Medication adherence and clinical outcomes in dispensing and non-dispensing practices: a cross-sectional analysis

Mayam Gomez-Cano PhD
Postdoctoral Research Associate

Bianca Wiering PhD
Postdoctoral Research Associate

Gary Abel PhD
Associate Professor

John L Campbell MD
Professor of General Practice and Primary Care

Christopher E Clark PhD
Clinical Senior Lecturer in General Practice

Primary Care Research Group
Institute of Health Services Research, University of Exeter Medical School,
Smeall Building, St Luke's Campus, Magdalen Rd, Exeter, Devon, England EX1 2LU

Address for correspondence: c.e.clark@exeter.ac.uk

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Abstract

Background

Most patients obtain medications from pharmacies by prescription, but rural general practices can dispense medications. Clinical implications of this difference in drug delivery are unknown. We hypothesised that dispensing status may be associated with better medication adherence. This could impact intermediate clinical outcomes dependent on medication adherence in, for example, hypertension or diabetes.

Aim

We investigated whether dispensing status is associated with differences in achievement of Quality and Outcome Framework (QOF) indicators that rely on medication adherence.

Design and Setting

Cross-sectional analysis of QOF data for 7,392 general practices in England.

Method

We analysed QOF data from 2016/17 linked to dispensing status for general practices with list sizes ≥1000 in England. QOF indicators were categorised according to whether their achievement depended on a record of prescribing only, medication adherence, or neither.

We estimated differences between dispensing and non-dispensing practices using mixed-effects logistic regression adjusting for practice population age, sex, deprivation, list size, single-handed status and rurality.

Results

Data existed for 7,392 practices; 1,014 (13.7%) could dispense. Achievement was better in dispensing practices than in non-dispensing practices for seven of nine QOF indicators dependant on adherence, including blood pressure targets. Only one of ten indicators dependent on prescribing but not adherence displayed better achievement; indicators unrelated to prescribing showed a trend towards higher achievement by dispensing practices.

Conclusion

Dispensing practices may achieve better clinical outcomes than prescribing practices. Further work is required to explore underlying mechanisms for these observations, and to directly study medication adherence rates.

How this fits in

Around 15% of prescriptions given out by GPs do not get dispensed by pharmacies. In dispensing general practices, medications are usually dispensed, as opposed to prescriptions being issued to patients. This study hypothesised that this organisational difference may promote greater medication adherence for patients of dispensing practices by streamlining the issuing of medications. Quality and Outcome Framework (QOF) indicators were studied and higher achievement levels of blood pressure and other targets were found for dispensing than for nondispensing practices. Dispensing practices show greater achievement of QOF targets dependent on medication adherence than do non-dispensing practices. Further study is required to establish the mechanisms contributing to these findings.

Clinical impact

Dispensing practices show greater achievement of QOF targets dependent on medication adherence than non-dispensing practices.

Introduction

In some countries medications are both dispensed in pharmacies and issued directly to patients at primary care sites. United Kingdom (UK) general practices can hold contractual rights to dispense medication to patients who live more than 1 mile (1.6 km) from the nearest registered pharmacy.[1-3] Such d*ispensing practices* are predominantly rural, where geographical barriers to alternative sources of medication and health care co-exist.[4] Both rurality, and general practitioners' (GPs) dispensing of medications may affect quality of care and health outcomes.[5] Demographically, rural populations have slightly higher life expectancy, with higher proportions of elderly in comparison to urban areas.[6 7] Dispensing practices are less likely to be single handed,[8] and have shorter opening times than pharmacies. Historically, trained dispensers have run primary care dispensaries, however pharmacists are increasingly becoming integrated members of the primary health care team in all types of practices.[9 10] In dispensing practice patient records of allergies and co-morbidities are fully accessible to pharmacists and dispensers.[10] Importantly, patients of dispensing practices can leave in possession of their prescribed medication, whereas in prescribing practices they leave with a prescription for dispensing elsewhere by a registered pharmacy. This raises the hypothesis that adherence to prescribed medications may be greater for patients of dispensing practices in comparison to non-dispensing practices, by virtue of streamlined access to medications.

Non-adherence to prescription medication is a major cause of non-response to treatment. Between 11% and 19% of prescriptions are not actually dispensed to the patient, and barriers to medication possession exist at patient, doctor, and healthcare system levels.[11] Easy access to on-site pharmacy services may improve medication uptake and adherence,[12,13] overcoming logistical barriers that keep patients from presenting their prescriptions elsewhere.[14] These barriers are reduced or absent when patients attend dispensing practices. Patients' medication beliefs,[15] and concerns about taking medication,[16-18] also play a role in medication adherence. A collaborative patient-physician relationship may be key to achieving positive beliefs about treatment and increasing adherence.[19,20] incorporating the act of, or discussion of, dispensing into consultations may modify patients' beliefs, since patients report higher levels of trust in their GPs than in community pharmacists.[21] Furthermore, GPs are more likely to be aware of patients' personal and medical circumstances than pharmacists, therefore they may better tailor their information to patients' needs, taking account of issues such as health literacy.[22,23]

Reduced logistical barriers, opportunities to address patients' beliefs and tailoring of information to the patients' needs may thus all influence medication adherence. However, no research has yet investigated how the dispensing status of practices may impact clinical outcomes dependent on good medication adherence. We hypothesised that on-site dispensing of medication may overcome some barriers to medication possession in comparison to the giving of a prescription. Medication adherence is not systematically recorded in primary care, but National Health Service (NHS) Quality and Outcome Framework (QOF) indicators are. QOF indicators include some measures of intermediate outcomes whose achievement is dependent on medication adherence, others where

achievement reflects prescribing irrespective of adherence, and a third group where achievement is unrelated to prescribing. Therefore we investigated how dispensing practices differ from non-dispensing practices in demographic profile, and sought to establish whether dispensing status is independently associated with better clinical outcomes, defined as higher achievement of QOF indicators that depend on medication adherence in comparison to other groups of indicators.

Methods

Study design and setting

We undertook cross-sectional analyses of QOF clinical indicator data from 1st April 2016 to 31st March 2017, obtained from NHS Digital[24] and linked it to dispensing practice data from March 2017, obtained from the NHS Business Services Authority.[25] Data from March 2017 on practice population age, sex, practice list size, practice deprivation and workforce were also obtained from NHS Digital.[24] Practices were classified as rural or urban using Office for National Statistic classification based on the postcodes.[26] Datasets were linked to QOF and dispensing status using practice codes. All data are in the public domain; thus, no ethical approval was required.

Outcome measures

We classified QOF performance indicators into three groups according to their relation to prescribing: Group 1 were dependent on medication adherence, requiring the taking of a medication, for example indicators reporting percentages of patients meeting pre-specified blood pressure targets; Group 2 were achieved by evidence of *prescription* of a medication (regardless of adherence), for example indicators reporting percentage of patients with coronary heart disease with a record of antiplatelet or anticoagulant prescribing within the preceding year). The remaining QOF indicators were unrelated to specific medications (Group 3), for example the percentage of patients with stroke referred for further investigation. Group classification of indicators was achieved through consensus by discussion between three authors.

Given organisational differences in the processes of obtaining medication between dispensing and non-dispensing practices, and our hypothesis that these differences may affect medication adherence, we expected greater achievement of indicators in group 1 by dispensing practices compared to non-dispensing practices, whilst indicators from group 2 to should show no consistent differences. Thus group 2 represented a control set of indicators subject to any underlying trends according to dispensing status except differences in medication adherence. Group 3 provided further information on any underlying trends.

Statistical analysis

The raw counts of eligible patients (i.e. all patients fitting the corresponding indicator criterion, including those reported as exceptions) and of patients achieving each indicator in the QOF data, were used. QOF business rules allow doctors to report as exceptions certain patients from any indicator so that practices are not penalised financially for inappropriate reasons. Raw figures include any patients subsequently excluded through the exception reporting process. Thus raw data overcome any risk of bias due to variation in rates of exception reporting between practices. Similarly, missing data were not an issue since all people on a disease register were included in the denominator whether or not they had the appropriate outcome recorded.

For each indicator we fitted unadjusted and adjusted mixed-effects grouped logistic regression models with numbers of patients at each practice achieving the indicator as numerator and the number of eligible patients at each practice as denominator. Type of

practice (dispensing/not dispensing) was included as a fixed effect with practice as random effects. Adjusted models included the following practice level population characteristics: percentage of practice population aged ≥65, sex distribution, practice deprivation score, list size, single-handed status and rurality.[27] Analyses were restricted to practices with list sizes ≥1000.

Results

Data existed for 7,392 practices and 1,014 (13.7%) had dispensing status. Dispensing practices had more patients aged ≥65, fewer deprived patients, were less often single-handed, were more often rurally located, and had slightly larger list sizes when compared with non-dispensing practices (Table 1).

Group 1: prescribing indicators dependent on adherence

In adjusted and unadjusted models, the odds ratio (OR) for association with dispensing status was greater than one for all nine indicators, indicating higher achievement in dispensing practices. In unadjusted analyses, this only failed to reach significance for one indicator: percentage of patients with diabetes having total cholesterol ≤ 5 mmol/L (OR 1.01, (95% confidence interval (CI) 0.99 to 1.03; *P* = 0.22; Table 2).

After adjustment there were minor changes in ORs for most indicators. Substantial attenuation of differences in achievement for the three indicators related to hemoglobin A1c (HbA1c) levels was observed; two of these had *P*-values > 0.05: percentage of patients with diabetes whose last HbA1c was ≤ 59 mmol/mol (OR 1.01 (0.98 to 1.03); *P* = 0.57) and ≤ 64 mmol/mol (OR 1.02 (0.99 to 1.04); *P* = 0.22). For the remaining seven indicators, achievement was greater for dispensing practices than non-dispensing practices. These included blood pressure targets in hypertension, coronary heart disease, peripheral arterial disease, cerebrovascular disease and diabetes, achievement of diabetes targets for cholesterol lowering and for the highest threshold (≤75 mmol/mol) for HbA1c (Table 2; Figure 1).

Group 2: prescribing indicators independent of adherence

In contrast to group 1, unadjusted ORs for the ten prescribing indicators independent of adherence showed no consistency in direction. Only two indicators had ORs >1 indicating with half of the differences showing lower achievement (P<0.05). After adjustment the range of ORs was narrower and largely non-discriminatory; we only observed one statistically significant difference between dispensing and non-dispensing practice: the percentage of patients with atrial fibrillation being prescribed anticoagulants (OR 1.06 (1.03 to 1.10); *P* < 0.001; Table 3, Figure 2).

Group 3: prescribing indicators unrelated to medication

There were 27 further QOF indicators not included in the above analyses. ORs in the adjusted analyses showed an overall trend towards higher achievement by dispensing practices (only three ORs being <1); ORs were significantly >1 for 13 (48%) indicators and < 1 for none (Supplementary Table 1).

Discussion

Summary

To the authors' knowledge, this is the first study to consider the impact of primary care dispensing status on differential achievement of QOF indicators for chronic conditions. We found evidence for greater achievement by dispensing practices for seven of the nine QOF indicators that depend on adherence to medications. In contrast, a difference according to dispensing status was only observed in one of ten indicators dependent on prescribing but not adherence. Where indicator achievements were unrelated to prescribing, almost half of them were better achieved in dispensing practices.

Strengths and limitations

This large study analysed data covering over 7,000 practices in England. These findings are directly relevant to other UK health services, as well as to other countries where access to medications is co-located with primary health care settings. The full set of current QOF clinical indicators in unadjusted and adjusted models were examined. The impact of exception reporting on net achievement of QOF indicators has been previously observed by the present authors; therefore, only raw achievement rates were analysed to avoid potential bias due to differences in exception reporting.[9,28]

This practice-level observational analysis of routine data did not include any direct measures of individual medication adherence, only intermediate outcomes known to depend on good adherence. Medication adherence is affected by individual as well as organisational factors and we cannot be sure that our findings reflect impacts on individuals. The observed trends towards greater achievement in dispensing practices of QOF indicators unrelated to prescribing (group 3), suggest that other organisational characteristics of dispensing practices such as continuity of care, which could not be adjusted for in our analyses, may also be important.[29] Residual confounding due to this, and other unknown and/or unadjusted factors, is highly likely to be implicated in our findings.[30] Therefore we do not interpret these findings as clear evidence of differences in medication adherence rates according to practice dispensing status. The results are, however, consistent with our hypothesis that leaving a consultation with a medication, rather than with a prescription which may or may not be dispensed, removes one barrier to medication possession and therefore may plausibly affect medication adherence.

Comparison with existing literature

Practice characteristics previously associated with greater achievement of QOF indicators in Scotland have included higher deprivation levels, lower income from non NHS sources, younger ages of GPs and larger sizes of practice teams.[31] The rural workforce tends to be older;[32] we found lower rates of deprivation and single handed status amongst dispensing practices in the current study, therefore lower rather than higher underlying achievement of QOF indicators might have been predicted in dispensing practices, however no trend in either direction was evident from our control indicators, whilst adherence indicators uniformly showed higher achievement with dispensing. Evidence relating deprivation to QOF achievement is mixed; associations are weak in magnitude, and complex in nature

when other barriers to access for the most disadvantaged are accounted for.[28,33,34] It has also been observed that generic indices of deprivation cannot reflect true levels of deprivation in rural areas due to wide heterogeneity of deprivation within such settings.[35]

Our findings cannot readily be explained by any systematic differences in quality of care between dispensing and non-dispensing practices, although the trend to higher achievement of indicators unrelated to prescribing suggests that there may be underlying characteristics of dispensing practices, their patients, or both, contributing to these complex outcomes. Remoteness from urban centres, strongly correlated with dispensing status, does not correlate to a range of measures of quality of care.[36] Historically dispensing practice has been associated with lower generic prescribing rates and higher drug unit costs than non-dispensing practice.[37,38] We found no evidence for higher rates of prescribing per se in association with dispensing status, thus the "perverse incentive" (now largely mitigated against anyway within the current GP contract) does not account for our findings either. It follows from our hypothesis that dispensing practice drug costs overall will appear to be higher due to improved medication collection alone, in comparison with non-dispensing practices. In fact, by demonstrating greater achievement of targets for intermediate outcomes such as blood pressure, fewer cardiovascular events and deaths might be predicted. Therefore to consider drug costs of dispensing practices in isolation, without health economic assessment inclusive of outcomes is potentially misleading.[38,39]

Estimates of proportions of prescriptions issued but not dispensed vary widely; the median rate is around 15%.[11,40] On-site provision of medication is a distinguishing feature of dispensing practices. Co-location of pharmacies within care settings can improve medication uptake and adherence,[13] and logistical barriers to medication possession are lower where prescriptions can be dispensed on site or within easy geographical proximity.[14]

Implications for research and/or practice

Although barriers to integration of community pharmacy services with primary care exist,[41] pharmacist engagement in primary care is rising, with roles beyond medication advice, increasingly including elements of direct patient care.[9,42] Pharmacist led care can improve medication adherence in long-term conditions such as hypertension,[43,44] and such interventions are cost and time saving for GPs.[45,46] Community pharmacies are being increasingly co-located with, and/or managed by, primary care teams. Such proximity should facilitate medication adherence. This trend might lead to erosion, in time, of the differences in QOF achievement that we have observed here. The impact of financial incentives on achievement of these quality indicators is also important and may confound time-dependent trends in differences in medication adherence.[47] We have not found any evidence addressing the impact of expanding numbers of pharmacies co-located with surgeries on outcomes such as adherence. Further research on this topic could provide new insights into the importance of ready access to medications, irrespective of the right to dispense medications.

Dispensing directly to patients removes one barrier to medication possession in comparison to prescribing alone. Our findings offer initial evidence that dispensing of drugs may result in better intermediate clinical outcomes, as assessed by a range of QOF indicators, in

comparison to prescribing alone. A range of organisational and individual factors, which we could not adjust for, may well contribute to our observations. The findings are consistent with our hypothesis that differences may be mediated through improved medication adherence, however we were unable to directly measure adherence. Further work is required to clarify the possible underlying mechanisms for and significance of these observations, incorporating adherence measures, and to assess the implications for other models of primary care dispensing such as on-site pharmacies.

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Contributors

CEC proposed this study, GA designed the study and supervised the analyses, MG-C and BW undertook the analyses. JLC, CEC and GA contributed to interpretation of the analyses. CEC BW and MG-C drafted the initial manuscript. All authors revised and edited the manuscript and all authors have read, reviewed and approved the final manuscript.

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Disclaimer

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Ethical Approval

None required

Competing interests

CEC is a rural dispensing GP; he is Chair of the RCGP Rural Forum Steering Group.

Prior publication

Interim findings from this study were presented to the Annual Scientific Meeting of the British and Irisih Hypertension Society in Birmingham, September 2019: Gomez-Camo M, Campbell JL, Clark CE, Wiering B, Abel G. The rural dispensing practice: does it achieve better medication adherence and clinical outcomes compared to non-dispensing practices? A cross-sectional analysis of routine data: in abstracts from the 2019 Annual Scientific Meeting of the British and Irish Hypertension Society (BIHS). *Journal of Human Hypertension.* 2019;33(1):1-29.

Data sharing statement

All data used are in the public domain: QOF and NHS Business Authority data can be accessed as referenced.[24,25]

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Legends for tables and figures

Table 1 - Characteristics of dispensing and non-dispensing practices in England

Table 2 - Associations of group 1 outcomes – those dependent on medication adherence with dispensing status

Table 3 - Associations of group 2 outcomes - those independent of medication adherence with dispensing status

Figure 1 - Differences (OR) between dispensing and non-dispensing practices in outcomes dependent on adherence to medication

Figure 2 – Differences (OR) between dispensing and non-dispensing practices in outcomes dependent on prescription but not adherence

	Dispensing (n=1,014)	Not dispensing (n=6,378)	Total (n=7,392)
Age over 65 sample median % (IQR)	23.7 (20.9 – 26.9)	16.2 (11.3 – 20.3)	17.3 (12.2 – 21.6)
Males sample median % (IQR)	49.4 (48.8 – 50.0)	49.8 (48.9 – 51.1)	49.7 (48.9 – 50.9)
Single-handed practices N (%)	28 (2.8)	476 (7.5)	504 (6.8)
IMD least deprived N (%)	424 (41.8)	1,004 (15.7)	1,420 (19.2)
Rural N (%)	717 (70.7)	375 (5.9)	1,092 (14.8)
List size median (IQR)	7,016 (4,538 – 10,558)	6,795 (4,200 – 10,096)	6,825 (4,245 – 10,169)

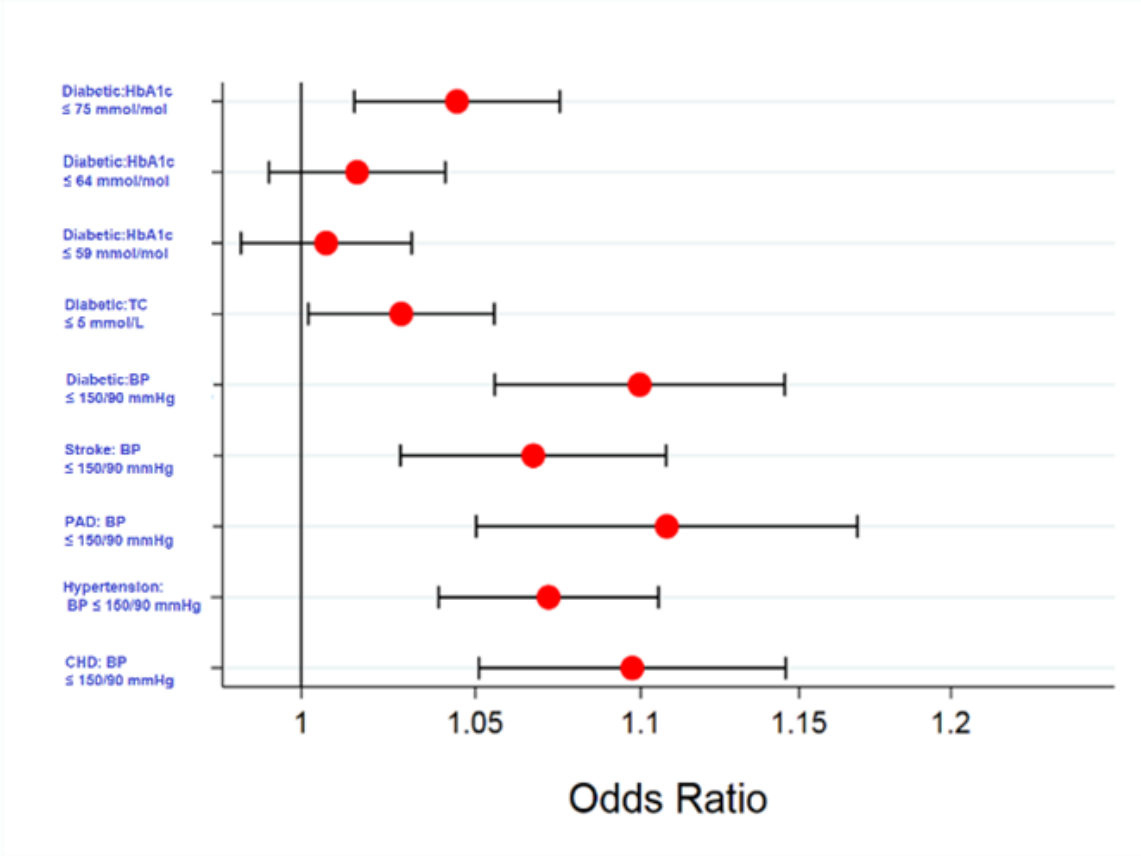
Table 1 - Characteristics of dispensing and non-dispensing practices in England

		Dispensing	Not dispensing	Unadjusted		Adjusted	
Code	**Indicator**	**Median % (IQR)**	**Median % (IQR)**	**OR (CI)**	***P*-value**	**OR (CI)**	***P*- value**
CHD002	Percentage of patients with coronary heart disease whose last blood pressure is ≤ 150/90 mmHg	90.5 (87.6-92.7)	90.1 (86.4, 92.8)	1.08 (1.04, 1.12)	< 0.001	1.10 (1.05, 1.15)	< 0.001
HYP006	Percentage of patients with hypertension whose last blood pressure is ≤ 150/90 mmHg	82.2(78.6,85.2)	80.5 (76.9, 83.7)	1.12 (1.09, 1.15)	< 0.001	1.07 (1.04, 1.11)	< 0.001
PAD002	Percentage of patients with peripheral arterial disease whose last blood pressure is ≤ 150/90 mmHg	88.2 (83.6, 92.0)	88.2 (82.5, 92.7)	1.06 (1.02, 1.11)	0.008	1.11 (1.05, 1.17)	< 0.001
STIA003	Percentage of patients with a history of stroke or transient ischaemic attack whose last blood pressure is ≤ 150/90 mmHg	85.8 (82.3, 89.1)	85.1 (80.8, 88.9)	1.07 (1.04, 1.10)	< 0.001	1.07 (1.03, 1.11)	0.001
DM002	Percentage of patients with diabetes whose last blood pressure is ≤ 150/90 mmHg	88.7 (85.6, 91.6)	87.6 (83.8, 90.8)	1.12 (1.08, 1.15)	< 0.001	1.10 (1.06, 1.15)	< 0.001
DM004	Percentage of patients with diabetes whose last total cholesterol is ≤ 5 mmol/L	70.3 (66.1, 73.6)	69.9 (65.6, 73.9)	1.01 (0.99, 1.03)	0.22	1.03 (1.00, 1.06)	0.035
DM007	Percentage of patients with diabetes whose last HbA1c is ≤ 59 mmol/mol	64.3 (60.2,68.4)	61.6 (57.1, 66.1)	1.12 (1.10, 1.14)	< 0.001	1.01 (0.98, 1.03)	0.57
DM008	Percentage of patients with diabetes whose last HbA1c is ≤ 64 mmol/mol	72.8 (69.0, 76.3)	69.5 (65.0, 73.6)	1.18 (1.15, 1.20)	< 0.001	1.02 (0.99, 1.04)	0.22
DM009	Percentage of patients with diabetes whose last HbA1c is ≤ 75 mmol/mol	84.1 (80.9, 86.6)	80.3 (76.2, 83.8)	1.28 (1.25, 1.31)	< 0.001	1.04 (1.01, 1.08)	0.003

Table 2 - Associations of group 1 outcomes – those dependent on medication adherence with dispensing status

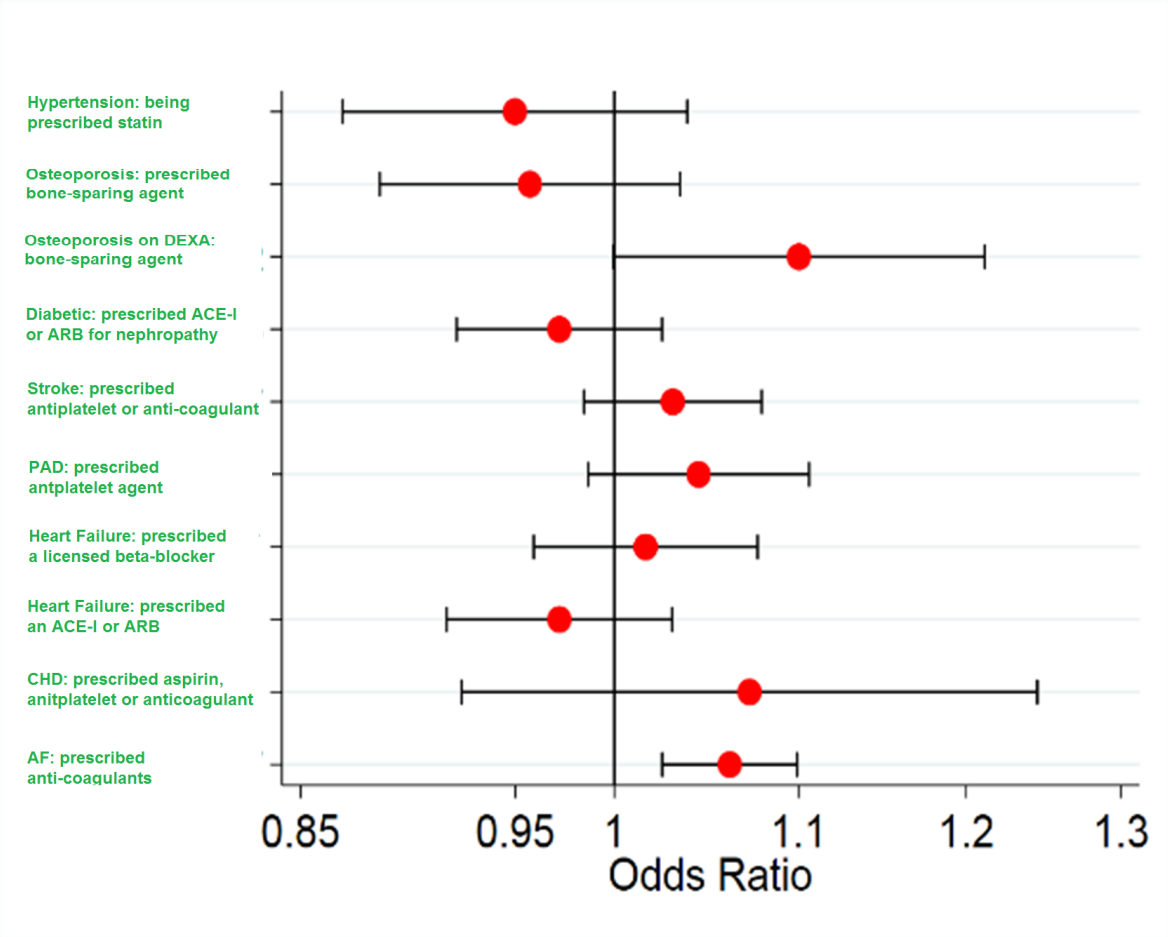
		Dispensing	Not dispensing	Unadjusted		Adjusted	
	Indicator	**Median % (IQR)**	**Median % (IQR)**	**OR (CI)**	***P*-value**	**OR (CI)**	***P*-value**
AF007	Percentage of patients with atrial fibrillation and CHA2DS2-VASc score ≥ 2 treated with anti-coagulants	82.7 (79.0, 86.4)	81.2(76.2, 85.7)	1.12 (1.09, 1.15)	< 0.001	1.06 (1.03, 1.10)	< 0.001
CHD005	Percentage of patients with coronary heart disease prescribed anti-platelet agent or an anti-coagulant	92.5 (90.2, 94.4)	92.7 (90.0, 94.8)	1.01 (0.97, 1.04)	0.75	1.07 (0.92, 1.24)	0.36
HF003	Percentage of patients with left ventricular systolic dysfunction prescribed an ACE-I or ARB	84.8 (77.8, 91.7)	86.2 (78.3, 100)	0.95 (0.90, 0.99)	0.017	0.97 (0.92, 1.03)	0.34
HF004	Percentage of patients with left ventricular systolic dysfunction, treated with an ACE-I or ARB, also being prescribed a beta-blocker licensed for heart failure	80.0 (70.0, 88.9)	81.8 (72.7, 93.6)	0.91 (0.86, 0.95)	< 0.001	1.02 (0.96, 1.08)	0.58
PAD004	Percentage of patients with peripheral arterial disease prescribed aspirin or other antiplatelet agent	88.5 (83.7, 92.3)	88.9 (83.3, 93.6)	0.92 (0.82, 1.02)	0.11	1.04 (0.99, 1.11)	0.14
STIA007	Percentage of patients with non-haemorrhagic stroke or TIA prescribed antiplatelet agent or oral anti-coagulant	92.5 (90.0, 94.7)	92.7 (89.4, 95.6)	1.00 (0.97, 1.04)	0.87	1.03 (0.98, 1.08)	0.24
DM006	Percentage of patients with diabetic nephropathy or micro-albuminuria, prescribed an ACE-I or ARB	80.8 (74.4,87.5)	82.1 (75.0, 88.9)	0.92 (0.88, 0.96)	< 0.001	0.97 (0.92, 1.03)	0.29
OST002	Percentage of patients with previous fragility fracture, and osteoporosis on DEXA scanning, prescribed a bone-sparing agent	85.7 (66.7, 100)	100 (66.7, 100)	0.93 (0.86, 1.01)	0.080	1.10 (1.00, 1.21)	0.053
OST005	Percentage of patients with previous fragility fracture and osteoporosis prescribed a bone-sparing agent	66.7 (54.6, 89.7)	75.0 (57.1, 100)	0.88 (0.82, 0.93)	< 0.001	0.96 (0.88, 1.03)	0.26
CVD-PP001	Percentage of patients newly diagnosed with hypertension, with QRISK2 score ≥20%, prescribed a statin	62.5 (50.0, 83.3)	75.0 (50.0, 100)	0.68 (0.63, 0.73)	< 0.001	0.95 (0.87, 1.04)	0.26

Table 3 - Associations of group 2 outcomes - those independent of medication adherence with dispensing status



HbA1c = hemoglobin A1c; TC = total cholesterol; BP = blood pressure; PAD = peripheral arterial disease; CHD = coronary heart disease

Figure 1 - Differences (OR) between dispensing and non-dispensing practices in outcomes dependent on adherence to medication



DEXA = dual energy x-ray absorptiometry; ACE-I = angiotensin converting enzyme inhibitor; ARB = angiotensin receptor blocker; PAD = peripheral arterial disease; CHD = coronary heart disease; AF = atrial fibrillation

Figure 2 – Differences (OR) between dispensing and non-dispensing practices in outcomes dependent on prescription but not adherence

The rural dispensing practice – better medication adherence and clinical outcomes compared to non-dispensing practices? A cross-sectional analysis of routine data: Data Supplement

		Dispensing	Not dispensing	Adjusted	
	Indicator	**Median % (IQR)**	**Median % (IQR)**	**OR (CI)**	***P*-value**
AF006	Percentage of patients with atrial fibrillation CHA2DS2-VASc score recorded in preceding 12 months (excluding those with previous CHADS2 or CHA2DS2-VASc ≥ 2)	94.6(90.9, 97.0)	94.8(91.0, 98.0)	1.00 (0.92, 1.08)	0.98
HF002	Percentage of patients with heart failure confirmed echocardiogram or specialist assessment between 3 months before and 12 months after diagnosis	91.3 (87.2, 94.7)	92.1 (88.5, 96.0)	0.99 (0.87, 1.14)	0.93
STIA008	Percentage of patients with stroke or TIA referred for further investigation between 3 months before or 1 month after the latest recorded stroke or first TIA	84.2 (79.1, 90.1)	84.6 (78.6, 90.9)	1.04 (0.98, 1.1)	0.20
STIA009	Percentage of patients with stroke or TIA who have had influenza immunisation in the preceding 1 August to 31 March	77.4 (73.8, 81.3)	75.1 (69.6,80.3)	1.01 (0.98, 1.05)	0.49
DM012	Percentage of patients with diabetes with record of foot examination and risk classification within preceding 12 months	86.1 (81.3, 89.8)	84.4 (77.9, 89.1)	1.16 (1.1, 1.22)	< 0.001
DM014	Percentage of patients newly diagnosed with diabetes in preceding 1 April to 31 March referred to a structured education programme within 9 months of diagnosis	71.0 (48.5,85.0)	76.5(57.1, 88.9)	0.96 (0.86, 1.08)	0.52
DM018	Percentage of patients with diabetes who have had influenza immunisation in the preceding 1 August to 31 March	77.5 (74.0, 80.9)	75.3 (70.5, 79.6)	1.01 (0.98, 1.04)	0.49
AST002	Percentage of patients aged 8 or over with asthma, with measures of variability or reversibility recorded between 3 months before or any time after diagnosis	86.3 (81.0, 91.2)	85.4 (80.3, 90.6)	1.02 (0.97, 1.08)	0.49
AST003	Percentage of patients with asthma who have had an asthma review in the preceding 12 months including assessment of control using the 3 RCP questions	72.9 (68.5, 77.8)	72.9 (67.6, 77.6)	1.09 (1.05, 1.14)	< 0.001
AST004	Percentage of patients with asthma aged ≥ 14 and < 20 for whom smoking status recorded in last 12 months	85.3 (80.0, 90.9)	87.1 (80.8,93.8)	1.09 (1.02, 1.17)	0.010
COPD002	Percentage of patients with COPD diagnosis confirmed by post bronchodilator spirometry between 3 months before and 12 months after diagnosis	82.4 (76.5, 87.9)	81.7 (75.5, 87.7)	1.09 (1.03, 1.15)	0.002
COPD003	Percentage of patients with COPD who have had a review including assessment of breathlessness using MRC dyspnoea scale in preceding 12 months	83.6 (77.2, 88.8)	83.1 (75.8, 88.9)	1.15 (1.08, 1.22)	< 0.001

COPD004	Percentage of patients with COPD with a record of FEV_1 in the preceding 12 months	77.3 (69.2, 84.0)	75.0 (66.0, 83.0)	1.16 (1.09, 1.23)	< 0.001
COPD005	Percentage of patients with COPD and MRC dyspnoea grade ≥3 in preceding 12 months, with a record of oxygen saturation value within preceding 12 months	96.6 (93.6, 100)	96.6 (93.2, 100)	1.04 (0.95, 1.13)	0.44
COPD007	Percentage of patients with COPD who have had influenza immunisation in preceding 1 August to 31 March	82.0 (78.3, 86.1)	79.7 (74.9, 84.2)	1.01 (0.97, 1.04)	0.70
DEM004	Percentage of patients with dementia whose care plan has been reviewed face-to-face in preceding 12 months	80.0 (73.3, 86.3)	80.0 (72.7, 87.5)	1.09 (1.03,1.16)	0.005
DEM005	Percentage of patients with a new diagnosis of dementia with a record of FBC, calcium, glucose, renal and liver function, thyroid function tests, serum vitamin B12 and folate levels recorded between 12 months before or 6 months after diagnosis	70.0 (57.8, 81.9)	66.7 (55.6, 81.3)	1.10 (1.03, 1.17)	0.005
DEP003	Percentage of patients aged ≥18 with new diagnosis of depression reviewed not earlier than 10 days after and not later than 56 days after date of diagnosis	68.5 (61.5, 75.0)	66.7 (58.1, 73.6)	1.07 (1.01, 1.13)	0.028
MH002	Percentage of patients with schizophrenia, bipolar affective disorder and other psychoses who have a comprehensive care plan documented in preceding 12 months	83.3 (73.3, 89.7)	83.6 (74.3, 89.5)	1.11 (1.03, 1.21)	0.008
MH003	Percentage of patients with schizophrenia, bipolar affective disorder and other psychoses who have a record of blood pressure in the preceding 12 months	85.7 (79.5, 90.9)	84.2 (77.8, 89.7)	1.09 (1.03, 1.15)	0.003
MH007	Percentage of patients with schizophrenia, bipolar affective disorder and other psychoses who have a record of alcohol consumption in preceding 12 months	85.2 (75.3, 91.3)	85.7 (77.2, 91.4)	1.08 (1.00, 1.16)	0.059
MH008	Percentage of women aged ≥25 and <65 with schizophrenia, bipolar affective disorder and other psychoses with cervical screening in preceding 5 years	75.0 (66.7, 84.6)	71.2 (62.5, 80.0)	1.11 (1.05, 1.17)	<0.001
MH009	Percentage of patients on lithium therapy with a record of serum creatinine and TSH in preceding 9 months	100 (100, 100)	100 (93.3,100)	1.08 (0.91, 1.28)	0.39
MH010	Percentage of patients on lithium therapy with record of lithium levels in therapeutic range in preceding 4 months	91.7 (80.0,100)	88.9 (73.3, 100)	1.07 (0.96, 1.19)	0.22

CAN003	Percentage of patients with cancer who have a patient review recorded within 6 months of diagnosis	71.8 (61.1, 81.0)	73.0 (61.4, 83.3)	0.98 (0.92, 1.05)	0.65
RA002	Percentage of patients with rheumatoid arthritis who have had face-to-face review in preceding 12 months	89.7 (83.3, 93.3)	90.0 (83.3, 94.1)	1.16 (1.07, 1.26)	< 0.001
SMOK005	Percentage of patients with any of CHD, PAD, stroke or TIA, hypertension, diabetes, COPD, CKD, asthma, schizophrenia, bipolar affective disorder or other psychoses and current smokers with a record of offer of support and treatment within the preceding 12 months	97.2 (98.6, 95.1)	97.1 (95.0, 98.7)	1.11 (0.93, 1.32)	0.25

Table S1 - Associations of group 3 outcomes - those unrelated to prescribing or dispensing status