BMJ Open

Evaluating quality and its determinants in lipid control for secondary prevention of heart disease and stroke in primary care: a study in an inner London Borough

Hiten Dodhia,[1] Liu Kun,[2] Hugh Logan Ellis,[3] James Crompton,[1] Anthony S Wierzbicki,[4] Helen Williams,[5] Anna Hodgkinson,[6] John Balazs[7]

For numbered affiliations see end of article.

Correspondence to
Dr Hiten Dodhia;
hiten.dodhia@southwark.gov.uk

ABSTRACT

Objectives: To assess quality of management and determinants in lipid control for secondary prevention of cardiovascular disease (CVD) using multilevel regression models.

Design: Cross-sectional study.

Setting: Inner London borough, with a primary care registered population of 378 000 (2013).

Participants: 48/49 participating general practices with 7869 patients on heart disease/stroke registers were included.

Outcome measures: (1) Recording of current total cholesterol levels and lipid control according to national evidence-based standards. (2) Assessment of quality by age, sex, ethnicity, deprivation, presence of other risks or comorbidity in meeting both lipid measurement and control standards.

Results: Some process standards were not met. Patients with a current cholesterol measurement >5 mmol/L were less likely to have a current statin prescription (adjusted OR=3.10; 95% CI 2.70 to 3.56). They were more likely to have clustering of other CVD risk factors. Women were significantly more likely to have raised cholesterol after adjustment for other factors (adjusted OR=1.74; 95% CI 1.53 to 1.98).

Conclusions: In this study, the key factor that explained poor lipid control in people with CVD was having no current prescription record of a statin. Women were more likely to have poorly controlled cholesterol (independent of comorbid risk factors and after adjusting for age, ethnicity, deprivation index and practice-level variation). Women with CVD should be offered statin prescription and may require higher statin dosage for improved control.

Strengths and limitations of this study

- This is a large study using epidemiological design and multilevel regression modelling to identify determinants in management of lipid control using routine data.
- We used a systematic approach that can be used by Clinical Commissioning Groups to meet their duty to understand and reduce variation in access and outcomes to healthcare.
- There may be potential measurement errors/biases and the data did not include date of any original cardiovascular disease event;
- The findings from this study may not be generalisable to rest of UK.

INTRODUCTION

Hyperlipidaemia contributes a significant proportion of modifiable cardiovascular disease (CVD) risk.[1] Most of the CVD risk attributable to lipids is due to lipoprotein particles associated with cholesterol deposition in the vascular wall including total cholesterol, non-high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C).[2] Interventions that reduce LDL-C reduce CVD risk with a relationship from clinical trials that show a 21% relative risk reduction in major vascular events per 1 mmol/L reduction in LDL-C in all groups.[3]

The National Institute for Health and Care Excellence (NICE) lipid modification guidelines (CG67 2008 and updated CG181, 2014) advise clinicians to offer statins to all individuals with increased risk of CVD as determined by a QRISK2 or Framingham (1991)-based CVD risk score of 20% over the next decade.[4–6] These risk calculation tools give similar results but Framingham overpredicts CVD in UK populations.[7] Statin treatment is to be prescribed to all patients with established CVD using simvastatin 40 mg in most patients and atorvastatin 80 mg in acute coronary syndromes. NICE guideline advises

that cholesterol is checked within 3 months of starting a statin with the aim that patients with established CVD should ideally reach total cholesterol <4 mmol/L; LDL-C <2 mmol/L with an audit standards of total cholesterol <5 mmol/L and LDL-C <3 mmol/L.[6] In primary prevention, no target is specified but all should be treated with simvastatin 40 mg or another off-patent agent of similar efficacy.[8]

General practitioners (GPs) are currently incentivised to manage CVD by the Quality and Outcomes Framework (QOF) which is a 'Pay for Performance' (P4P) system. The QOF control target in 2012–2013 was total cholesterol of <5 mmol/L.[9] There is some evidence that P4P can improve quality of care, but this evidence is not strong and other factors are also likely to play a role.[10] [11] In addition, the EUROASPIRE III survey has shown that evidence-based guideline targets for lifestyle, risk factors and drug treatments are not being achieved and there remains considerable potential to raise standards to prevent further events and that statins are suboptimally used.[12] [13] Inequalities in the management of CVD in primary care have been reported previously with key sex inequalities between men and women and ethnic inequalities.[14] [15]

The Health and Social Care Act 2012 in the UK places a duty on Clinical Commissioning Groups to improve quality and reduce inequalities in access and outcomes of care.[16] [17] Our aim was to evaluate the quality in the management of cholesterol for the secondary prevention of CVD in Lambeth patients on the coronary heart disease (CHD) and/or stroke registers. We compared lipid measurement and control to predefined standards based on QOF and NICE guidelines.[6] [18] We also evaluated the determinants in the management of lipid control and hypothesised that there should be no group differences in the management and control of cholesterol in this cohort of patients on the above registers, according to the predefined standards.

METHODS
This evaluation was carried out in an inner city London borough, with a registered population of 378 000 (2013). We used a cross-sectional study design and identified those patients who were on the CHD and/or stroke registers as of 31 March 2013 and the period 15 months prior to this date.

We used patient-level data from the Lambeth DataNet. This is a pseudo-anonymised database of patients registered with practices in primary care that supports local commissioning, healthcare/service evaluation and monitoring health inequalities. We identified people registered on the CHD and/or stroke registers from 48 of 49 practices that contribute data to the Lambeth DataNet. A key purpose of this database is also to collect and analyse markers of health inequalities such as ethnicity, index of multiple deprivation (IMD), as well as age and sex. The IMD includes income deprivation; employment

deprivation; health deprivation and disability; education deprivation; and other markers of deprivations such as crime, barriers to housing and services, and the living environment.

Predefined standards
The standards that were used to assess the quality of care were a combination of the upper range of the QOF 12-13 and NICE guidelines.[6] [9]

Coronary heart disease
► Cholesterol level is measured in the past 15 months (at or prior to 31 March 2013) in 90% (range 50–90%) of all patients on the CHD register;
► Cholesterol control ≤5 mmol/L in 70% (range 45–70%) of all patients on CHD register.

Stroke
► Cholesterol level measured in the past 15 months (at or prior to 31 March 2013) in 90% (range 50–90%) of all patients on the stroke register;
► Cholesterol ≤5 mmol/L in 65% (range 40–65%) of all patients on stroke register.

We also analysed data on the current prescription of statins for this cohort of patients within the past 3 months from their last review date. NICE guidelines recommend that all patients with heart disease or stroke should be prescribed a statin or have reasons recorded if not prescribed.

Hypothesis tested
The hypotheses we were testing were as follows:
1. Patients in Lambeth with one or more diagnoses of CHD and stroke are managed according to the predefined quality standards for cholesterol for people on these two registers as of 2012/2013.
2. In Lambeth patients with one or more diagnoses of CHD and stroke—there are no significant group differences as assessed by age, sex, ethnicity, deprivation, presence of other risks or comorbidity in meeting these predefined quality standards.

Analysis
We used STATA V.13.1 to test the hypotheses.[19] Descriptive analyses were done to test the first hypothesis. The outcome (dependent) variables for the regression models were dichotomous and were defined above in the 'predefined standards' section. They include (1) measurement of cholesterol (DO1—yes/no) and (2) total cholesterol ≤5 mmol/L (DO2—as controlled and >5 mmol/L as uncontrolled).

The presence of group differences (independent variables) in these were reviewed by: age group (16–44, 45–54, 55–64, 65–74 and ≥75), sex (male, female), ethnic groups (white group, black African/black Caribbean/black British group, missing/unknown, Asian/Asian-British group, mixed group, other ethnic group), IMD quintiles (grouped as follows: least deprived two quintiles 0–40%, 40–60%, 60–80%; most deprived

80–100%), as well as risk factors for smoking (current smokers, ex-smokers, non-smokers and unknown) and blood pressure or BP (controlled defined as BP≤150/90; uncontrolled defined as BP >150/90), type 2 diabetes status (yes or no) and statin prescription status within time frame described above (yes or no).

A number of univariate multilevel logistic regression models taking into account the variation among different general practices were fitted to explore the associations between the outcome variable and different independent variables tested in the second hypothesis. Then a series of multivariate multilevel logistic regression models were fitted to investigate the associations between the predefined standards and all potential independent variables, using random-effect equation for the practice-level variation. Best and final models chosen by series of Wald goodness-of-fit tests were reported in the Results section.[20]

RESULTS

The total number of primary care practices that participated was 48/49 (98%). The number of people on the CHD and stroke registers was 7869 (CHD only: 4464; stroke only: 2738; combined CHD/stroke=667). The diagnosed crude prevalence of CHD and stroke were 1.3% and 0.9%, respectively, in Lambeth in 2012–2013.[18] The mean age was 69.8 years (95% confidence limits 69.5 to 70.1). There were significantly more males on the registers: male 57.8% (56.7% to 58.9%) compared with female 42.2% (41.1% to 43.3%). Other demographic characteristics are shown in table 1.

Table 2 shows the risk factor characteristics. In this population, about 19% of people with CHD or stroke remained current smokers, just over one in four were not controlled for their blood pressure to a level of 150/90 mm Hg and 70% were overweight or obese. Just over one in four had type 2 diabetes.

Hypothesis 1: Patients with one or more of CHD and stroke are managed according to predefined standards for cholesterol measurement and control for people on these two registers as of 2012/2013 and 2013/2014.

Table 3 shows the evaluation of patients having a current record for cholesterol measurement, degree of cholesterol control achieved and a record of a statin prescription. Overall, predefined auditable standards were not met for current records for both cholesterol measurement and statin prescription. However, predefined auditable standards for those patients with a current record, the proportion of patients whose cholesterol was below 5 mmol/L were met. When comparing subgroups within the study, patients with a history of stroke were consistently the least likely to meet all three QOF standards.

Primary care records showed that overall 80.1% of patients had been prescribed a statin in the past 6 months. This rate was significantly lower in patients with stroke.

Hypothesis 2: In patients with one or more of CHD and stroke—there are no significant group differences in the

outcome (dependent) variables DO1 and DO2 as assessed by age, sex, ethnicity and deprivation in meeting the predefined standards.

We found significant group differences in meeting the lipid measurement standards. Table 4 shows the findings for patients who did not have a current record of cholesterol measurement in the past 15 months. The random effect at the general practice level is reported at the

Table 1 Demographic baseline characteristics

Demographic characteristics	Sublevel	Number (n=7869)	Per cent
Age	16–44	333	4.2
	45–54	840	10.7
	55–64	1340	17.0
	65–74	2035	25.9
	≥75	3293	41.9
	Unknown	28	0.4
Sex	Male	4547	57.8
	Female	3322	42.2
Ethnicity	White group	4361	55.4
	Black/black British group	1616	20.5
	Asian/Asian-British group	694	8.8
	Mixed group	212	2.7
	Other ethnic group	193	2.5
	Missing/unknown	793	10.1
Index of deprivation	Least deprived	195	2.5
	40–60%	976	12.4
	60–80%	3816	48.5
	Most deprived 80–100%	2837	36.1
	Missing	45	0.6

Table 2 Risk factor characteristics

Risk factor	Sublevel	Number	Per cent
Smoking*	Non-smoker	4146	52.7
	Current smoker	1456	18.5
	Ex-smoker	2191	27.8
	Unknown	76	1.0
BP*	BP ≤150/90	5604	71.2
	BP >150/90	2182	27.7
	Missing	83	1.1
Body mass index†	<18.5	138	1.9
	18.5–24.9	1999	27.8
	25–29.9	2613	36.4
	30–39.9	2164	30.1
	≥40	267	3.7
Type 2 diabetes*	Yes	2104	26.3
	No	5765	73.3

*n=7869.
†n=7181.
BP, blood pressure.

Table 3 Evaluation against standards

Register	Number	Per cent	95% confidence limits		Standard (%)
			Lower limit	Upper limit	
Current record in the past 15 months					
Stroke only	2284	83.4	82.0	84.8	90
CHD only	3831	85.8	84.8	86.8	90
CHD and stroke	597	89.5	86.9	91.7	90
Cholesterol ≤5 mmol/L with current record in the past 15 months					
Stroke only	1716	75.1	73.3	76.9	65
CHD only	3114	81.3	80.0	82.5	70
Stroke and CHD	505	84.6	81.4	87.4	70
Statin prescription recorded in the past 6 months and current record in the past 15 months					
Stroke only	1630	71.4	69.5	73.2	100
CHD only	3203	83.6	82.4	84.8	100
Stroke and CHD	511	85.6	82.5	88.3	100

CHD, coronary heart disease.

bottom of the table. The variance component was estimated to be 0.12. Patients categorised as African-American/black British group (compared with the white group) were significantly more likely to have a current record, as were patients with type 2 diabetes (compared with people without type 2 diabetes). Patients aged between 16 and 64 years or over 75 years were significantly less likely to have a current record for cholesterol levels. Patients aged 16–44 were 68% more likely to not have a current record compared with those aged 65–74. After taking into account other factors, deprivation did not appear to have an effect on current cholesterol recording. Those who were current smokers and had previously raised cholesterol level were also less likely to have a current record of cholesterol level.

Patients with no current record for cholesterol in the past 15 months were nearly three times less likely (adjusted odds=2.97; 95% CI 2.51 to 3.52) to have a record of a current statin prescription.

Table 5 shows the finding for the subgroup of patients who had a current record of cholesterol but were not achieving a lipid control standards (cholesterol level <5 mmol/L) within the past 15 months of the study date. The random effect at the general practice level is reported at the bottom of the table. The variance component was estimated to be 0.022. These patients were significantly more (OR 3.10; 95% CI 2.70 to 3.56) likely not to have a current record for a statin prescription. After adjustment for other factors, they were also more likely to be current smokers and to have raised blood pressure. Women were also significantly more likely than men to have raised cholesterol after adjustment for other factors. Women were significantly less likely to have a current record for a statin prescription (75%; 74% to 77%) compared with men (83%; 82% to 84%). There were significant differences in current recorded prescribing with age (those aged 16–44 and 45–54 were less likely to have a current record of statins prescribed: 44% and 71%, respectively) and ethnicity (African-American/black British groups were less likely to have statins prescribed

and Asian groups more likely: 74% and 88%, respectively). However, there was no significant difference in the adjusted OR with age (apart from the 75+ age group who were significantly better controlled) and ethnicity for poor lipid control. Patients with additional comorbidity with type 2 diabetes were significantly more likely to achieve cholesterol control <5 mmol/L.

DISCUSSION
Key findings
In this study of patients attending primary care practices in an inner London borough in South London, the key factor that explained poor lipid control in people on the CHD and stroke registers was having no record of having been prescribed a statin in the past 3 months from their last review date. Women were less likely to be prescribed a statin compared with men. Among individuals with previous history of CHD or stroke, women are more likely than men to have poorly controlled cholesterol. This finding was independent of smoking status, blood pressure, statin prescription and type 2 diabetes status and also remained unchanged after adjusting for age, ethnicity, deprivation index and practice-level variation. We found no ethnic difference in lipid control after adjustment for other factors. The very elderly (75+) were significantly better controlled.

Patients with a history of both CHD and stroke were those most likely to be managed according to current guidelines. Patients who had only had a stroke were less likely to have had their cholesterol measured, controlled or to be prescribed a statin than patients with CHD.

There was a clustering of risk factors in that patients who had poor lipid control were also more likely to be current smokers, have raised blood pressure and were less likely to have a current statin prescription recorded.

What is already known
Studies looking at the efficacy of lipid-lowering treatments in patients with established CVD have found no

Table 4 Multilevel logistic regression model—current record for measurement of cholesterol (DO1) in the past 15 months and demographic, risk factor and treatment with statin characteristics

Variable	Category	Total N	DO1: N (%)	Adjusted OR (95% confidence limits)	p Value
Age (years) (n=7841)	16–44	333	147 (44)	**1.68 (1.14 to 2.47)**	0.008
	45–54	840	170 (20)	**1.50 (1.13 to 1.98)**	0.005
	55–64	1340	190 (14)	**1.45 (1.13 to1.87)**	0.004
	65–74	2035	189 (9)	Ref	
	75+	3293	433 (13)	**1.41 (1.13 to 1.75)**	0.002
Sex (n=7869)	Male	4547	663 (15)	Ref	
	Female	3322	494 (15)	0.90 (0.76 to 1.06)	0.220
Ethnicity (n=7869)	White group	4361	643 (15)	Ref	
	Black/Black British	1616	197 (12)	**0.78 (0.62 to 0.97)**	0.029
	Asian/Asian British	694	82 (12)	1.07 (0.78 to 1.47)	0.6736
	Mixed groups	212	38 (18)	1.07 (0.67 to 1.72)	0.769
	Other ethnic groups	193	28 (15)	1.18 (0.72 to 1.93)	0.5010
	Not known/missing	793	169 (21)	1.18 (0.90 to 1.54)	0.231
Deprivation—Index of Multiple Deprivation national ranking (n=7824)	Least deprived	195	22 (11)	Ref	
	40–60%	976	153 (16)	1.46 (0.76 to 2.79)	0.254
	60–80%	3816	538 (14)	1.49 (0.80 to 2.78)	0.210
	Most deprived	2837	438 (15)	1.59 (0.85 to 2.99)	0.147
Smoking (7869)	Non-smoker	4146	579 (14)	Ref	
	Ex-smoker	2191	266 (12)	1.07 (0.88 to 1.30)	0.514
	Current Smoker	1456	271 (19)	**1.40 (1.13 to 1.74)**	0.002
	Unknown	76	41 (54)	1.54 (0.51 to 4.63)	0.440
Blood pressure (n=7786)	≤150/90 mm Hg	5604	742 (13)	Ref	
	>150/90 mm Hg	2182	343 (16)	1.15 (0.96 to 1.36)	0.123
Total cholesterol (n=7562)	≤5 mmol/L	5897	562 (10)	Ref	
	>5 mmol/L	1665	289 (17)	**1.33 (1.12 to 1.59)**	0.001
Statin prescription (n=7869)	Yes	5891	547 (9)	Ref	
	No	1978	610 (31)	**2.97 (2.51 to 3.52)**	<0.0001
BMI (kg/m^2) (n=7181)	<18.5	138	23 (17)	1.24 (0.75 to 2.04)	0.403
	18.5–24.9	1999	255 (13)	Ref	
	25–29.9	2613	267 (10)	0.97 (0.80 to 1.18)	0.742
	30–39.9	2164	201 (9)	0.94 (0.76 to 1.16)	0.576
	≥40	267	24 (9)	0.94 (0.59 to 1.50)	0.801
Type 2 diabetes (n=7869)	Yes	2104	111 (5)	**0.37 (0.29 to 0.47)**	<0.0001
	No	5765	1046 (18)	Ref	
Practice-level variance				0.12 (0.06 to 0.25)	

Logistic model for current record for cholesterol in the past 15 months, goodness-of-fit test; number of observations=7135; number of groups=10; Hosmer-Lemeshow χ^2 (8)=5.74; probability > χ^2=0.676; likelihood ratio test for testing multilevel logistic regression model compared with conventional logistic regression model p value <0.0001.
BMI, body mass index.

significant differences between sexes but found that women were more likely than men to have higher LDL-C levels both before and after treatment suggesting that women may need more aggressive lipid-lowering treatment than men to achieve targets.[14 21–25]

Women are less likely to be prescribed medication including statins as secondary prevention following stroke[26 27] and acute coronary syndrome.[28] These findings are true internationally with similar results being found in Ireland,[29] Italy[30] and Sweden.[31] Large studies suggest that the effect is mainly seen in younger women.[32 33] Similar results have previously been found in East London.[34] Women were also less likely to be prescribed aggressive lipid-lowering treatment or any treatment at all. A Canadian study also found discrepancies between the three groups: stroke, CHD and both, as well as sex discrepancies similar to the results found in Lambeth.[35] Some studies have failed to find a significant difference in lipid treatment between the sexes.[36 37] Others suggest that sex differences disappear once the data have been adjusted for age and severity of disease.[38 39] Millett et al in their study identified improvements in lipid control and blood pressure targets in ethnic groups, although black groups were less likely to be prescribed statins. They suggested that the introduction of QOF led to marked improvements in both the process of care and management of CHD. They did not report on sex or age differences in lipid control.[15] A systematic review of 27 studies looking at equity dimensions in the evaluation of QOF, across a

Table 5 Multilevel logistic regression model—total cholesterol level >5 mmol/L (DO2) in the past 15 months

Variable	Category	Total N	DO2: N (%)	Adjusted OR (95% confidence limits)	p Value
Age (n=6711)	16–44	186	49 (26)	0.79 (0.54 to 1.14)	0.208
	45–54	670	186 (28)	1.20 (0.96 to 1.50)	0.102
	55–64	1149	261 (23)	1.10 (0.91 to 1.33)	0.330
	65–74	1846	380 (21)	Ref	
	75+	2860	500 (17)	**0.74 (0.63 to 0.88)**	**<0.0001**
Sex (n=6711)	Male	3883	649 (17)	Ref	
	Female	2828	727 (26)	**1.74 (1.53 to 1.98)**	**<0.0001**
Ethnicity (n=6711)	White group	3717	762 (21)	Ref	
	Black/Black British	1419	310 (22)	0.99 (0.84 to 1.16)	0.892
	Asian/Asian British	612	90 (15)	0.85 (0.66 to 1.09)	0.198
	Mixed groups	174	41 (24)	1.04 (0.71 to 1.54)	0.830
	Other ethnic groups	165	29 (18)	0.85 (0.56 to 1.31)	0.470
	Not known/missing	624	144 (23)	1.13 (0.91 to 1.40)	0.264
Deprivation (Index of Multiple Deprivation national ranking) (n=6672)	Least deprived	173	37 (21)	Ref	
	40–60%	822	148 (18)	0.79 (0.52 to 1.21)	0.276
	60–80%	3278	677 (21)	0.91 (0.61 to 1.35)	0.634
	Most deprived	2399	508 (21)	0.91 (0.61 to 1.37)	0.664
Smoking (n=6711)	Non-smoker	3566	736 (21)	Ref	
	Ex-smoker	1925	346 (18)	1.00 (0.86 to 1.18)	0.939
	Current Smoker	1185	286 (24)	**1.28 (1.07 to 1.52)**	**0.006**
	Unknown	35	8 (23)	1.33 (0.57 to 3.11)	0.506
Blood pressure (n=6700)	≤150/90 mm Hg	4861	898 (18)	Ref	
	>150/90 mm Hg	1839	477 (26)	**1.35 (1.17 to 1.54)**	**<0.0001**
Statin prescription (n=6711)	Yes	5344	845 (16)	Ref	
	No	1367	531 (39)	**3.10 (2.70 to 3.56)**	**<0.0001**
Type 2 diabetes (n= 6711)	Yes	1993	1098 (23)	**0.62 (0.53 to 0.72)**	**<0.0001**
	No	4718	278 (14)	Ref	
Practice-level variance				0.022 (0.005 to 0.095)	

Logistic model for total cholesterol level>5 mmol/L in the past 15 months, goodness-of-fit test number of observations=6370; number of groups=10; Hosmer-Lemeshow χ^2 (8)=16.26; probability >χ^2=0.039; likelihood ratio test for testing multilevel logistic regression model compared with conventional logistic regression model p value=0.045.

range of conditions, did not suggest worsening inequity in treatment or treatment outcomes.[40]

What this paper adds

The Health and Social Care Act 2012 places a duty on Clinical Commissioning Groups to reduce inequalities in access and outcomes of care.[16] This paper shows that routine pseudo-anonymised patient-level data can be used to monitor quality and its determinants in a systematic way. We found important age differences in the processes of care—people aged 16–64 were less likely to meet lipid measurement standards. Lack of cholesterol measurement may be a proxy to access care. Possible explanations for these age differences need further exploration but could be related to higher risk taking behaviour in younger age groups, more reluctance to take time off work and attend routine healthcare leading to lower access to care in this age group. Patients from black ethnic groups and with comorbidity with diabetes were more likely to meet the lipid measurement standard. Possible explanations for this may be better systems in place for people with comorbidities or that they are more likely to attend or be followed up for care processes.

For the lipid control standards, the findings of this study in South London are similar to those observed worldwide. In patients with established CVD population, women are more likely than men to have raised cholesterol, and yet they are less likely to be prescribed a statin. Critically patients with poor lipid control were also significantly less likely to have a current statin prescription record. Possible explanation for these findings need further exploration but could include (1) the majority of women in this area live in more deprived circumstances which may lead to lower health literacy and lower level of clinical engagement; (2) women may see themselves as lower risk of CVD and can be mistakenly perceived as being at lower risk by clinicians. However, patients with diabetes (as an additional comorbidity) were more likely to meet lipid control standards. Possible explanations for this are that additional comorbidity may lead to better systems of care provided by primary care. We believe that the methodology used in this paper provides an approach for evaluating determinants of quality of care that partly fit into the theory-based framework for conceptualising equity of care developed by Boeckxstaens et al.[40] We have outlined some of the limitations to our

approach below. We have also provided online supplementary data tables that show improvements overall in recording of total cholesterol, current statin prescription and change in mean total cholesterol by age, sex, ethnicity and deprivation for the cohort of patients that had records in 2013 and 2011. These online supplementary data suggest that P4P is continuing to have a positive impact locally but also shows differential changes in total cholesterol control by some of the characteristics we have reported.

Limitations

In the UK, all diagnosed cases of CHD and stroke are registered by GPs as part of QOF disease registers as this is part of the GP contract. We know from modelled estimates that the registers may underestimate actual number of cases by as much as 50%—however, these estimates are based on a number of assumptions and there is uncertainty in modelled prevalence estimates.[41] It would be important to understand the characteristics of people who may not be registered on the CHD/ stroke registers to understand equity of access to care more completely. This study used data from all cases that were diagnosed and on the QOF registers from all but one practice. There was a small proportion of data that was missing in the age, deprivation and some of the risk factors in the disease register. This varied for different indicators—for example, missing age was 28 records or 0.4% of all records; IMD 45 records or 0.6% of all records; cholesterol level recorded—this was 307 records or 4% of all records; body mass index was 688 records or 9% of all records; for the second outcome cholesterol level >5 mmol missing data were: IMD 39 records or 0.6% and 1 record for cholesterol level. However, as this was a large study, we do not think this will have introduced substantial non-response biases. This study used data collected from routine practice consultations, so there could be potential measurement errors or biases introduced as part of this. The data gathered did not include the date of any original CVD event and this factor was not considered in the regression analysis. Registry studies show a decline in adherence with cardiovascular preventive therapies including statins with time postevent.[9] [12] The data gathered in this study do not allow differentiation of haemorrhagic from ischaemic strokes which may explain some of the differences in prescriptions. However, it is likely that most strokes were ischaemic in aetiology in this population. We also did not assess whether there was a record of prescriptions for other lipid-lowering strategies in this cohort, though statins are the most commonly prescribed lipid-lowering drugs there is substantial usage of ezetimibe in some areas in the UK.[42] The data obtained did not include reasons for why women are not being prescribed statins, for example, whether they were declining them when offered, or whether they were experiencing more side effects and asking to stop taking statins or whether they were not being offered statins in the first place. We also

were not able to explore whether healthcare professionals have a perception that women are lower risk of further CVD and not treated as aggressively as men. This study was conducted in a single setting and the findings may not be more widely generalisable to the UK population as implementation of NICE guidelines may vary in different areas. However, some of these results on lipid control outcomes are consistent with findings from other studies. These factors need further exploration to inform future strategies.

CONCLUSIONS

This evaluation has identified important quality issues and their determinants. Some of these variations in quality suggest possible health inequities in the secondary prevention of heart disease and stroke. The findings suggests that primary care has an important role in identifying and optimising management in those patients with CVD who do not have current record of cholesterol reading. GPs should also identify people with established CVD who have no current record of statin prescription as these patients had a greater probability of poor lipid control. This evaluation identified these patients were also more likely to have other CVD risks (raised blood pressure and current smokers). Finally, this study suggests that primary care professionals need to identify and optimise lipid management in patients with CVD who have no current statin prescription and also that women with CVD may require higher statin dosage for better lipid control for secondary prevention. Potential policy implications for P4P systems such as QOF are that these need to consider the determinants of quality and the variation in implementation by social characteristics within a broader framework of equity of access, treatment and treatment outcomes based on an assessment of needs.[40]

Author affiliations
[1]Lambeth & Southwark Councils, Public Health, London, UK
[2]Division of Health and Social Care Research, King's College London, London, UK
[3]Kings College NHS Foundation Trust, F2 Doctor, London, UK
[4]Department of Chemical Pathology, St Thomas' NHS Foundation Trust, London, UK
[5]NHS Southwark Clinical Commissioning Group, Medicines Management Team, London UK
[6]NHS Lambeth Clinical Commissioning Group, Medicines Management Team, London, UK
[7]NHS Lambeth Clinical Commissioning Group, Governing Body Member, London, UK

Competing interests ASW was the Chair of Lipids Guideline Group (CG181) (2013-2014) and a member of the Post-MI and Lipids Quality Standards Committee (2014). No other authors declared any competing interests.

Disclaimer The views expressed are those of the authors and not necessarily those of the NHS, the National Institute for Health Research, or the Department of Health.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement No additional data are available.

Open Access This is an Open Access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/

REFERENCES

1. Yusuf S, Hawken S, Ounpuu S, et al. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. *Lancet* 2004;364:937–52.
2. Di Angelantonio E, Sarwar N, Perry P, et al., The Emerging Risk Factors Collaboration. Major lipids, apolipoproteins, and risk of vascular disease. *JAMA* 2009;302:1993–2000.
3. Baigent C, Blackwell L, Emberson J, et al., Cholesterol Treatment Trialists' (CTT) Collaboration. Efficacy and safety of more intensive lowering of LDL cholesterol: a meta-analysis of data from 170,000 participants in 26 randomised trials. *Lancet* 2010;376:1670–81.
4. Anderson KM, Odell PM, Wilson PW, et al. Cardiovascular disease risk profiles. *Am Heart J* 1991;121:293–8.
5. Hippisley-Cox J, Coupland C, Vinogradova Y, et al. Predicting cardiovascular risk in England and Wales: prospective derivation and validation of QRISK2. *BMJ* 2008;336:1475–82.
6. National Clinical Guideline Centre. *Lipid modification: cardiovascular risk assessment and the modification of blood lipids for the primary and secondary prevention of cardiovascular disease CG67 (2008) & CG181 (2014)*. London: National Institute of Health and Clinical Excellence, 2014.
7. Collins GS, Altman DG. An independent external validation and evaluation of QRISK cardiovascular risk prediction: a prospective open cohort study. *BMJ* 2009;339:b2584.
8. Armitage J, Bowman L, Wallendszus K, et al. Collins R Study of the Effectiveness of Additional Reductions in Cholesterol and Homocysteine (SEARCH) Collaborative Group. Intensive lowering of LDL cholesterol with 80 mg versus 20 mg simvastatin daily in 12, 064 survivors of myocardial infarction: a double-blind randomised trial. *Lancet* 2010;376:1658–69.
9. NHS Employers and BMA. *Quality and Outcomes Framework for 2012/13*. Guidance for PCOs and practices, 2012.
10. Roland M, Campbell S. Successes and failures of pay for performance in the United Kingdom. *N Engl J Med* 2014;370:1944–9.
11. Eijkenaar F, Emmert M, Scheppach M, et al. Effects of pay for performance in health care: a systematic review of systematic reviews. *Health Policy* 2013;110:115–30.
12. Penning-van Beest FJA, Termorshuizen F, Goettsch WG, et al. Adherence to evidence-based statin guidelines reduces the risk of hospitalizations for acute myocardial infarction by 40%: a cohort study. *Eur Heart J* 2007;28:154–9.
13. Kotseva K, Wood D, De Backer GD, et al. EUROASPIRE III: a survey on the lifestyle, risk factors and use of cardioprotective drug therapies in coronary patients from 22 European countries. *Eur J Cardiovasc Prev Rehabil* 2009;16:121–37.
14. Hippisley-Cox J, Pringle M, Crown N, et al. Sex inequalities in ischaemic heart disease in general practice: cross sectional survey. *BMJ* 2001;322:832.
15. Millett C, Gray J, Wall M, et al. Ethnic disparities in coronary heart disease management and pay for performance in the UK. *J Gen Intern Med* 2009;24:8–13.
16. Secretary of State for Health. *Health Inequalities: working together to reduce health inequalities and meet new duties (Letter)*. Department of Health, 2015. 31-3-0015. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/286551/SofS_letter_health_inequalities.pdf
17. Health and Social Care Act 2012. 2015. The Stationary Office. 4-7-2015. http://www.legislation.gov.uk/ukpga/2012/7/contents/enacted
18. Health and Social Care Information Centre. *Quality and Outcomes Framework 2012–13*. 2015. 31-3-0015. http://www.hscic.gov.uk/catalogue/PUB12262
19. Stata Statistical Software: Release 13. [computer program]. Version 13. College Station, TX: StataCorp LP., 2013.
20. Goldstein H. *Multilevel statistical models*. 922 edn. John Wiley & Sons, 2011.
21. Karalis DG, Subramanya RD, Hessen SE, et al. Achieving optimal lipid goals in patients with coronary artery disease. *Am J Cardiol* 2011;107:886–90.
22. Kauffman AB, Olson KL, Youngblood ML, et al. Attainment of low-density lipoprotein cholesterol goals in coronary artery disease. *J Clin Lipidol* 2010;4:173–80.
23. Reibis RK, Bestehorn K, Pittrow D, et al. Elevated risk profile of women in secondary prevention of coronary artery disease: A 6-year survey of 117,913 patients. *J Womens Health (Larchmt)* 2009;18:1123–31.
24. Singh M, Chin SH, Crothers D, et al. Time trends of gender-based differences in lipid goal attainments during secondary prevention of coronary artery disease: results of a 5-year survey. *Am J Ther* 2013;20:613–17.
25. Victor BM, Teal V, Ahedor L, et al. Gender differences in achieving optimal lipid goals in patients with coronary artery disease. *Am J Cardiol* 2014;113:1611–15.
26. Giralt D, Domingues-Montanari S, Mendioroz M, et al. The gender gap in stroke: a meta-analysis. *Acta Neurol Scand* 2012;125:83–90.
27. Simpson CR, Wilson C, Hannaford PC, et al. Evidence for age and sex differences in the secondary prevention of stroke in Scottish primary care. *Stroke* 2005;36:1771–5.
28. Bugiardini R, Navarro Estrada JL, Nikus K, et al. Gender bias in acute coronary syndromes. *Curr Vasc Pharmacol* 2010;8:276–84.
29. Williams D, Bennett K, Feely J. Evidence for an age and gender bias in the secondary prevention of ischaemic heart disease in primary care. *Br J Clin Pharmacol* 2003;55:604–8.
30. Buja A, Boemo DG, Furlan P, et al. Tackling inequalities: are secondary prevention therapies for reducing post-infarction mortality used without disparities? *Eur J Prev Cardiol* 2014;21:222–30.
31. Lawesson SS, Alfredsson J, Fredrikson M, et al. Time trends in STEMI—improved treatment and outcome but still a gender gap: a prospective observational cohort study from the SWEDEHEART register. *BMJ Open* 2012;2:e000726.
32. Hawkins NM, Scholes S, Bajekal M, et al. The UK National Health Service: delivering equitable treatment across the spectrum of coronary disease. *Circ Cardiovasc Qual Outcomes* 2013;6:208–16.
33. Koopman C, Vaartjes I, Heintjes EM, et al. Persisting gender differences and attenuating age differences in cardiovascular drug use for prevention and treatment of coronary heart disease, 1998–2010. *Eur Heart J* 2013;34:3198–205.
34. Mathur R, Badrick E, Boomla K, et al. Prescribing in general practice for people with coronary heart disease; equity by age, sex, ethnic group and deprivation. *Ethn Health* 2011;16:107–23.
35. Saposnik G, Goodman SG, Leiter LA, et al. Applying the evidence: do patients with stroke, coronary artery disease, or both achieve similar treatment goals? *Stroke* 2009;40:1417–24.
36. Hawkins NM, Scholes S, Bajekal M, et al. Reducing socioeconomic inequality in coronary disease treatments: the NHS finally triumphs? *J Epidemiol Community Health* 2011;65(Suppl 2): A20–1.
37. Reid FDA, Cook DG, Whincup PH. Use of statins in the secondary prevention of coronary heart disease: is treatment equitable? *Heart* 2002;88:15–19.
38. DeWilde S, Carey IM, Bremner SA, et al. Evolution of statin prescribing 1994-2001: a case of agism but not of sexism? *Heart* 2003;89:417–21.
39. Carey IM, DeWilde S, Shah SM, et al. Statin use after first myocardial infarction in UK men and women from 1997 to 2006: Who started and who continued treatment? *Nutr Metab Cardiovasc Dis* 2012;22:400–8.
40. Boeckxstaens P, Smedt DD, Maeseneer JD, et al. The equity dimension in evaluations of the quality and outcomes framework: a systematic review. *BMC Health Serv Res* 2011;11:209.
41. Walford H, Kearns B, Barron S. *Technical briefing: prevalence modelling*. Association of Public Health Observatories, 2011.
42. McGinn D, Godman B, Lonsdale J, et al. Initiatives to enhance the quality and efficiency of statin and PPI prescribing in the UK: impact and implications. *Expert Rev Pharmacoecon Outcomes Res* 2010;10:73–85.