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Association between continuity of primary care and both prescribing and adherence of common cardiovascular medications: a cohort study among patients in England

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ABSTRACT

Objectives To investigate whether better continuity of care is associated with increased prescribing of clinically relevant medication and improved medication adherence.

Setting Random sample of 300 000 patients aged 30+ in 2017 within 83 English general practitioner (GP) practices from the Clinical Practice Research Datalink.

Design Patients were assigned to a randomly selected index date in 2017 on which medication use and continuity of care were determined. Adjusted associations between continuity of care and the prescribing and adherence of five cardiovascular medication groups were examined using logistic regression.

Participants Continuity of Care Index was calculated for 173 993 patients with 4+ GP consultations 2 years prior to their index date and divided into five categories: absence of continuity, below-average continuity, average, above-average continuity and perfect continuity.

Main outcome measures (A) Prescription for statins (primary or secondary prevention separately), anticoagulants, antiplatelet agents and antihypertensives covering the patient's index date. (B) Adherence (>80%) estimated using medication possession ratio.

Results There was strong evidence ($p<0.01$) that prescription of all five cardiovascular medication groups increased with greater continuity of care. Patients with absence of continuity were less likely to be prescribed cardiovascular medications than patients with above-average continuity (statins primary prevention OR 0.73, 95% CI 0.59 to 0.85; statins secondary prevention 0.77, 95% CI 0.57 to 1.03; antiplatelets 0.55, 95% CI 0.33 to 0.92; antihypertensives 0.51, 95% CI 0.39 to 0.65). Furthermore, patients with perfect continuity were more likely to be prescribed cardiovascular medications than those with above-average continuity (statins primary prevention OR 1.23, 95% CI 1.01 to 1.49; statins secondary prevention 1.37, 95% CI 1.10 to 1.71; antiplatelets 1.37, 95% CI 1.08 to 1.74; antihypertensives 1.10, 95% CI 0.99 to 1.23). Continuity was generally not associated with medication adherence, except for adherence to statins for secondary prevention (OR 0.75, 95% CI 0.60 to 0.94 for average compared with above-average continuity).

Conclusion Better continuity of care is associated with improved prescribing of medication to patients at higher risk of cardiovascular disease but does not appear to be related to patient's medication adherence.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Despite continuity of primary care and prescribing of and adherence to medication being crucial aspects in English general practices, the relationship between continuity with both prescribing and adherence has not previously been studied in detail in English primary healthcare setting.
⇒ This study investigated the above relationship on medication for cardiovascular disease by focusing on five important specific therapeutic areas, relevant to a large patient population: statins (primary or secondary prevention separately), anticoagulants, antiplatelet agents and antihypertensives.
⇒ The study made use of anonymised individual electronic records of nearly 174 000 patients in English general practices to (a) identify medication prescribing on a randomly selected index date in 2017, (b) estimate adherence to prescribed medication over a year prior the index date and (c) measure longitudinal continuity of care over 2 years prior to the index date.
⇒ The study associated Continuity of Care Index with prescription on an index date rather than with the initial prescription of a medication.
⇒ Electronic patient's records do not provide information on whether patients had collected the prescribed medication at the pharmacy and whether they had taken it, hence the use of the medication possession ratio in our study as a proxy measure of adherence might overstate true adherence.

INTRODUCTION

Prescribing of medication is the main therapeutic intervention available to primary care practitioners but use of medicines may be suboptimal. If a medicine has been prescribed, non-adherence represents a lost opportunity to improve or maintain the patient's health status.[1] A key aspect of

the doctor–patient relation is longitudinal continuity of primary care, defined as the ongoing therapeutic relationship between an individual clinician and a patient. Better longitudinal continuity of care may result in better understanding of patients' health and improved problem recognition, affecting the initiation of prescribed medication.[2 3] Seeing the same general practitioner (GP) often may also enhance communication about problems and sharing of care goals and increase patients' readiness to believe in and accept medical advice,[2 3] thus encouraging patients' adherence to treatments. Despite longitudinal continuity of primary care, and prescribing of and adherence to medication, both being crucial aspects of primary healthcare, the relationship between them does not appear to have been previously studied in detail.

Previous evidence reviews on medication adherence have identified a range of important associations, including patients' sociodemographic factors, drug regimen or prescription factors and prescriber-related factors such as number of different prescribing doctors.[4–6] There is some evidence that a higher level of continuity of care is associated with a higher likelihood of drug persistence and adherence among patients treated with orally administered antidiabetics,[7 8] statins[9–12] and drugs used in heart failure.[13] These studies all involved particular patient groups or drug types and were based in healthcare settings outside the UK. A recent study among patients with dementia in England associated high continuity of care with patients receiving fewer and safer prescribed medications.[14] Conversely, there is some evidence from qualitative research that overfamiliarity can lead to slips and lapses in practice.[15] However, whether this translates to poorer prescribing, including potentially due to a reduction in the number of clinicians making a judgement about treatment initiation, remains unclear.

The aim of this study was to provide evidence about the relationship between continuity of care and both medication prescribing and patients' adherence to prescribed medicines. The study's main hypothesis was that better continuity of care is associated with increased prescribing of clinically relevant medication and improved medication adherence. A secondary study hypothesis was that over-familiarity results in suboptimal prescribing and use of medication, and that perfect continuity of care will be associated with no better (and potentially worse) medication prescribing and medication adherence compared with patients receiving good (but not perfect) continuity of care. The study's focus was on prescribing and adherence to commonly prescribed cardiovascular medication in UK primary care.

METHODS

Study design and setting

This study used data from the Clinical Practice Research Datalink (CPRD), which contains anonymised electronic primary healthcare records on 4.4 million patients (6.9% of the UK population) and is nationally representative in terms of age, sex and ethnicity.[16] Coded data include administrative activity (including consulting), diagnoses and prescribing. Almost all individuals in the UK are registered with a GP who provides primary healthcare, and electronic records are ubiquitous, so these data accurately capture most clinical activity in this setting. We obtained a random sample of 300 000 patients in 83 English GP practices (family practices) who were aged 30 years or older and were registered with their GP practice at least 1 year before 2017 and with at least 1 year follow-up after 2017. This was the maximum number of patients, and most recent complete year of data, available to us. Prescribing is much less common in younger adults in England[17] and GP consultation rates are also lowest in this age group,[18] so focusing on slightly older patients makes it more likely that relationships with continuity can be identified, while still capturing a younger population that may have a different experience of medication use compared with older patients. Patients were assigned to a randomly selected index date within the calendar year 2017 (to avoid seasonality), on which medication use and continuity of care were based. We focused on medication for cardiovascular disease (CVD), as a leading cause of morbidity and mortality,[19] with statins, anticoagulants, antiplatelets and antihypertensives accounting for around a quarter of all medications dispensed in English primary care.[20]

Exposure

We calculated continuity of care indices based on a 2-year period prior to the index date using CPRD information on patients' consultations and general practice staff codes.[21 22] We used a combination of CPRD staff codes to identify GP staff (senior partners, partners, salaried doctors, locum doctors, GP registrars and GP retainers) within the practice. Consultations included clinic and surgery consultations, home visits, out-of-hours' visits, telephone consultations and third-party consultations over the 2-year period. Following Hobbs *et al*,[18] we did not restrict according to consultation duration. Where a patient had more than one contact per day, we used information about staffing relating to the first consultation only, to avoid potential concerns about duplication of consultations.

We used the Bice & Boxerman (BB) Index to measure longitudinal continuity of care at the patient level (also known as the Continuity of Care Index), which has been recommended for use in primary care research.[23] This index takes into account the number of GPs seen by a patient and the number of GP consultations a patient had in a given period, and ranges between 0 (complete absence of continuity) and 1 (perfect continuity of care).[24]

This study calculated the BB Index for patients in our sample with at least four or more GP consultations (instead of the required minimum of two consultations) to arrive at more robust estimates of continuity. The BB

Index values were divided into five categories, labelled as 'absence' of continuity (BB Index 0), 'perfect' continuity (1) and the remainder in three equal sized groups labelled 'below average' (>0 to <0.178), 'average' (0.178 to 0.357) or 'above average' (>0.357 to <1). This separates out extremes of continuity (ie, absent, perfect),[21] while ensuring the other groups remain large enough while representing a useful range of continuity. To test our hypotheses, we took the fourth category (BB Index 'above average') as reference in the analyses.

Outcome measures

We explored two aspects of medicines use, which are clinically meaningful: prescribing of medication and medication adherence. Prescribing of statins, anticoagulants (direct oral anticoagulants, warfarin), antiplatelet agents (aspirin, dipyridamole, clopidogrel, ticagrelor, prasugrel) and antihypertensives (ACE inhibitors, angiotensin receptor blockers, beta-blockers, calcium channel blockers, thiazide diuretics) was determined by the presence or absence of a prescription in the patient's records where the anticipated start and end date of the prescription overlapped the study index date (binary outcome). Individual issues of a given drug were considered to be contiguous if the start dates were separated by less than three times the prior prescription length. Adherence to medications was estimated using medication possession ratio. This was calculated based on the sum of the days' supply for all fills of the given drug in the period up to 1 year prior to the index date, divided by the number of days in that time period (some patients may have received a drug for less than a year).[25] Using a threshold of 80%, we created a binary adherence variable with a ratio of 0.8 or higher as good adherence and lower as poor adherence.[26] Online supplemental figure S1 provides a graphical representation of how prescribing and adherence were assessed.

Therapeutic areas

We studied five specific therapeutic areas, as follows:

1. The use of statins for primary prevention of CVD. For this, we included all patients aged 65 or older with no prior diagnosis of CVD or diabetes (types 1 and 2). This age cut-off was selected as a pragmatic means of identifying persons more likely to be eligible for primary prevention of cardiovascular risk; although not all patients in this age group will require statins, a substantial proportion will be based on current UK guidance.[27] We defined CVD as any historical coded record of heart failure, coronary heart disease, peripheral vascular disease or stroke (including transient ischaemic attack).
2. The use of statins for secondary prevention of CVD. We included all patients aged 30 or older with a historical coded record of CVD (as defined above) or diabetes (types 1 and 2).
3. The use of anticoagulants for management of atrial fibrillation (including atrial flutter) or venous thromboembolism (pulmonary embolus or deep venous thrombosis recorded within 1 year prior the index date). We included all patients aged 30 or older with a relevant coded diagnosis in their patient file.
4. The use of antiplatelet agents for secondary prevention of CVD. We included all patients aged 30 or older with a historical coded record of CVD (as defined above), but not diabetes alone.
5. The use of antihypertensive medications in people with hypertension. All patients aged 30 or older were included if they had a historical diagnostic code for hypertension, or recent high blood pressure readings recorded in their patient file (>80% of measures in past year (or 2 years if ≤1 recordings in past year) >140 mm Hg systolic or >90 mm Hg diastolic).

We did not account for contraindications or other individual patient circumstances that might have justified not prescribing a medication.

Covariates

The analyses were adjusted for potential covariates at the individual level including the Cambridge Multimorbidity Score (general outcome based on 37 long-term conditions),[28] the number of GP consultations in the last 2 years, neighbourhood socioeconomic deprivation level divided into deciles (based on the national Index of Multiple Deprivation,[29 30] whether the patient had or had not received a medication review within the last year prior the index date, gender and age (categorised between 30 and 49, between 50 and 64, between 65 and 84, and those 85 or older). The analyses on medication adherence were also adjusted for the number of medicines a patient was prescribed.

Statistical methods

We applied multivariable logistic regression to test the associations between continuity of care and prescribing of medication and adherence to medication. A random intercept term was included in models to account for clustering of prescribing and consulting behaviour within practices. A Wald test was performed to investigate whether the modelled associations were jointly significant across continuity of care categories. Separate models were run for each of the five therapeutic areas and each of the two outcomes. We used 95% CI to provide evidence as to whether our sample results are likely to infer population effects for all patients represented by this sample. We also reported p values but did not use a stringent cut-off of 0.05 to determine a population effect. We used a strength of evidence approach,[31] whereby smaller p values suggest stronger evidence for a population effect.

Patient and public involvement statement

A group of five patient and public involvement and engagement (PPIE) contributors were involved in the writing of the funded research proposal. These PPIE contributors stressed the importance of the communication between GPs and patients in relation to instruction

for use of medicines. Furthermore, they raised the importance of occasionally seeing someone other than the usual GP as an opportunity to get a new perspective, resulting in our formulated secondary hypothesis. At the start of the study, the PPIE contributor group was enlarged to eight and we discussed a plan how to conduct the study, working out how to group patients according to their use of medicines, and what factors could help us to interpret the results such as having received medication review and living in deprived areas. The PPIE contributor group's perspectives informed our interpretation and discussion of the results.

RESULTS

There was a total of 173 993 patients with four or more consultations. Of these, 6992 patients (4.0%) had complete absence of continuity, and 10 376 patients (6.0%) had perfect continuity, with around 30% of patients falling into the other three categories (52 211, 52 334 and 52 080 patients in the low, average and high continuity groups, respectively, table 1). The median age of these 173 933 patients was 57 years (IQR 45–70), and 41.3% of the patients were male (likely reflecting a tendency for women to consult more frequently). The deprivation deciles showed proportionally fewer patients in the four most deprived deciles.

The association between continuity of care, and prescribing and adherence for each of the five therapeutic areas, is summarised in figures 1 and 2, and discussed in detail below.

Table 1 Descriptive statistics (N=173 993)

Exposure and covariates	N (%)
Continuity of care (CoC)	
Absence of CoC (index value: 0)	6992 (4.0%)
Below average CoC (index value<0.178)	52 211 (30.0%)
Average CoC (index value: 0.178–0.357)	52 334 (30.1%)
Above average CoC (index value: 0.357–0.999)	52 080 (29.9%)
Perfect CoC (index value: 1)	10 376 (6.0%)
Gender	
Male	71 766 (41.3%)
Female	102 227 (58.7%)
Medicine review in year prior index date	
Yes	52 098 (29.9%)
No	121 895 (70.1%)
Index of Multiple Deprivation Score 2015	
Deprivation 1 (least deprived)	28 994 (16.7%)
Deprivation 2	22 374 (12.9%)
Deprivation 3	19 039 (10.9%)
Deprivation 4	17 671 (10.2%)
Deprivation 5	20 139 (11.6%)
Deprivation 6	13 137 (7.6%)
Deprivation 7	14 392 (8.3%)
Deprivation 8	13 819 (7.9%)
Deprivation 9	13 878 (8.0%)
Deprivation 10 (most deprived)	10 513 (6.0%)
Deprivation unknown	37 (0.0%)
	Median (IQR)
Age in years	57 (45–70)
Cambridge comorbidity score	0.70 (0.25–1.52)
Number of general practitioner consultations in 2 years prior index date	9 (6–14)

Statins for primary prevention

The adjusted analysis (model 1, top half of table 2) showed very strong evidence (Wald test, p<0.001) for an association between continuity of care and prescribing of statins for primary prevention. Patients aged 65 or over not diagnosed with CVD-related conditions, with no or below-average continuity of care, were 10%–27% less likely to be prescribed statins than similar patients with above-average continuity of care (reference category). Patients with perfect continuity of care were more likely (OR 1.23, 95% CI 1.01 to 1.49) to be prescribed statins than patients with above-average continuity of care. There was no evidence of an association (Wald test, p=0.711) between continuity of care and adherence to statins for primary prevention (model 1, bottom half of table 2).

Statins for secondary prevention

The adjusted analysis (model 2, top half of table 2) showed strong evidence (Wald test, p=0.007) for an association between continuity of care and prescribing of statins for secondary prevention. Patients aged 30 or over diagnosed with CVD-related conditions (including type 1 or 2 diabetes) with poorer continuity of care were 9%–23% less likely to be prescribed statins than similar patients with above-average continuity of care, and patients with perfect continuity of care were more likely (OR 1.37, 95% CI 1.10 to 1.71) to be prescribed statins than patients with above-average continuity of care. The adjusted analysis also showed moderate evidence (Wald test, p=0.026) for an association between continuity of care and adherence to statins for secondary prevention (model 2, bottom half of table 2). Specifically, patients aged 30 or over prescribed statins for secondary prevention with average continuity of care were 25% less likely to be adherent to their treatment than those with above-average continuity (OR 0.75, 95% CI 0.60 to 0.94).

Anticoagulants

The adjusted analysis (model 3, top half of table 2) showed strong evidence (Wald test, p=0.006) for an association between continuity of care and anticoagulant prescribing for atrial fibrillation or venous thromboembolism. Patients with below-average continuity of care were 21% less likely (OR 0.79, 95% CI 0.68 to 0.92) to be prescribed anticoagulants than patients with above-average continuity

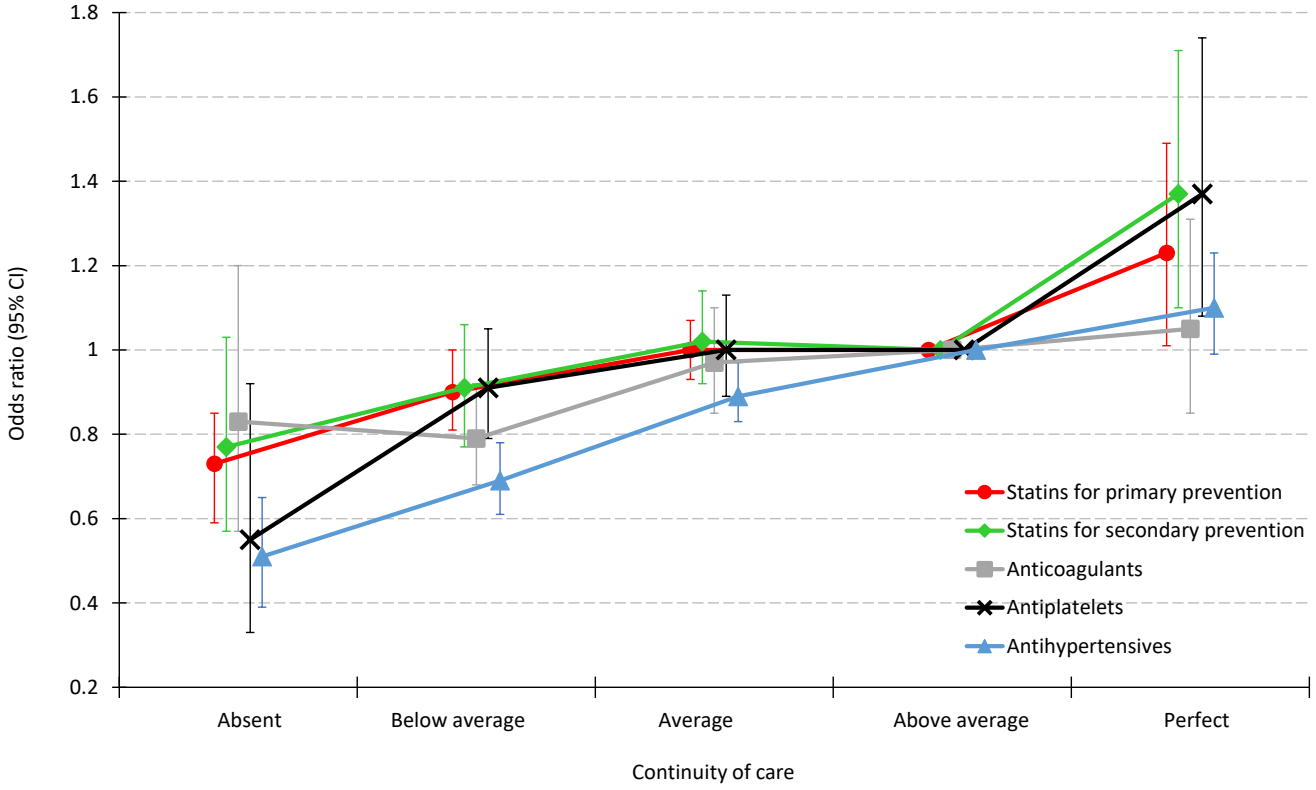

Figure 1 Graphical presentation of association between continuity of care and medication prescribing.

of care. However, there was no evidence (p=0.644) that perfect continuity was associated any further increases in prescribing. The adjusted analyses showed no evidence (Wald test, p=0.599) for an association between continuity of care and adherence to prescribed anticoagulants (model 3, bottom half of table 2).

Antiplatelets

The adjusted analysis (model 4, top half of table 2) showed strong evidence (p=0.002) for an association between continuity of care and antiplatelet prescribing for cardiovascular conditions. Patients with absence of continuity were 45% less likely (OR 0.55, 95% CI 0.33 to 0.92) to be prescribed antiplatelets than those with above-average continuity. Patients with perfect continuity of care were more likely (OR 1.37, 95% CI 1.08 to 1.74) to be prescribed antiplatelets than those with above-average continuity of care. The adjusted analysis showed no evidence (p=0.733) for an association between continuity of care and adherence to prescribed antiplatelets (model 4, bottom half of table 2).

The antihypertension model

The adjusted analysis (model 5, top half of table 2) showed very strong evidence (p<0.001) for an association between continuity of care and antihypertensive prescribing for raised blood pressure. Patients aged 30 or older with high blood pressure with average or worse continuity of care were 11%–49% less likely to be prescribed antihypertensive medication than those with above-average continuity of care. There was weak evidence (p=0.078) that patients with perfect continuity of care were more likely to be prescribed antihypertensives than patients with above-average continuity (OR 1.10, 95% CI 0.99 to 1.23). The adjusted analysis showed no evidence (Wald test, p=0.377) for an association between continuity of care and adherence to prescribed antihypertensives.

DISCUSSION

Analyses showed strong evidence that prescription of cardiovascular medications varied with continuity of care. Those patients with low or absent continuity of care were less likely to be prescribed medications considered appropriate for cardiovascular conditions compared with those with above-average continuity. There was a clear trend of increased clinically relevant prescribing associated with increasing continuity in all five therapeutic areas, providing strong support for our first hypothesis. Furthermore, the trend continued, so that in four of five models perfect continuity was associated with increased prescribing compared with above-average prescribing. This contradicted our second hypothesis that perfect continuity might be detrimental.

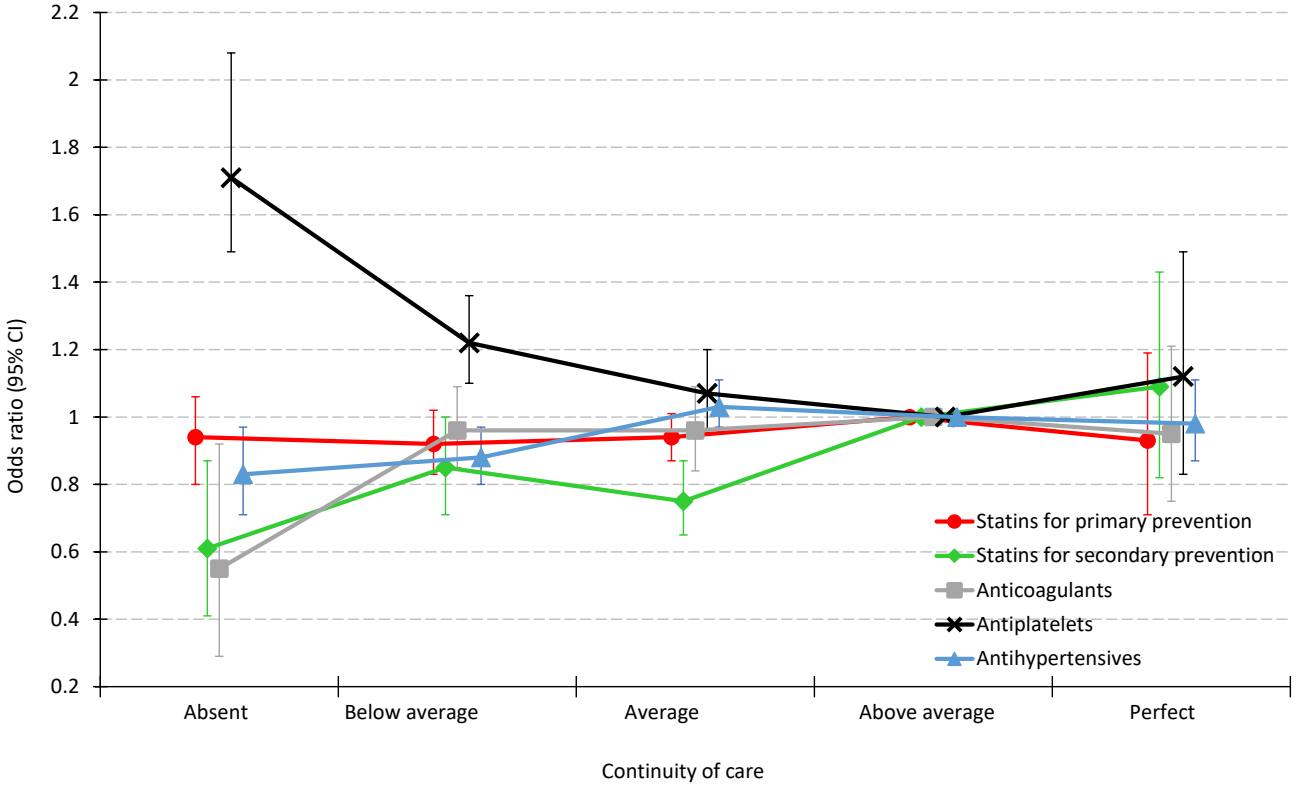

Figure 2 Graphical presentation of association between continuity of care and medication adherence.

There was no evidence in the adjusted models that continuity of care was associated with adherence to statins used in primary prevention, anticoagulants, antiplatelet agents or antihypertensives. However, there was weak evidence that continuity of care may be associated with adherence to statins used for secondary prevention.

Strengths and weaknesses of the study

The strength of this study is the use of anonymised individual electronic patient records. Electronic record systems are ubiquitous in UK primary care, so these allowed us to calculate a Continuity of Care Index based on near-complete information about patients' contact with their GP, and similarly accurately determine when a medication was first prescribed and when its prescription was repeated. Additionally, we were able to include important covariates and select patients with relevant conditions for our analyses.

Our study also has some limitations. For the analyses on initiating medication prescribing, we selected patients with certain characteristics and conditions for our five models. However, as we could not fully account for individual patient circumstances, not all patients with these characteristics and conditions might have needed the drugs specified by our study and this could have underestimated the relationship between continuity and prescribing (this is arguably particularly relevant to statin use for primary prevention, where the patient population was based only on age). We associated Continuity of Care Index with prescription on an index date rather than with the initial prescription of a medication, which again may weaken the observed association. Furthermore, adherence was assessed over a 1-year period, whereas continuity was assessed over 2 years, again potentially reducing the strength of association observed. For the analyses on medication adherence, we selected only those patients being prescribed statins, anticoagulants, antiplatelets or antihypertension. While this analysis thus contained lower numbers of patients, continuity of care was measured over a time period partly overlapping the period of measurement of medication possession ratio, hence improving the testing of a potential relationship between continuity and adherence. We limited our analysis to patients with four or more consultations; this increased the robustness of our continuity measurement and reflects the approach of others,[12] but may limit generalisability. We were also unable to determine the number of GPs working in a practice, so could not adjust for this factor; it is possible that practices with a smaller medical workforce may be more likely to provide improved continuity, as there is more limited choice available to patients. Finally, electronic patient records do not provide information on

Table 2 Association between continuity of care (CoC) and probability of being prescribed statins, anticoagulants, antiplatelets or antihypertensives, and adherence to these prescribed medicines

	Statins for primary prevention*			Statins for secondary prevention†			Anticoagulants‡			Antiplatelets§			Antihypertensives¶		
CoC	**OR**	**P value**	**95% CI**	**OR**	**P value**	**95% CI**	**OR**	**P value**	**95% CI**	**OR**	**P value**	**95% CI**	**OR**	**P value**	**95% CI**
Being prescribed	Statins, N=49 345			Statins, N=20 488			Anticoagulants, N=8935			Antiplatelets, N=15 993			Antihypertensives, N=27 929		
Absence of CoC	0.73	<0.001	0.59 to 0.85	0.77	0.080	0.57 to 1.03	0.83	0.323	0.57 to 1.20	0.55	0.022	0.33 to 0.92	0.51	<0.001	0.39 to 0.65
Below average CoC	0.90	0.044	0.81 to 1.00	0.91	0.213	0.77 to 1.06	0.79	0.002	0.68 to 0.92	0.91	0.192	0.79 to 1.05	0.69	<0.001	0.61 to 0.78
Average CoC	1.00	0.972	0.93 to 1.07	1.02	0.653	0.92 to 1.14	0.97	0.623	0.85 to 1.10	1.00	0.953	0.89 to 1.13	0.89	0.005	0.83 to 0.97
Above average CoC	Ref.			Ref.			Ref.			Ref.			Ref.		
Perfect CoC	1.23	0.036	1.01 to 1.49	1.37	0.005	1.10 to 1.71	1.05	0.644	0.85 to 1.31	1.37	0.009	1.08 to 1.74	1.10	0.078	0.99 to 1.23
Adherence to	**Statins, N=16 273**			**Statins, N=6574**			**Anticoagulants, N=4694**			**Antiplatelets, N=1927**			**Antihypertensives, N=10 982**		
Absence of CoC	0.94	0.793	0.60 to 1.47	0.61	0.170	0.31 to 1.23	0.55	0.101	0.27 to 1.12	1.71	0.577	0.26 to 11.37	0.83	0.418	0.53 to 1.30
Below average CoC	0.92	0.374	0.77 to 1.10	0.85	0.287	0.64 to 1.14	0.96	0.700	0.77 to 1.19	1.22	0.216	0.89 to 1.67	0.88	0.153	0.73 to 1.05
Average CoC	0.94	0.189	0.82 to 1.04	0.75	0.011	0.60 to 0.94	0.96	0.552	0.81 to 1.12	1.07	0.636	0.80 to 1.44	1.03	0.716	0.87 to 1.23
Above average CoC	Ref.			Ref.			Ref.			Ref.			Ref.		
Perfect CoC	0.93	0.586	0.76 to 1.17	1.09	0.643	0.77 to 1.54	0.95	0.759	0.66 to 1.36	1.12	0.706	0.62 to 2.04	0.98	0.911	0.74 to 1.31

Estimates of OR from multivariable logistic regression models adjusted for age, gender, medicine review last year, Cambridge Comorbidity Score, deprivation, number of general practitioner (GP) consultation in last 2 years and clustering in GP practices.

*Patients aged 65+ not diagnosed with CVD-related conditions. Analysis on being prescribed statins N=49 345, and on adherence to prescribed statins N=16 273. Online supplemental tables S1 and S2 show the complete results for the univariable and the multivariable logistic regressions.

†Patients aged 30+ diagnosed with heart failure, coronary heart disease, peripheral vascular disease, stroke and transient ischaemic attack, or diabetes (type one or 2). Analysis on being prescribed statins N=20 488, and on adherence to prescribed statins N=6574. Online supplemental tables S3 and S4 show the complete results for the univariable and the multivariable logistic regressions.

‡Patients aged 30+ and diagnosed with atrial fibrillation or venous thromboembolism (pulmonary embolus or deep venous thrombosis recorded within year prior the index date). Analysis on being prescribed anticoagulants N=8935, and on adherence to prescribed anticoagulants N=4694. Online supplemental tables S5 and S6 show the complete results for the univariable and the multivariable logistic regressions.

§Patients aged 30+ and diagnosed with heart failure, coronary heart disease, peripheral vascular disease, or stroke & transient ischaemic attack. Analysis on being prescribed antiplatelets N=15 993, and on adherence to prescribed antiplatelets N=1927. Online supplemental tables S7 and S8 show the complete results for the univariable and the multivariable logistic regressions.

¶Patients aged 30+ who were diagnosed with hypertension or had high blood pressure recordings within 1 year before index date. Analysis on being prescribed antihypertensives N=27 929, and on adherence to prescribed antihypertensives N=10 982. Online supplemental tables S9 and S10 show the complete results for the univariable and the multivariable logistic regressions.

whether patients had collected the prescribed medication at the pharmacy and whether they had taken it, so our use of the medication possession ratio as a proxy measure of adherence, although commonly used for research, will overestimate true adherence.

Comparison with other studies

Contrary to other studies, our analyses showed little evidence of an association between continuity of care and adherence to CVD-related medication.[10–13] In an Australian general practice population, Youens found improved continuity to be associated with better adherence to statins.[11] Warren reported similar findings from the Australian 45 and Up Study.[12] Positive associations between continuity and adherence have also been found in a specific heart failure population.[13] Brookhart found that continuity might be an effective means of addressing non-persistence in a Canadian population of new statins users.[10] Our own study presents evidence consistent with these findings for patients receiving statins for secondary, but not primary, prevention. This may reflect continuity having a stronger influence in patients who perceive themselves to be at higher risk due to a prior event, with patients considering their condition to be more severe tending to focus more on medical aspects of care (of which drug therapy might be considered one) during doctor–patient interactions.[32] There is less evidence examining the association between continuity and other cardiovascular medications. However, adherence to anticoagulation has been demonstrated to be positively associated with continuity after valvular surgery.[33] Studies of antihypertensives have shown conflicting findings.[34 35] Although the majority of previous studies have focused on adherence, the likelihood of prescribing of cardiovascular medication more generally has received less attention, although Youens reported improved continuity to be associated with increased statin initiation, which aligns with our own observations.[11] The reasons for the differences between our study and previous work are unclear, but may reflect differences in population, access to health services, or the measurements of continuity or adherence used.

Meaning of the study: possible explanations and implications for clinicians and policy-makers

Finnikin *et al*[36] concluded that most patients at high risk of CVD were not initiated on statins whereas many low-risk patients were overtreated. Our results suggest that better continuity of care can improve prescribing of statins to patients at higher risk of CVD. Following the discussion by Sidaway-Lee *et al*[3] on mechanisms linking continuity of care to patients' outcomes, longitudinal continuity as measured in this study could be related to accumulating knowledge of the patient or increased responsibility over time which then might improve a patient's prescribed medication. Longitudinal continuity itself, however, seems to be less relevant or not enough to encourage patient's medication adherence. Brookhart *et al*[10] suggest that the important factor in promoting adherence might not be the doctor a patient sees most frequently (as measured by the Continuity of Care Index in our study) but the one who initiated the statin regimen; this could imply other mechanisms such as trust or liking the doctor who made the initial decision to prescribe might be of most importance.

Unanswered questions and future research

Future research might focus on why continuity of care may improve prescribing since there could be several potential underlying mechanisms.[3] This could include distinguishing between preventative medication (discussed in this study) and symptom relief medication, or differences in perceived safety of medications. Further work might also examine how continuity of care is related to drug safety, such as the risk of drug-drug interactions or medication errors. Adverse drug reactions, for example, cause an estimated 6.5% of unplanned hospital admissions[37] and 20% of hospital readmissions in the UK.[38] Given many adverse drug reaction-related hospital admissions are avoidable, better continuity may afford an improved opportunity to identify problems and resolve them. Related to this is the growing concern about overprescribing in general,[39] and the association between continuity and both unnecessary prescribing as well as deprescribing, also merits exploration.

Conclusion

Although we cannot prove a causal association, the current study's findings suggest that prescribing of important cardiovascular medications may be positively influenced by improved continuity of primary care, although there is less evidence for improved adherence to ongoing medication. Clinicians and policy-makers should consider implementing strategies to improve continuity of care, as there is the potential for this to translate to better pharmacotherapy. Future work should explore the reasons for these findings in more detail and should consider whether continuity may also impact other relevant aspects of medication use including drug safety and overprescribing.

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Contributors PT and RAP designed the study. PT managed and performed the analysis. CS and RAP contributed to the methodological approach and also added significant input to the results and discussion. All authors contributed to the interpretation of the findings. PT was the lead investigator for the overall project and is responsible for the final content as guarantor.

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Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by CPRD Independent Scientific Advisory Committee (ISAC). Protocol no.: 18_197. Participants gave informed consent to participate in the study before taking part.

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