there are two main forms of stroke, ischaemic and haemorrhagic. Both types of stroke can be caused by high blood pressure; however, high blood pressure is more likely to result in haemorrhagic strokes, where a blood vessel bursts and bleeds into the brain.

Vascular Dementia

Vascular Dementia makes up approximately 17% of all dementias, and is caused by problems with blood supply to the brain. This can be caused by the damage that long-term high blood pressure does to the vascular system. Specifically, stroke is a leading cause of VaD either resulting from multiple small strokes, called multi-infarct dementia, or as a result of a single stroke.

VaD is not only a sequel of stroke caused by high blood pressure, but can also be caused by other damage done by hypertension. As VaD can only be comprehensively diagnosed through brain autopsy after death, longitudinal studies that also include autopsy were required.

Chronic Kidney Disease

Chronic Kidney Disease is caused by long term damage to the kidneys that causes them to lose function and eventually fail. There are five stages of the disease, but specialist treatment is not required before stage 4. Previous stages of the disease are managed through the use of blood pressure medication.

Dialysis and kidney transplantation are the main treatments for late-stage Chronic Kidney Disease, both of which incur significant costs and negative health impacts.

2.2.7 Utility

Measures of annual utility are the building blocks of the QALY, or quality adjusted life year, an instrument that calculates how many years of good health are lost as a result of disease (and thus the potential benefits of reducing the risk of disease).

Table 8– Utility values used in model

Disease	Value of utility gain	Comment	Source
Stroke	0.485	Average gain from minor and major stroke, measured using the EQ-5D	Post et al (2001)
Coronary Heart Disease	0.38	Value taken from earlier Optimity Matrix CHD model	MyAction (2014)
Chronic Kidney Disease	0.3	13-24 month follow up post-transplant Time-	Wyld et al (2012)

		Trade Off value	
Vascular Dementia	0.43	Average of EQ-5D values for three dementia states (measured using MMSE)	Andersen et al 2004

2.2.8 Disease costs

Disease costs have been taken from highly referenced academic studies, NHS reference costs or NICE guidance and where necessary, have been inflated to £2013 using the HM Treasury GDP deflator, release 20th December 2013.

Table 9– Disease costs used in model

Disease	Annual cost of each incidence of disease (in £2013)	Comment	Source
Stroke	£3,977.55	Taken from 5 year average costs, then divided by 5 and inflated to 2013	Youman et al 2003
Coronary Heart Disease	£3,815.03		NICE Public Health Guidance 25 - Prevention of cardiovascular disease - Costing Report - Implementing NICE Guidance (2010)
Chronic Kidney Disease (stage 4)	£23,426	Annual average cost of dialysis	Kerr et al (2012)
Chronic Kidney Disease (stage 5)	Year 1 cost - £65,634 Subsequent year costs - £14,618	Year 1 cost is cost of kidney transplant from live donor, subsequent years costs are annual costs per patient post-transplant	Kerr et al (2012)
Vascular Dementia	£2,605.91	Average all costs per person for dementia, of which 8% is said to be NHS costs.	Alzheimer's Society 2007

2.2.9 Social Care costs

Social care costs are taken from PSSRU's Unit Costs of Health and Social Care 2013, and the Alzheimer's Society UK's 2014 report 'Dementia UK: second look report'. Social care costs were calculated only for stroke and vascular dementia.

Table 10 - Social care costs

Disease	Annual social care cost of each incidence of disease (in £2013)	Comment	Source
Stroke	£21,112.00	All costs of stroke except GP costs (page 132)	Unit costs of health and social care 2013
Vascular Dementia	£29,968	Includes Social services costs, informal care costs and accommodation costs of dementia	Alzheimer's Society 2007

2.2.10 Life years saved

Life years saved are calculated using life tables and estimates from the literature of the average length of survival of people with each of the four diseases. Life years saved are then calculated by multiplying the length of lost life by the probability of the disease.

Table 11 - Impact of disease on survival

Disease	Average number of years lost from disease (if untreated)	Comment	Source
Stroke	12 years	Taken from previous model for Health England	Health England (2010)
Coronary Heart Disease	26 years	Taken from previous model for Health England	Health England (2010)
Chronic Kidney Disease	Stage 4 – 25 years Stage 5 – 30 years		Turin et al (2012)
Vascular Dementia	1 year	Average time between symptom onset and death is 8.41 years. Average age of onset is 75.4 years.	Jost and Grossberg 1995

2.2.11 Discounting

An annual discounting rate of 3.5% is applied to both costs and benefits in the model after year 1.

2.2.12 Sensitivity analysis

Sensitivity analysis was undertaken to test the level of uncertainty in the model, and to establish points of weakness where the results would not stand up to robustness.

Interventions

In order to test the robustness of the interventions, a break-even analysis was undertaken on the costs and effects of selected interventions. For ease of analysis the standard ICER output was used for this (the incremental cost of intervention/Incremental QALYs gained) of which 19 papers and 40 interventions were included for sensitivity analysis. The break-even analysis was tasked with finding the point where the intervention would no longer be green RAG rated. This was done using the goal seek function in Microsoft Excel.

Incidence of disease

The incidence of disease that feeds into the calculation of was varied by 1%, 5% 10% and 20% by multiplying the existing incidence estimates retrieved from the literature by a percentage increase.

Population size

The population size sensitivity analysis was designed to test the impact of a change in the size of the population who are either hypertensive above 140/90 mmHg or pre-hypertensive with measured blood pressure above 120/80. As a change in the size of the population running through the model will not change any of the ratios, the magnitude of extra health care cost savings if the population size was increased was investigated. The population was varied by 1%, 5% and 10%.

2.2.13 Calculations of the NHS cost of high blood pressure

As reported in Chapter 1, calculations were also made of the NHS costs of high blood pressure. This follows a 'burden of disease' costing approach, and details of the methods are outlined in Chapter 1, alongside the findings.

2.2.14 Scenario analyses

The model was also used as the basis for the calculation of the national impact of three implementation scenarios. The methods are reported alongside the results in Chapter 4.

3.0 Findings

3.1 Introduction

This chapter includes two main sub-sections. The first (Section 3.2) reports summarises the findings of the evidence review, and the second (Section 3.4) reports the detailed findings of the economic analysis.

The final main section of the Chapter (Section 3.6) summarises the key findings.

3.2 Evidence review

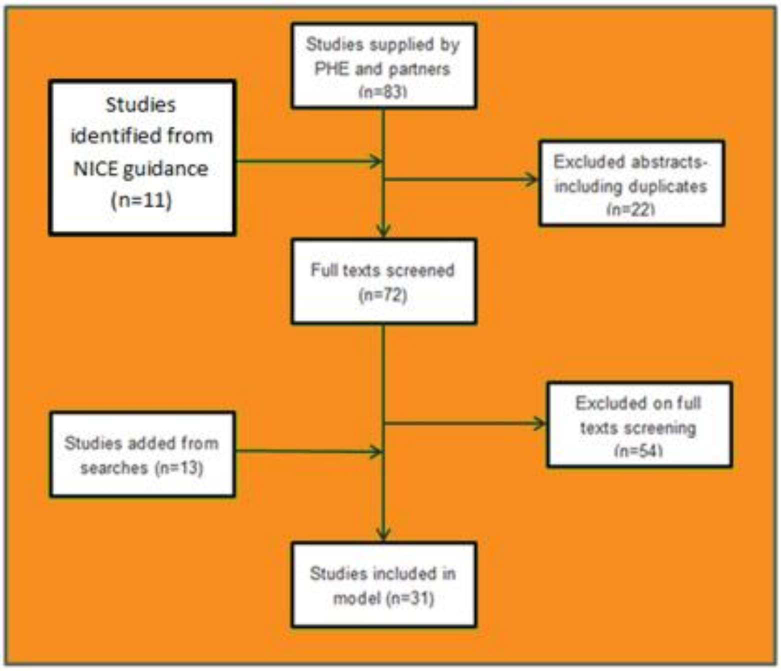
This section reports the findings from the evidence review based on the methods outlined above, with a descriptive overview of the evidence base used for the economic model.

The full references of included studies are set-out in Appendix 2, and full evidence tables and narrative summary discussion of included studies in Appendix 3.

3.2.1 Search Results

The figure below shows the results from the searches for and screening of relevant evidence.

Figure 6: Evidence collection results



83 references were provided by PHE and its partners following the call for evidence. A search of the NICE website identified 4 sets of public health and clinical guidance (CG68[14], CG48[15], CG43[16], PH32[17]) in addition to the 3 identified by the PHE team (CG127, PH49, PH25) from which a total of 11 relevant references were identified. These 94 references were screened using titles and abstracts only, in addition to the removal of duplicates. 22 references were removed at this stage, leaving 72 references. The reasons for excluding these studies can be found below.

Table 12: Title and abstract screening exclusion reasons

Reason for exclusion	Number excluded
Country	3
Irrelevant intervention	6
Setting	1
Duplicate	2
Date	5
Outcome data	6

Full texts of 13 references from the targeted Medline search to fill gaps in the evidences, were added to the 72 full texts left after title screening, using the inclusion/exclusion criteria. 54 references were excluded at this stage, leaving 31 studies that were included in the model. The reasons for excluding these studies can be found below, and a bibliography of included references can be found in Appendix 1.

Table 13: Full text screening exclusion reasons

Reason for exclusion	Number excluded
Irrelevant intervention	8
Duplicate	1
Country	4
Outcome data	41

As can be noted, the vast majority of the studies were excluded as a result of the fact that they did not report outcome data that fit the requirements of the model. As explained earlier, the model required studies that report empirical outcomes directly related to blood pressure changes (e.g. in terms of mm of Hg). Most of the excluded studies report cardio-vascular outcomes related to blood pressure, rather than blood pressure changes, and thus were excluded from use in the model.

An overview of the studies included in the economic model is as follows.

[14] NICE (2008) Stroke: Diagnosis and initial management of acute stroke and transient ischaemic attack (TIA
[15] NICE (2007) MI – secondary prevention: Secondary prevention in primary and secondary care for patients following a myocardial infarction
[16] NICE (2006) Obesity: Guidance on the prevention, identification, assessment and management of overweight and obesity in adults and children
[17] NICE (2011) Skin cancer prevention: information, resources and environmental changes

Intervention category of study

Based on the category of intervention, the number of studies used in the model is as follows:

- national dietary salt reduction – 10 studies
- healthy behaviour/lifestyle advice & change: diet, alcohol, exercise, and obesity – 4 studies
- blood pressure testing (general practice, community pharmacy, secondary care & community settings) – 4 studies
- effective management of diagnosed raised blood pressure in primary care – 4 studies
- approaches to improving drug therapy adherence – 2 studies
- support for self-management – 6 studies
- Education & awareness raising initiatives – 1 study

Country of study

The studies included in the model were conducted many different countries. Of the 31 included studies, there were:

- 11 multinational studies (mostly systematic reviews of literature)
- 11 studies conducted in the US
- 4 studies conducted in the UK
- 2 each conducted in Turkey and Canada
- 1 study each conducted in Sweden, and Australia.

Type of study

Due to the varied nature of the interventions considered, the types of studies used to evaluate them were similarly varied. Of the 31 included studies there were:

- 9 systematic review of published literature
- 8 observational studies
- 7 randomised controlled trials
- 5 economic analyses
- 1 analysis of survey data

Target population

There was an even spread of the studies with respect to the populations targeted by the interventions. As stated above, the interventions were categorised into those targeted at the 'general population', and those targeted at individuals already 'diagnosed' with high blood pressure. The distribution of the included studies is as follows:

- 16 of the included studies considered the general adult population.
- 15 of the included studies considered adults diagnosed with high blood pressure.

Quality of the included studies

The quality assessments for the studies used in the economic model are as follows:

- Level 1 – 9 studies
- Level 2 – 14 studies
- Level 3 – 8 studies

This indicates the high quality of the studies included in this model. However, as shown above, the number and quality of studies are not necessarily evenly distributed across the modelled interventions; and in some cases the fit of studies to the interventions of interest has limitations.

Assignment of evidence to intervention categories

Given the availability and variations in relevance of evidence across the range of interventions of interest it was necessary to make judgements in collaboration with the BPSLB regarding the assignment of the included available studies to the intervention categories.

In numerous cases evidence was not a perfect fit with the intervention category, and where agreed appropriate, it was judged as preferable to use the best fit available evidence rather than to omit the intervention category from the modelling.

For instance, most controversially, as noted in later results tables and fully in Appendix 3, the only available two evidence sources for Intervention Category 3.a.i were based a study of testing in general practice type settings in Turkey and testing by dentists in dental clinics in Sweden.

These considerations are further noted in the discussion of findings in the Chapters that follow.

3.3 Key findings: evidence review

The key findings of the effectiveness evidence review is summarised in the short sub-sections below.

3.3.1 Characteristics of the evidence-base

The main characteristics of the included studies are summarised in the table below.

Table 14 – Main characteristics of included studies

Characteristic	Findings
Country of study	• Most of the studies were multinational • The USA had the most studies for an individual country, with most of the RCTs conducted here. • Four studies, mainly observational studies, were conducted in the UK
Type of study	• Large heterogeneity of studies due to the different methods of evaluating the interventions • Large heterogeneity of the components of interventions within the same category • Most of the included studies were systematic reviews of RCTs with meta-analysis, providing results with high validity • There were also good quality RCTs and observational studies included in the model

3.3.2 Effectiveness findings

The key effectiveness findings can be summarised as follows:

- There is good evidence that national dietary salt reduction interventions contributes a great deal to improvements in blood pressure outcomes, mostly from systematic reviews and economic analyses.
- Effectiveness of interventions aimed at identifying people with high blood pressure varies according to the setting of the intervention.
- Interventions that are aimed at improving a primary care systems management of high blood pressure were effective at controlling the blood pressure of patients.
- The interventions that increased an individual's capacity to self-manage their blood pressure were quite effective in achieving good blood pressure control.

3.4 Economics Findings

3.4.1 Introduction

This section reports the findings of the economic modelling by the following main categories of analysis outputs:

- Incremental cost effectiveness ratios
- Health care cost savings
- Social care cost savings
- Total intervention costs
- Total Quality Adjusted Life Years gained
- Total life years saved
- Red-Amber-Green (RAG) rating of interventions
- Sensitivity analysis

In addition, these findings are summarised at the end of the Chapter in Section 3.6.

Please note that the first figure in each cell of Tables 15 to 26 represents the median estimate of the relevant outcome for the studies in the given category of intervention while the figures in brackets represent the range of estimates from evidence included in the category. The RAG ratings presented in Tables 27 and 28 are based on individual studies presented by intervention category.

The full modelling results tables are set-out in Appendices 5-9.

3.4.2 Incremental Cost Effectiveness Ratios

Incremental cost effectiveness ratios (ICERs) are a measure of cost effectiveness (or more precisely cost utility where the effect is transformed into Quality Adjusted Life Years [QALYs]). The ICER of an intervention is calculated by the incremental cost of the intervention, less the healthcare cost savings and the social care cost savings, divided by its benefits in terms of QALYs.

This provides a complete overview of the cost-effectiveness of an intervention, and gives a final metric that can be used to directly compare interventions and groups of interventions with each other, even if they are aimed at different populations. An ICER gives a whole service perspective and can be used to determine the best investment for each pound.

ICERs are considered to be value for money if they are under £20,000/QALY or in some cases between £20,000 and £30,000/QALY over the lifetime time horizon. If the ICER is negative this indicates that the intervention is overall cost-saving, and referred to by economists as 'dominant'.

Table 15 and Table 16 show the ICERs for the categories of interventions included in the model. Table 15 shows the results for the general population interventions, and Table 16 for the diagnosed population.

Table 15– ICER results for general adult population interventions

General adult population					
Category	Description	**ICER (including healthcare and social care costs) (1 year)**	**ICER (including healthcare and social care costs) (5 year)**	**ICER (including healthcare and social care costs) (10 year)**	**ICER (including healthcare and social care costs) (lifetime)**
1	National dietary salt reduction	**£-1,900** (£-2,000 – £-1,800)	**£-9,900** (£-9,900 - £-9,800)	**£-17,300** (£17,300 – £-17,300)	**£-34,262** (£-34,262 – £-34,262)
2	Healthy lifestyle advice and change: improved lifestyle – diet, alcohol, exercise, obesity (health educator delivered)	**£170,100** (£170,100 - £170,100)	**£85,300** (£85,300 - £85,300)	**£25,700** (£25,700 - £25,700)	**£-18,700** (£-18,700 – £-18,700)
	(clinician delivered)	**£60,700** (£11,400 - £109,900)	**£24,700** (£-2,500 - £52,000)	**£-2,500** (£-15,200 - £10,200)	**£-28,600** (£-33,000 – £-24,100)
3.a. i	Testing - General practice (n.b. one included study is based on testing by dentists)	**£682,700** (£319,300 - £1,046,200)	**£368,800** (£167,800 - £569,700)	**£157,800** (£64,100 - £251,400)	**£27,700** (£-5,200 - £60,600)
3.a. ii	Testing – Pharmacy	**£191,700** (£191,700 - £191,700)	**£97,200** (£97,200 - £97,200)	**£31,300** (£31,300 - £31,300)	**£-16,700** (£-16,700 – £-16,700)

3.b	Testing – Secondary care	**As 3.a. i**			
3.c	Testing – Community venues	**£814,800** (£814,800 - £814,800)	**£446,200** (£446,200 - £446,200)	**£191,800** (£191,800 - £191,800)	**£39,700** (£39,700 - £39,700)
3.d	Testing – Home/commercial setting	**As 3.c**			
7	Education & awareness raising initiatives	**£493,200** (£493,200 - £493,200)	**£347,900** (£347,900 - £347,900)	**£149,100** (£149,100 - £149,100)	**£27,000** (£27,000 - £27,000)

These results show that achieving national dietary salt reduction is cost-saving at each time horizon, lifestyle changes are potentially cost-effective at 10 years and cost saving over the lifetime time horizon. Testing is more cost effective in GP and Pharmacy settings rather than in commercial settings.
Education and awareness campaigns only become cost-effective over a lifetime time horizon.

The key messages are that investment into blood pressure interventions for the general adult population need to be considered as bringing returns in the long term.

Table 16 – ICER results for diagnosed adult population interventions

Adults with diagnosed hypertension					
Category	**Description**	**ICER (1 year)**	**ICER (5 year)**	**ICER (10 year)**	**ICER (lifetime)**
1	National dietary salt reduction	**£-9,700** (£-9,800 – £-9,600)	**£-9,900** (£-10,000 – £-9,900)	**£-16,100** (£-16,800 – £-15,300)	**£-32,400** (£-32,400 – £-32,400)
2	Healthy lifestyle advice and change: improved lifestyle – diet, alcohol, exercise, obesity	**£71,000** (£7,700 - £357,200)	**£7,300** (£-6,200 - £68,600)	**£-9,000** (£-15,100 - £18,900)	**£-30,000** (£-21,000 – £-32,000)
4	Effective primary care management of hypertension	**£2,083,600** (£578,900 - £5,388,200)	**£438,000** (£116,000 - £1,145,200)	**£187,000** (£40,500 - £508,800)	**£33,000** (£-14,000 - £136,200)
5	Drug therapy adherence interventions	**£693,600** (£255,400 - £1,582,500)	**£140,600** (£46,800 - £330,800)	**£51,700** (£9,000 - £138,200)	**£-10,500** (£-24,100 - £17,300)
6	Support for self-	**£1,297,100** (£294,300 -	**£269,700** (£55,100 -	**£110,400** (£12,800 -	**£8,400** (£-22,900 –

Adults with diagnosed hypertension					
Category	**Description**	**ICER (1 year)**	**ICER (5 year)**	**ICER (10 year)**	**ICER (lifetime)**
	management	£9,855,800)	£2,101,200)	£943,800)	£-275,600)

In adults diagnosed with high blood pressure, the results again show that dietary reductions in salt intake are the most cost-saving across all timelines. Lifestyle improvement interventions become cost effective within 5 years, and potentially cost saving within 10 years. Drug therapy adherence interventions become cost saving over a lifetime but are not cost effective in shorter time horizons. Similarly, self-management support programmes are only cost effective over the lifetime time horizon.

Primary care management programmes interventions (above and beyond standard care) are not cost-effective at any time horizon. This is a surprising result, but is likely to be due to the interventions being some of the most expensive to deliver, with unit costs ranging from £53 to £329 per person. The interventions did not have particularly low effectiveness levels; the degree of effectiveness ranged between 6% and 49%, and was in general roughly comparable to other intervention groups, but the high cost is likely the driving force behind these not being cost-effective.

3.4.3 Health care costs savings

Health care cost savings are the costs that would have been spent on treatment of blood pressure related disease had people not been controlling their blood pressure. Health care costs are calculated for the life of the disease and therefore the majority of the benefits are incurred between 10 years and lifetime.

The perspective for this is the whole NHS and the population that runs through the model is the whole England adult population above the age of 18. The healthcare cost savings are based on the assumption that the intervention will be run nationally.

Table 17 shows the health care cost savings for the general population interventions in terms of all four diseases: CHD, Stroke, VaD and CKD. Table gives the cost savings for the diagnosed population.

Table 17– Healthcare cost savings for general adult population interventions

General adult population					
Category	**Description**	**Health care cost savings (1 year)**	**Health care cost savings (5 year)**	**Health care cost savings (10 year)**	**Health care cost savings (lifetime)**
1	National dietary salt reduction	**£22,630,000** (£17,750,000 - £30,250,000)	**£185,890,000** (£145,840,000 - £248,520,000)	**£692,060,000** (£542,940,000 - £925,210,000)	**£3,061,400,000** (£2,401,800,000 - £4,092,800,000)

2	Healthy lifestyle advice and change: improved lifestyle – diet, alcohol, exercise, obesity (health educator delivered)	**£29,110,000** (£29,110,000 - £29,110,000)	**£890,290,000** (£890,290,000 - £890,290,000)	**£50,000** (£50,000 - £50,000)	**£3,938,300, 000** (£3,938,300,000 - £3,938,300,000)
	(clinician delivered)	**£19,910,000** (£18,010,000 - £21,820,000)	**£163,600,000** (£147,950,000 - £179,250,000)	**£20,000** (£550,790,000 - £667,340,000)	**£2,694,200,00 0** (£2,436,500,000 - £2,952,000,000)
3.a. i	Testing - General practice (n.b. one included study is based on testing by dentists)	**£3,600,000** (£3,600,000 - £3,600,000)	**£29,520,000** (£29,520,000 - £29,520,000)	**£109,890,000** (£109,890,000 - £109,890,000)	**£486,100,000** (£486,100,000 - £486,100,000)
3.a. ii	Testing – Pharmacy	**£3,370,000** (£1,680,000 - £5,050,000)	**£27,620,000** (£13,770,000 - £41,470,000)	**£102,800,000** (£51,230,000 - £154,360,000)	**£454,800,000** (£226,700,000 - £682,900,000)
3.b	Testing – Secondary care	**As 3.a. i**			
3.c	Testing – Community venues	**£3,600,000** (£3,600,000 - £3,600,000)	**£29,520,000** (£29,520,000 - £29,520,000)	**£109,890,000** (£109,890,000 - £109,890,000)	**£486,100,000** (£486,100,000 - £486,100,000)
3.d	Testing – Home/commercia l setting	**As 3.c**			
7	Education & awareness raising initiatives	**£3,340,000** (£3,340,000 - £3,340,000)	**£44,470,000** (£44,470,000 - £44,470,000)	**£173,470,000** (£173,470,000 - £173,470,000)	**£718,800,000** (£718,800,000 - £718,800,000)

Therefore again, this supports the case for 10 year investment in blood pressure measures, as the majority of benefits are lagged by at least 10 years.

Table 18– Healthcare cost savings for diagnosed adult population interventions

Adults with diagnosed hypertension					
Category	**Description**	**Health care cost savings (1 year)**	**Health care cost savings (5 year)**	**Health care cost savings (10 year)**	**Health care cost savings (lifetime)**
1	National dietary salt reduction	**£15,350,000** (£12,210,000 - £18,500,000)	**£71,730,000** (£57,030,000 - £86,440,000)	**£241,720,000** (£192,170,000 - £291,270,000)	**£1,224,600,000** (£973,600,000 - £1,475,700,000)

Adults with diagnosed hypertension						
Category	**Description**	**Health care cost savings (1 year)**	**Health care cost savings (5 year)**	**Health care cost savings (10 year)**	**Health care cost savings (lifetime)**
2	Healthy lifestyle advice and change: improved lifestyle – diet, alcohol, exercise, obesity	**£24,610,000** (£18,370,000 - £40,730,000)	**£114,980,000** (£85,840,000 - £190,320,000)	**£387,450,000** (£289,260,000 - £641,350,000)	**£1,962,900,000** (£1,465,400,000 - £3,249,200,000)
4	Effective primary care management of hypertension	**£4,810,000** (£1,010,000 - £20,370,000)	**£22,460,000** (£4,680,000 - £95,160,000)	**£75,680,000** (£15,780,000 - £320,680,000)	**£383,400,000** (£79,900,000 - £1,624,600,000)
5	Drug therapy adherence interventions	**£3,610,000** (£610,000 - £7,740,000)	**£16,850,000** (£2,810,000 - £36,160,000)	**£56,780,000** (£9,470,000 - £121,840,000)	**£287,700,000** (£48,000,000 - £617,300,000)
6	Support for self-management	**£11,920,000** (£260,000 - £19,850,000)	**£55,670,000** (£1,180,000 - £92,750,000)	**£187,600,000** (£3,980,000 - £312,560,000)	**£950,400,000** (£20,200,000 - £1,583,500,000)

3.4.4 Social care cost savings (CHD & stroke)

Social care cost savings are from a local government perspective. It was only feasible to include costs for stroke and vascular dementia. As social care cost savings are incurred some time after the onset of disease, there are no entries for the first two time horizons.

Table 19– Social care cost savings in general adult population interventions

General adult population					
Category	**Description**	**Social care cost savings (1 year)**	**Social care cost savings (5 year)**	**Social care cost savings (10 year)**	**Social care cost savings (lifetime)**
1	National dietary salt reduction	**£0** (£0 - £0)	**£0** (£0 - £0)	**£52,610,000** (£41,280,000 - £70,330,000)	**£819,500,000** (£643,000,000 - £1,095,600,000)

General adult population					
Category	**Description**	**Social care cost savings (1 year)**	**Social care cost savings (5 year)**	**Social care cost savings (10 year)**	**Social care cost savings (lifetime)**
2	Healthy lifestyle advice and change: improved lifestyle – diet, alcohol, exercise, obesity (health educator delivered)	**£0** (£0 - £0)	**£0** (£0 - £0)	**£67,680,000** (£67,680,000 - £67,680,000)	**£1,054,300,000** (£1,054,300,000 - £1,054,300,000)
	(clinician delivered)	**£0** (£0 - £0)	**£0** (£0 - £0)	**£46,300,000** (£41,870,000 - £50,730,000)	**£721,200,000** (£652,200,000 - £790,300,000)
3.a. i	Testing – General practice (n.b. one included study is based on testing by dentists)	**£0** (£0 - £0)	**£0** (£0 - £0)	**£7,820,000** (£3,900,000 - £11,740,000)	**£121,800,000** (£60,700,000 - £182,800,000)
3.a. ii	Testing - Pharmacy	**£0** (£0 - £0)	**£0** (£0 - £0)	**£7,820,000** (£3,900,000 - £11,740,000)	**£121,800,000** (£60,700,000 - £182,800,000)
3.b	Testing – Secondary care	**As 3.a. i**			
3.c	Testing – Community venues	**£0** (£0 - £0)	**£0** (£0 - £0)	**£8,360,000** (£8,360,000 - £8,360,000)	**£130,200,000** (£130,200,000 - £130,200,000)
3.d	Testing – Home/commercial setting	**As 3.c**			
7	Education & awareness raising initiatives	**£0** (£0 - £0)	**£0** (£0 - £0)	**£11,500,000** (£11,500,000 - £11,500,000)	**£180,600,000** (£180,600,000 - £180,600,000)

There are potentially, other benefits from cost savings, especially around informal carers, who make up 36% of the costs in terms of lost earnings. From a societal perspective, improving outcomes will have knock on benefits in terms of tax receipts to HM Treasury from people now able to find paid work as a result of not being informal carers.

Table 20 – Social care cost savings in diagnosed adult population interventions

Adults with diagnosed hypertension					
Category	**Description**	**Social care cost savings (1 year)**	**Social care cost savings (5 year)**	**Social care cost savings (10 year)**	**Social care cost savings (lifetime)**
1	National dietary salt reduction	**£0** (£0 - £0)	**£0** (£0 - £0)	**£241,720,000** (£192,170,000 - £291,270,000)	**£365,500,000** (£290,600,000 - £440,500,000)
2	Healthy lifestyle advice and change: improved lifestyle – diet, alcohol, exercise, obesity	**£0** (£0 - £0)	**£0** (£0 - £0)	**£38,090,000** (£28,440,000 - £63,040,000)	**£585,900,000** (£437,400,000 - £969,800,000)
4	Effective primary care management of hypertension	**£0** (£0 - £0)	**£0** (£0 - £0)	**£7,440,000** (£1,560,000 - £31,520,000)	**£114,500,000** (£23,900,000 - £484,900,000)
5	Drug therapy adherence interventions	**£0** (£0 - £0)	**£0** (£0 - £0)	**£56,780,000** (£9,470,000 - £121,840,000)	**£85,900,000** (£14,400,000 - £184,300,000)
6	Support for self-management	**£0** (£0 - £0)	**£0** (£0 - £0)	**£18,440,000** (£400,000 - £30,730,000)	**£283,700,000** (£6,100,000 - £472,700,000)

Again, the social care cost savings do not emerge until year 10.

3.4.5 Total intervention costs

The total intervention costs cover the costs to all people receiving the intervention, not just those who benefit from it. Therefore, if an intervention is rolled out to the whole population, but has a small effect size, the cost may be far higher than the resulting benefits.

Table 21 – Total intervention costs in general adult population interventions

General adult population		
Category	**Description**	**Total intervention costs**
1	National dietary salt reduction	**£2,600,000** (£2,600,000 - £2,600,000)
2	Healthy lifestyle advice and change: improved lifestyle – diet, alcohol, exercise, obesity (health educator delivered)	**£2,269,700,000** (£2,269,700,000 - £2,269,700,000)
	(clinician delivered)	**£608,600,000** (£110,500,000 - £1,106,700,000)

3.a. i	Testing - General practice (n.b. one included study is based on testing by dentists)	**£315,200,000** (£315,200,000 - £315,200,000)
3.a. ii	Testing – Pharmacy	**£739,600,000** (£739,600,000 - £739,600,000)
3.b	Testing – Secondary care	**As 3.a. i**
3.c	Testing – Community venues	**£739,600,000** (£739,600,000 - £739,600,000)
3.d	Testing – Home/commercial setting	**As 3.c**
7	Education & awareness raising initiatives	**£1,585,300,000** (£1,585,300,000 - £1,585,300,000)

The interventions' cost and effectiveness relationship requires that a larger cost be correlated with a higher effectiveness in order to be cost-effective.

Table 22 – Total intervention costs in diagnosed adult populations interventions

Adults with diagnosed hypertension		
Category	**Description**	**Total intervention costs**
1	National dietary salt reduction	**£500,000** (£200,000 - £800,000)
2	Healthy lifestyle advice and change: improved lifestyle – diet, alcohol, exercise, obesity	**£215,100,000** (£42,000,000 - £671,900,000)
4	Effective primary care management of hypertension	**£571,000,000** (£169,100,000 - £4,246,400,000)
5	Drug therapy adherence interventions	**£95,400,000** (£95,400,000 - £542,200,000)
6	Support for self-management	**£930,100,000** (£247,800,000 - £1,558,900,000)

As mentioned in the ICER section, primary care management as a category has higher individual costs, ranging from £50 to over £300. They are also aimed at a smaller population, who are already on treatment but need support to get their blood pressure under control. Support for self-management interventions are also expensive; though all are clustered around £100 per person, they are aimed to a broader population, and therefore have more benefits to accrue, even though the cost-category is the largest, at nearly £1 billion.

3.4.6 Total QALYs gained

QALYs are measures of burden of disease. In this case, the QALYs are the loss of quality of life that would have occurred if people were not controlling their blood pressure.

Table 23 – QALYs gained from general adult population interventions

General adult population		
Category	**Description**	**Total QALYs saved (lifetime)**
1	National dietary salt reduction	**114,000** (89,000 - 152,000)
2	Healthy lifestyle advice and change: improved lifestyle – diet, alcohol, exercise, obesity (health educator delivered)	**146,000** (146,000 - 146,000)
	(clinician delivered)	**100,000** (91,000 - 110,000)
3.a. i	Testing - General practice (n.b. one included study is based on testing by dentists)	**17,000** (9,000 - 26,000)
3.a. ii	Testing – Pharmacy	**18,000** (18,000 - 18,000)
3.b	Testing – Secondary care	**As 3.a. i**
3.c	Testing – Community venues	**18,000** (18,000 - 18,000)
3.d	Testing – Home/commercial setting	**As 3.c**
7	Education & awareness raising initiatives	**26,000** (26,000 - 26,000)

This table can be seen as the burden of disease avoided, or the number of healthy years gained as a result of the intervention category in the population. At lifetime, the per-person QALY gain is 0.00894295, or approximately 130 days extra at full health over lifetime in the general population.

Table 24– QALYs gained from diagnosed adult population interventions

Adults with diagnosed hypertension		
Category	**Description**	**Life years saved (lifetime)**
1	National dietary salt reduction	**49,000** (39,000 - 59,000)
2	Healthy lifestyle advice and change: improved lifestyle – diet, alcohol, exercise, obesity	**79,000** (59,000 - 130,000)
4	Effective primary care management of hypertension	**16,000** (4,000 - 65,000)
5	Drug therapy adherence interventions	**12,000** (2,000 - 25,000)
6	Support for self-management	**38,000** (1,000 - 64,000)

The per-person QALY gain in the diagnosed population is much higher than in the general population, at 0.020104263. This is equivalent of 294 days of extra full health over lifetime.

3.4.7 Life years saved

Life years saved are the number of years that otherwise would have been lost if a person had died prematurely from disease.

Table 25– Life years saved in general adult population interventions

General adult population		
Category	**Description**	**Life years saved (lifetime)**
1	National dietary salt reduction	**122,000** (96,000 - 162,000) **122,000** (89,000 - 228,000)
2	Healthy lifestyle advice and change: improved lifestyle – diet, alcohol, exercise, obesity (health educator delivered)	**156,000** (156,000 - 156,000)
	(clinician delivered)	**107,000** (97,000 - 117,000)
3.a. i	Testing - General practice (n.b. one included study is based on testing by dentists)	**18,000** (9,000 - 28,000)
3.a. ii	Testing - Pharmacy	**20,000** (20,000 - 20,000)
3.b	Testing – Secondary care	**As 3.a. i**
3.c	Testing – Community venues	**20,000** (20,000 - 20,000)
3.d	Testing – Home/commercial setting	**As 3.c**
7	Education & awareness raising initiatives	**29,000** (29,000 - 29,000)

This represents the mortality risk prevented from the four diseases in the model.

Table26– Life years saved in diagnosed adult population interventions

Adults with diagnosed hypertension		
Category	**Description**	**Life years saved (lifetime)**
1	National dietary salt reduction	**48,000** (38,000 - 58,000)
2	Healthy lifestyle advice and change: improved lifestyle – diet, alcohol, exercise, obesity	**77,000** (58,000 - 127,000)
4	Effective primary care management of hypertension	**77,000** (58,000 - 127,000)
5	Drug therapy adherence interventions	**12,000** (2,000 - 25,000)
6	Support for self-management	**38,000** (1,000 - 62,000)

3.4.8 RAG rating of interventions

Although the research question for this project does not include making recommendations for investment priorities, the interventions have been RAG rated (Red Amber Green). For this, a total healthcare perspective ICER is included, calculated as:

Cost of the intervention – healthcare cost savings – social care cost savings/total QALY gained

This ratio is useful for decision making. It incorporates the full perspective of the tool, both NHS and PSS/Local government, and is generalisable to allow each intervention to be compared to each other, despite their differences.

This again shows how the benefits from blood pressure interventions are generally 'lagged' – delayed in time, and underlines that a longer perspective of investment in blood pressure will give better results in terms of both morbidity and mortality.

As salt reduction was a dominant strategy (generated health benefits and cost savings) at each time horizon, it was excluded from this analysis.

The results have been grouped into general population and diagnosed population results.

In this case, a Red rating means that the intervention had a total ICER of over £30,000, an Amber rating implies an ICER of between £20,000 and £30,000, a Green rating reflects an intervention which has positive costs but an ICER of below £20,000 but above £0 and Green (dominant) is associated with a negative ICER indicating health gains and cost savings.

Table 27– General adult population: ICER RAG rating results

Study	1 year RAG rating	5 year RAG rating	10 year RAG rating	Lifetime RAG rating
Category 1: National dietary salt reduction				
Smith-Spangler 2010 (salt reduction)	Green (Dominant)	Green (Dominant)	Green (Dominant)	Green (Dominant)
Palar 2009 (salt reduction)	Green (Dominant)	Green (Dominant)	Green (Dominant)	Green (Dominant)
Joffres 2007(salt reduction)	Green (Dominant)	Green (Dominant)	Green (Dominant)	Green (Dominant)
Asaria 2007 (salt reduction)	Green (Dominant)	Green (Dominant)	Green (Dominant)	Green (Dominant)
He 2014 (salt reduction)	Green (Dominant)	Green (Dominant)	Green (Dominant)	Green (Dominant)
Aburto 2013 (salt reduction)	Green (Dominant)	Green (Dominant)	Green (Dominant)	Green (Dominant)
He 2013 (salt reduction)	Green (Dominant)	Green (Dominant)	Green (Dominant)	Green (Dominant)
Taylor 2011 (salt reduction)	Green (Dominant)	Green (Dominant)	Green (Dominant)	Green (Dominant)

Study	1 year RAG rating	5 year RAG rating	10 year RAG rating	Lifetime RAG rating
Graudal 2011 (salt reduction)	Green (Dominant)	Green (Dominant)	Green (Dominant)	Green (Dominant)
Category 2: Healthy lifestyle advice and change				
Hartley 2013 (dietary advice)	Red	Red	Green	Green (dominant)
Hartley 2013 (provision of fruit and vegetables)	Red	Green (dominant)	Green (dominant)	Green (dominant)
Zoellner et al 2014 (Exercise based lifestyle intervention)	Red	Red	Amber	Green (dominant)
Category 3a.i: Testing - General practice				
Engstrom et al 2011 (blood pressure testing at dentist)	Red	Red	Red	Red
Erem et al 2008 (Wide ranging blood pressure measurement programme)	Red	Red	Red	Green
Category 3a.ii: Testing – Pharmacy				
Magnum et al 2003 (community pharmacy screening)	Red	Green	Green (dominant)	Green (dominant)
Category 3b: Testing – Secondary care				
	n/a	n/a	n/a	n/a
Category 3c: Testing – Community venues				
Lucky et al 2011 (screening at community health fairs by nurses)	Red	Red	Red	Red
Category 3d: Testing – Home/commercial setting				
	n/a	n/a	n/a	n/a
Category 7: Education and awareness raising initiatives				
Kaczorowski et al 2011 (Cardiac Health Awareness Programme)	Red	Red	Red	Green

Table 28– Diagnosed adult population: ICER RAG rating results

Study	1 year RAG rating	5 year RAG rating	10 year RAG rating	Lifetime RAG rating
Category 1: National dietary salt reduction (to be added in!)				
Graudal 2011 (salt reduction)	Green (Dominant)	Green (Dominant)	Green (Dominant)	Green (Dominant)
Pimenta 2009 (salt reduction)	Green (Dominant)	Green (Dominant)	Green (Dominant)	Green (Dominant)

Study	1 year RAG rating	5 year RAG rating	10 year RAG rating	Lifetime RAG rating
Category 2: Healthy lifestyle advice and change				
Dickinson et al 2006 (diet)	Red	Red	Red	**Green (Dominant)**
Dickinson et al 2006 (exercise)	Red	Red	Green	**Green (Dominant)**
Dickinson et al 2006 (relaxation)	Red	Red	Green	**Green (Dominant)**
Dickinson et al 2006 (alcohol restriction)	Red	Red	**Green (Dominant)**	**Green (Dominant)**
Dickinson et al 2006 (sodium restriction)	Red	Amber	**Green (Dominant)**	**Green (Dominant)**
Dickinson et al 2006 (combined intervention)	Red	Red	Green	**Green (Dominant)**
Dickinson et al 2006 (calcium supplement)	Red	Green	**Green (Dominant)**	**Green (Dominant)**
Dickinson et al 2006 (magnesium supplement)	Red	Green	**Green (Dominant)**	**Green (Dominant)**
Dickinson et al 2006 (potassium supplement)	Red	**Green (dominant)**	**Green (Dominant)**	**Green (Dominant)**
Dickinson et al 2006 (fish oil supplement)	Red	Amber	**Green (Dominant)**	**Green (Dominant)**
Horvath 2008 (6kg weight reduction)	Red	Red	**Green (Dominant)**	**Green (Dominant)**
Horvath 2008 (3kg weight reduction)	Red	Red	Red	**Green (Dominant)**
Category 4: Effective primary care management of hypertension				
Howard et al 2010 (testing and management)	Red	Red	Red	Amber
Howard et al 2010 (testing and management in existing patients)	Red	Red	Red	Amber
Reid et al 2005 (Pharmacist led clinic in primary are)	Red	Red	Red	**Green (Dominant)**
Robson et al 2014 (Managed networks in general practice)	Red	Red	Red	Red

Study	1 year RAG rating	5 year RAG rating	10 year RAG rating	Lifetime RAG rating
Weber 2010 (Pharmacist and physician co-management)	Red	Red	Red	Red
Category 5: Drug therapy adherence interventions				
Hacihasanoglu et al. 2011 (Education and medication adherence)	Red	Red	Red	Green
Hacihasanoglu et al. 2011 (Education and medication adherence plus lifestyle information)	Red	Red	Amber	**Green (dominant)**
Parker et al 2014 (Pharmacist advice and guidance)	Red	Red	Red	**Green (Dominant)**
Category 6: Support for self-management				
Bray et al 2010 (self-monitoring)	Red	Red	Amber	Amber
Green 2008 (monitoring)	Red	Red	Red	**Green (dominant)**
Green 2008 (monitoring and pharmacist management)	Red	Red	Red	Green
Margolis 2014	Red	Red	Red	**Green (Dominant)**
McManus et al 2010	Red	Red	Red	Amber
Omboni et al 2013	Red	Red	Red	**Green (dominant)**
Zilich 2005	Red	Red	Red	Red

3.5 Sensitivity analysis

3.5.1 Interventions

The vast majority of interventions in the model are not sensitive to changes in their costs or effects. There are three interventions that have some sensitivity to changes in their inputs. The intervention studied by Zoellner 2014 would cease to be cost effective if there was a 28% change in either costs or effect. For the intervention considered by Reid et al (2005), a 9% change in costs or an 8% change in effectiveness will raise its ICER above £20,000, and, for the second intervention investigated by Hacihasanoglu et al. 2011, a 1% change in effectiveness would mean that it is no longer cost effective.

3.5.2 Incidence of disease

Varying the incidence of disease by 1%, 5%, 10% or 20% did not change the RAG rating of any of the interventions.

3.5.3 Population size

An overview of the projected healthcare cost savings should both the hypertensive and prehypertensive groups increase by a specified percentage.

Table 29– Population change sensitivity analysis results

Study	Description	1% population change – additional healthcare cost savings over lifetime	5% population change- additional healthcare cost savings	10% population change- additional healthcare cost savings
Smith-Spangler et al. 2010	9.5% reduction in salt consumption	£105,467,765	£500,228,024	£940,454,984
	6% reduction in salt consumption	£102,113,652	£484,319,643	£910,546,392
	20% reduction in salt consumption	£115,930,990	£549,854,543	£1,033,755,449
Palar et al. 2009	32.35% reduction in salt consumption	£130,158,794	£617,336,266	£1,160,624,637
	50% reduction in salt consumption	£153,317,053	£727,174,663	£1,367,126,598
	56% reduction in salt consumption	£160,963,546	£763,441,571	£1,435,310,292
	65% reduction in salt consumption	£174,010,482	£825,322,500	£1,551,649,691
Joffres et al. 2007	23% reduction in salt consumption	£150,300,272	£712,866,231	£1,340,225,993
Asaria et al. 2007	15% reduction in salt consumption	£110,894,020	£525,964,463	£988,840,844
	30% reduction in salt consumption	£130,158,794	£617,336,266	£1,160,624,637
	Reduction in salt consumption to under 5g	£165,879,150	£786,756,023	£1,479,142,686
He et al. 2014	No particular intervention. Assesses 'dietary salt' reduction	£125,510,030	£595,287,426	£1,119,171,658
Aburto et al 2013	Low salt vs high (normal) salt diets	£138,008,355	£654,566,319	£1,230,619,093
	Low salt vs high (normal) salt diets	£100,799,287	£480,730,615	£909,112,827
	Low salt vs high (normal) salt diets	£99,198,114	£474,143,714	£898,753,054

Study	Description	1% population change – additional healthcare cost savings over lifetime	5% population change- additional healthcare cost savings	10% population change- additional healthcare cost savings
He et al 2013	Meta analysis of approx. a 4.4g reduction in salt consumption per day	£244,074,963	£1,157,634,623	£2,176,413,953
Taylor et al 2011	Reducing salt (no specific amount) – meta analysis	£138,974,472	£659,148,561	£1,239,233,949
Graudal et al 2011	Low salt vs high (normal) salt diets	£106,414,264	£504,717,219	£948,894,907
Zoellner et al 2014	Motivational enhancement, social support provided by peer coaches, pedometer diary self-monitoring, and monthly nutrition and physical activity education sessions	£167,442,515	£794,170,980	£1,493,083,196
Hartley 2013	Specific dietary advice to increase fruit and vegetable consumption	£125,510,030	£595,287,426	£1,119,171,658
	Provision of fruit and vegetables	£103,589,151	£491,317,858	£923,703,404
Kaczorowski et al 2011	Cardiovascular Health Awareness Program (CHAP)	£46,862,621	£222,266,931	£417,873,516
Graudal et al 2011	Low salt vs high (normal) salt diets	£62,527,843	£300,146,030	£571,482,536
Pimenta et al 2009	Low salt vs high (normal) salt diets	£41,253,538	£198,025,156	£377,042,863
Dickinson et al 2006	Diet	£95,337,387	£457,638,340	£871,350,253
	Exercise	£96,096,615	£461,282,787	£878,289,334
	Relaxation	£80,667,620	£387,220,553	£737,273,731
	Alcohol restriction	£79,259,921	£380,463,320	£724,407,858
	Sodium restriction	£85,683,576	£411,298,136	£783,117,811
	Combined interventions	£91,575,513	£439,580,602	£836,968,049
	Calcium supplements	£70,404,386	£337,954,999	£643,471,379
	Magnesium supplements	£62,713,850	£301,038,903	£573,182,580
	Potassium supplements	£137,679,785	£660,890,242	£1,258,344,918
	Fish oil supplements	£69,089,336	£331,642,500	£631,452,286
Horvath 2008	6kg reduction	£103,024,347	£494,537,273	£941,606,374
	3kg reduction	£62,095,037	£298,068,476	£567,526,843
Reid et al. 2005	Hypertension Management Clinic vs usual care	£32,907,726	£157,963,602	£300,765,064

Study	Description	1% population change – additional healthcare cost savings over lifetime	5% population change- additional healthcare cost savings	10% population change- additional healthcare cost savings
Hacihasanoglu et al. 2011	Education and medication adherence	£12,188,047	£58,505,038	£111,394,468
	Education and medication adherence plus education and healthy lifestyle	£67,097,301	£322,080,335	£613,245,781
Omboni et al. 2013	home blood pressure measurement + tele-monitoring vs usual care	£44,057,531	£211,484,878	£402,670,374

3.6 Summary findings

Tables 30 and 31 below report our results for interventions applicable to all adults, and adults diagnosed with hypertension respectively. Generally speaking, the 'all adults' interventions are applied at a population level, with the total incremental cost being based on the incremental unit cost multiplied by the adult (aged 18+) population of England (around 43mn). There are subsets of the total population who benefit from these interventions, namely those with hypertension (blood pressure of 140/90 and above) and those who are pre-hypertensive (blood pressure of above 120/80 but less than 140/90). The base case analysis does not allow for any benefits in the currently normotensive population who might be prevented from becoming hypertensive in future. However, we have varied the population benefiting in the sensitivity analysis to allow for some benefit in this group.

The interventions in the hypertensive population apply to those diagnosed with hypertension (blood pressure of 140/90 and above) or to subsets thereof, such as those on drugs but not controlling. In those with hypertension, it is not considered advisable to attempt to manage patients' blood pressure to below 120/80.

The cost per QALY ratio is presented for the lifetime time horizon as this gives the most comprehensive approach to the consideration of costs and benefits and is often considered to be the most appropriate time horizon to be used in economic evaluation. For preventive interventions, which involve costs today but for which the benefits in terms of reduced mortality and morbidity may be delayed well into the future, cost-effectiveness can be sensitive to the time horizon, with cost-effectiveness improving rapidly as the time horizon is extended.

At the same time, we acknowledge that decision makers, in practice, will be interested in results presented over shorter time horizons. In subsequent sections, we provide the results across all time horizons. For brevity, those results are summarised according to category of intervention. The tables below, which present results for all studies included in the modelling exercise, serve to highlight a number of key features about the evidence base on which we have drawn.

Firstly, the categorisation of intervention types was developed before a full assessment of the literature had been undertaken. Thus, while the interventions assessed in the studies on which the modelling was based correspond as closely as possible to the pre-defined categories, they do not necessarily encapsulate precisely what a policy maker might envisage on the basis of the category description alone. The reader should therefore be mindful to interpret the results based on the specific intervention considered in each study. For instance, the evidence base for the modelled impact of national dietary salt intake reduction is based on the general assumption that this can be achieved by a number of alternative interventions/mechanisms, including food industry product agreements and/or personal behaviour change in salt consumption behaviour by individuals. A more detailed description of the studies is presented in the appendices.

Secondly, the quantity of studies available for modelling varies across categories of intervention. For some categories of intervention, the literature we were able to consider was much more extensive than for others. Where a number of interventions are applicable to an intervention category, readers may be reassured that uncertainty around cost-effectiveness has been captured. At the same time, given the restrictions of our evidence gathering, we are unable to draw firm conclusions about the representativeness of the evidence base allocated to the different categories.

There are two further aspects to the evidence base which will need to be taken into account when interpreting the cost-effectiveness results. One is the design of individual studies, of which further details are given in appendices. The second is the generalizability of results to the decision maker's own context. For example, there may be reason for supposing that it is possible to deliver the more costly interventions we have identified using fewer or less expensive resources. To assist the reader in interpreting the cost-effectiveness results, the tables below report the costs and effectiveness separately from the cost-effectiveness ratio. Within each intervention category, variation in the cost per QALY ratio will depend both on differences in unit costs (cost per recipient of the intervention) and in effectiveness expressed in terms of increased numbers controlling and the population targeted.

In both groups of interventions (all adults and adults with hypertension), our findings suggest that interventions to control blood pressure can be highly cost-effective and, in some cases, generate cost savings well in excess of their intervention costs. This is particularly the case for interventions to reduce dietary salt consumption. Where wide variation was found in cost-effectiveness estimates, some studies suggested a cost-effectiveness ratio around the reference points used by NICE of £20,000 to £30,000 per QALY while others suggested that cost savings would be possible and others gave cost per QALY ratios well above the normally accepted range. Variation between studies was particularly noticeable in the Category 6 (effective primary care management of hypertension), category 7 (drug therapy adherence interventions) and category eight (support for self-management). The study which gave the highest cost-effectiveness ratio in the effective primary care management category investigated an intervention which was intended to address a range of risk factors. Focussing solely on blood pressure-related benefits is therefore likely to underestimate the benefits of the programme as a whole.

For interventions among all adults, the testing categories showed wide variation in cost-effectiveness from cost saving to a cost per QALY well above the upper end of the range normally considered by NICE. Due the limited evidence available, the least cost-effective intervention across the testing categories was based on a study of testing in dental surgeries and therefore should be regarded with caution.

Table 30: key findings for interventions among general adult population

Study ID	Population of effect	Intervention	Percentage improvement in people controlling their blood pressure	Incremental Unit cost	Incremental cost of intervention	Number of people controlling their blood pressure below 120	Number of people controlling their blood pressure below 140	Total ICER & RAG Rating (lifetime)*
General adult population								
Category 1	**National dietary salt reduction**							
Smith-Spangler et al. 2010	Population prevalence HBP	Government collaboration with food manufacturers to voluntarily cut sodium in processed foods, modelled on the UK experience, and a sodium tax	23%	£0.06	£2,541,562	3,717,981	2,907,652	**-£34,262**
			22%	£0.06	£2,541,562	3,599,741	2,815,182	**-£34,262**
			25%	£0.06	£2,541,562	4,086,834	3,196,114	**-£34,265**
Palar et al. 2009	Population prevalence HBP	Package labelling and changing the regulatory status of salt.	28%	£0.06	£2,541,562	4,588,397	3,588,362	**-£34,268**
			33%	£0.06	£2,541,562	5,404,779	4,226,814	**-£34,271**
			34%	£0.06	£2,541,562	5,674,335	4,437,621	**-£34,272**
			37%	£0.06	£2,541,562	6,134,270	4,797,314	**-£34,273**
Joffres et al. 2007	Population prevalence HBP	Data from Cochrane review of low sodium diet interventions	32%	£0.06	£2,541,562	5,298,431	4,143,644	**-£34,271**
Asaria et al. 2007	Population prevalence HBP	Low salt diets and advise to reduce dietary salt	24%	£0.06	£2,541,562	3,909,269	3,057,249	**-£34,264**
			28%	£0.06	£2,541,562	4,588,397	3,588,362	**-£34,268**

			35%	£0.06	£2,541,562	5,847,622	4,573,140	**-£34,273**
He et al. 2014	Population prevalence HBP	No particular intervention. Assesses 'dietary salt' reduction	27%	£0.06	£2,541,562	4,424,517	3,460,200	**-£34,267**
Aburto et al 2013	Population prevalence HBP	Low salt vs high (normal) salt diets	29%	£0.06	£2,541,562	4,865,112	3,804,767	**-£34,269**
	% of total population who are hbp but not on treatment		28%	£0.06	£1,308,904	4,696,485	1,505,284	**-£35,360**
	% of total population who are on drugs but not controlled		31%	£0.06	£1,181,826	5,075,405	976,040	**-£35,942**
He et al 2013	Population prevalence HBP	Personal behaviour change to reduce dietary salt including brief advice	52%	£0.06	£2,541,562	8,604,204	6,728,929	**-£34,278**
Taylor et al 2011	Population prevalence HBP	Personal behaviour change to reduce dietary salt (restricted diets as well as brief advice)	30%	£0.06	£2,541,562	4,899,170	3,831,402	**-£34,269**
Graudal et al 2011	Population prevalence HBP	Low salt vs high (normal) salt diets	23%	£0.06	£2,541,562	3,751,348	2,933,746	**-£34,263**

Category 2	**Health lifestyle advice and change**							
Zoellner et al 2014	Population prevalence HBP	Behaviour change programme delivered by health educators: nutrition and physical activity education sessions	36%	£54	£2,269,614,830	5,902,734	4,616,241	**-£18,702**
Hartley 2013	Population prevalence HBP	Specific dietary advice to increase fruit and vegetable consumption delivered by a range of clinicians in clinic settings	27%	£26	£1,106,638,437	4,424,517	3,460,200	**-£24,150**
		Provision of fruit and vegetables	22%	£3	£110,452,047	3,651,756	2,855,860	**-£33,064**

Study ID	Population of effect		Intervention	Percentage improvement in people controlling their blood pressure	Incremental Unit cost	Incremental cost of intervention	Number of people controlling their blood pressure below 120	Number of people controlling their blood pressure below 140
Category 3.a. i	**Testing - general practice**							
Erem et al 2008	Population prevalence HBP	Large study examining testing for raised BP in general practice in Turkey.	6%	£17	£734,229,011	1,023,423	800,370	-£5,204
Engstrom et al 2011	Population prevalence HBP	Swedish study evaluating blood pressure testing by dentists in a dental clinic.	3%	£31	£794,555,808	339,655	265,628	£60,551
Category 3.a. ii	**Testing - community pharmacy**							
Mangum et al 2003	Population prevalence HBP	BP reading	4%	£16	£315,153,683	728,539	569,755	**-£16,752**
Category 3.b	**Testing – secondary care**							
No data found								

Study ID	**Population of effect**		**Intervention**	**Percentage improvement in people controlling their blood pressure**	**Incremental Unit cost**	**Incremental cost of intervention**	**Number of people controlling their blood pressure below 120**	**Number of people controlling their blood pressure below 140**
Category 3.c	**Testing - community venues**							
Lucky et al 2011	% of total population who are hbp but not on treatment	BP test	2%	£17	£739,523,931	405,676	317,260	£39,616
Category 3.d	**Testing - home/commercial settings**							
No data found								

*Note: The total ICER (lifetime) is RAG rated in the following ranges – Red(>£30,000), Amber(£20-30,000), Green(£0-20,000),Green (dominant)[<£0]

Category 7	**Education and awareness raising initiatives**							
Kaczorowski et al 2011	% of total population who are hbp but not on treatment	Cardiovascular Health Awareness Program (CHAP):residents aged 65 or over were invited to attend volunteer run cardiovascular risk assessment and education sessions held in community based pharmacies over a 10 week period; automated blood pressure readings and self-reported risk factor data were collected and shared with participants and their family physicians and pharmacists.	10%	£73	£1,585,228,674	1,652,015	529,492	**£26,986**

Table 31: key findings – Adults diagnosed with hypertension

Study ID	Population of effect	Intervention	Documented effect size	Percentage improvement in people controlling their blood pressure below 140	Incremental Unit cost	Incremental cost of intervention	Number of people controlling their blood pressure below 140	Total ICER (lifetime)*
Adults with diagnosed hypertension								
Category 1	**National dietary salt reduction**							
Graudal et al 2011	Two adult populations: normotensive and hypertensive	Low salt vs high (normal) salt diets		23%	£0.06	£775,176	2,933,746	**-£32,472**
Pimenta et al 2009	% of total population who are on drugs but not controlled	Low salt vs high (normal) salt diets		61%	£0.06	£190,617	1,935,576	**-£32,481**

Study ID	Population of effect					Intervention	Documented effect size	Percentage improvement in people controlling their blood pressure below 140
Category 2	**Healthy lifestyle advice and change: improved lifestyle - diet, alcohol, exercise, obesity**							
Dickinson et al 2006	Population prevalence HBP	Advice and supervised activities related to diet changes, exercise, relaxation, alcohol restriction, sodium restriction etc as well as combinations of some of these	Diet	35%	£52	£671,819,545	4,473,139	-£25,015
			Exercise	35%	£26	£332,033,890	4,508,761	-£28,823
			Relaxation	29%	£18	£232,552,919	3,784,847	-£29,429
			Alcohol restriction	29%	£16	£206,067,726	3,718,799	-£29,729
			Sodium restriction	31%	£14	£181,520,473	4,020,191	-£30,240
			Combined interventions	33%	£25	£324,798,911	4,296,635	-£28,725
			Calcium supplements	26%	£3	£41,988,722	3,303,306	-£31,853
			Magnesium supplements	23%	£5	£65,244,013	2,942,474	-£31,383
			Potassium supplements	50%	£6	£71,703,817	6,459,803	-£31,933
			Fish oil supplements	25%	£10	£135,526,674	3,241,605	-£30,406
Horvath 2008	Population prevalence HBP	Interventions for weight loss: weight loss diets, drugs	6kg reduction	37%	£17	£223,939,848	4,833,803	-£30,181
			3kg reduction	23%	£52	£671,819,545	2,913,439	-£21,016

Study ID	Population of effect			Intervention	Documented effect size	Percentage improvement in people controlling their blood pressure below 140	Study ID	Population of effect
Category 4	**Effective primary care management of hypertension**							
Howard et al. 2010	Population prevalence HBP	BP measurement in GP practice + intensive BP control		25%	£329	£4,246,327,678	3,229,902	£32,908
	Population prevalence HBP	As above, but in already diagnosed patients		5%	£53	£169,085,794	158,848	£20,461
Reid et al. 2005	% of total population who are on drugs but not controlled	Hypertension Management Clinic vs usual care		49%	£180	£570,948,481	1,543,999	**-£14,092**
Robson et al. 2014	Population prevalence HBP	Improved system wide management of CHD risk factors		6%	£200	£2,583,921,326	762,257	£136,127

Weber 2010	% of total population who are on drugs but not controlled	Pharmacist-physician co-management - treatment and changes to it involved discussions by physician and pharmacist		8%	£130	£413,003,819	254,156	£48,343

Study ID	Population of effect		Intervention	Documented effect size	Percentage improvement in people controlling their blood pressure below 140	Study ID	Population of effect	Intervention
Category 5	**Drug therapy adherence interventions**							
Parker et al. 2014	% of total population who are on drugs but not controlled	Structured visits with the pharmacist at baseline and 1, 2, 4, and 6 months and telephone calls at 2 weeks and between the in-person visits as needed.		39%	£171	£542,199,885	1,227,142	**-£10,508**
Hacihasanoglu et al. 2011	% of total population who are on drugs but not controlled	6 monthly education sessions, 4 times during clinic visits and 2 home visits. Medication adherence education for	Education and medication adherence	3%	£30	£95,308,574	95,309	£17,255
			Education and medication adherence plus education and healthy lifestyle	18%	£30	£95,308,574	571,851	**-£24,195**

		Groups A and B and education about healthy lifestyle behaviours for Group B were administered in a semi-structured and individualised format.						

Study ID	Population of effect		Intervention	Documented effect size	Percentage improvement in people controlling their blood pressure below 140	Study ID	Population of effect	Intervention
Category 6	**Support for self-management**							
Bray 2010	Population prevalence HBP	Home based self-monitoring of BP		9%	£97	£1,258,270,190	1,162,765	£21,341
Green 2008	Population prevalence HBP	Home BP monitoring and secure patient website training; home BP monitoring and secure patient website training and pharmacist care management web communications		24%	£72	£930,082,481	3,148,141	**-£17,790**
				15%	£104	£1,343,509,893	1,889,528	£2,882
Margolis 2014	Population prevalence HBP	Intervention patients received home BP telemonitors and transmitted BP data to		15%	£121	£1,558,836,671	1,899,182	**£8,341**

		pharmacists who adjusted antihypertensive therapy according						
Zillich 2005	% of total population who are on drugs but not controlled	Pharmacist led adherence improvement programme. 4 pharmacist meetings in 3 months, Patient specific education about hypertension, lasting 15-60 minutes. Hand-outs given. Following baseline and third visit, patient given home blood pressure monitoring equipment and advice on how to use it, instructions to fill out a log book. This was		1%	£78	£247,770,522	39,993	£275,672

		validated and examined at second and fourth visit. Treatment changes if necessary discussed with physician.						
McManus et al. 2010	% of total population who are on drugs but not controlled	Self-monitoring of blood pressure and self-titration of antihypertensive drugs, combined with tele-monitoring of home blood pressure measurements		23%	£252	£800,560,248	721,413	£22,712
Omboni et al. 2013	Population prevalence HBP	home blood pressure measurement + tele-monitoring vs usual care		16%	£124	£394,969,318	2,067,137	**-£22,982**

*Note: The total ICER (lifetime) is RAG rated in the following ranges – Red(>£30,000), Amber(£20-30,000), Green(£0-20,000),Green (dominant)[<£0]

4.0 Scenario analysis

4.1 Introduction

As requested, three implementation scenarios were run through the model to help inform future work. As with the main analysis, the impacts of the scenarios are based on increases in the numbers who are ultimately expected to control their blood pressure. Below, we report the impact on health care costs, social care costs and QALYs over one, five and ten years and the lifetime, while life years gained are estimated over the lifetime. It is key to note that the way the economic model works is to translate all changes into an ultimate impact in the numbers of the population controlling their blood pressure at different thresholds.

As the life years are calculated using average life years lost from the disease, rather than as a simulation of people dying from disease, we don't have data in the model for the proportion of people who will die at different time horizons, and therefore all the life years saved relate to people who die prematurely (before their age of death had they been in full health).

4.2 Scenario 1

What would be the gain in terms of health gain, life years saved, health care costs and social care costs, if England achieved a 5mmHg reduction in the average population systolic blood pressure?

The baseline proportion of the hypertensive population controlling their hypertension is 34%. A 5mmHg reduction in the population systolic blood pressure would be equal to an additional 32% controlling their blood pressure.

Over ten years, an additional 32% of this population controlling would give around **£800mn** savings in health care costs, **£60mn** savings in social care costs, and a gain of over **45,000** QALYs. Over the lifetime, we expect around **140,000** life years to be generated.

Table 32: Scenario 1 results

	1 year	5 year	10 year	Lifetime
QALY	11764	21274	45663	130036
Health care cost savings	£25,992,749	£213,582,217	£795,153,693	£3,517,404,798
Social care cost savings	£0	£0	£60,443,345	£941,560,707
Life years savings	-	-	-	139154

4.3 Scenario 2

What would be the gain in terms of health gain, life years saved, health care costs and social care costs, if England achieved a 15% increase in the proportion of adults who have had their high blood pressure diagnosed?

The baseline percentage of the population who have not been diagnosed is 13% of the general population, or 41% of the whole hypertensive population, meaning that 59% are diagnosed. A 15 percentage point increase in the diagnosed proportion increases the proportion of hypertensives whose condition is diagnosed to 74%.

This is equivalent to around an extra 1.94 mn people diagnosed, of whom we estimate that 1.13mn will control their blood pressure. This is based on the proportion of the overall population diagnosed and treated, who control their blood pressure.

At the ten year time horizon, this change gives health care cost savings due to an increase in those controlling of **£112 million**, social care cost savings of **£11 million**, and over **7,000** QALYs. Approximately **22,000** life years are expected to be generated over the lifetime.

Table 33: Scenario 2 results

	1 year	5 year	10 year	Lifetime
QALY	710	3317	7290	22727
Health care cost savings	£7,126,898	£33,304,559	£112,234,662	£568,598,147
Social care cost savings	£0	£0	£11,031,755	£169,706,192
Life years savings	-	-	-	22142

4.4 Scenario 3

What would be the gain in terms of health gain, life years saved, health care costs and social care costs, if England achieved a 15% increase in the proportion of adults on treatment controlling their blood pressure to 140/90mmHg or below?

Under this scenario, the proportion of people on treatment who control their blood pressure would increase from 58% to 73%. This is equivalent to around an extra 1.14 million people controlling.

At ten years, this increase gives health care cost savings of **£114mn**, social care cost savings of **£11mn**, and over **7,000** QALYs. **22,000** life years are expected to be generated over the lifetime.

Table 34: Scenario 3 results

	1 year	5 year	10 year	Lifetime
QALY	718	3356	7375	22993
Health care cost savings	£7,210,351	£33,694,542	£113,548,885	£575,256,205
Social care cost savings	£0	£0	£11,160,932	£171,693,384
Life years savings	-	-	-	22401

5.0 Discussion

Building on the commentary on the earlier summarised overall results in Section 3.6, this Chapter discusses the findings in relation to the policy setting content and limitations of our project.

High blood pressure has been shown to be associated with a number of conditions which result in premature mortality, morbidity and cost implications for the NHS and personal social services (PSS) in England. Control of blood pressure has been acknowledged as a prime target for the prevention of hypertension-related conditions, particularly coronary heart disease and stroke. With around 13% of the English population estimated to have high blood pressure but not on treatment, public health measures have a role to play in the control of blood pressure at a population level.

For example declines in salt consumption are thought to have largely explained the fall in blood pressure observed in England over the period 2003 to 2011 and therefore to have contributed substantially to improvements in stroke and ischemic heart disease (IHD) mortality[18]. However, an estimated prevalence of hypertension in England of around 30% in England in 2010 indicates that further gains could be achieved.

Decisions about public health measures which might be pursued in the course of reducing blood pressure further will be influenced by a number of factors. In this report, we have attempted to contribute to this discussion by presenting an overall picture of the cost-effectiveness of a range of potential interventions.

While this has not been based on a full systematic review of the literature, estimates are based on key literature identified by PHE and other public health partners, relevant to the measures of interest to the Blood Pressure Systems Leadership Board. In order to estimate cost-effectiveness on a comparable basis for all interventions, an economic model has been developed using the best evidence available for effect sizes, relative risk and disease costs.

Given the time and other resources available, it has not been possible to conduct a dynamic simulation of the population of England. Rather a method akin to that of Joffres et al. (2007) for Canada has been adopted whereby an initial change in blood pressure leads to subsequent reductions in disease from a static population. As explained in the Methods Chapter, this study is also referenced for the way in which population shifts in the distribution of blood pressure are handled. Amongst the group of economic evaluations reviewed, a second study to employ a static population approach is that by Palar and Sturm (2009). Whilst there are limitations of this approach compared with a longitudinal model, the model used for this review has a basis in the published literature and is able to accommodate a wide range of interventions aimed at the control of blood pressure.

Given the different time horizons used by different decision makers a time element is incorporated into the model by phasing in the disease impacts resulting from a change in blood pressure. As shown by the Results, and as discussed in the Conclusion, value for money

[18] He F J, Pombo-Rodrigues S, MacGregor G A (2014). Salt reduction in England from 2003 to 2011: its relationship to blood pressure, stroke and ischaemic heart disease mortality. BMJ Open 4:e004549.

generally becomes more favourable (increasingly cost-effective) as the time horizon lengthens. In addition to varying the time horizon, the results of the model have been stress tested using a number of sensitivity analyses.

As the tables above show, the base case results show salt reduction to be the most cost-effective means of controlling blood pressure both in the general population and in the diagnosed population. Salt reduction is less effective than only than personal behaviour change, and cost by far the lowest of all the measures considered, with the result that it is dominant over the short, medium and long term. Despite the sizeable benefits associated with personal behaviour change, it is not until the ten year time point that the cost-effectiveness of personal behaviour change fall to between £20,000 and £30,000 per QALY, with improved lifestyle becoming dominant over lifetime in the general population.

General population interventions are generally more effective, both in terms of life years and QALYs gained, than diagnosed population interventions. The most effective interventions are also those which generate the greatest health and social care cost savings.

Overall, most blood pressure interventions examined are cost-effective over the long term when compared against a threshold of £20,000 per QALY, either generating QALYs at a lower cost, or yielding both health gains and cost savings. In this analysis, the only exceptions were, of the general population interventions- testing in community venues (£46,900 per QALY gained) and, of diagnosed population interventions- effective primary care management of hypertension (interventions above and beyond standard care) (£33,000 per QALY gained).

In general, interventions which were cost-effective over the long term were also cost-effective over the medium term, although the ICERs for drug therapy adherence interventions and support for self-management in the diagnosed population improved sufficiently in moving from one time period to the other, given the time lags in benefits being realised, that they fell from well above to well below the £20,000 threshold.

The results of the modelling were found to be robust in sensitivity analysis. Varying costs and effects in the model can be seen as one way of addressing variation in population characteristics and therefore exploring, crudely, the issue of health inequalities.

This is not a straightforward policy concern as a social gradient for elevated blood pressure is not perhaps as clear cut as for other risk factors related to cardiovascular disease. For example, evidence linking smoking status with blood pressure suggests that the impact may be small[19]. However, it appears that there may be differences in access to treatment by social and, indeed, ethnic group. Where some groups are harder to reach than others, there may be additional costs involved in identifying those at risk. For the interventions considered here, the results indicate that changes in cost have relatively little effect on cost-effectiveness. Nevertheless, differential access and use of health services by different groups suggests that, as argued by Capewell and Graham 2010[20], population wide interventions may be preferable in terms of addressing health inequalities.

[19] Primatesta P, Falaschetti E, Gupta S, Marmot M G, Poulter N R (2001). Association Between Smoking and Blood Pressure: Evidence From the Health Survey for England. Hypertension 37:187-193.
[20] Capewell S, Graham H (2010). Will cardiovascular disease prevention widen health inequalities? PLoS Medicine 7(8): e1000320. doi:10.1371/journal.pmed.1000320.

6.0 Conclusions

The results of this analysis show salt reductions to be among the interventions with the greatest impact in terms of savings in health and social care costs, these amounting to almost £4bn over the average future lifespan of the current adult population of England (30-40 years). Because of the potentially low cost of population wide changes to dietary salt, reduction in salt consumption generates health benefits and cost savings in the short, medium and long-term.

For other interventions, as we might expect, cost savings take some time to accrue, with the result that incremental cost-effectiveness ratios (ICERs) improve as the time period lengthens. In general, at a lifetime time horizon, many interventions either had an ICER below the NICE reference point of £20,000 per QALY or were dominant. Low cost population wide interventions tended to be more cost effective than more resource intensive blood pressure testing interventions although, in some cases, these interventions nevertheless had an ICER below the higher of NICE's reference points of £30,000 per QALY at lifetime.

The results presented in this report are able to support the work of the Blood Pressure System Leadership Board by highlighting to decision makers those interventions and approaches which provide the best return. Given the results presented here, the key to exploiting the potential public health benefits of blood pressure control may be to define a strategy which includes action across a number of the cost effective interventions, including action to bring about further reductions in dietary salt intake.

7.0 Appendices

7.1 Appendix 1 – Modelling parameter references

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7.2 Appendix 2 – References for included studies

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7.3 Appendix 3 – Summary of included studies & data tables

General population interventions

Category 1: National dietary salt reduction

This category comprised of interventions aimed at reducing the salt content of processed food products and personal diets. Nine studies were included for this category of interventions. They are as follows:

Aburto 2013

This was a systematic review and meta-analyses of randomised controlled trials and prospective cohort studies assessing the way in which the relationships between sodium intake and blood pressure, renal function, blood lipids, and catecholamine levels in non-acutely ill adults and children were mediating factors for all-cause mortality, cardiovascular disease, stroke, and coronary heart disease. They included 64 studies in the review, and report that in adults, a reduction in sodium intake significantly reduced resting systolic blood pressure by 3.39 mm Hg (95% confidence interval 2.46 to 4.31) and resting diastolic blood pressure by 1.54 mm Hg (0.98 to 2.11). When sodium intake was <2 g/day versus ≥ 2 g/day, systolic blood pressure was reduced by 3.47 mm Hg (0.76 to 6.18) and diastolic blood pressure by 1.81 mm Hg (0.54 to 3.08).

Asaria 2007

This study modelled the number of deaths that could potentially be averted over 10 years by the implementation of selected population-based interventions, and calculated the financial costs of their implementation. The salt reduction interventions modelled aimed to reduce salt intake in the population by 15%. The impact of reduction in salt intake (RSI) (g per day) and decrease in mean systolic blood pressure (SBP) (mm hg) were as follows: 30-44 years: RSI 1.70 SBP 1.24; 45-59 years: RSI 1.69 SBP 1.70; 60-69 years: RSI 1.68 SBP 2.34; 70-79 years RSI 1.68 SBP 2.83; 80-100 years: RSI 1.68 SBP 3.46.

Graudal 2011

The objective of this systematic review was to estimate the effects of low sodium versus high sodium intake on systolic and diastolic blood pressure (SBP and DBP). 167 studies were included in this study. It reports that the effect of sodium reduction in normotensive Caucasians was a change in SBP of -1.27 mmHg (i.e. a fall with 95% CI: -1.88, -0.66; p=0.0001) and in DBP of -0.05 mmHg (95% CI: -0.51, 0.42; p=0.85). The effect of sodium reduction in normotensive Blacks was: SBP -4.02 mmHg (95% CI:-7.37, -0.68; p=0.002), DBP -2.01 mmHg (95% CI:-4.37, 0.35; p=0.09). The effect of sodium reduction in normotensive Asians was SBP -1.27 mmHg (95% CI: -3.07, 0.54; p=0.17), DBP -1.68 mmHg (95% CI:-3.29, -0.06; p=0.04). The effect of sodium reduction in hypertensive Caucasians was SBP -5.48 mmHg (95% CI: -6.53, -4.43; p<0.00001) and DBP -2.75 mmHg (95% CI: -3.34, -2.17; p<0.00001). The effect of sodium reduction in hypertensive Blacks was SBP -6.44 mmHg (95% CI:-8.85, -4.03; p=0.00001) and DBP -2.40 mmHg (95% CI:-4.68, -0.12; p=0.04). The effect of sodium reduction in hypertensive Asians was SBP -10.21 mmHg (95% CI:-16.98, -3.44; p=0.003) and DBP -2.60 mmHg (95% CI: -4.03, -1.16; p=0.0004).

He 2013

This systematic review aimed to determine the effects of longer term modest salt reduction on blood pressure, hormones, and lipids. 34 trials (3230 participants) were included and meta-analysis showed that the mean change in urinary sodium (reduced salt v usual salt) was -75 mmol/24 h (equivalent to a reduction of 4.4 g/day salt), and with this reduction in salt intake, the mean change in blood pressure was -4.18 mm Hg (95% confidence interval -5.18 to -3.18, I(2)=75%) for systolic blood pressure and -2.06 mm Hg (-2.67 to -1.45, I(2)=68%) for diastolic blood pressure.

He 2014

This study sought to determine the relationship between the reduction in salt intake that has occurred in England, and blood pressure (BP), as well as mortality from stroke and ischaemic heart disease (IHD) via an analysis of UK census data. It found that, from 2003 to 2011, there was a decrease in mortality from stroke by 42% (p<0.001) and in mortality from IHD by 40% (p<0.001). In parallel, there was a fall in BP of 3.0±0.33/1.4±0.20 mm Hg (p<0.001/p<0.001), and an increase in fruit and vegetable consumption (0.2±0.05 portion/day, p<0.001). Salt intake, as measured by 24h urinary sodium, decreased by 1.4 g/day (p<0.01). It is likely that all of these factors (with the exception of BMI), along with improvements in the treatments of BP, cholesterol and cardiovascular disease, contributed to the falls in stroke and IHD mortality.

Joffres 2007

This economic model estimated the reduction in hypertension prevalence and specific hypertension management cost savings associated with a population-wide reduction in dietary sodium additives in Canadian adults. It found that reducing dietary sodium additives may decrease hypertension prevalence by 30%, resulting in one million fewer hypertensive patients in Canada, and almost double the treatment and control rate. Direct cost savings related to fewer physician visits, laboratory tests and lower medication use are estimated to be approximately $430 million per year. Physician visits and laboratory costs would decrease by 6.5%, and 23% fewer treated hypertensive patients would require medications for control of blood pressure.

Palar 2009

This study modelled the potential societal savings of reducing hypertension and related cardiovascular disease via a reduction in population-level sodium intake in the US. It reports that by reducing average population sodium intake to 2300 mg per day, the recommended maximum for adults would reduce average systolic blood pressure (SBP) by 3.4 mmHg and average diastolic blood pressure by 1.8mmHg and reduce the prevalence of high blood pressure by 28%. This equates to a reduction of hypertension by 11 million people, saves $18 billion health care dollars, and gain 312,000 QALYs that are worth $32 billion annually. In addition, greater reductions in population sodium consumption bring even greater savings to society.

Smith-Spangler 2010

This study modelled the cost-effectiveness of 2 population strategies to reduce sodium intake: government collaboration with food manufacturers to voluntarily cut sodium in processed foods, modelled on the United Kingdom experience, and a sodium tax in the US. It found that collaboration with industry that decreases mean population sodium intake by 9.5% would result in a 1.25–mm Hg decrease in mean SBP of persons aged 40 to 85 years, and averts 513 885 strokes and 480 358 myocardial infarctions (MIs) over the lifetime of these adults who are alive today compared with the status quo, increasing QALYs by 2.1 million and saving $32.1 billion in medical costs. A tax on sodium that decreases population sodium intake by 6% increases QALYs by 1.3 million and saves $22.4 billion over the same period.

Taylor 2011

This review of RCTs, assessed the long term effects of interventions such as restricted diets, aimed at reducing dietary salt on mortality and cardiovascular morbidity. The seven included studies show that systolic blood pressure was reduced in all intervention arms - normotensives (random effects mean difference 1.1mmHg, 95%CI -0.1 to 2.3) hypertensives (fixed effect mean difference 4.1 mmHg, 95% CI 2.4 to 5.8), and those with heart failure (by 4.0 mmHg, 95% CI 0.7 to 7.3). Diastolic blood pressure was also reduced in normotensives (fixed effect mean difference 0.8 mmHg, 95% CI 0.2 to 1.4) but not in hypertensives (random effect mean difference -3.7 mmHg, 95% CI: 0.9 to -8.4) or those with heart failure (mean difference -2.0 mmHg, 0.70 to -4.80).

Category 2: Healthy lifestyle advice and change

This category comprised of interventions aimed at promoting improved lifestyle choices including brief advice to encourage lifestyle change. Two studies were included in this category.

Hartley 2013

This systematic review aimed to determine the effectiveness of i) advice to increase fruit and vegetable consumption ii) the provision of fruit and vegetables to increase consumption, for the primary prevention of CVD. It included 10 trials and reports that trials of dietary advice showed some favourable effects on blood pressure (systolic blood pressure (SBP): mean difference (MD) -3.0 mmHg (95% confidence interval (CI) -4.92 to -1.09), diastolic blood pressure (DBP): MD -0.90 mmHg (95% CI -2.03 to 0.24)) and there was no strong evidence for effects of individual trials of provision of fruit and vegetables on cardiovascular risk factors, but trials were heterogeneous and short term. The interventions were delivered by a range of clinicians in clinic settings.

Zoellner 2014

This 6-month observational study examined the effectiveness of a community based participatory intervention (using a multicomponent behaviour change intervention approach) in achieving improvements in risk factors including blood pressure in an American population. The intervention was delivered by health educators and dietitians/nutritionists. It found that post interventions, blood pressure decreased significantly: mean (± standard deviation) systolic blood pressure decreased from 126.0 ± 19.1 to 119.6 ± 15.8 mm Hg, (P=0.0002) while mean diastolic blood pressure decreased from 83.2 ± 12.3 to 78.6 ± 11.1 mm Hg, (P<0.0001).

Category 3a.i: Testing - General practice

This category comprised of opportunistic testing of individuals by general practice clinicians. Two studies were included for this category.

Engstrom 2011

This Swedish observational study tested the effectiveness of blood pressure screening in dental care centres with subsequent work-up of subjects screening positive, in primary health care.

1,149 subjects 40-65 years old or 20-39 years old with body mass index >25, and with no previously known hypertension, who came for a dental examination had their blood pressure measured. 237 (20.6%) subjects screened positive. Of those who screened positive, 76 (32.1%) received a subsequent diagnosis of hypertension, as compared with 26 (2.9%) of those who screened negative. The number of subjects needed to screen to find one case of hypertension was 18.

Erem 2008

This observational study estimated the prevalence, awareness and control of prehypertension (preHT) and hypertension in an adult Turkish population. A sample of households was systematically selected from the central province of Trabzon and its nine towns. A total of 4809 adult subjects (2601 women and 2208 men) were included in the study. Systolic blood pressure (BP) and diastolic BP levels were measured for all subjects. The prevalence of HT and preHT were 44.0% (46.1% in women and 41.6% in men) and 14.5% (12.6% in women and 16.8% in men), respectively. Testing was undertaken in primary care settings.

Category 3a.ii: Testing – Pharmacy

This category comprised of opportunistic testing of individuals in community pharmacies. One study was included in this category.

Mangum 2003

This US observational study assessed whether a community pharmacist can be successful in identifying and referring patients with elevated blood pressure and/or increased risk of stroke. A total of 351 patients were screened for hypertension. Of these, 216 (62%) had readings greater than 140/90 mm Hg.

Category 3b: Testing – Secondary care

This category comprised of opportunistic testing of individuals in secondary care. No evidence was found for this category. However for the model, we suggest data for other settings is a broadly suitable proxy for this category.

Category 3c: Testing – Community venues

This category comprised of opportunistic testing of individuals in non-clinical community venues. One study was included in this category.

Lucky 2011

This study evaluated the effectiveness of blood pressure [BP] screenings through community-based health fairs in an American population. Of 958 screened, 170 (17.8%) were identified with high BP readings and provided with a primary care physician (PCP) referral. Data were analysed on 124 individuals with high BP recordings. Of the 124 PCP referrals, 116 (93%) either made an appointment with or followed up in person with their PCP following BP screening. Of the 98 who visited their PCP, 29 (30%) were either placed on BP medication, had their current BP medication dose increased, or were changed to another BP medication by their PCP.

Category 3d: Testing – Home/commercial setting

This category comprised of opportunistic testing by individuals in their home. No evidence was found for this category. However for the model, we suggest data for other settings is a broadly suitable proxy for this category.

Category 7: Education and awareness raising initiatives

This category comprised of interventions aimed at improving high blood pressure awareness and education using mass media as well as patient and public networks. One study was included in this category

Kaczorowski 2011

This community cluster randomised trial sought to evaluate the effectiveness of a community based Cardiovascular Health Awareness Program (CHAP), using cardiovascular risk assessment and education, in terms of morbidity from cardiovascular disease, in a Canadian population. CHAP was associated with a 9% relative reduction in the composite end point (rate ratio 0.91, 95% confidence interval 0.86 to 0.97; P = 0.002) or 3.02 fewer annual hospital admissions for cardiovascular disease per 1000 people aged 65 and over.

Interventions for adults with diagnosed hypertension

Category 1: National dietary salt reduction

This category comprised of interventions aimed at reducing the salt content of processed food products and personal diets. One study was included in this category.

Pimenta 2009

This RCT conducted in Australia, examined the effects of dietary salt restriction on office and 24-hour ambulatory blood pressure in subjects with resistant hypertension. The results of the study showed that when participants on low-salt diets were compared to those on high-salt diets, there was a mean difference in reduced office systolic and diastolic blood pressure by 22.7 and 9.1 mm Hg, respectively.

Category 2: Healthy lifestyle advice and change

This category comprised of interventions aimed at promoting improved lifestyle choices including brief advice to encourage lifestyle change. Two studies were included in this category.

Dickinson 2006

This review aimed to evaluate which of many possible lifestyle interventions are effective at reducing high blood pressure. It included 105 trials and reports significant effects for improved diet, increased aerobic exercise, reduced alcohol consumption, dietary sodium restriction and fish oil supplements on blood pressure, with mean reductions in systolic blood pressure of 5.0 mmHg [95% confidence interval (CI): 3.1–7.0], 4.6 mmHg (95% CI: 2.0–7.1), 3.8 mmHg (95% CI: 1.4–6.1), 3.6 mmHg (95% CI: 2.5–4.6) and 2.3 mmHg (95% CI: 0.2–4.3), respectively, with corresponding reductions in diastolic blood pressure.

Horvath 2008

This review examined the effect of weight reduction interventions on the blood pressure of hypertensive patients. It found that reduction of BP in patients treated with weight loss diets was (systolic BP [SBP]: weighted mean difference [WMD], -6.3 mm Hg; diastolic BP [DBP]: WMD, -3.4 mm Hg).

Category 4: Effective primary care management of hypertension

This category comprised of interventions aimed at effective primary care management of hypertension in line with NICE/professional guidelines. Six studies were included in this category.

Howard 2010

This economic model compared intensive management versus usual care for patients with sub optimally managed diabetes and hypertension; and screening for and intensive treatment of diabetes, hypertension, and proteinuria versus usual care in an Australian population. It reports that primary care screening for hypertension (between ages 50 and 69 years) plus intensive blood pressure management had an ICER of $A491 per QALY gained.

Reid 2005

This observational study was conducted in Scotland, and evaluated the impact of a dedicated hypertension management clinic vs usual care on blood pressure (BP) control and prevention of coronary heart disease (CHD). After five months, 74 patients (80%) achieved target level BP in the clinic compared with 27 (40%) with standard GP care; P < 0.001.

Robson 2014

The observational study evaluated CVD managed practice networks in one entire local health economy using practice networks, compared with PCTs in London, England, and local PCTs. Each network had a network manager, administrative support, and an educational budget to deliver financially-incentivised attainment targets in four care packages of which CVD comprised one. Key CVD indicators improved faster in Tower Hamlets than in England, London, or local PCTs, and in 2012/13, Tower Hamlets ranked top in the national Quality and Outcomes Framework for blood pressure and cholesterol control in coronary heart disease (CHD) and diabetes, top five for stroke and top in London for all these measures.

Weber 2010

This US RCT assessed the effect of pharmacist-physician co management of hypertension on ambulatory BP. The results of the study showed that mean (SD) ambulatory systolic BPs (SBPs) were reduced more in the intervention group than in the control group: daytime change in SBP, 15.2 (11.5) vs 5.5 (13.5) (P < .001).

Category 5: Drug therapy adherence interventions

This category comprised of interventions aimed at improving compliance with drug therapy. Two studies were included.

Hacihasanoglu 2011

This 3 group RCT set in Turkey tried to determine the effect of anti-hypertensive patient-oriented education and in-home monitoring for medication adherence and management of hypertension in a primary care setting. Participants in Group A and B received a total of six monthly education sessions, four times during clinic visits and two home visits. Medication adherence education for Groups A and B and education about healthy lifestyle behaviours for Group B were administered in a structured and individualised format. The control group was routinely monitored in health care facilities. Systolic and diastolic blood pressures of subjects in Group A and B showed a significant decrease compared with those of the control group (SBP reduction: group A – 29.9mmHg, group B- 25.1mmHg, control- 1.5mmHg; DBP reductions: group A- 9.8nmmHg, group B- 12mmHg, control- 1.8mmHg).

Parker 2014

This observational study examined blood pressure (BP) control after 6 months of an intensive pharmacist-managed intervention (using structured visits and telephone calls) in a mixed-methods randomized controlled trial conducted in the US. BP was significantly reduced in diabetic patients following an intensive pharmacist intervention (-8.0/-4.0 ± 14.4/9.1 mm Hg systolic/diastolic, P<.001 and P=.001, respectively). BP was reduced even more in non-diabetic patients (-14.0/-5.0 ± 1.9/10.0 mm Hg, P<.001). Medication adherence significantly improved from baseline to 6 months (P=.017).

Category 6: Support for self-management

This category comprised of interventions aimed at improving support for self-management of high blood pressure. Six studies were included in this category.

Bray 2010

The objective of this systematic review was to evaluate the systolic and diastolic BP reduction, and achievement of target BP, associated with self-monitoring. The review included 27 RCTs and reports that office systolic BP (20 RCTs, 21 comparisons, 5,898 patients) and diastolic BP (23 RCTs, 25 comparisons, 6,038 patients) were significantly reduced in those who self-monitored compared to usual care (weighted mean difference systolic -3.82 mmHg (95% confidence interval -5.61 to -2.03), diastolic -1.45 mmHg (-1.95 to -0.94)). Self-monitoring increased the chance of meeting office BP targets (12 RCTs, 13 comparisons, 2,260 patients, relative risk = 1.09 (1.02 to 1.16)).

Green 2008

This 3-group randomized controlled trial was designed to determine if a new model of care that uses patient Web services, home blood pressure (BP) monitoring, and pharmacist-assisted care improves BP control. Participants aged 25-75 were randomly assigned to usual care, home BP monitoring and secure patient Web site training only, or home BP monitoring and secure patient Web site training plus pharmacist care management delivered through Web communications. The results show that patients assigned to the home BP monitoring and Web training only group had a non-significant increase in the percentage of patients with controlled BP (<140/90 mm Hg) compared with usual care (36% [95% confidence interval {CI}, 30%-42%] vs 31% [95% CI, 25%-37%]; P = .21). Adding Web-based pharmacist care to home BP monitoring and Web training significantly increased the percentage of patients with controlled BP (56%; 95% CI, 49%-62%) compared with usual care (P < .001) and home BP monitoring and Web training only (P < .001). Systolic BP was decreased stepwise from usual care to home BP monitoring and Web training only to home BP monitoring and Web training plus pharmacist care. Diastolic BP was decreased only in the pharmacist care group compared with both the usual care and home BP monitoring and Web training only groups.

Margolis 2014

Eight US clinics were randomized to provide usual care to patients (n = 222) and 8 clinics were randomized to provide a tele monitoring intervention (n = 228). Intervention patients received home BP tele monitors and transmitted BP data to pharmacists who adjusted antihypertensive therapy accordingly. Results show that at 18 months (6 months of post intervention follow-up), BP was controlled in 71.8% (95% CI, 65.0% to 77.8%) of patients in the tele monitoring intervention group vs 57.1% (95% CI, 51.5% to 62.6%) of patients in the usual care group (P = .003). Compared with the usual care group, systolic BP decreased more from baseline among patients in the tele monitoring intervention group at 18 months (-6.6 mm Hg [95% CI, -10.7 to -2.5 mm Hg]; P = .004) while diastolic BP also decreased (-3.0 mm Hg [95% CI, -6.3 to 0.3 mm Hg]; P = .07).

McManus 2010

This UK RCT assessed whether self-management by people with poorly controlled hypertension resulted in better blood pressure control compared with usual care. Results showed that mean systolic blood pressure decreased by 17.6 mm Hg (14.9-20.3) in the self-management group and by 12.2 mm Hg (9.5-14.9) in the control group, and the difference between the groups was 5.4 mm Hg, (2.4-8.5; p=0.0004) at 12 months.

Omboni 2013

This review included 23 RCTs and assessed the effectiveness of home blood pressure tele monitoring (HBPT) versus usual care with respect to improvement of BP control. It reported that compared to usual care, HBPT improved office SBP by 4.71 mmHg [95% confidence interval (CI): 6.18, 3.24; P < 0.001] and DBP by 2.45 mmHg (3.33, 1.57; P < 0.001). A larger proportion of patients achieved office BP normalization (<140/90 mmHg for non-diabetic patients and <130/80 mmHg for diabetic patients) in the intervention group [RR: 1.16 (1.04, 1.29); P < 0.001]. HBPT led to a significantly larger prescription of antihypertensive medications [+0.40 (+0.17, +0.62), P < 0.001].

Zillich 2005

This RCT evaluated the effectiveness of a high intensity vs low intensity community pharmacist-assisted home blood pressure (BP) monitoring program in a US community. The assistance from the pharmacist included education and awareness training. Results showed that at the final visit, the difference in SBP/DBP change between the HI and LI group was -4.5/-3.2 mmHg (P=.12 for SBP and P=.03 for DBP).

Study ID	Study type	Country	Intervention category	Intervention	Target population	Outcome measure	Results	Evidence level
Aburto 2013	Systematic review	Multinational	1 (general population)	Low salt vs high salt diets. Advice to reduce salt intake.	Adults and Children	Change in blood pressure	The meta-analysis found that a reduction in sodium intake significantly reduced resting systolic blood pressure by 3.39 mm Hg (95% confidence interval 2.46 to 4.31 mm Hg) and resting diastolic blood pressure by 1.54 mm Hg (0.98 to 2.11) The reduction in systolic blood pressure was greater in studies of participants with hypertension (4.06 mm Hg, 2.96 to 5.15 mm Hg) than in studies of those without hypertension (1.38 mm Hg, 0.02 to 2.74 mm Hg).	1
Asaria 2007	Economic model	Multinational	1 (general population)	Low salt vs high salt diets. Advice to reduce salt intake.	General population	Change in blood pressure	Results of salt reduction intervention: impact of reduction in salt intake (RSI) (g per day) and decrease in mean systolic blood pressure (SBP) (mm hg): 30-44 years: RSI 1.70 SBP 1.24; 45-59 years: RSI 1.69 SBP 1.70; 60-69 years: RSI 1.68 SBP 2.34; 70-79 years RSI 1.68 SBP 2.83; 80-100 years: RSI 1.68 SBP 3.46.	2
Bray 2010	Systematic review	Multinational	6 (diagnosed population)	Home based BP monitoring	Uncontrolled hypertensives	Change in blood pressure	Systolic blood pressure- Weighted mean difference = 3.82 mmHg (CI 95% -5.61 to -2.03) Diastolic Blood pressure- Weighted mean difference = -1.45 mmHg (CI 95% -1.95 to 0.94) Office Target Blood Pressure: Self-monitoring increases the chance of meeting target compared to usual care.	1

Study ID	Study type	Country	Intervention category	Intervention	Target population	Outcome measure	Results	Evidence level
							Relative Risk 1.09. (CI 95% 1.02 to 1.16)	
Dickinson 2006	Systematic review	Multinational	2 (diagnosed population)	Advice and supervised activities related to diet changes, exercise, relaxation, alcohol restriction, sodium restriction.	Adults with blood pressure at least 140/85 mmHg	Change in blood pressure	Mean reduction in BP (mmHg) (CI): Diet: SBP: -6.0(-8.6 to -3.4) P=0.49, DBP: -4.8(-6.9 to -2.7) P=0.25; Exercise: SBP: -6.1 (-10.1 to -2.1) P=0.57, DBP: -3.0 (-4.9 to -1.1) P=0.45; Relaxation: SBP: -4.0 (-6.4 to -1.6) P=0.93, DBP:-3.1 (- 4.7 to -1.5) P=0.68; Alcohol restriction: SBP:-3.8 (-6.1 to -1.4) P=0.71, DBP: -3.2 (-5.0 to -1.4) P=0.73 Sodium restriction: SBP: -4.7 (-7.2 to -2.2) P=0.21, DBP: -2.5 (-3.3 to -1.8) P=0.002 Potassium supplements: SBP: -11.3 (-25.2 to 2.7) P=0.57, DBP: -5.0 (-2.4 to 2.4) P=0.23	1
Engstrom 2011	Observational study	Sweden	3a.i (general population)	Primary care (dental clinic) testing of blood pressure	Adults attending dentist clinic aged 40-65 years old or 20-39 years old with body mass index >25, and with no previously known hypertension	BP reading	237 (20.6%) subjects had blood pressure greater than 140/80 mmHg.	3
Erem I 2008	Observational study	Turkey	3a.i (general	Primary care clinic	Adult population	BP reading	The prevalence of hypertension and pre-hypertension was 44.0% (46.1% in women	3

Study ID	Study type	Country	Intervention category	Intervention	Target population	Outcome measure	Results	Evidence level
			population)	testing of blood pressure			and 41.6% in men) and 14.5% (12.6% in women and 16.8% in men), respectively. Pre-hypertension defined as BO of 120-139/8—89 mmHg.	
Graudal 2011	Systematic review	Multinational	1 (general population)	Low vs high salt diets	Adults populations	Change in blood pressure	The effect of sodium reduction in normotensive people: Caucasians - SBP -1.27 mmHg (95% CI: -1.88, -0.66; p=0.0001), DBP -0.05 mmHg (95% CI: -0.51, 0.42; p=0.85). Blacks - SBP -4.02 mmHg (95% CI:-7.37, -0.68; p=0.002), DBP -2.01 mmHg (95% CI:-4.37, 0.35; p=0.09). Asians - SBP -1.27 mmHg (95% CI: -3.07, 0.54; p=0.17), DBP -1.68 mmHg (95% CI:-3.29, -0.06; p=0.04). Hypertensive population: Caucasians - SBP -5.48 mmHg (95% CI: -6.53, -4.43; p<0.00001), DBP -2.75 mmHg (95% CI: -3.34, -2.17; p<0.00001). Blacks - SBP -6.44 mmHg (95% CI:-8.85, -4.03; p=0.00001), DBP -2.40 mmHg (95% CI:-4.68, -0.12; p=0.04). Asians - SBP -10.21 mmHg (95% CI:-16.98, -3.44; p=0.003), DBP -2.60 mmHg (95% CI: -4.03, -1.16; p=0.0004).	1
Green 2008	RCT	USA	6 (diagnosed population)	Group A - Home BP monitoring and secure	Adults aged 25 to 75 with poorly controlled BP	Percentage of patients with controlled BP	Home BP monitoring, web training and web based pharmacist care increased the percentage of patients with controlled BP (56%; 95%CI, 49%-62%) compared with	2

Study ID	Study type	Country	Intervention category	Intervention	Target population	Outcome measure	Results	Evidence level
				patient website training. Group B- home BP monitoring, secure patient website training and pharmacist care management via web communications		(140/90 mm Hg) and changes in systolic and diastolic BP at 12 months.	usual care (P .001) and home BP monitoring and Web training only (P .001). Compared with usual care, the patients who had baseline systolic BP of 160 mm Hg or higher and received home BP monitoring and Web training plus pharmacist care had a greater net reduction in systolic BP (−13.2 mm Hg [95% CI, −19.2 to −7.1]; P .001) and diastolic BP (−4.6 mm Hg [95% CI, −8.0 to −1.2]; P .001), and improved BP control (relative risk, 3.32 [95% CI, 1.86 to 5.94]; P .001).	

Study ID	Study type	Country	Intervention category	Intervention	Target population	Outcome measure	Results	Evidence level
Hacihasanoglu 2011	RCT	Turkey	5 (diagnosed population)	Participants in Groups A and B received a total of 6 monthly education sessions, 4 times during clinic visits and 2 home visits. Medication adherence education for Groups A and B and education about healthy lifestyle behaviours for Group B were administered in a semi-structured	Patients with hypertension who started medication therapy at least one year prior to start of study	Change in blood pressure	SBP reduction: group A – 29.9 mmHg, group B- 25.1 mmHg, control- 1.5 mmHg. DBD reduction: group A- 9.8 mmHg, group B- 12 mmHg, control- 1.8 mmHg	2

Study ID	Study type	Country	Intervention category	Intervention	Target population	Outcome measure	Results	Evidence level
				and individualised format.				
Hartley 2013	Systematic review	Multinational	2 (general population)	Specific dietary advice to increase fruit and vegetable	General population	Change in blood pressure	Dietary advice showed some favourable effects on blood pressure (systolic blood pressure (SBP): mean difference (MD) -3.0 mmHg (95% confidence interval (CI) -4.92 to -1.09). Diastolic blood pressure (DBP):	1

Study ID	Study type	Country	Intervention category	Intervention	Target population	Outcome measure	Results	Evidence level
				consumption.			MD -0.90 mmHg (95% CI -2.03 to 0.24))	
He 2013	Systematic review	Multinational	1 (general population)	Personal behaviour change to reduce dietary salt and brief advice for behaviour change.	General population	Change in blood pressure	Meta-analysis showed that the mean change in urinary sodium (reduced salt v usual salt) was −75 mmol/24 h (equivalent to a reduction of 4.4 g/day salt), and with this reduction in salt intake, the mean change in blood pressure was −4.18 mm Hg (95% confidence interval −5.18 to −3.18, I2=75%) for systolic blood pressure and −2.06 mm Hg (−2.67 to −1.45, I2=68%) for diastolic blood pressure. Meta-regression showed that a 100 mmol reduction in 24 hour urinary sodium (6 g/day salt) was associated with a fall in systolic blood pressure of 5.8 mm Hg (2.5 to 9.2, P=0.001) after adjustment for age, ethnic group, and blood pressure status.	1
He 2014	Analysis of survey data	UK	1 (general population)	Dietary salt reduction (non-specific)	General population	Change in blood pressure	From 2003 to 2011, there was a decrease in mortality from stroke by 42% (p<0.001) and IHD by 40% (p<0.001). In parallel, there was a fall in BP of 3.0±0.33/1.4±0.20 mm Hg (p<0.001/p<0.001), an increase in fruit and vegetable consumption (0.2±0.05 portion/day, p<0.001). Salt intake, as measured by 24h urinary sodium, decreased by 1.4 g/day (p<0.01). It is likely that all of these factors (with the exception of BMI), along with improvements in the treatments	2

Study ID	Study type	Country	Intervention category	Intervention	Target population	Outcome measure	Results	Evidence level
							of BP, cholesterol and cardiovascular disease, contributed to the falls in stroke and IHD mortality	
Horvath 2008	Systematic review	Multinational	2 (diagnosed population)	Weight loss interventions	Patients with essential hypertension aged 18 years or older (excluding pregnant women)	Total mortality, cardiovascular morbidity, and adverse events, duration and magnitude of BP and body weight reduction.	Reduction of BP was higher in patients treated with weight loss diets (systolic BP [SBP]: weighted mean difference [WMD], −6.3 mmHg; diastolic BP [DBP]: WMD, −3.4mmHg)	1
Howard 2010	Economic model	Australia	4 (diagnosed population)	BP measurement in GP practice plus intensive BP control	Diagnosed adults aged 50-69 years	Incremental cost-effectiveness ratio	Intensive management of hypertension had an incremental cost-effectiveness ratio (ICER) $A2588 per QALY gained. Primary care screening for hypertension (between ages 50 and 69 years) plus intensive blood pressure management had an ICER of $A491 per QALY gained.	2
Joffres 2007	Economic model	Canada	1 (general population)	Reducing dietary sodium additives by 1849 mg/day	General population	Change in blood pressure	Based on data from clinical trials, reducing dietary sodium additives by 1840 mg/day would result in a decrease of 5.06 mmHg (systolic) and 2.7 mmHg (diastolic) blood pressures. Reducing dietary sodium additives may decrease hypertension prevalence by 30%, resulting in one million fewer hypertensive patients in Canada, and	2

Study ID	Study type	Country	Intervention category	Intervention	Target population	Outcome measure	Results	Evidence level
							almost double the treatment and control rate. Direct cost savings related to fewer physician visits, laboratory tests and lower medication use are estimated to be approximately $430 million per year. Physician visits and laboratory costs would decrease by 6.5%, and 23% fewer treated hypertensive patients would require medications for control of blood pressure.	
Kaczorowski 2011	RCT	Canada	7 (general population)	Cardiovascular risk assessment and education sessions	Adults aged ≥65 years	Composite of hospital admissions for acute myocardial infarction, stroke, and congestive heart failure among all community residents aged 65 and over in the year before compared with the year after implementation of CHAP.	CHAP was associated with a 9% relative reduction in the composite end point (rate ratio 0.91, 95% confidence interval 0.86 to 0.97; P=0.002) or 3.02 fewer annual hospital admissions for cardiovascular disease per 1000 people aged 65 and over. Statistically significant reductions favouring the intervention communities were seen in hospital admissions for acute myocardial infarction (rate ratio 0.87, 0.79 to 0.97; P=0.008) and congestive heart failure (0.90, 0.81 to 0.99; P=0.029) but not for stroke (0.99, 0.88 to 1.12; P=0.89).	

Study ID	Study type	Country	Intervention category	Intervention	Target population	Outcome measure	Results	Evidence level
Lucky 2011	Observational study	USA	3c (general population)	BP testing in a community setting	General population	BP greater than 140/90 mmHg	Of the 958 individuals screened, 170 (17.5%) presented with high BP readings and were subsequently referred to their PCPs. Eight individuals (0.04%) were referred to the emergency room due to dangerously high BP recordings (SBP greater than 200 mm Hg and/or DBP greater than 100 mm Hg).	3
Magnum 2003	Observational study	USA	3a.ii (general population)	Community pharmacy testing for BP	General population	BP greater than 140/90 mmHg	216(62%) had readings greater than 140/90 mm Hg.	3
Margolis 2014	RCT	USA	6 (diagnosed population)	Intervention patients received home BP tele-monitors and transmitted BP data to pharmacist who adjusted antihypertensive therapy accordingly. Control	Adults with high blood pressure	Control of systolic BP to less than 140mmHg and diastolic BP to less than 90mmHg	The proportion of patients with BP control at both 6 and 12 months was significantly greater in the tele-monitoring group than in the usual care group. Compared with the usual care group, systolic BP decreased more from baseline among patients in the tele-monitoring intervention group at 6 months (−10.7mmHg [95%CI, −14.3 to −7.3mmHg]; P<.001), at 12 months (−9.7mmHg [95%CI, −13.4 to −6.0mmHg]; P<.001), and at 18 months (−6.6mmHg [95%CI, −10.7 to −2.5mmHg]; P = .004).	2

Study ID	Study type	Country	Intervention category	Intervention	Target population	Outcome measure	Results	Evidence level
				patients had usual care.				
McManus 2010	RCT	UK	6 (diagnosed population)	Self-monitoring of blood pressure and self-titration of antihypertensive drugs, combined with tele-monitoring of home blood pressure measurements vs usual care	Patients aged 35-85 years with blood pressure more than 140/90 mmHg despite antihypertensive treatment	Mean change in systolic blood pressure	Mean systolic blood pressure decreased by 12·9 mm Hg (95% CI 10·4–15·5) from baseline to 6 months in the self-management group and by 9·2 mm Hg (6·7–11·8) in the control group (difference between groups 3·7 mm Hg, 0·8–6·6; p=0·013). From baseline to 12 months, systolic blood pressure decreased by 17·6 mm Hg (14·9–20·3) in the self-management group and by 12·2 mm Hg (9·5–14·9) in the control group (difference between groups 5·4 mm Hg, 2·4–8·5; p=0·0004).	2
Omboni 2013	Systematic review	Multinational	6 (diagnosed population)	Home blood pressure measurement plus tele-monitoring vs usual care	Patients with uncontrolled BP	Mean change in systolic blood pressure	Mean changes in office SBP in the HBPT group were reported in 17 studies (21 comparisons) and were 4.71mmHg (95% CI: 6.18, 3.24) larger than in the control group (P<0.001). A significantly high level of between-studies heterogeneity was detected (I2=52.2%; P=0.003). A sensitivity analysis, excluding those studies with potential bias, did not significantly alter the	1

Study ID	Study type	Country	Intervention category	Intervention	Target population	Outcome measure	Results	Evidence level
							study results, and the range of weighted mean difference (from 4.24 to 4.98 mmHg) was very similar to the overall random effect. Mean changes in office DBP were available from 15 studies (16 comparisons). These changes were significantly (P<0.001) larger in patients randomized to HBPT than in those receiving usual care [2.45mmHg (3.33, 1.57)]	
Palar 2009	Economic model	USA	1 (general population)	Dietary salt reduction	General population	Cost savings	Reducing average population sodium intake to 2300 mg per day, the recommended maximum for adults, may reduce cases of hypertension by 11 million, save $18 billion healthcare dollars, and gain 312,000 QALYs that are worth $32 billion annually. Greater reductions in population sodium consumption bring even greater savings to society.	2
Parker 2014	Observational study	USA	5 (diagnosed population)	Structured visits with the pharmacist at baseline and 1, 2, 4, and 6 months and telephone calls at 2 weeks and	US veterans diagnosed with high blood pressure	Mean reduction in blood pressure	BP was significantly reduced in diabetic patients following an intensive pharmacist intervention (-8.0/-4.0 ±14.4/9.1 mm Hg systolic/diastolic, P<.001 and P=.001, respectively). BP was reduced even more in non-diabetic patients (-14.0/-5.0 ±1.9/10.0 mm Hg, P<.001). Medication adherence significantly improved from baseline to 6 months (P=.017).	3

Study ID	Study type	Country	Intervention category	Intervention	Target population	Outcome measure	Results	Evidence level
				between the in-person visits as needed.				
Pimenta 2009	RCT	USA	1 (diagnosed population)	Low vs high salt diet	Diagnosed patients attending a secondary care clinic	Mean reduction in blood pressure	Low compared to high-salt diet decreased office systolic and diastolic blood pressure by 22.7 and 9.1 mm Hg respectively.	2
Reid 2005	Observational study	UK	4 (diagnosed population)	Pharmacist led clinic	Adult patients with a diagnosis of essential hypertension	Number of people with controlled BP	In 206 patients with established hypertension, the number achieving target level BPs increased from 74 (36%) pre-clinic to 174 (85%) post-clinic; P < 0.001 chi-squared test. After attending the clinic, for 5 months 74 patients (80%) achieved target level BP in the clinic compared with 27 (40%) with standard GP care; P < 0.001 chi-squared test. Of 188 patients assessed for primary prevention therapy, 126 (67%) required treatment with aspirin and 37 (20%) with a statin. Post-clinic 101 (80%) received aspirin compared with 17 (13%) pre-clinic and 34 (92%) received a statin in comparison with 4 (11%) pre-clinic; both P < 0.001 chi-squared test. A total of 52 (96%) of 54 patients received an antiplatelet agent for secondary prevention of artherosclerosis compared with 40 patients (74%) pre-clinic.	3

Study ID	Study type	Country	Intervention category	Intervention	Target population	Outcome measure	Results	Evidence level
							Thirty six of 54 patients required a statin for secondary prevention. Thirty five patients (97%) received a statin compared with 23 (64%) pre-clinic; both P < 0.01 chi squared test.	
Robson 2014	Observational study	UK	4 (diagnosed population)	Improved management of cardio-vascular risk factors.	Diagnosed patients with CHD risk factors	% of patients meeting QOF targets	From 2009 to 2012, blood pressure control in Tower Hamlets improved from 74.9% to 80.8% (5.9%); London 75.0% to 76.7% (1.7%); England 75.5% to 77.4% (1.9%). For stroke, blood pressure control in Tower Hamlets improved from 83.6% to 88.5% (4.9%); London 84.2% to 85.0% (0.8%); England 84.6% to 85.5% (1.1%). For CHD, blood pressure control in Tower Hamlets improved from 87.5% to 91.9% (4.4%); London 87.0% to 87.7% (0.7%); and England 87.1% to 88.1% (1.0%). All differences between Tower Hamlets and London or England were significant (P<0.001). The annual rate of change in Tower Hamlets, 1.24%, was significantly different from that in England, 0.28%, and London, 0.22% (P<0.001).	3
Smith-Spangler 2010	Economic model	USA	1 (general population)	Industrial dietary salt reduction	General population	Change in blood pressure	Collaboration with industry to achieve a 9.5% reduction in population sodium intake would result in a 1.25–mm Hg decrease in mean SBP of persons aged 40 to 85 years. This blood pressure reduction, in turn, would avert 513 885 strokes and 480 358	2

Study ID	Study type	Country	Intervention category	Intervention	Target population	Outcome measure	Results	Evidence level
							MIs and increase life years lived by more than 1.3 million over the lifetime of U.S. adults aged 40 to 85 years alive today, saving $32.1 billion in direct medical costs.	
Taylor 2011	Systematic review	Multinational	1 (general population)	Personal behaviour change to reduce dietary salt (restricted diets as well as brief advice)	General population	Change in blood pressure	There was evidence of substantial statistical heterogeneity. Systolic blood pressure was reduced in all intervention arms - normotensives (random effects mean difference 1.1mmHg, 95%CI -0.1 to 2.3, Chi^2 p-value = 0.05, I^2 = 67%), hypertensives (fixed effect mean difference 4.1 mmHg, 95% CI 2.4 to 5.8, Chi^2 p-value = 0.64; I^2 = 0%) and those with heart failure (by 4.0 mmHg, 95% CI 0.7 to 7.3). Diastolic blood pressure was also reduced in normotensives (fixed effect mean difference 0.8 mmHg, 95% CI 0.2 to 1.4, Chi^2 p-value = 0.39); I^2 = 0%) but not in hypertensives (random effect mean difference -3.7 mmHg, 95% CI: 0.9 to -8.4, Chi^2 p-value = 0.08; I^2 = 67%) or those with heart failure (mean difference -2.0 mmHg, 0.70 to -4.80).	1
Weber 2010	RCT	USA	4 (diagnosed population)	Pharmacist-physician co-management (intervention) -	Patients aged 21–85 years with uncontrolled hypertension, receiving zero to three	Percentage of patients with controlled BP	The results of the study showed that mean (SD) ambulatory systolic BPs (SBPs) were reduced more in the intervention group than in the control group: daytime change in SBP, 15.2 (11.5) vs 5.5 (13.5) (P < .001).	2

Study ID	Study type	Country	Intervention category	Intervention	Target population	Outcome measure	Results	Evidence level
				treatment and changes to it involved discussions by physician and pharmacist vs usual care	antihypertensive agents with no changes to their regimen within the past four weeks.			
Zillich 2005	RCT	USA	6 (diagnosed population)	Pharmacist led adherence improvement programme (4 pharmacist meetings in 3 months, Patient specific education about hypertension, lasting 15-60 minutes	Uncontrolled hypertensive patients over age of 20, taking medication	Change in blood pressure	Results showed that at the final visit, the difference in SBP/DBP change between the HI and LI group was -4.5/-3.2 mmHg (P=.12 for SBP and P=.03 for DBP).	2

Study ID	Study type	Country	Intervention category	Intervention	Target population	Outcome measure	Results	Evidence level
				with hand-outs given) divided into high and low intensity groups. Following baseline and third visit, patient given home blood pressure monitoring equipment and advice on how to use it, instructions to fill out a log book.				
Zoellner 2014	Observational study	USA	2 (general population)	Motivational enhancement, social support provided by	General population	Change in blood pressure	Mean (SD) systolic blood pressure decreased from 126.0 (+/-19.1) to 119.6 1(+/- 5.8) mm Hg, P=0.0002; mean diastolic blood pressure decreased from 83.2 (+/- 12.3) to 78.6 (+/- 11.1) mm Hg, P<0.0001.	3

Study ID	Study type	Country	Intervention category	Intervention	Target population	Outcome measure	Results	Evidence level
				peer coaches, pedometer diary self-monitoring, and monthly nutrition and physical activity education sessions				

7.4 Appendix 4 - Previous cost-effectiveness analyses

Study	Country/setting	Method	Perspective	Time horizon/ discounting	Intervention(s)	Findings
Song et al. (2013)	USA; community setting	Longitudinal (panel) study, with observed BP changes converted into changes in disease risk based on the literature	Health care (emergency department visits avoided by attending a health clinic, avoided costs of myocardial infarction and stroke)	30 months	Mobile health clinic	Savings from blood pressure reduction were estimated at US$0.2m and, from emergency department visits avoided, at US$1.4m, for a total saving of US$1.6m compared with total mobile clinic expenditures of US$1.2m.
Cadilhac et al. (2012)	Australian population aged 30-69, those aged 45-49, those aged 55-84 with high BP or >=15% absolute risk of stroke within 5 years	Population-level microsimulation model	Societal costs associated with the prevention of stroke (health care costs, productivity costs, patient out of pocket and time costs, informal care-giving costs)	Lifetime; 3% p.a. discount rate for costs and benefits	Primary prevention (e.g. older person's health assessment, effectiveness analysis, Well Person's Health Check), secondary prevention of stroke (any antihypertensive, angiotensin converting enzyme inibitor plus diuretic)	Secondary prevention had a cost per QALY of less than $A7,000 compared with a range of $A12,000 (health assessment in those aged 75+) to $A286,000 (the Well Person's Health Check in those aged 45-49) for primary prevention. The intervention aimed at the 75+ age group was cost saving with the inclusion of other vascular diseases.
Dodhia et al. (2012)	English adult population (aged over 16)	Simulation model	Healthcare (cost offsets refer to the number of ischaemic heart	10 years; 3.5% p.a. discount rate for costs and benefits	Scaled up salt reduction in the whole population (resulting in a 2mmHg or	The DASH-sodium diet in those aged 55+ was the most effective at reducing ischaemic heart disease and

Study	Country/setting	Method	Perspective	Time horizon/ discounting	Intervention(s)	Findings
			disease (IHD)/stroke events)		5mmHg reduction in SBP), reduction in blood pressure as a result of reducing average dietary salt intake from 9-10g to 6g; treat all people aged over 55 with a low-dose first line antihypertensive; improvement in detection, treatment and control	stroke (30% and 40% reductions, respectively), followed by improved detection, treatment and control (BP-DTC) and treating everyone over the age of 55 with a low dose first-line antihypertensive (25% reduction in IHD and 33% reduction in stroke). However, over 10 years, the greatest cost savings were achieved by salt reduction leading to a 5mmHg reduction in BP (£1.9bn) and BP-DTC; the former also provided the greatest reduction in DALYs (0.6m)
Yamagishi et al. (2012)	Two Japanese communities	Retrospective comparison of full versus minimal hypertension control interventions	Municipal government (funding public health services – costs of hypertension treatment and stroke)	1964-1987; a 4% discount rate is reported although the body of the text states that "costs were adjusted for changes in the consumer price index but not discounting"	Systematic cardiovascular screening, referral for antihypertensive medication, health education including 'healthy-diet' volunteers, group education and media-disseminated education (minimal	The prevalence and incidence of stroke were consistently lower in the full intervention than in the minimal intervention community; the full intervention community was associated with a saving of Y28,358 per capita over 24 years.

Study	Country/setting	Method	Perspective	Time horizon/ discounting	Intervention(s)	Findings
					intervention did not include the latter two types of education)	
CG 127 (2011)	People in the England population with suspected hypertension (with a screening clinic BP measurement above 140/90)	Markov model	NHS/PSS (reduced costs of hypertension treatment as a result of more accurate diagnosis)	Lifetime; 3.5% p.a. for costs and benefits	Clinic blood pressure monitoring (CBPM), home blood pressure monitoring (HBPM), ambulatory blood pressure monitoring (ABPM)	HBPM and ABPM were associated with increased QALYs in most age groups in men and women relative to CBPM. Both were cost saving compared with CBPM but ABPM was associated with greater cost savings in each age group for men and women.
Bibbins-Domingo et al. (2010)	US population, Medicare population	Coronary Heart Disease Policy Model	Health care	10 years (immediate versus gradual reduction in dietary salt); 3% p.a. discount rate for costs	Decrease in salt consumption by 1g, 2g or 3g per day; smoking cessation; weight loss; statin therapy for primary prevention; antihypertensive therapy for all persons with hypertension	A national decrease in salt consumption by 3g per day is estimated to result in an annual gain of 194,000 to 392,000 QALYs and cost savings of US$10bn to US$24bn. In comparison, antihypertensive therapy for all patients with hypertension is estimated to cost US$6,000 to US$26,000 per QALY gained.
Howard et al. (2010)	Australian population aged 25 and over	Markov model	Health care (glycaemic, hypertension and protein control;	Lifetime; 5% p.a. discount rate for costs and benefits	Improved management of known patients with a chronic kidney disease (CKD)	Among known patients with risk factors for chronic kidney disease (CKD), intensive glycaemic control of

Study	Country/setting	Method	Perspective	Time horizon/ discounting	Intervention(s)	Findings
			dialysis and transplant costs)		risk factor, primary care-based screening strategies for CKD risk factors.	previously uncontrolled diabetics dominated (was more effective and less costly than) conventional management. Population screening strategies were generally not dominant with the exception of some hypertension screening strategies and one proteinuria screening strategy. Diabetes screening strategies all increased costs as well as QALYs and were less favourable than other forms of screening but at a cost per QALY of less than $A17,000.
PH 25 (2010)	England population	Excel model	NHS (angina, myocardial infarction, TIA, stroke)	Lifetime effects from a reduction in the number of cases of disease over 10 years, 3.5% p.a. for costs and benefits	Legislation to reduce salt intake by 3g or 6g per person per day	Reductions in salt intake of 3g and 6g per day were estimated to lead to savings of around £350m and £700m, respectively.
Smith-Spangler et al. (2010)	US adults aged 40 to 85 years	Markov model	Healthcare (costs associated with stroke and myocardial infarction)	Lifetime; 3% p.a. discount rate for costs and benefits	Collaboration with industry to decrease sodium intake; national excise tax on sodium used for food	Collaboration with industry to achieve a 9.5% reduction in population sodium intake would lead to a 1.25mmHg reduction in mean SBP of

Study	Country/setting	Method	Perspective	Time horizon/ discounting	Intervention(s)	Findings
					production that would increase the price of salty foods by 40%	those aged 40-85, generating over 1.3m life years and saving US$32.1bn over their lifetime. A sodium tax giving a 6% decrease in sodium intake and a 0.9mmHg decrease in mean SBP would generate 840,113 life years and save US$22.4bn.
Szucs et al. (2010)	Swiss population aged 80 years or older with sustained systolic blood pressure above 160mmHg	Retrospective analysis of the randomized Hypertension in the Very Elderly Trial (HYVET)	Healthcare (costs of medications, stroke, acute myocardial infarction, heart failure)	Two years; 5% p.a. discount rate for costs	Indapamide and perindopril	Over two years, there was a discounted cost saving of CHF35 and gain in life expectancy of 0.0457 years per patient in the active treatment group compared with the placebo group.
Palar and Sturm (2009)	Noninstitutionalised US adults	Cross-sectional simulation	Healthcare costs (based on the cost per case for hypertension)	Unspecified (immediate?) transition to a lower prevalence of hypertension	Reduction of sodium from 3400mg per day to: 1) 2300mg per day; 2) 1700mg per day; 3) 1500 mg per day; 4) 1200mg per day	A reduction in population blood pressure attributable to a decrease in population sodium consumption to the recommended daily maximum of 2300 mg/day was estimated to generate cost savings of nearly US$18bn in 2005 and 312,000 QALYs through the entire population in one year.
Asaria et al. (2007)	23 low- and middle-income	Modelling approach	Intervention costs only	10 years	15% reduction in salt consumption plus	13.8 million deaths could be averted over 10 years with

Study	Country/setting	Method	Perspective	Time horizon/ discounting	Intervention(s)	Findings
	countries				selected Framework Convention on Tobacco Control (FCTC) population-based control measures	selected measures to reduce tobacco and salt exposure. The mean implementation cost across 23 countries for salt and tobacco strategies was US$0.36. Cost offsets were excluded.
Joffres et al. (2007)	Adult Canadian population with hypertension	Numbers were estimated for those who could control their blood pressure with diet alone	Health care (physician visits, antihypertensive drugs, laboratory costs)	Immediate transition to reduced sodium consumption	Reduction in dietary sodium intake by 1840 mg/day	Prevalence of hypertension is reduced by 30.3%. Savings are estimated at Can$430m per year.
Krakoff (2005)	Hypertensive subjects in the US	Hypertension model	Health care (costs of physician visits, diagnostic tests and medications)	5 years	Ambulatory blood pressure monitoring	Relative to no ambulatory blood pressure monitoring (ABPM), the three ABPM strategies (20% baseline white coat hypertension and 5%, 10% or 20% annual incidence of new hypertension) generated cost savings (US$85,000 to US$153,000 per 1000 participants).

7.5 Appendix 5 – Full results tables

Table 2 – Overview of all interventions

Study ID	Title	Study type	Country	Population of effect	Intervention	Documented effect size	Percentage improvement in people controlling their blood pressure	Unit cost	Total cost
All adults: 'normal BP' & undiagnosed hypertension									
Category 1	National dietary salt reduction								
Smith-Spangler et al. 2010	1.1 Population Strategies to Decrease Sodium Intake and the Burden of Cardiovascular Disease; A Cost-Effectiveness Analysis	Economic model	USA	Population prevalence HBP	1.2 Government collaboration with food manufacturers to voluntarily cut sodium in processed foods, modelled on the United Kingdom experience, and a sodium tax	9.5% reduction in salt consumption	23%	£0.06	£2,541,562
						6% reduction in salt consumption	22%	£0.06	£2,541,562
						20% reduction in salt consumption	25%	£0.06	£2,541,562
Palar et al. 2009	Potential Societal Savings From Reduced Sodium Consumption in the U.S. Adult Population	Economic model	USA	Population prevalence HBP	1.3 Package labelling and changing the regulatory status of salt.	32.35% reduction in salt consumption	28%	£0.06	£2,541,562
						50% reduction in salt consumption	33%	£0.06	£2,541,562

Study ID	Title	Study type	Country	Population of effect	Intervention	Documented effect size	Percentage improvement in people controlling their blood pressure	Unit cost	Total cost
						56% reduction in salt consumption	33%	£0.06	£2,541,562
						65% reduction in salt consumption	37%	£0.06	£2,541,562
Joffres et al. 2007	Estimate of the benefits of a population-based reduction in dietary sodium additives on hypertension and its related health care costs in Canada	Economic model	Canada	Population prevalence HBP	Data from Cochrane review of low sodium diet interventions	23% reduction in salt consumption	32%	£0.06	£2,541,562
Asaria et al. 2007	1.4 Chronic disease prevention: health effects and financial costs of strategies to reduce salt intake and control tobacco use	Economic model	Multiple (23 countries)	Population prevalence HBP	Low salt diets and advise to reduce dietary salt	15% reduction in salt consumption	24%	£0.06	£2,541,562
						30% reduction in salt consumption	28%	£0.06	£2,541,562
						Reduction in salt consumption to under 5g	35%	£0.06	£2,541,562

Study ID	Title	Study type	Country	Population of effect	Intervention	Documented effect size	Percentage improvement in people controlling their blood pressure	Unit cost	Total cost
He et al. 2014	Salt reduction in England from 2003 to 2011: its relationship to blood pressure, stroke and ischaemic heart disease mortality	Analysis of survey data	England	Population prevalence HBP	No particular intervention. Assesses 'dietary salt' reduction	No particular intervention. Assesses 'dietary salt' reduction	27%	£0.06	£2,541,562
Aburto et al 2013	Effect of Lower Sodium intake on health: Systematic Review and Meta-Analyses	Systematic review	International	Population prevalence HBP	Low salt vs high (normal) salt diets	Low salt vs high (normal) salt diets	29%	£0.06	£2,541,562
				% of total population who are hbp but not on treatment	Low salt vs high (normal) salt diets	Low salt vs high (normal) salt diets	28%	£0.06	£1,308,904
				% of total population who are on drugs but not controlled	Low salt vs high (normal) salt diets	Low salt vs high (normal) salt diets	31%	£0.06	£1,181,826
He et al 2013	Effect of longer term modest salt reduction on blood pressure: Cochrane systematic review and meta-analysis of randomised trials	Systematic review	International	Population prevalence HBP	Personal behaviour change to reduce dietary salt including brief advice	Meta analysis of approx a 4.4g reduction in salt consumption per day	52%	£0.06	£2,541,562

Study ID	Title	Study type	Country	Population of effect	Intervention	Documented effect size	Percentage improvement in people controlling their blood pressure	Unit cost	Total cost
Taylor et al 2011	Reduced Dietary Salt for the Prevention of cardiovascular disease - Review	Systematic review	International	Population prevalence HBP	Personal behaviour change to reduce dietary salt (restricted diets as well as brief advice)	Reducing salt (no specific amount) - meta analysis	30%	£0.06	£2,541,562
Graudal et al 2011	Effects of low sodium diet versus high sodium diet on blood pressure, renin, aldosterone, catecholamines, cholesterol, and triglyceride - review	Systematic review	International	Population prevalence HBP	Low salt vs high (normal) salt diets	Low salt vs high (normal) salt diets	23%	£0.06	£2,541,562

Study ID	Title	Study type	Country	Population of effect	Intervention	Documented effect size	Percentage improvement in people controlling their blood pressure	Unit cost	Total cost
Category 2	**Healthy lifestyle advice and change: improved lifestyle – diet, alcohol, exercise, obesity**								
Zoellner et al 2014	HUB City Steps: A 6-Month Lifestyle Intervention Improves Blood Pressure among a Primarily African-American Community	Observational study	USA	Population prevalence HBP	Motivational enhancement, social support provided by peer coaches, pedometer diary self-monitoring, and monthly nutrition and physical activity education sessions	6.4 mmHg reduction	36%	£53.58	£2,269,614,830
Hartley 2013	Increased consumption of fruit and vegetables for the primary prevention of cardiovascular diseases (Review)	Systematic review	International	Population prevalence HBP	Specific dietary advice to increase fruit and vegetable consumption	3 mmHg reduction	27%	£26.13	£1,106,638,437
					Provision of fruit and vegetables	1 mmHg reduction	22%	£2.61	£110,452,047

Category 3.a. i	Testing - General practice								
Erem et al 2008	Prevalence of prehypertension and hypertension and associated risk factors among Turkish adults: Trabzon Hypertension Study	Observational study	Turkey	Population prevalence HBP	Testing for raised BP. PreHT was defined as not being on antihypertensive medication and having an SBP of 120–139 mmHg or DBP of 80–89 mmHg. HT was defined based on the JNC-7 cut-off point of 140 mmHg and above for SBP and/or 90 mmHg and above for DBP	41% are aware of being HT	6%	£17.33	£734,229,011
Engstrom et al 2011	Efficacy of screening for high blood pressure in dental health care	Observational study	Sweden	Population prevalence HBP	BP reading	6.61% correctly identified as hypertensive following dental measurement.	3%	£30.75	£794,555,808
Category 3.a. ii	**Testing - Pharmacy**								
Mangum et al 2003	Identifying at-risk patients through community pharmacy-based hypertension and stroke prevention screening projects.	Observational study	USA	Population prevalence HBP	Opportunistic pharmacy screening and regime change with GP	25% of patients referred to GP went on to control their blood pressure	4%	£16.00	£315,153,683

Category 3.b	**Testing – Secondary care**								
No data found. Data for other settings used a broadly suitable proxy for this category.									
Category 3.c	**Testing – Community venues**								
Lucky et al 2011	Blood Pressure Screenings Through Community Nursing Health Fairs: Motivating Individuals to Seek Health Care Follow-Up	Observational study	USA	% of total population who are hbp but not on treatment	BP test	29 people went on treatment as a result of opportunistic screening (124 people identified)	3%	£17.46	£739,523,931
Category 3.d	**Testing – Home/commercial setting**								
No data found. Data for other settings used a broadly suitable proxy for this category.									

Category 7	Education & awareness raising initiatives								
Kaczorowski et al 2011	Improving cardiovascular health at population level: 39 community cluster randomised trial of Cardiovascular Health Awareness Program (CHAP)	RCT	Canada	% of total population who are hbp but not on treatment	Cardiovascular Health Awareness Program (CHAP):residents aged 65 or over were invited to attend volunteer run cardiovascular risk assessment and education sessions held in community based pharmacies over a 10 week period; automated blood pressure readings and self-reported risk factor data were collected and shared with participants and their family physicians and pharmacists.	Relative risk 1.10 of starting antihypertensive treatment	10%	£72.67	£1,585,228,674

Adults with diagnosed hypertension									
Category 1	**National dietary salt reduction**								
Graudal et al 2011	Effects of low sodium diet versus high sodium diet on blood pressure, renin, aldosterone, catecholamines, cholesterol, and triglyceride - review	Systematic review	International	Two adult populations: normotensive and hypertensive	Low salt vs high (normal) salt diets	Low salt vs high (normal) salt diets	23%	£0.06	£775,176
Pimenta et al 2009	Effects of dietary sodium reduction on blood pressure in subjects with resistant hypertension: results from a randomized trial	Randomised cross-over study	USA	% of total population who are on drugs but not controlled	Low salt vs high (normal) salt diets	Low salt vs high (normal) salt diets	61%	£0.06	£190,617
Category 2	**Healthy lifestyle advice and chaneg: improved lifestyle – diet, alcohol, exercise, obesity**								
Dickinson et al 2006	Lifestyle interventions to reduce raised blood pressure: a systematic review of randomized controlled trials	Systematic review	International	Population prevalence HBP	Advice and well as combinations of some of these	Diet	35%	£52.00	£671,819,545
						Exercise	35%	£25.70	£332,033,890
						Relaxation	29%	£18.00	£232,552,919
						Alcohol restriction	29%	£15.95	£206,067,726
						Sodium restriction	31%	£14.05	£181,520,473
						Combined interventions	33%	£25.14	£324,798,911
						Calcium supplements	26%	£3.25	£41,988,722

						Magnesium supplements	23%	£5.05	£65,244,013
						Potassium supplements	50%	£5.55	£71,703,817
						Fish oil supplements	25%	£10.49	£135,526,674
Horvath 2008	Long-term Effects of Weight-Reducing Interventions in Hypertensive Patients	Systematic review	International	Population prevalence HBP	Interventions for weight loss: weight loss diets, orlistat, or sibutramine	6kg reduction	34%	£17.33	£223,939,848
						3kg reduction	23%	£52.00	£671,819,545
Category 4	**Effective primary care management of hypertension**								
Howard et al. 2010	Cost-Effectiveness of Screening and Optimal Management for Diabetes, Hypertension, and Chronic Kidney Disease: A Modeled Analysis	Economic model	Australia	Population prevalence HBP	BP measurement in GP practice + intensive BP control	RR 0.75	25%	£328.67	£4,246,327,678
				Population prevalence HBP	As above, but in already diagnosed patients	RR 0.95	5%	£53.22	£169,085,794
Reid et al. 2005	Implementation of a pharmacist-led clinic for hypertensive patients in primary care – a pilot study	Observational study	UK	% of total population who are on drugs but not controlled	Hypertension Management Clinic vs usual care	Percentage reaching their target blood pressure reading	49%	£179.72	£570,948,481
Robson et al. 2014	Improving cardiovascular disease using managed networks in general practice: an observational study in	Observational study	UK	Population prevalence HBP	Improved system wide management of CHD risk factors	5.9 percentage point increase in people reaching their BP target	6%	£200.00	£2,583,921,326

	inner London								
Weber 2010	Pharmacist-physician co-management of hypertension reduces 24-hour ambulatory blood pressures	Observational study	USA	% of total population who are on drugs but not controlled	Pharmacist-physician co-management - treatment and changes to it involved discussions by physician and pharmacist	Percentage reaching their target blood pressure reading	8%	£130.00	£413,003,819
Category 5	**Drug therapy adherence interventions**								
Parker et al. 2014	A Mixed-Method Approach to Evaluate a Pharmacist Intervention for Veterans With Hypertension	Observational study	USA	% of total population who are on drugs but not controlled	Structured visits with the pharmacist at baseline and 1, 2, 4, and 6 months and telephone calls at 2 weeks and between the in-person visits as needed.	Percentage reaching their target blood pressure reading	39%	£170.67	£542,199,885
Hacihasanoglu et al. 2011	The effect of patient education and home monitoring on	Observational study	Turkey	% of total population who are on	6 monthly education sessions, 4 times	Education and medication adherance	3%	£30.00	£95,308,574

	medication compliance, hypertension management, healthy lifestyle behaviours and BMI in a primary health care setting			drugs but not controlled	during clinic visits and 2 home visits. Medication adherence education for Groups A and B and education about healthy lifestyle behaviours for Group B were administered in a semi-structured and individualised format.	Education and medication adherence plus education and healthy lifestyle	18%	£30.00	£95,308,574
Category 6	**Support for self-management**								
Bray 2010	Does self-monitoring reduce blood pressure Meta-analysis with meta-regression of RCTs	Systematic review	International	Population prevalence HBP	Home based self-monitoring of BP	RR 1.09 of controlling blood pressure	9%	£97.39	£1,258,270,190
Green 2008	Effectiveness of Home Blood Pressure Monitoring, Web Communication, and Pharmacist Care on Hypertension Control	RCT	USA	Population prevalence HBP	Home BP monitoring and secure patient website training; home BP monitoring and secure patient	People controlling their blood pressure at 140/90 converted to controlling at 120/80	24%	£71.99	£930,082,481

					website training and pharmacist care management web communications	People controlling their blood pressure at 140/90 converted to controlling at 120/80	15%	£103.99	£1,343,509,893
Margolis 2014	Effect of Home Blood Pressure Telemonitoring and Pharmacist Management on Blood Pressure Control A Cluster Randomized Clinical Trial	RCT	USA	Population prevalence HBP	Intervention patients received home BP telemonitors and transmitted BP data to pharmacists who adjusted antihypertensive therapy according	Percentage reaching their target blood pressure reading	15%	£120.66	£1,558,836,671
Zillich 2005	Hypertension Outcomes Through Blood Pressure Monitoring and Evaluation by Pharmacists (HOME Study)	RCT	USA	% of total population who are on drugs but not controlled	Pharmacist led adherence improvement programme. 4 pharmacist meetings in 3 months, Patient specific education about hypertension, lasting 15-60 minutes. Hand-outs given. Following baseline and third visit, patient given home blood	Percentage reaching their target blood pressure reading	1%	£77.99	£247,770,522

					pressure monitoring equipment and advice on how to use it, instructions to fill out a log book. This was validated and examined at second and fourth visit. Treatment changes if necessary discussed with physician.				
McManus et al. 2010	Telemonitoring and self-management in the control of hypertension (TASMINH2): a randomised controlled trial	RCT	UK	% of total population who are on drugs but not controlled	Self-monitoring of blood pressure and self-titration of antihypertensive drugs, combined with tele-monitoring of home blood pressure measurements	Percentage reaching their target blood pressure reading	23%	£251.99	£800,560,248
Omboni et al. 2013	Clinical usefulness and cost effectiveness of home blood pressure tele-monitoring: meta-analysis of randomized controlled studies	Systematic review	Internatio nal	Population prevalence HBP	home blood pressure measurement + tele-monitoring vs usual care	RR 1.16	16%	£124.32	£394,969,318

7.6 Appendix 6 – Full results for all interventions (1 year time horizon)

	Incremental QALY	ICER (Intervention cost/QALY)	Healthcare cost savings	ICER (incl. healthcare and social care cost savings)	Net present value	Social care cost savings
All adults: 'normal BP' & undiagnosed hypertension						
Category 1	**National dietary salt reduction**					
Smith-Spangler et al. 2010	8297	£306	£18,330,979	£-1903	£15,789,417	£0.00
	8033	£316	£17,748,012	£-1893	£15,206,450	£0.00
	9120	£279	£20,149,555	£-1931	£17,607,993	£0.00
Palar et al. 2009	10239	£248	£22,622,439	£-1961	£20,080,877	£0.00
	12061	£211	£26,647,494	£-1999	£24,105,932	£0.00
	12662	£201	£27,976,504	£-2009	£25,434,942	£0.00
	13689	£186	£30,244,146	£-2024	£27,702,584	£0.00
Joffres et al. 2007	11823	£215	£26,123,158	£-1994	£23,581,596	£0.00
Asaria et al. 2007	8723	£291	£19,274,097	£-1918	£16,732,535	£0.00
	10239	£248	£22,622,439	£-1961	£20,080,877	£0.00
	13049	£195	£28,830,868	£-2015	£26,289,306	£0.00
He et al. 2014	9873	£257	£21,814,454	£-1952	£19,272,892	£0.00
Aburto et al 2013	10856	£234	£23,986,743	£-1975	£21,445,182	£0.00
	9119	£144	£9,489,898	£-897	£8,180,994	£0.00
	9446	£125	£6,153,335	£-526	£4,971,509	£0.00
He et al 2013	19200	£132	£42,421,805	£-2077	£39,880,243	£0.00
Taylor et al 2011	10932	£232	£24,154,661	£-1977	£21,613,099	£0.00
Graudal et al 2011	8371	£304	£18,495,486	£-1906	£15,953,924	£0.00
Category 2	Healthy lifestyle advice and change					
Zoellner et al 2014	13172	£172,308	£29,102,591	£170,099	-£2,240,512,240	£0.00
Hartley 2013	9873	£112085	£21,814,454	£109875	-£1,084,823,983	£0.00
	8149	£13554	£18,004,464	£11345	-£92,447,583	£0.00
Category 3.a. i	Testing - General practice					
Erem et al 2008	2284	£321501	£5,045,844	£319292	-£729,183,167	£0.00

	Incremental QALY	ICER (Intervention cost/QALY)	Healthcare cost savings	ICER (incl. healthcare and social care cost savings)	Net present value	Social care cost savings
Engstrom et al 2011	758	£1048317	£1,674,621	£1046107	-£792,881,186	£0.00
Category 3.a. ii	Testing - Pharmacy					
Magnum et al 2003	1626	£193855	£3,591,957	£191645	-£311,561,726	£0.00
Category 3.b	Testing – Secondary care					
Category 3.c	Testing – Community venues					
Lucky et al 2011	905	£816919	£2,000,129	£814709	-£737,523,802	£0.00
Category 3.d	Testing – Home/commercial setting					
Category 7	Education & awareness raising initiatives					
Kaczorowski et al 2011	3208	£494203	£3,338,126	£493162	-£1,581,890,548	£0.00
Adults with diagnosed hypertension						
Category 1	National dietary salt reduction					
Graudal et al 2011	1842	£421	£18,495,486	-£9619	£17,720,310	£0.00
Pimenta et al 2009	1215	£157	£12,202,632	-£9883	£12,012,015	£0.00
Category 2	Healthy lifestyle advice and change: improved lifestyle – diet, alcohol, exercise, obesity					
Dickinson et al 2006	2809	£239173	£28,200,419	£229133	-£643,619,126	£0.00
	2831	£117273	£28,424,995	£107233	-£303,608,895	£0.00
	2377	£97846	£23,861,160	£87807	-£208,691,759	£0.00
	2335	£88243	£23,444,768	£78203	-£182,622,957	£0.00
	2524	£71904	£25,344,860	£61864	-£156,175,613	£0.00
	2698	£120381	£27,087,671	£110341	-£297,711,239	£0.00
	2074	£20242	£20,825,337	£10203	-£21,163,38	£0.00
	1848	£35310	£18,550,507	£25271	-£46,693,507	£0.00
	4056	£17676	£40,725,131	£7637	-£30,978,685	£0.00
	2036	£66579	£20,436,350	£56539	-£115,090,323	£0.00
Horvath 2008	3035	£73776	£30,474,191	£63736	-£193,465,657	£0.00

	Incremental QALY	ICER (Intervention cost/QALY)	Healthcare cost savings	ICER (incl. healthcare and social care cost savings)	Net present value	Social care cost savings
	1830	£367213	£18,367,464	£357174	-£653,452,081	£0.00
Category 4	Effective primary care management of hypertension					
Howard et al. 2010	2028	£2093610	£20,362,566	£2083571	-£4,225,965,112	£0.00
	100	£1695111	£1,001,438	£1685071	-£168,084,356	£0.00
Reid et al. 2005	970	£588873	£9,733,974	£578833	-£561,214,506	£0.00
Robson et al. 2014	479	£5398208	£4,805,566	£5388168	-£2,579,115,760	£0.00
Weber 2010	160	£2587766	£1,602,300	£2577726	-£411,401,518	£0.00
Category 5	Drug therapy adherence interventions					
Parker et al. 2014	771	£703617	£7,736,386	£693577	-£534,463,498	£0.00
Hacihasanoglu et al. 2011	60	£1592471	£600,863	£1582432	-£94,707,711	£0.00
	359	£265412	£3,605,176	£255372	-£91,703,398	£0.00
Category 6	Support for self-management					
Bray 2010	730	£1723272	£7,330,524	£1713232	-£1,250,939,666	£0.00
Green 2008	1977	£470,478	£19,847,114	460438 £	-£910,235,367	£0.00
	1187	£113,294	£11,912,322	£1122255	-£1,331,597,571	£0.00
Margolis 2014	1193	£1307090	£11,973,189	£1297051	-£1,546,863,482	£0.00
Zillich 2005	25	£9865805	£252,134	£9855765	-£247,518,387	£0.00
McManus et al. 2010	453	£1767184	£4,548,070	£1757144	-£796,012,177	£0.00
Omboni et al. 2013	1298	£304275	£13,032,042	£294235	-£381,937,276	£0.00

7.7 Appendix 7 – Full results for all interventions (5 year time horizon)

	Incremental QALY	ICER (Intervention cost/QALY) [£]	Healthcare cost savings	ICER (incl. healthcare and social care cost savings)[£]	Net present value	Social care cost savings
All adults: 'normal BP' & undiagnosed hypertension						
Category 1	**National dietary salt reduction**					
Smith-Spangler et al. 2010	15003	169	£150,625,508	-9870	£148,083,946	£0.00
	14526	175	£145,835,277	-9865	£143,293,715	£0.00
	16492	154	£165,568,732	-9885	£163,027,171	£0.00
Palar et al. 2009	18516	137	£185,888,403	-9902	£183,346,842	£0.00
	21810	117	£218,962,249	-9923	£216,420,687	£0.00
	22898	111	£229,882,712	-9929	£227,341,150	£0.00
	24754	103	£248,515,906	-9937	£245,974,344	£0.00
Joffres et al. 2007	21381	119	£214,653,784	-9921	£212,112,222	£0.00
Asaria et al. 2007	15775	161	£158,375,102	-9878	£155,833,540	£0.00
	18516	137	£185,888,403	-9902	£183,346,842	£0.00
	23597	108	£236,903,012	-9932	£234,361,450	£0.00
He et al. 2014	17854	142	£179,249,196	-9897	£176,707,634	£0.00
Aburto et al 2013	19632	129	£197,098,882	-9910	£194,557,320	£0.00
	12591	103	£126,407,595	-9936	£125,098,690	£0.00
	11697	101	£117,436,357	-9939	£116,254,530	£0.00
He et al 2013	34721	73	£348,579,637	-9966	£346,038,075	£0.00
Taylor et al 2011	19770	129	£198,478,658	-9911	£195,937,096	£0.00
Graudal et al 2011	15138	168	£151,977,266	-9872	£149,435,704	£0.00
Category 2	**Healthy lifestyle advice and change**					
Zoellner et al 2014	23819	95285	£239,135,757	85245	-£2,030,479,073	£0.00
Hartley 2013	17854	61982	£179,249,196	51942	-£927,389,241	£0.00
	14736	7495	£147,942,535	-2544	£37,490,488	£0.00
Category 3.a.i	**Testing - General practice**					
Erem et al 2008	4130	177787	£41,461,659	167747	-£692,767,352	£0.00
Engstrom et al 2011	1371	579709	£13,760,351	£569,669	-£780,795,456	£0.00

	Incremental QALY	ICER (Intervention cost/QALY) [£]	Healthcare cost savings	ICER (incl. healthcare and social care cost savings)[£]	Net present value	Social care cost savings
Category 3.a. ii	**Testing - Pharmacy**					
Magnum et al 2003	2940	107200	£29,515,079	97160	-£285,638,604	£0.00
Category 3.b	**Testing – Secondary care**					
Category 3.c	**Testing – Community venues**					
Lucky et al 2011	1637	451748	£9,088,414	446196	-£730,435,517	£0.00
Category 3.d	**Testing – Home/commercial setting**					
Category 7	**Education & awareness raising campaigns**					
Kaczorowski et al 2011	4429	357925	£44,464,589	347886	-£1,540,764,085	£0.00
Adults with diagnosed hypertension						
Category 1	**National dietary salt reduction**					
Graudal et al 2011	8609	90	£86,430,873	-9950	£85,655,697	£0.00
Pimenta et al 2009	5680	34	£57,023,866	-10006	£56,833,249	£0.00
Category 2	**Healthy lifestyle advice and change: improved lifestyle – diet, alcohol, exercise, obesity**					
Dickinson et al 2006	13126	51181	£131,782,790	41141	-£540,036,755	£0.00
	13231	25095	£132,832,255	15056	-£199,201,635	£0.00
	11107	20938	£111,505,091	10899	-£121,047,828	£0.00
	10913	18883	£109,559,260	8844	-£96,508,466	£0.00
	11797	15387	£118,438,538	5347	-£63,081,935	£0.00
	12608	25761	£126,582,834	15721	-£198,216,076	£0.00
	9693	4332	£97,318,447	-5708	£55,329,726	£0.00
	8635	7556	£86,687,987	-2483	£21,443,974	£0.00
	18956	3783	£190,311,765	-6257	£118,607,948	£0.00
	9512	14247	£95,500,683	4208	-£40,025,991	£0.00
Horvath 2008	14185	15787.41	£142,408,308	5748	-£81,531,540	£0.00
	8549	78580.56	£85,832,615	68541	-£585,986,930	£0.00

	Incremental QALY	ICER (Intervention cost/QALY) [£]	Healthcare cost savings	ICER (incl. healthcare and social care cost savings)[£]	Net present value	Social care cost savings
Category 4	**Effective primary care management of hypertension**					
Howard et al. 2010	9478	448015	£95,155,882	£437,976	-£4,151,171,796	£0.00
	466	362740	£4,679,797	£352,700	-£164,405,996	£0.00
Reid et al. 2005	4531	126014	£45,487,632	115974	-£525,460,849	£0.00
Robson et al. 2014	2237	1155171	£22,456,788	1145132	-£2,561,464,538	£0.00
Weber 2010	746	553760	£7,487,676	543721	-£405,516,143	£0.00
Category 5	**Drug therapy adherence interventions**					
Parker et al. 2014	3601	£150,568.09	£36,152,747	£140,529	-£506,047,138	£0.00
Hacihasanoglu et al. 2011	280	£340,775.59	£2,807,878	£330,736	-£92,500,695	£0.00
	1678	£56,795.93	£16,847,271	£46,756	-£78,461,303	£0.00
Category 6	**Support for self-management**					
Bray 2010	3412	368766	£34,256,118	358726	-£1,224,014,072	£0.00
Green 2008	9238	100678	£92,747,136	£90,639	-£837,335,346	£0.00
	5545	242,302	£55,667,226	232262	-£1,287,842,668	£0.00
Margolis 2014	5573	279706	£55,951,659	269667	-£1,502,885,012	£0.00
Zillich 2005	117	2111200	£1,178,244	2101160	-£246,592,278	£0.00
McManus et al. 2010	2117	378163	£21,253,493	368123	-£779,306,755	£0.00
Omboni et al. 2013	6066	65112	£60,899,765	55073	-£334,069,554	£0.00

7.8 Appendix 8 - Full results for all interventions (10 year time horizon)

	Incremental QALY	ICER (Intervention cost/QALY) [£]	Healthcare cost savings	ICER (incl. healthcare and social care cost savings)[£]	Net present value	Social care cost savings
All adults: 'normal BP' & undiagnosed hypertension						
Category 1	**National dietary salt reduction**					
Smith-Spangler et al. 2010	32203	79	£560,769,668	-17335	£558,228,106	£42,626,721
	31179	82	£542,935,927	-17332	£540,394,365	£41,271,095
	35398	72	£616,402,391	-17342	£613,860,829	£46,855,624
Palar et al. 2009	39742	64	£692,051,298	-17350	£689,509,736	£52,606,050
	46813	54	£815,183,227	-17359	£812,641,665	£61,965,883
	49147	52	£855,839,450	-17362	£853,297,888	£65,056,352
	53131	48	£925,209,709	-17366	£922,668,147	£70,329,510
Joffres et al. 2007	45892	55	£799,143,072	-17358	£796,601,511	£60,746,596
Asaria et al. 2007	33860	75	£589,620,940	-17339	£587,079,378	£44,819,841
	39742	64	£692,051,298	-17350	£689,509,736	£52,606,050
	50648	50	£881,975,605	-17364	£879,434,043	£67,043,084
He et al. 2014	38322	66	£667,333,929	-17347	£664,792,367	£50,727,168
Aburto et al 2013	42138	60	£733,787,233	-17353	£731,245,671	£55,778,594
	26700	49	£493,149,735	-18421	£491,840,831	£32,692,469
	24658	48	£468,335,912	-18946	£467,154,086	£28,980,304
He et al 2013	74524	34	£1,297,740,935	-17380	£1,295,199,373	£98,647,348
Taylor et al 2011	42433	60	£738,924,055	-17354	£736,382,493	£56,169,067

	Incremental QALY	ICER (Intervention cost/QALY) [£]	Healthcare cost savings	ICER (incl. healthcare and social care cost savings)[£]	Net present value	Social care cost savings
Graudal et al 2011	32492	78	£565,802,182	-17335	£563,260,620	£43,009,266
Category 2	**Healthy lifestyle advice and change**					
Zoellner et al 2014	51126	44393	£890,287,981	25655	-£1,379,326,849	£67,674,946
Hartley 2013	38322	28877	£667,333,929	10140	-£439,304,508	£50,727,168
	31629	3492	£550,781,122	-15245	£440,329,075	£41,867,445
Category 3.a. i	**Testing - General practice**					
Erem et al 2008	8864	82831	£154,359,250	64093	-£579,869,760	£11,733,567
Engstrom et al 2011	2942	270085	£51,228,957	251347	-£743,326,850	£3,894,152
Category 3.a. ii	**Testing - Pharmacy**					
Magnum et al 2003	6310	49944	£109,882,856	31207	-£205,270,827	£8,352,709
Category 3.b	**Testing – Secondary care**					
Category 3.c	**Testing – Community venues**					
Lucky et al 2011	3514	210468	£61,186,690	191731	-£678,337,241	£4,651,086
Category 3.d	**Testing – Home/commercial setting**					
Category 7	**Education & awareness raising campaigns**					
Kaczorowski et al 2011	9392	168790	£173,468,218	149095	-£1,411,760,456	£11,499,762
Adults with diagnosed hypertension						

	Incremental QALY	ICER (Intervention cost/QALY) [£]	Healthcare cost savings	ICER (incl. healthcare and social care cost savings)[£]	Net present value	Social care cost savings
Category 1	**National dietary salt reduction**					
Graudal et al 2011	18919	41	£291,267,628	-16868	£290,492,451	£28,629,240
Pimenta et al 2009	12482	15	£192,167,517	-15380	£191,976,900	£0
Category 2	**Healthy lifestyle advice and change: improved lifestyle – diet, alcohol, exercise, obesity**					
Dickinson et al 2006	28846	23290	£444,101,272	6381	-£227,718,273	£43,651,545
	29076	11420	£447,637,915	-5489	£115,604,025	£43,999,168
	24408	9528	£375,766,462	-7381	£143,213,543	£36,934,788
	23982	8593	£369,209,110	-8316	£163,141,384	£36,290,254
	25925	7002	£399,131,824	-9907	£217,611,351	£39,231,414
	27708	11722	£426,577,687	-5187	£101,778,776	£41,929,119
	21302	1971	£327,958,197	-14938	£285,969,476	£32,235,625
	18975	3438	£292,134,089	-13470	£226,890,076	£28,714,406
	41658	1721	£641,340,927	-15188	£569,637,110	£63,038,599
	20904	6483	£321,832,423	-10426	£186,305,750	£31,633,511
Horvath 2008	31172	7184	£479,908,724	-9725	£255,968,876	£47,171,126
	18788	35758	£289,251,529	18849	-£382,568,016	£28,431,074
Category 4	**Effective primary care management of hypertension**					
Howard et al. 2010	20829	203868	£320,670,463	186959	-£3,925,657,215	£31,519,300
	1024	165063	£15,770,679	148155	-£153,315,115	£1,550,129

	Incremental QALY	ICER (Intervention cost/QALY) [£]	Healthcare cost savings	ICER (incl. healthcare and social care cost savings)[£]	Net present value	Social care cost savings
Reid et al. 2005	9957	5734	£153,290,995	40433	-£417,657,485	£15,067,259
Robson et al. 2014	4916	525,65	£75,678,229	508748	-£2,508,243,097	£7,438,555
Weber 2010	1639	251,987	£25,233,086	235078	-£387,770,733	£2,480,207
Category 5	**Drug therapy adherence interventions**					
Parker et al. 2014	7914	68516	£121,832,910	51607	-£420,366,975	£11,975,185
Hacihasanoglu et al. 2011	615	155069	£9,462,407	138160	-£85,846,166	£930,078
	3688	25845	£56,774,443	8936	-£38,534,131	£5,580,466
Category 6	**Support for self-management**					
Bray 2010	7498	167,806	£115,441,367	150897	-£1,142,828,823	£11,346,948
Green 2008	20302	45813	£312,553,110	28905	-£617,529,372	£30,721,430
	12185	110259	£187,595,708	93350	-£1,155,914,185	£18,439,133
Margolis 2014	12247	127279	£188,554,232	110371	-£1,370,282,438	£18,533,348
Zillich 2005	258	960695	£3,970,621	943786	-£243,799,901	£390,280
McManus et al. 2010	4652	172082	£71,623,187	155173	-£728,937,061	£7,039,977
Omboni et al. 2013	13330	29629	£205,229,096	12720	-£189,740,222	£20,172,352

7.9 Appendix 9 - Full results for all interventions (Lifetime time horizon)

	Incremental QALY	ICER (Intervention cost/QALY)[£]	Healthcare cost savings	ICER (incl. healthcare and social care cost savings)[£]	Net present value	Social care cost savings	Life years saved
All adults: 'normal BP' & undiagnosed hypertension							
Category 1	National dietary salt reduction						
Smith - Spangler et al. 2010	91,706	28	£2,480,594,554	-34263	£2,478,052,992	£664,020,918	98136
	88,789	29	£2,401,706,048	-34262	£2,399,164,486	£642,903,554	95015
	100,804	25	£2,726,688,871	-34265	£2,724,147,309	£729,896,969	107872
Palar et al. 2009	113,175	22	£3,061,325,852	-34268	£3,058,784,290	£819,474,669	121111
	133,312	19	£3,606,006,510	-34271	£3,603,464,948	£965,278,162	142660
	139,960	18	£3,785,851,483	34272	£3,783,309,921	£1,013,420,178	149775
	151,305	17	£4,092,714,526	-34273	£4,090,172,964	£1,095,563,179	161915
Joffres et al. 2007	130,689	19	£3,535,052,030	-34271	£3,532,510,468	£946,284,627	139853
Asaria et al. 2007	96,424	26	£2,608,219,697	-34264	£2,605,678,135	£698,184,406	103185
	113,175	22	£3,061,325,852	-34268	£3,058,784,290	£819,474,669	121111
	144,235	18	£3,901,466,159	-34273	£3,898,924,597	£1,044,368,631	154348
He et al. 2014	109,133	23	£2,951,987,248	-34267	£2,949,445,686	£790,206,234	116785
Aburto et al 2013	120,000	21	£3,245,946,988	-£3269	£3,243,405,426	£868,895,199	128415
	72,263	18	£2,043,183,769	-£35360	£2,041,874,864	£513,376,147	81509
	65,012	18	£1,880,747,689	-35942	£1,879,565,863	£457,113,765	75340
He et al 2013	212,227	12	£5,740,626,285	-34278	£5,738,084,723	£1,536,686,407	227109

	Incremental QALY	ICER (Intervention cost/QALY)[£]	Healthcare cost savings	ICER (incl. healthcare and social care cost savings)[£]	Net present value	Social care cost savings	Life years saved
Taylor et al 2011	120,841	21	£3,268,669,993	-3426918	£3,266,128,431	£874,977,833	129314
Graud al et al 2011	92,529	27	£2,502,856,149	-34262	£2,500,314,587	£669,980,039	99017
Category 2	**Healthy lifestyle advice and change**						
Zoellner et al 2014	145,594	15589	£3,938,236,396	-18702	£1,668,621,566	£1,054,211,516	155803
Hartley 2013	109,133	10140	£2,951,987,248	-24150	£1,845,348,811	£790,206,234	116785
	90,072	1226	£2,436,409,689	-33064	£2,325,957,642	£652,193,239	96388
Category 3.a. i	**Testing - General practice**						
Erem et al 2008	25,243	29086	£682,816,382	-5204	-£51,412,628	£182,780,519	27013
Engstrom et al 2011	8,378	94841	£226,614,027	60551	-£567,941,781	£60,661,447	8965
Category 3.a. ii	**Testing - Pharmacy**						
Magnum et al 2003	17,970	17538	£486,072,679	-16752	£170,918,996	£130,114,946	19230
Category 3.b	**Testing – Secondary care**						
Category 3.c	**Testing – Community venues**						
Lucky et al 2011	10,006	73906	£270,662,590	39616	-£468,861,341	£72,452,639	10708
Category 3.d	**Testing – Home/commercial setting**						

	Incremental QALY	ICER (Intervention cost/QALY)[£]	Healthcare cost savings	ICER (incl. healthcare and social care cost savings)[£]	Net present value	Social care cost savings	Life years saved
Category 7	**Education & awareness raising campaigns**						
Kaczorowski et al 2011	25,419	62364	£718,701,484	26,986	-£866,527,189	£180,582,973	28671
Adults with diagnosed hypertension							
Category 1	**National dietary salt reduction**						
Graudal et al 2011	58981	13	£1,475,606,825	-32472	£1,474,831,648	£440,415,813	57461
Pimenta et al 2009	38913	5	£973,550,348	-32481	£973,359,731	£290,569,927	37911
Category 2	**Healthy lifestyle advice and change: improved lifestyle – diet, alcohol, exercise, obesity**						
Dickinson et al 2006	89929	7471	£2,249,885,692	-25015	£1,578,066,148	£671,510,337	87612
	90645	3663	£2,267,802,872	£28823	£1,935,768,982	£676,857,973	88310
	76092	3056	£1,903,690,982	-29429	£1,671,138,063	£568,183,609	74131
	74764	2756	£1,870,470,421	-29729	£1,664,402,696	£558,268,461	72838
	80823	2246	£2,022,063,517	-30240	£1,840,543,044	£603,513,573	78741
	86381	3760	£2,161,108,499	-28725	£1,836,309,589	£645,013,523	84155
	66411	632	£1,661,486,921	-31853	£1,619,498,200	£495,894,367	64700
	59156	1,103	£1,479,996,454	-31383	£1,414,752,441	£441,725,960	57632
	129870	552	£3,249,132,271	-3193	£3,177,428,454	£969,749,669	126524
	65170	£2,079.58	£1,630,452,804	-30406	£1,494,926,131	£486,631,794	63491
Horvath 2008	97180	2304	£2,431,291,781	-30181	£2,207,351,933	£725,653,560	94677
	58573	11470	£1,465,392,956	-21016	£793,573,411	£437,367,339	57064

	Incremental QALY	ICER (Intervention cost/QALY)[£]	Healthcare cost savings	ICER (incl. healthcare and social care cost savings)[£]	Net present value	Social care cost savings	Life years saved
Category 4	**Effective primary care management of hypertension**						
Howard et al. 2010	64935	65394	£1,624,566,135	32908	-£2,621,761,543	£484,874,834	63262
	3194	52947	£79,896,695	20461	-£89,189,099	£23,846,303	3111
Reid et al. 2005	31041	18393	£776,595,877	-14092	£205,647,397	£231,786,068	30241
Robson et al. 2014	15325	168613	£383,397,608	136127	-£2,200,523,718	£114,430,461	14930
Weber 2010	5110	80829	£127,834,712	48343	-£285,169,106	£38,154,085	4978
Category 5	**Drug therapy adherence interventions**						
Parker et al. 2014	24671	21977	£617,224,353	-10508	£75,024,468	£184,219,374	24035
Hacihasanoglu et al. 2011	1916	49742	£47,938,017	17255	-£47,370,556	£14,307,782	1867
	11497	8290	£287,628,103	-24195	£192,319,529	£85,846,692	11200
Category 6	**Support for self-management**						
Bray 2010	23377	53826	£584,843,809	21341	-£673,426,381	£174,554,940	22774
Green 2008	63291	14695	£1,583,442,368	-17790	£653,359,886	£472,600,862	61661
	37988	35367	£950,388,855	28827	-£393,121,038	£283,657,051	37009
Margolis 2014	38182	40827	£955,244,888	8341	-£603,591,783	£285,106,403	37198
Zillich 2005	804	308158	£20,115,778	275672	-£227,654,744	£6,003,839	783
McManus et al. 2010	14503	55198	£362,854,137	22712	-£437,706,111	£108,298,970	14130
Omboni et al. 2013	41558	9504	£1,039,722,327	-22982	£644,753,008	£310,319,894	40488