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Retrospective case review of missed opportunities for primary prevention of stroke and TIA in primary care: protocol paper

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ABSTRACT

Introduction: Stroke is a major health problem and transient ischaemic attack (TIA) is an important risk factor for stroke. Primary prevention of stroke and TIA will have the greatest impact on reducing the burden of these conditions. Evidence-based guidelines for stroke/TIA prevention identify individuals eligible for preventative interventions in primary care. This study will investigate: (1) the proportion of strokes/TIAs with prior missed opportunities for prevention in primary care; (2) the influence of patient characteristics on missed prevention opportunities and (3) how the proportion of missed prevention opportunities has changed over time.

Methods and analysis: A retrospective case review will identify first-ever stroke and patients with TIA between 2000 and 2013 using anonymised electronic medical records extracted from the health improvement network (THIN) database. Four categories of missed opportunities for stroke/TIA prevention will be sought: untreated high blood pressure in patients eligible for treatment (either blood pressure ≥160/100 or ≥140/90 mm Hg in patients at high cardiovascular disease (CVD) risk); patients with atrial fibrillation with high stroke risk and no anticoagulant therapy; no lipid modifying drug therapy prescribed in patients at high CVD risk or with familial hypercholesterolaemia. The proportion of patients with each missed opportunity and multiple missed opportunities will be calculated. Mixed effect logistic regression will model the relationship between demographic and patient characteristics and missed opportunities for care; practice will be included as a random effect.

Ethics and dissemination: THIN data collection was approved by the NHS South East Multi-centre Research Ethics Committee (MREC) in 2003. This study was approved by the independent scientific review committee in May 2013. Dissemination of findings has the potential to change practice, improve the quality of care provided to patients and ultimately reduce the incidence of strokes and TIAs. Findings will be published in a peer-reviewed journal and disseminated at national and international conferences.

INTRODUCTION

Stroke is one of the leading causes of mortality and disability in the UK.[1] Transient ischaemic attack (TIA) is characterised by transient stroke-like symptoms and is an important risk factor for stroke. Given there are approximately 110 000 first strokes and 46 000 first TIAs a year reported in the UK,[1 2] primary prevention is important to reduce the burden of stroke and TIA.[3]

Understanding risk factors for stroke and TIA is important to identify people at high risk and implement preventative intervention. Hypertension is arguably the most well-documented risk factor; a positive and continuous relationship has been shown between increasing blood pressure and stroke.[4 5] Atrial fibrillation is associated with a fivefold increase in stroke risk.[6] In addition, evidence suggests strokes in patients with atrial fibrillation are associated with greater disability and higher mortality rates.[6] Cholesterol has been identified as risk factor for stroke; however, the relationship is not well characterised and is likely to be complex. Epidemiological studies have observed an association between lipid levels and stroke[7] but findings are inconsistent across studies.[8] On the other hand, a systematic review of 26 studies found a 20% reduction in strokes with statin therapy compared with placebo or usual care.[9] Other conditions found to increase stroke risk include diabetes and cardiovascular disease (CVD).[10] In addition, lifestyle factors related to diet, obesity, physical inactivity, smoking and alcohol intake have been identified as risk factors for stroke and, moreover, have been shown to interact with other risk factors to exacerbate the risk. For example, obesity is associated with hypertension and high cholesterol.[11]

Age is an important risk factor; incidence and prevalence of stroke and TIA increases with age[2] and stroke risk doubles every decade over 55 years.[12] Male sex has also been identified as a risk factor with men having a higher incidence of stroke compared with women.[13] Although the mechanism is not fully understood, increased stroke

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incidence has been observed in south Asian and Afro-Caribbean ethnic groups.[14]

A person's stroke and CVD risk is determined by the combination of different risk factors. Multivariable CVD risk equations have been developed to identify high-risk patients and express risk as a probability over a period of time.[15] Multiple risk equations exist, although they differ slightly in the risk factors included, the majority include age, sex, blood pressure, cholesterol, smoking and diabetes.[16] Patients with atrial fibrillation stroke risk is increased by independent risk factors.[17] Stroke risk algorithms for these patients include the risk factors: age, congestive heart failure, hypertension, diabetes and previous stroke or TIA.[6]

Primary care offers the best opportunity to identify people at high risk of stroke and TIA and administer preventative action. Studies have shown that pharmacological treatments reduce risk by a constant proportion.[18] Evidence-based guidelines relevant to stroke prevention have been developed for hypertension, atrial fibrillation and lipid modification. Hypertension guidelines advise antihypertensive drug therapy is initiated in people with sustained blood pressure ≥160/100 mm Hg or a lower threshold of ≥140/90 mm Hg for people with established CVD, diabetes or an estimated CVD risk of ≥20% over 10 years.[19] Atrial fibrillation guidelines recommend patients' stroke risk is assessed using an algorithm and high-risk patients should be prescribed anticoagulant therapy.[6] Lipid modification guidelines advise lipid lowering drug therapy should be initiated in people considered high risk as opposed to measuring blood cholesterol levels. Guidelines regard high risk as people with established CVD, diabetes or an estimated CVD risk of ≥20% over 10 years and endorse prescription of statins.[16]

Despite the extensive evidence-based guidelines to reduce stroke risk, patients who present at hospital with first stroke have been found to have multiple untreated or undertreated risk factors.[20] Furthermore, it has been found that some general practitioners (GPs) accept higher blood pressure thresholds than recommended by the guidelines[21] and overestimate the proportion of their patients with controlled blood pressure.[22] Existing studies of adherence to stroke prevention guidelines are limited as they use hypothetical questionnaires or retrospective interviews, where responses may differ from actual practice, and often focus on only one risk factor. Considering the complexity of the risk factors for first-time stroke and TIA, a large-scale UK study using real-life primary care data to examine the administration of primary prevention is an important and necessary step to reduce the burden of strokes and TIAs on the National Health Service (NHS) and society.

AIMS

The study aims to investigate: (1) the proportion of first strokes and TIAs with prior missed opportunities for prevention in primary care; (2) the influence of patient characteristics on missed prevention opportunities and (3) how proportions of missed prevention opportunities have changed over time.

METHODS AND ANALYSIS

Study design

A retrospective case review of patients with a first-ever stroke or TIA.

Data source

Relevant data will be extracted from the health improvement network (THIN), a large database of anonymised UK electronic primary care records. Data are comprised of over 500 general practices, include 11.9 million patients and cover 6% of the UK population.[23] The information recorded within THIN is comprehensive and includes demographics, diagnoses, prescriptions, additional health information (eg, lifestyle factors), socioeconomic data and free-text comments. Data are coded using drug codes which correspond to British National Formulary (BNF) chapters[24] and Read codes (V.2).[25] THIN data collection was approved by the NHS South East Multi-centre Research Ethics Committee (MREC) in 2003.[26]

Population

Patients with stroke and TIA between 2000 and 2013 will be identified and relevant data extracted from the THIN database. This study will investigate primary prevention of stroke and TIA; therefore, will comprise of patients with first-ever stroke and TIA. However, as TIA is a risk factor for stroke, patients will be categorised into three groups: stroke only, TIA only, stroke with a history of TIA. To exclude childhood stroke, only patients with a diagnosis of stroke or TIA over 18 years will be included in the study. Date of stroke or TIA will be taken as the index date, and patients must be registered for at least 1 year prior to the index date to allow sufficient time for risk factor data to be recorded. To ensure data quality, the index date must occur at least 1 year after the practice had begun using Vision software, and after the practice date of acceptable mortality recording, the year mortality rates for the practice correspond to expected regional mortality rates.[27]

Outcomes

Four missed opportunities for primary stroke and TIA prevention have been defined through consulting relevant guidelines[6 16 19] and encompass the risk factors hypertension, atrial fibrillation and dyslipidaemia. The missed opportunities will be defined as:

1. *Untreated high blood pressure*: Patients with an average of three blood pressure recordings ≥160 mm Hg for systolic or ≥100 mm Hg for diastolic but no antihypertensive medication has been prescribed.

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2. *Untreated moderately high blood pressure and at high CVD risk*: Patients with an average of three blood pressure recordings ≥140 mm Hg for systolic or ≥90 mm Hg for diastolic and have a history of coronary heart disease (CHD), peripheral arterial disease (PAD), chronic kidney disease (CKD), diabetes mellitus and over 40 years or an estimated CVD risk of ≥20% over 10 years but no antihypertensive medication has been prescribed.
3. *Atrial fibrillation and at high risk of stroke with no anticoagulant therapy prescribed*: Patients with atrial fibrillation and a CHADS2 score ≥1 but no anticoagulant medication prescribed.
4. *Patients at high CVD risk or with familial hypercholesterolaemia and no lipid-modifying drug therapy prescribed*: High CVD risk will be defined as having a history of CHD, PAD, CKD, diabetes mellitus and over 40 years or an estimated CVD risk of ≥20% over 10 years.

Definition of outcomes and variables

Stroke/TIA

A comprehensive list of stroke and TIA Read codes has been developed to identify the eligible population (see online supplementary appendix 1). A systematic search strategy was conducted to ensure all relevant Read codes were included:

1. Quality Outcomes Framework (QOF)[28] stroke and TIA Read codes were reviewed for relevance to the study's eligibility criteria. To capture first stroke and TIA, Read codes relating to history of stroke or TIA were removed.
2. To identify additional Read codes not included in QOF, we conducted a hierarchy screening of QOF stroke and TIA Read codes and key word searches using STATA V.12 (College Station, Texas, USA).
3. Literature was searched for additional Read codes and a clinician was consulted.

Missed opportunities variables

To identify patients with blood pressure ≥160/100 or ≥140/90 mm Hg, the average of the three most recent systolic and diastolic blood pressure recordings within 3 years prior to the index date will be used. Diagnoses of atrial fibrillation, CHD, CKD, diabetes mellitus and PAD will be identified using QOF Read codes (V.27).[28] In addition, where present, Read codes indicating history of diagnosis will be used. Similarly, where available, we have identified 'resolved' Read codes (eg, 212H.00 diabetes resolved), which will be used to indicate if the condition resolved before the index date (see online supplementary appendix 2). Familial hypercholesterolaemia is poorly coded in primary care but is associated with total cholesterol of ≥9 mmol/L.[29] Therefore, in addition to Read codes for familial hypercholesterolaemia, total cholesterol of ≥9 mmol/L (most recent record prior to index date) will be used to indicate familial hypercholesterolaemia.

A missed opportunity will be identified if a patient was eligible for primary prevention drug therapy but was not on relevant treatment at the time of stroke or TIA. To determine if patients were on antihypertensive, anticoagulant or lipid-modifying drug therapies before their stroke or TIA, the most recent prescriptions for these drugs prior to the index date will be extracted. Prescriptions will be identified using drug codes corresponding to relevant BNF chapters (V.67) and relevant Read codes (eg, 66Q..11, anticoagulant monitoring; see online supplementary appendix 3). In primary care, 90 days is the maximum prescribing length for any treatment. Therefore, a missed opportunity will be recorded when patients were eligible for treatment but their most recent prescription was over 90 days from the index date and consequently were not on treatment at the time of stroke or TIA. However, prescribing anticoagulant therapy usually involves referral to an anticoagulant clinic; to account for this, an additional lag period of 30 days will be allowed for anticoagulant prescribing (ie, 120 days from the index date). The length of the lag period was determined though consultation with eight practising GPs.

The Framingham risk equation will be used to calculate CVD risk over 10 years (table 1). This risk equation was chosen as it can be incorporated within Vision, the electronic system used by general practices that contribute to the THIN database. In addition, it was the risk score recommended by the guidelines during the majority of the study period[16] and the equation is freely available. For consistency, the Framingham CVD risk will be calculated at the index date for all eligible patients and in accordance with Vision calculations.[30] As recommended by the guidelines, the Framingham CVD risk will be adjusted for South Asian ethnicity and family history of premature CHD.[16] The CHADS2 score will be used to determine stroke risk for patients with atrial

Table 1 Variables required for the Framingham cardiovascular disease risk equation

Variable	Criteria	Default value
Age*	30–74	†
Sex	Male/female	†
Systolic blood pressure	Most recent record prior to index date	†
Total cholesterol	Most recent record prior to index date	6.0
HDL cholesterol	Most recent record prior to index date	Female: 1.4 Male: 1.15
Smoking	Yes/no	
Diabetes mellitus	Yes/no	
ECG-LVH	Yes/no	

*Age at index date.
†Mandatory field.
HDL, high-density lipoprotein; LVH, left ventricular hypertrophy.

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fibrillation (table 2). Similar to the Framingham risk equation, CHADS2 will be used because it can be incorporated within Vision and it will be calculated at the index date in compliance with Vision calculations.

Predictor variables

Sociodemographic variables will be extracted including Townsend deprivation quintiles,[31] urban rural scores,[31] strategic health authority[32] and ethnicity. Comorbidities will be identified and defined by QOF Read codes (QOF business rules V.27; see online supplementary appendix 2).[33] To document patients' contact with primary care before their stroke or TIA, the number of consultations in the year prior to the index date and length of registration will be extracted for each patient. In addition, Read codes indicating exceptions for initiating stroke prevention drug therapy will be extracted including white coat hypertension and contraindications to prescribing antihypertensive, anticoagulant or lipid-modifying drugs (eg, 8I3N.00, hypertension treatment refused; see online supplementary appendix 4).

Predictor variables encompassing modifiable and non-modifiable risk factors for stroke and TIA will be extracted. Non-modifiable risk factors include sex and age at index date, whereas modifiable risk factors relate to lifestyle: body mass index (BMI), smoking and alcohol intake. GPs initiating lifestyle interventions has been reported to delay initiation of antihypertensive drug therapy by up to 12 months;[21] therefore, we have also identified Read codes indicating lifestyle interventions related to smoking, alcohol intake, diet, exercise and weight (see online supplementary appendix 5).

Quality checks, missing data and extreme values

Absence of a diagnosis code will be taken to indicate the diagnosis is not present. For categorical variables (eg, smoking status), a separate 'missing' category will be created. Extreme values for blood pressure, total and high-density lipoprotein cholesterol, height and BMI will be identified using the ranges seen in the Health Survey for England statistics as a guide[34] and excluded. Incidence of stroke and TIA diagnoses will be investigated over time to check for indication of unusual variation which might indicate incorrect clinical coding. If appropriate, a cut-off date will be introduced for quality of reporting.

Table 2 Variables required for the CHADS2 stroke risk equation for patients with atrial fibrillation

	Variable	Points
C	Congestive heart failure	1
H	Hypertension	1
A	Age ≥75 years	1
D	Diabetes mellitus	1
S2	Prior stroke or TIA	2

TIA, transient ischaemic attack.

Analysis

The primary analysis will calculate the proportion of strokes and TIAs with missed opportunities for primary prevention drug therapy. Proportions will be calculated for each missed opportunity: untreated high blood pressure; untreated moderately high blood pressure and high CVD risk; atrial fibrillation and high risk of stroke with no anticoagulant therapy prescribed; high CVD risk or with familial hypercholesterolaemia and no lipid-modifying drug therapy prescribed. In addition, the proportion of patients with two, three or four missed opportunities will be calculated.

Secondary analysis will comprise of multivariable logistic regression modelling to predict the effect of demographic and patient characteristics on missed opportunities. The logistic regression model will be mixed effect and include practice as a random effect. Year of stroke will be included to investigate how missed opportunities have changed over time. We aim to develop a model that fits the data well, is biologically meaningful and can be meaningfully interpreted. To achieve this, explanatory variables will be entered into the logistic regression model which have been prespecified and informed through literature searches and clinical input (table 3). There is compelling evidence from the literature that age and sex are important predictors of non-adherence to guidelines in primary care;[21 35 36] therefore, these variables will be included in the model regardless of statistical contribution. Although the other prespecified variables have been informed through the literature and clinical advice, the evidence is limited; for that reason, a backwards elimination approach will be adopted to inform model selection. Backwards elimination will be used as it is favourable over forwards or stepwise selection.[37] Traditionally, a p value of >0.1–0.2 is used as a criteria to eliminate variables. However, our sample size is expected to be large and consequently we will use a p-to-eliminate value of >0.05. Exploratory analysis will be conducted to explore the relationship of the effect of consultation frequency in the year prior to the index date and duration of registration on missed opportunities for stroke and TIA prevention.

DISCUSSION

This study will quantify the proportion of patients in whom opportunities to prevent strokes and TIAs were missed. In addition, it will identify the risk factors with the highest proportion of untreated patients. The results of the regression model will be important to provide insight into patient characteristics that predict missed prevention opportunities. Dissemination of these findings to GPs will raise awareness of patients who are vulnerable to not being prescribed relevant stroke and TIA prevention pharmacotherapy when eligible. Furthermore, the findings have the potential to change practice and improve patient care.

The strength of this study is that data are available from over 500 general practices and reflect actual practice.

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Table 3 Explanatory variables for logistic regression modelling

Variable	Categories
Age	5 year age bands
Sex	Male, female
Townsend deprivation quintiles	1, 2, 3, 4 ,5, Missing
Urban/rural score	Urban, rural, missing
Strategic health authority	East of England, East Midlands, London, North East, North West, South Central, South East Coast, South West, West Midlands, Yorkshire and the Humber
Country	England, Northern Ireland, Scotland, Wales
BMI	Healthy, overweight, obese, missing
Smoking status	Current smoker, ex-smoker, non-smoker, missing
Alcohol intake	High, moderate, low, never, missing
Comorbidities: asthma/atrial fibrillation/cancer/CHD/CKD/ COPD/dementia/depression/diabetes mellitus/epilepsy/heart failure/hypertension/hypothyroidism/learning disabilities/ mental health/osteoporosis/palliative care/rheumatoid arthritis	Individually entered: yes/no Number of comorbidities
Lifestyle intervention	Yes/no
Year of stroke	Year
GP practice	Random effect

BMI, body mass index; CHD, coronary heart disease; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; GP, general practitioner.

However, the data will be extracted from routinely collected electronic medical records and, therefore, does not capture the decision-making process which occurs during a consultation. For instance, patients' preferences and GPs knowledge of patient's adherence to medication.[38] Although our study will include comorbidities in the regression model and report Read codes which indicate contraindications for medications, there may be other legitimate reasons for not prescribing stroke prevention drug therapy and patients might decline antihypertensive, anticoagulant or lipid-lowering drug therapy. Inevitably, there will be missing data and errors in data entry; however, this is expected to be a small proportion of the population and we will exclude extreme values and incorporate missing data as a category in the analysis. The use of QOF Read codes to identify comorbidities is likely to result in missing diagnoses that have been recorded using alternative Read codes. However, the use of QOF Read codes provides a consistent method to identify diagnoses and, since being introduced, GPs are incentivised to use QOF Read codes.

In conclusion, this study will offer an insight into whether stroke and TIA risk factors are being managed adequately in UK primary care. Primary prevention of stroke and TIA is important to reduce the burden of these conditions on the NHS and society. If optimal rates of prevention are not being delivered in primary care, dissemination of our findings will be important and further research should be conducted to identify barriers to guideline adherence and intervention(s) to overcome these.

ETHICS AND DISSEMINATION

Individual studies using THIN data do not require separate ethical approval but must be approved by the independent Scientific Review Committee (SRC). The findings will be disseminated through publication in a peer-reviewed journal and presented at national and international conferences.

Contributors GMM led the design of the study as doctoral research supervised by TM, MC and MGF. GMM drafted the manuscript. TM, MC and MGF provided feedback on the manuscript and all authors approved the final version.

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Competing interests None.

Ethics approval This study was approved by the SRC on 31 May 2013 (reference number: 13-023)

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Appendices

Appendix 1: Read code lists for stroke and transient ischaemic attack (TIA)

Stroke Read codes

Read code	Description
G60..00	Subarachnoid haemorrhage
G600.00	Ruptured berry aneurysm
G601.00	Subarachnoid haemorrhage from carotid siphon and bifurcation
G602.00	Subarachnoid haemorrhage from middle cerebral artery
G603.00	Subarachnoid haemorrhage from anterior communicating artery
G604.00	Subarachnoid haemorrhage from posterior communicating artery
G605.00	Subarachnoid haemorrhage from basilar artery
G606.00	Subarachnoid haemorrhage from vertebral artery
G60X.00	Subarachnoid haemorrhage from intracranial artery, unspecified
G60z.00	Subarachnoid haemorrhage NOS
G61..00	Intracerebral haemorrhage
G61..11	CVA - cerebrovascular accident due to intracerebral haemorrhage
G61..12	Stroke due to intracerebral haemorrhage
G610.00	Cortical haemorrhage
G611.00	Internal capsule haemorrhage
G612.00	Basal nucleus haemorrhage
G613.00	Cerebellar haemorrhage
G614.00	Pontine haemorrhage
G615.00	Bulbar haemorrhage
G616.00	External capsule haemorrhage
G617.00	Intracerebral haemorrhage, intraventricular
G618.00	Intracerebral haemorrhage, multiple localized
G61X.00	Intracerebral haemorrhage in hemisphere, unspecified
G61X000	Left sided intracerebral haemorrhage, unspecified
G61X100	Right sided intracerebral haemorrhage, unspecified
G61z.00	Intracerebral haemorrhage NOS
G62..00	Other and unspecified intracranial haemorrhage
G62z.00	Intracranial haemorrhage NOS
G630.00	Basilar artery occlusion
G631.00	Carotid artery occlusion
G631.11	Stenosis, carotid artery
G631.12	Thrombosis, carotid artery
G632.00	Vertebral artery occlusion

G63y000	Cerebral infarct due to thrombosis of precerebral arteries
G63y100	Cerebral infarction due to embolism of precerebral arteries
G63z.00	Precerebral artery occlusion NOS
G64..00	Cerebral arterial occlusion
G64..11	CVA - cerebral artery occlusion
G64..12	Infarction – cerebral
G64..13	Stroke due to cerebral arterial occlusion
G640.00	Cerebral thrombosis
G640000	Cerebral infarction due to thrombosis of cerebral arteries
G641.00	Cerebral embolism
G641.11	Cerebral embolus
G641000	Cerebral infarction due to embolism of cerebral arteries
G64z.00	Cerebral infarction NOS
G64z.11	Brainstem infarction NOS
G64z.12	Cerebellar infarction
G64z000	Brainstem infarction
G64z100	Wallenberg syndrome
G64z111	Lateral medullary syndrome
G64z200	Left sided cerebral infarction
G64z300	Right sided cerebral infarction
G64z400	Infarction of basal ganglia
G66..00	Stroke and cerebrovascular accident unspecified
G66..11	CVA unspecified
G66..12	Stroke unspecified
G66..13	CVA - Cerebrovascular accident unspecified
G660.00	Middle cerebral artery syndrome
G661.00	Anterior cerebral artery syndrome
G662.00	Posterior cerebral artery syndrome
G663.00	Brain stem stroke syndrome
G664.00	Cerebellar stroke syndrome
G665.00	Pure motor lacunar syndrome
G666.00	Pure sensory lacunar syndrome
G667.00	Left sided CVA
G668.00	Right sided CVA
G671000	Acute cerebrovascular insufficiency NOS
G676000	Cerebral infarct due cerebral venous thrombosis, nonpyogenic
G677000	Occlusion and stenosis of middle cerebral artery
G677100	Occlusion and stenosis of anterior cerebral artery
G677200	Occlusion and stenosis of posterior cerebral artery
G677300	Occlusion and stenosis of cerebellar arteries
G6W..00	Cerebral infarct due unspecified occlusion/stenosis precerebral arteries
G6X..00	Cerebral infarction due/unspecified occlusion or stenosis/cerebral arteries
Gyu6000	[X]Subarachnoid haemorrhage from other intracranial arteries
Gyu6100	[X]Other subarachnoid haemorrhage

Gyu6200	[X]Other intracerebral haemorrhage
Gyu6300	[X]Cerebral infarction due/unspecified occlusion or stenosis/cerebral arteries
Gyu6400	[X]Other cerebral infarction
Gyu6500	[X]Occlusion and stenosis of other precerebral arteries
Gyu6600	[X]Occlusion and stenosis of other cerebral arteries
Gyu6E00	[X]Subarachnoid haemorrhage from intracranial artery, unspecified
Gyu6F00	[X]Intracerebral haemorrhage in hemisphere, unspecified
Gyu6G00	[X]Cerebral infarct due unspecified occlusion/stenosis precerebral arteries
Fyu5600	[X]Other lacunar syndromes
Fyu5700	[X]Other vascular syndromes/brain in cerebrovascular diseases

TIA Read codes

Read code	**Description**
G65..00	Transient cerebral ischaemia
G65..11	Drop attack
G65..12	Transient ischaemic attack
G65..13	Vertebro-basilar insufficiency
G650.00	Basilar artery syndrome
G650.11	Insufficiency - basilar artery
G651.00	Vertebral artery syndrome
G651000	Vertebro-basilar artery syndrome
G652.00	Subclavian steal syndrome
G653.00	Carotid artery syndrome hemispheric
G654.00	Multiple and bilateral precerebral artery syndromes
G656.00	Vertebrobasilar insufficiency
G657.00	Carotid territory transient ischaemic attack
G65y.00	Other transient cerebral ischaemia
G65zz00	Transient cerebral ischaemia NOS
Fyu5500	[X]Other transient cerebral ischaemic attacks+related syndromes

Appendix 2: Read codes for diagnoses including history of and resolved Read codes

Diagnosis	**Read codes**
Atrial fibrillation	G573.% (excluding G5731, G5736)
Asthma	H33..%, H3120, 173A.
Cancer	B0... - B32z., B34.. -B6z0. (excluding B677.), Byu.. - Byu41, Byu5. - ByuE0, K1323, K01w1
CHD	G3-G309, G30B-G330z (except G310), G33z-G3401, G342-G365X, G38-G3z, Gyu3% (except Gyu31)
CKD	1Z12. -1Z16, 1Z1B. – 1Z1L., K053. - K055.
COPD	H3…, H31..% (excluding H3101, H31y0, H3122), H32..%, H36.. - H3z.. (excluding H3y0., H3y1.), H5832
Dementia	Eu02.%, E00..%, Eu01.%, E02y1, E012.%, Eu00.%, E041., Eu041, F110. – F112., F116.
Depression	E0013, E0021, E112.%, E113.%, E118., E11y2, E11z2, E130., E135., E2003, E291., E2B.., E2B1., Eu204, Eu251, Eu32.% (excluding Eu32A, Eu32B, Eu329), Eu33.%, Eu341, Eu412
Diabetes mellitus	C10.., C109J, C109K, C10C., C10D., C10E.%, C10F.% (Excluding C10F8), C10G.%, C10H.%, C10M.%, C10N.%, PKyP.
Epilepsy	F25..% (excluding F2501, F2504, F2511, F2516, F256.%, F258. – F25A., F25y4, F25G., F25H.), F1321, SC200
Familial hypercholesterolaemia	1W2.., C320.11, C3200, C3201, C3204, C3205
Heart Failure	G58..%, G1yz1, 662f. – 662i., 585f., G5yy9
Hypertension	G2..., G20..%, G24.. - G2z.. (Excluding G24z1, G2400, G2410, G27..), Gyu2., Gyu20
Hypothyroidism	C03..%, C04..%
Learning disabilities	E3…%, Eu7..%, Eu814 – Eu817, Eu81z, 918e
Osteoporosis	N330.% (Excluding N3308, N3309), N3312, N3313, N3316, N3318 – N331B, N331H – N331M, NyuB0, NyuB1, NyuB8, N3314, N3315, N3746, NyuB2
PAD	G73.., G73z.% (Excluding G73z1), Gyu74, G734., G73y.
Palliative care	1Z01., 2JE.., 8B2a., 8BA2., 8Bae., 8BAP., 8BAS., 8BAT., 8BJ1., 8CM1.% (excluding 8CM15), 8CM4., 8CMb., 8CME., 8CMQ., 8CMW3, 8H6A., 8H7g., 8H7L., 8HH7., 8IEE., 9367, 9c0L0, 9c0M., 9c0N., 9c0P., 9EB5., 9G8.., 9K9.., 9Ng7., 9NgD., 9NNd., 9NNf0, ZV57C
Psychosis, schizophrenia, bipolar affective disease	E10..%, E110.%, E111.%, E1124, E1134, E114. – E117z, E11y.% (excluding E11y2), E11z., E11z0, E11zz, E12..%, E13..% (excluding E135.), E2122, Eu2..%, Eu30.%, Eu31.%, Eu323, Eu328, Eu333, Eu32A, Eu329
Rheumatoid arthritis	N040.%, N041., N042.% (excluding N0420), N047., N04X., N04y0, N04y2, Nyu11, Nyu12, Nyu1G, Nyu10, G5yA., G5y8.
History of Read codes	
Atrial fibrillation	14AN.00
CHD	14A3.-14A5., 14AH., 14AJ., 14AL., 14AT., 14AW., G32..12
COPD	14B3.12
Diabetes	1434
Heart failure	14A6., 14AM.

Resolved Read codes	
Atrial Fibrillation	212R.
Asthma	21262, 212G.
Depression	212S.
Diabetes	21263, 212H.
Epilepsy	21260, 212J.
Heart failure	21264
Hypertension	21261, 212K.
Psychosis, schizophrenia, bipolar affective disease	212T.-212X., E1005, E1015, E1025, E1035, E1055, E1075, E1106, E1116, E1146, E1156, E1166, E1176, Eu223, Eu26., Eu317, Eu329, Eu32A

CHD: Coronary Heart Disease, CKD: Chronic Kidney Disease, COPD: Chronic Obstructive Pulmonary Disease, PAD: Peripheral Arterial Disease

Appendix 3: BNF chapters and Read codes indicating on medication

BNF chapters

	BNF chapter	Description
Anticoagulants	2.8.1	Parenteral anticoagulants
	2.8.2	Oral anticoagulants
Antihypertensives	2.2.1	Thiazides and related diuretics
	2.4	Beta-adrenoceptor blocking drugs (excluding propranolol)
	2.5.1	Vasodilator antihypertensive drugs
	2.5.2	Centrally acting antihypertensive drugs
	2.5.3	Adrenergic neurone blocking drugs
	2.5.5	Drugs affecting the renin-angiotensin system
	2.6.2	Calcium-channel blockers
Lipid regulating drugs	2.12	Lipid-regulating drugs (excluding Omega-3 fatty acid compounds: Omacor®, Prestylon®, Maxepa®)
Indicates smoking lifestyle intervention	4.10.2	Nicotine dependence

Read codes indicating prescribed anticoagulant or lipid regulating drugs

	Read code	Description
Anticoagulants	66Q..00	Warfarin monitoring
	66Q..11	Anticoagulant monitoring
	66Q1.00	Initial warfarin assessment
	66Q2.00	Follow-up warfarin assessment
	66Q4.00	Warfarin dose changed
	66Q6.00	Warfarin therapy started
	66Q9.00	Warfarin dose unchanged
	66QA.00	Warfarin treatment plan
	66QB.00	Annual warfarin assessment
	66QC.00	Anticoagulation monitoring - secondary care
	66QD.00	Anticoagulation monitoring - primary care
	66QF.00	Slow induction of warfarin therapy
	66QG.00	International normalised ratio derived warfarin dose
	66QH.00	Warfarin daily dose
	66QZ.00	Warfarin monitoring NOS
	88A5.00	Anticoagulant therapy
	88A5000	Bridging anticoagulant therapy with low molecular weight heparin
	8B2K.00	Anticoagulant prescribed by third party

	8B3T.00	Aspirin OTC
	8B61.00	Anticoagulant prophylaxis
	8B61000	Warfarin anticoagulation prophylaxis
	8CAu.00	Patient advised of anticoagulant dose
	8CMW900	On anticoagulation care pathway
	8HHW.00	Referral for warfarin monitoring
	9k27.00	Home visit for anticoagulation monitoring
	9NkC.00	Seen in community anticoagulation clinic
	9NkD.00	Seen in hospital anticoagulation clinic
	9NkE.00	Seen in general practitioner anticoagulation clinic
	Z1Q2C00	Giving anticoagulant therapy
	ZV1C200	[V]personal history of long term (current) use of warfarin
Lipid regulating drugs	8B3z.00	Over the counter statin therapy

Appendix 4: Read codes indicating exceptions and white coat hypertension

	Read codes	Description
Exception Read codes		
Anticoagulants	14LP.00	Warfarin allergy
	8I25.00	Warfarin contraindicated
	8I2o.00	Dabigatrin contraindicated
	8I2R.00	Anticoagulation contraindicated
	8I3d.00	anticoagulation declined
	8I3E.00	Warfarin declined
	8I71.00	Warfarin not tolerated
	8I7R.00	Dabigatran not tolerated
	8IES.00	Dabigatran declined
	9hF1.00	Excepted from atrial fibrillation qual indic: Inform dissent
	TJ42.00	Adverse reaction to anticoagulants
	TJ42100	Adverse reaction to warfarin
	TJ42200	Adverse reaction to nicoumalone
	TJ42300	Adverse reaction to phenindione
	TJ42z00	Adverse reaction to anticoagulants NOS
	U604200	[x]anticoagulant causing adverse effects in therapeutic use
	U604211	[x] adverse reaction to anticoagulants
	U604212	[X] Adverse reaction to heparin
	U604213	[x] adverse reaction to warfarin sodium
	U604214	[X] Adverse reaction to acenocoumarol
	U604215	[X] Adverse reaction to phenindione
	U604216	[x] adverse reaction to anticoagulants NOS
	ZV14A00	Personal history of allergy to warfarin
Antihypertensives	8I3N.00	Hypertension treatment refused
	TJC7z00	Adverse reaction to antihypertensives NOS
Lipid lowering drugs	8I27.00	Statins contraindicated
	8I27000	Simvastatin contraindicated
	8I2C.00	Lipid lowering therapy contraindicated
	8I3C.00	Statin declined
	8I3J.00	Lipid lowering therapy declined
	8I76.00	Statin not tolerated
	TJC2.00	Adverse reaction to antilipaemic/anti-arteriosclerotic drugs
	TJC2400	Adverse reaction to simvastatin
	TJC2500	Adverse reaction to pravastatin
	TJC2z00	Adverse reaction to antilipaemic/antiarterioscler drugs NOS
	U60C600	[X]Antihyperlipidaem/antiarterioscl drug caus adv ef ther use
	U60C611	[X] Adverse react to antilipaemic & anti-arteriosclerot drug
	U60C615	[X] Adverse reaction to simvastatin
	U60C616	[X] Adverse reaction to pravastatin

	U60C617	[X] Adverse react to antilipaemic/antiarterioscler drugs NOS
	U60C900	[x]lipid-lowering drug adverse reaction
	U60CA00	[x]statin causing adverse effect in therapeutic use
White coat hypertension		
	246M.00	White coat hypertension

Appendix 5: Read codes indicating lifestyle interventions

Read code	Description
Alcohol	
6792.00	Health ed. Alcohol
67H0.00	Lifestyle advice regarding alcohol
8BA8.00	Alcohol detoxification
8CAM.00	Patient advised about alcohol
8CAM000	Advised to abstain from alcohol consumption
8CAv.00	Advised to contact primary care alcohol worker
8CE1.00	Alcohol leaflet given
8G32.00	Aversion therapy – alcoholism
8H35.00	Admitted to alcohol detoxification centre
8H7p.00	Referral to community alcohol team
8HHe.00	Referral to community drug and alcohol team
8HkG.00	Referral to specialist alcohol treatment service
8HkJ.00	Referral to alcohol brief intervention service
9k14.00	Alcohol counselling by other agencies
9k1A.00	Brief intervention for excessive alcohol consumption completed
9k1B.00	Extended intervention for excessive alcohol consumption completed
9NN2.00	Under care of community alcohol team
Z191.00	Alcohol detoxification
Z191100	Alcohol withdrawal regime
Z191200	Planned reduction of alcohol consumption
Z191211	Alcohol reduction programme
Z191400	Self-monitoring of alcohol intake
Z4B1.00	Alcoholism counselling
ZC22200	Advice to change alcoholic drink intake
ZC2H.00	Advice to change alcohol intake
ZG23100	Advice on alcohol consumption
ZR1E.00	Alcohol dependence scale
Diet	
13A3.00	Weight reducing diet
66C3.00	Understands reducing diet
66C4.00	Has seen dietician – obesity
66C6.00	Treatment of obesity started
66CR.00	Interview risk health assessment overweight obesity advice about diet physical activity
66CS.00	Interview risk health overweight obesity advice diet physical activity consider drugs
66CT.00	Interview risk health overweight obesity advice diet physical activity consider drugs consider surgery
6799.00	Health ed. Diet
8B57.00	Weight reducing diet
8B5C.00	Calorie restricted diet

8B5C.11	Low calorie diet
8B5C011	Very low calorie diet
8CA4000	Pt advised re weight reducing diet
8CA4011	Patient advised to lose weight
8H4n.00	Referral to weight management special interest GP
ZC1..00	Actions to lose weight
ZC14.00	Attending slimming club
ZC2C700	Patient advised about weight reducing diet
ZC2C711	Dietary advice for weight reduction
ZC2CO00	Dietary advice for weight loss
ZC2F.11	Advice to change high calorie food intake
Exercise	
1384.00	Enjoys moderate exercise
1385.00	Enjoys heavy exercise
1389.00	Aerobic exercise 1 time/week
67H2.00	Lifestyle advice regarding exercise
6798.00	Health ed. – exercise
138A.00	Aerobic exercise 2 times/week
138B.00	Aerobic exercise 3+ times/week
138D.00	Anaerobic exercise 1 time/week
138E.00	Anaerobic exercise 2 times/week
138F.00	Anaerobic exercise 3+ times/week
138G.00	Attends exercise classes
138H.00	Enjoys intermediate exercise
138P.00	Aerobic exercise three times a week
138Q.00	Aerobic exercise four times a week
138R.00	Aerobic exercise five times a week
13CR.00	Physical activity target light exercise
13CS.00	Physical activity target moderate exercise
13CT.00	Physical activity target strenuous exercise
67H2.00	Lifestyle advice regarding exercise
8BAH.00	Exercise on prescription
8CA5.00	Patient advised re exercise
8CA5000	Advice about aerobic exercise
8CA5100	Advice about muscle strengthening exercise
8CAn.00	Pt given written advice on benefits of physical activity
8E79.00	Home exercise programme
8E7A.00	Group exercise programme
8E7B.00	Graded exercise therapy
8E7C.00	Aerobic exercises
8E7D.00	Exercise circuits
8H7q.00	Referral for exercise therapy
8H7q000	Referral for graded exercise therapy
8H7s.00	Referral to physical activity programme

8HHc.00	Referred for exercise programme
8HkX.00	Referral to exercise on referral programme
Z4G1400	Giving encouragement to exercise
Z4G1411	Offering encouragement to exercise
Z4M1200	Reassuring about exercise
Z65..00	Exercise therapy
Z658.00	Aerobic exercises
Z65A.00	Exercise circuits
Z65B.00	Home exercise programme
Z67..00	Exercise class
Z67..11	Group exercise
Z68..00	Exercises
Z6D3.00	Cardiovascular exercises in water
Z6D3100	Aquaerobic exercises
ZC17.00	Exercising to lose weight
ZG12.00	Advice to undertake activity
ZG16.00	Advice about exercise
ZG16100	Advice to exercise
Smoking	
67H1.00	Lifestyle advice regarding smoking
6791.00	Health ed. smoking
137b.00	Ready to stop smoking
137c.00	Thinking about stopping smoking
137G.00	Trying to give up smoking
13p0.00	Negotiated date for cessation of smoking
13p5.00	Smoking cessation programme start date
13p5000	Practice based smoking cessation programme start date
67H6.00	Brief intervention for smoking cessation
745H.00	Smoking cessation therapy
745H000	Nicotine replacement therapy using nicotine patches
745H100	Nicotine replacement therapy using nicotine gum
745H200	Nicotine replacement therapy using nicotine inhalator
745H300	Nicotine replacement therapy using nicotine lozenges
745H400	Smoking cessation drug therapy
745Hy00	Other specified smoking cessation therapy
745Hz00	Smoking cessation therapy NOS
8B2B.00	Nicotine replacement therapy
8B3f.00	Nicotine replacement therapy provided free
8B3Y.00	Over the counter nicotine replacement therapy
8BP3.00	Nicotine replacement therapy provided by community pharmacist
8CAg.00	Smoking cessation advice provided by community pharmacist
8CAL.00	Smoking cessation advice
8CdB.00	Stop smoking service opportunity signposted
8H7i.00	Referral to smoking cessation advisor

8HBM.00	Stop smoking face to face follow-up
8HBP.00	Smoking cessation 12 week follow-up
8HkQ.00	Referral to NHS stop smoking service
8HTK.00	Referral to stop smoking clinic
8T08.00	Referral to smoking cessation service
9kc..00	Smoking cessation - enhanced services administration
9kc0.00	Smoking cessation monitor template completed - enhanced service admin
9kc0.11	Smoking cessation ESA monitoring template completed
9N2k.00	Seen by smoking cessation advisor
9Ndf.00	Consent given for follow-up by smoking cessation team
9NdV.00	Consent given follow-up after smoking cessation intervention
9NS0200	Referral for smoking cessation service offered
9OO..00	Anti-smoking monitoring admin.
9OO..11	Stop smoking clinic admin.
9OO..12	Stop smoking monitoring admin.
9OO1.00	Attends stop smoking monitor.
9OO3.00	Stop smoking monitor default
9OO4.00	Stop smoking monitor 1st letter
9OO5.00	Stop smoking monitor 2nd letter
9OO6.00	Stop smoking monitor 3rd letter
9OO7.00	Stop smoking monitor verbal inv.
9OO8.00	Stop smoking monitor phone inv.
9OOA.00	Stop smoking monitor check done
9OOB.00	Stop smoking invitation short message service text message
9OOB000	Stop smoking invitation first SMS text message
9OOB100	Stop smoking invitation second SMS text message
9OOB200	Stop smoking invitation third SMS text message
9OOZ.00	Stop smoking monitor admin. NOS
ZG23300	Advice on smoking
Weight	
13A3.00	Weight reducing diet
66C4.00	Has seen dietician – obesity
66C5.00	Treatment of obesity changed
66C6.00	Treatment of obesity started
66C9.00	Target weight discussed
66C9.11	Weight loss advised
66CA.00	Ideal weight discussed
66CC.00	Wants to lose weight
66CG.00	Weight management programme offered
66CH.00	Weight management plan started
67H7.00	Lifestyle advice regarding diet
67H8.00	Lifestyle advice regarding hypertension
679P.00	Health education - weight management
67I9.00	Advice about weight

67K9.00	Cycle of change stage, weight management
6B4..00	Counterweight weight management programme
6B4..11	Counterweight programme
8B57.00	Weight reducing diet
8B5B.00	Weight gain diet
8CA4011	Patient advised to lose weight
8Cd7.00	Advice given about weight management
8CdC.00	Weight management service opportunity signposted
8CP5.00	Discussion about weight management programme
8H4n.00	Referral to weight management special interest GP
8HHH.00	Refer to weight management programme
8HHH000	Referral to local authority weight management programme
8HHH100	Referral to residential weight management programme
9NS0300	Referral to weight management service offered
ZC1..00	Actions to lose weight
ZC17.00	Exercising to lose weight
ZC2C700	Patient advised about weight-reducing diet
ZC2C711	Dietary advice for weight reduction
ZC2CM00	Dietary advice for obesity
ZC2CN00	Dietary advice for weight gain
ZC2CO00	Dietary advice for weight loss
ZG53.00	Advice about weight
ZG53100	Patient advised to lose weight
ZV65319	[V]dietary counselling in obesity