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

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To cite: Dodhia H. Kun L. Logan Ellis H, et al. 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. BMJ Open 2015;5:e008678. doi:10.1136/bmjopen-2015-008678

Prepublication history and additional material is available. To view please visit the journal (http://dx.doi.org/ 10.1136/bmjopen-2015-008678).

Received 6 May 2015 Revised 3 October 2015 Accepted 16 October 2015



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ABSTRACT

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

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

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.

Protected by copyright, including for uses related to text and data mining 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 rela-, and tionship 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 ORISK2 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

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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.¹⁴¹⁵

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.¹⁶¹⁷ 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 OOF 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 OOF 12-13 and NICE guidelines.⁶ 9

Coronary heart disease

- Protected ▶ Cholesterol level is measured in the past 15 months (at or prior to 31 March 2013) in 90% (range 50-90%) of by copyright, includ all patients on the CHD register;
- Cholesterol control $\leq 5 \text{ mmol/L in } 70\%$ (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 $\leq 5 \text{ mmol/L}$ 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

training, and simi 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 regrestechnolog sion models were dichotomous and were defined above in the 'predefined standards' section. They include (1) measurement of cholesterol (DO1-ves/no) and (2) total cholesterol $\leq 5 \text{ mmol/L}$ (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, $45-54, 55-64, 65-74 \text{ and } \ge 75$), 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

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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

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Demographic		Number	Per
characteristics	Sublevel	(n=7869)	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	1616	20.5
	British group		
	Asian/	694	8.8
	Asian-British		
	group		
	Mixed group	212	2.7
	Other ethnic	193	2.5
	group		
	Missing/	793	10.1
	unknown		
Index of	Least deprived	195	2.5
deprivation	40-60%	976	12.4
	60-80%	3816	48.5
	Most deprived	2837	36.1
	80–100%		
	Missing	45	0.6

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

data mining, AI training, and similar technologies 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

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.			

			95% confidence	95% confidence limits		
Register	Number	Per cent	Lower limit	Upper limit	Standard (%)	
Current record in the pa	ist 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 mont	hs			
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 recor	ded in the past 6 m	onths and current r	ecord in the past 15 m	onths		
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	

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

Protected by copyright, includ 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 for uses related to text 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 and 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 З 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 , and 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 nologies 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

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

Category	Total N	DO1: N (%)	Adjusted OR (95% confidence limits)	p Value				
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	0.001				
75+	3293	433 (13)	1.41 (1.13 to 1.75)	0.002				
Male	4547	663 (15)	Ref					
Female	3322	494 (15)	0.90 (0.76 to 1.06)	0.220				
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 aroups	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				
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				
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				
<150/90 mm Ha	5604	742 (13)	Ref					
>150/90 mm Ha	2182	343 (16)	1.15 (0.96 to 1.36)	0.123				
<5 mmol/L	5897	562 (10)	Ref					
>5 mmol/L	1665	289 (17)	1.33 (1.12 to 1.59)	0.001				
Yes	5891	547 (9)	Ref	0.001				
No	1978	610 (31)	2.97 (2.51 to 3.52)	<0.0001				
<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				
Yes	2104	111 (5)	0.37 (0.29 to 0.47)	< 0.0001				
No	5765	1046 (18)	Ref	ģ				
		(- /	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.								
ignificant differences between sexes but found that vomen were more likely than men to have higher LDL-C levels both before and after treatment suggesting hat women may need more aggressive lipid-lowering reatment than men to achieve targets. ¹⁴ $^{21-25}$ Women are less likely to be prescribed medication ncluding statins as secondary prevention following troke ²⁶ 27 and acute coronary syndrome. ²⁸ These find-								
	Category16-4445-5455-6465-7475+MaleFemaleWhite groupBlack/Black BritishAsian/Asian BritishMixed groupsOther ethnic groupsNot known/missingLeast deprived40-60%60-80%Most deprivedNon-smokerEx-smokerCurrent SmokerUnknown $\leq 150/90 \text{ mm Hg}$ $\geq 5 \text{ mmol/L}$ $\geq 5 \text{ mmol/L}$ γes No<18.5	CategoryTotal N16-4433345-5484055-64134065-74203575+3293Male4547Female3322White group4361Black/Black British1616Asian/Asian British694Mixed groups212Other ethnic groups193Not known/missing793Least deprived19540-60%97660-80%3816Most deprived2837Non-smoker4146Ex-smoker2191Current Smoker1456Unknown76<150/90 mm Hg	CategoryTotal NDO1: N (%)16-44333147 (44)45-54840170 (20)55-641340190 (14)65-742035189 (9)75+3293433 (13)Male4547663 (15)Female3322494 (15)White group4361643 (15)Black/Black British1616197 (12)Asian/Asian British69482 (12)Mixed groups21238 (18)Other ethnic groups19328 (15)Not known/missing793169 (21)Least deprived19522 (11)40-60%976153 (16)60-80%3816538 (14)Most deprived2837438 (15)Non-smoker4146579 (14)Ex-smoker2191266 (12)Current Smoker1456271 (19)Unknown7641 (54)<150/90 mm Hg	Adjusted OR (95% confidence limits) $16-44$ 333 147 (44)1.68 (1.14 to 2.47) $45-54$ 840170 (20)1.50 (1.13 to 1.98) $55-64$ 1340190 (14)1.45 (1.13 to 1.75) $65-74$ 2035189 (9)Ref $75+$ 3293433 (13)1.41 (1.13 to 1.75)Male4547663 (15)RefFemale3222494 (15)0.90 (0.76 to 1.06)White group4361643 (15)RefBlack/Black British169482 (12)1.07 (0.78 to 1.47)Mixed groups21238 (18)1.07 (0.67 to 1.72)Other ethnic groups19328 (15)1.18 (0.90 to 1.54)Least deprived19522 (11)Ref40-60%376153 (16)1.46 (0.76 to 2.79)60-80%3816538 (14)1.49 (0.80 to 2.78)Most deprived2837438 (15)1.59 (0.85 to 2.99)Non-smoker4146579 (14)Ref×-smoker1456271 (19)1.40 (1.13 to 1.74)Unknown7641 (54)1.54 (0.51 to 4.63)<150/90 mm Hg				

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 Italy³⁰ 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

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

				Adjusted OR		
Variable	Category	Total N	DO2: N (%)	(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	Least deprived	173	37 (21)	Ref		
Deprivation national ranking) (n=6672)	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.⁹¹² 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. Protected by

CONCLUSIONS

This evaluation has identified important quality issues and their determinants. Some of these variations in copyright 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 ğ as these patients had a greater probability of poor lipid uses related 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 e Ä 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

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Contributors HD and JC designed the study. JC extracted and cleaned the data from Lambeth DataNet and HD and JC performed the primary analyses. KL and HD performed the logistic regression analyses and KL performed the multilevel logistic regression analyses. HLE reviewed the literature. HD and HLE drafted the manuscript and AW, HW, AH and JB critically edited the manuscript and provided final approval. HD is guarantor of this work and had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Funding This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

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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.

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Title: 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.

(supplementary data tables).

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Supplementary data:

The following tables provide supplementary data referred to in the response to the peer reviewers comments.

Factor	Detail	Current prescription	95% confidence interval
		record (%)	
Age (n = 6711)	16-44	44	37 to 51
	45-54	71	68 to 75
	55-64	83	81 to 85
	65-74	84	82 to 85
	75+	80	78 to 81
Sex (n = 6711)	Male	83	82 to 84
	Female	75	74 to 77
Ethnicity (n = 6711)	White Group	81	79 to 82
	Black/Black British	74	72 to 76
	Asian/Asian British	88	86 to 91
	Mixed groups	78	72 to 84
	Other ethnic groups	83	77 to 89
	Not known/missing	78	75 to 81
IMD (6672)	Least deprived 0-40%	78	72 to 84
	40-60%	80	78 to 83
	60-80%	80	79 to 82
	Most deprived 80-100%	79	77 to 80

Supplementary table 1: Variation in statin prescribing by age, sex, ethnicity and deprivation index.

Supplementary table 2: Comparison of recording of current (within 15 months) recording of cholesterol status between 2011 & 2013 in cohort of patients with two readings

	Yes	No	Total
Yes	5,557	645	6,202
Row %	90	10	100
Column %	83	56	79
No	1,155	512	1,667
Row %	69	31	100
Column %	17	44	21
Total	6,712	1,157	7,869
Row %	85	15	100
Column %	100	100	100

Cholesterol record in 2013

Pearson chi square < 0.0001

Recording of cholesterol improved from 79% to 85% in the cohort of patients who had records in both time periods.

Supplementary table 3: Comparison of current statin prescribing between 2011 & 2013 in cohort of patients with two readings

	Yes	No	Total
	4,120	313	4,433
' %	93	7	100
ımn %	77	23	66
	1,224	1,055	2,279
' %	53.71	46.29	100
ımn %	23	77	34
	5,344	1,368	6,712
%	80	20	100
ımn %	100	100	100
	/ % /mn % / % /mn %	Yes 4,120 % 93 mn % 77 1,224 % 53.71 mn % 23 5,344 % 80 mn % 100	Yes No 4,120 313 % 93 7 mn % 77 23 1,224 1,055 % 53.71 46.29 mn % 23 77 5,344 1,368 % 80 20 mn % 100 100

Current statin prescription record in 2013

Pearson chi square < 0.0001

Recording of current statin prescribing improved from 66% to 80% in the cohort of patients who had records in both time periods.

Profile characteristics	Number	Mean 2011	Mean 2013	Difference in mean	95% confidence limits	p-value (paired t-
						test)
Overall	6931	4.50	4.33	0.17	0.14 to 0.19	<0.0001
Age group						
16-44	144	4.77	4.55	0.22	0.02 to 0.41	0.03
45-54	665	4.73	4.55	0.18	0.09 to 0.27	0.0001
55-64	1184	4.64	4.41	0.22	0.16 to 0.29	<0.0001
65-74	1865	4.46	4.31	0.15	0.10 to 0.19	<0.0001
75+	3072	4.40	4.24	0.16	0.13 to 0.19	<0.0001
Sex						
Male	3955	4.35	4.17	0.18	0.15 to 0.21	<0.0001
Female	2976	4.69	4.54	0.15	0.11 to 0.18	<0.0001
Ethnic category						
White Group	3860	4.51	4.35	0.16	0.14 to 0.20	<0.0001
Black/Black British group	1442	4.50	4.36	0.14	0.10 to 0.20	<0.0001
Asian/Asian British	607	4.28	4.10	0.18	0.10 to 0.26	<0.0001
Mixed groups	183	4.41	4.29	0.12	- 0.02 to 0.27	0.08
Other ethnic groups	166	4.35	4.23	0.12	-0.02 to 0.26	0.09
Not known/missing	673	4.65	4.43	0.22	0.15 to 0.30	<0.0001
IMD						
Least deprived (0-40%)	178	4.54	4.27	0.27	0.14 to 0.41	0.0001
40-60%	836	4.49	4.25	0.24	0.18 to 0.30	<0.0001
60-80%	3376	4.51	4.34	0.17	0.14 to 0.20	<0.0001
Most deprived	2500	4.48	4.35	0.13	0.10 to 0.17	<0.0001

Supplementary table 4: Comparison of mean total cholesterol by age, sex, ethnicity and deprivation index between 2011 & 2013 in cohort of patients with two readings

Note greater improvements in mean total cholesterol seen in younger age groups, men (compared to women), Asian/Asian British and least deprived categories compared to most deprived groups. However none of these differential impacts are significantly different within each category analysed.