Is higher primary care quality associated with lower hospital admissions for people with severe mental illness?*†

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Abstract

Most patients with severe mental illness (SMI) such as schizophrenia, bipolar disorder and psychoses in England are treated in primary care by their general practitioner (GP). GPs oversee care, prescribe medication and provide both mental and physical health services. One key indicator of the quality of care is 'unplanned hospital admissions'. People with SMI are at higher risk of hospitalization as they are more likely to experience severe mental health crises and to suffer from preventable physical illnesses like obesity, hypertension and smoking-related diseases. The Quality and Outcomes Framework (QOF) offers financial rewards to GP practices for good quality care and has the potential to reduce preventable admissions, but evidence for this is mixed.

In this paper, we examine whether better primary care practice performance on relevant QOF indicators is associated with lower rates of emergency hospital admissions for (a) SMI and (b) for physical conditions in patients with SMI, and (c) higher rates of elective hospital admissions for physical conditions in patients with SMI.

Using the GP practice as the unit of analysis, we test for an association between achievement on five mental health QOF indicators and a composite QOF indicator and the number of patients that have had at least one admission in a given year for SMI or a physical condition. We merge QOF data from around 8,500 practices in England over the period 2006/07 to 2010/11 with admissions data from Hospital Episodes Statistics. We run cross-sectional and panel data count models at the level of the individual GP practice. We include year indicators to allow for temporal trends and control for a rich set of relevant local practice characteristics, patient population characteristics, local area population characteristics, and covariates on access to services.

Descriptive statistics show a large increase in emergency admissions over time, particularly for physical conditions. Preliminary estimation results show a positive and significant association between two QOF indicators, and the composite QOF indicator, and hospital admissions for both SMI and physical conditions. This casts doubt on the theory that incentivizing quality of primary care by means of the QOF framework is effective in lowering the risk of unplanned admission.

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1 Introduction

Severe mental illness (SMI) encompasses a set of serious and chronic enduring conditions such as schizophrenia, bipolar disorder and psychoses. Although some people make a full recovery, most will develop a lifelong illness [1]. The prevalence of bipolar disorder is about 1-2% of the UK population, although bipolar spectrum disorder may affect as many as 8% [2]. The prevalence of schizophrenia is 0.7% [3]. Life expectancy for people with schizophrenia and bipolar disorder is typically 25 years less than for the general population [4, 5].

Despite its prevalence and poor health outcomes, there has been little empirical evidence on the processes of health care for people with SMI. In England, most patients with SMI are treated in primary care by their general practitioner (GP). People with SMI consult their GPs more frequently [6] and are in contact with primary care services for a longer cumulative time than patients without mental health problems [7, 8]. Recent evidence from the UK finds that the estimated national rate of SMI patients seen only in primary care is around 57% for schizophrenia and 38% for bipolar disorder [9]. Primary care is therefore central in the care of people with SMI. The GP oversees care, prescribes medication and provides both mental and physical health services.

One key indicator of the quality of primary care is 'unplanned hospital admissions' [10] and SMI patients are at higher risk of hospitalizations than the general population [11, 12] as medical comorbidity is more common. SMI patients are more likely to experience mental health crises that require treatment and suffer from preventable physical illnesses like obesity, hypertension and smoking-related diseases [13, 14]. Poor compliance with medication is well recognised in this patient population and this may lead to relapse and unplanned admissions.

Quality indicators for mental health have been routinely measured in English primary care as part of the Quality and Outcomes Framework (QOF) which was introduced in 2004 [15]. The QOF is a voluntary[1] incentive scheme for primary care practices which offers financial rewards for good quality care. The QOF has the potential to reduce unplanned, preventable hospital admissions, but evidence for this is mixed. No association has been found between admission rates and primary care quality indicators for coronary heart disease, asthma or COPD [16, 17, 18]. However, other studies have found a significant association between poorer quality of care and higher emergency admissions for diabetes [19, 20] and a small effect for stroke [21]. There has been no evidence to date on the relationship between primary care quality and admission rates for SMI.

Effective primary care can have an important preventive role, and could therefore be associated with lower emergency admissions. Conversely, better quality of care may result in more health problems being identified as part of regular screening activities and more frequent GP-patient contacts, thereby leading to more elective admissions for hospital care. We examine whether better primary care practice performance on specific mental health QOF indicators is associated with lower rates of (a) emergency hospital admissions for SMI, (b) emergency hospital admissions for physical conditions in patients with SMI, and (c) higher rates of elective admissions for physical conditions in patients with SMI. Our null hypotheses are that QOF performance will have no effect on hospital admissions for SMI or for physical conditions in people with SMI.

Our empirical approach is to estimate cross-sectional and panel data Poisson models that relate the number of people admitted from a GP practice to the practice QOF achievements. We control for a wide range of observed and unobserved GP practice and patient population characteristics that may be correlated with admissions but are unrelated to quality of care.

The remainder of the paper is organised as follows: we first describe the data and discuss our strategy to identify SMI patients from routinely available inpatient records. We then outline our approach and set out the econometric model to be estimated. After providing a description of the distribution of admissions and QOF achievements in our study population, we present our empirical estimates of the association between QOF achievement and admissions. Lastly, we discuss our findings and consider some research and policy implications.

[1] In practice, nearly all GP practices participate. This may be related to the generous financial incentives attached to achievements on the QOF and the ease with which many practices have fulfilled the requirements.

2 Data

Our study combines patient and GP practice level data for the study period April 2006 - March 2011. We merge QOF data from around 8,500 GP practices in England with admissions data from Hospital Episodes Statistics (HES). These data are linked to publicly available information on GP practice characteristics, to patient characteristics such as disease prevalence, and to population characteristics such as deprivation and other potential confounders that are recorded at small area level (i.e. Lower Super Output Areas (LSOAs)). We also control for measures of access. All analyses are carried out at GP practice level and data are aggregated accordingly.

2.1 Hospital admissions

Our outcome of interest is the number of SMI patients aged 18 or over who are admitted for secondary care in England at least once within a financial year (hereafter: 'year'). We extract information on all NHS-funded inpatient activity from the HES data warehouse[2]. To identify patients that have been diagnosed with SMI, we search all primary and secondary diagnosis fields for relevant ICD-10 diagnosis codes[3]. We consider diagnosis codes that cover two large groups of SMI: schizophrenia, schizotypal and delusional disorders (F20-F25, F28-F29), and mood affective disorders (F30-F31) (see Table 1).

Table 1 about here

We distinguish three types of admissions based on the primary diagnosis and the mode of admission: SMI admission, elective admission for physical care, and emergency admission for physical care. All SMI admissions are deemed to be emergency admissions. Physical care admissions are defined as all main diagnoses other than mental health diagnoses (all F-codes) or unknown diagnosis (R69). For each type of admission, we calculate the total number of patients admitted at least once within the financial year to any hospital provider per GP practice. This definition is insensitive to the frequency with which the same patient is admitted for the same type of care but is consistent with the measure of patients at risk. (For simplicity, we will refer to the number of patients admitted at least once within the financial year as 'admissions' throughout this paper.)

For some episodes of physical care, a diagnosis of SMI may not have been made or recorded in the inpatient records even though the patient suffers from SMI. This may occur if i) the diagnosis is not deemed clinically relevant for the physical care provided, i.e. the patient was treated for an unrelated medical problem, ii) the diagnosis is not important for reimbursement purposes, iii) the condition is not apparent at the time of assessment, or iv) to avoid any stigma associated with the diagnosis. As a result, SMI patients admitted for physical care may not be identified as such when detection is based solely on diagnostic information contained in the current inpatient record.

To capture all relevant activity, we therefore link patient records across time, based on the patient's unique identifier, and identify all secondary care provided to this patient after a diagnosis of SMI has been made, whether or not the diagnosis is recorded in this specific inpatient record. This identification strategy can be justified on the grounds that SMI is an enduring illness that may increase or reduce in burden over time but rarely resolves. To ensure that activity at the beginning of our study period is identified correctly, we extend our search period retrospectively by five years to April 2001 - March 2011. Hence, if a patient is diagnosed with bipolar affective disorder (F31) in 2002 and receives inpatient care in 2008, we will count the activity in 2008 even if no diagnosis of SMI was recorded then.

[2]These data are reported at the level of Finished Consultant Episodes (FCEs) and we convert these to inpatient spells.

[3]Although the QOF uses diagnosis to define patients eligible for practices' SMI registers, ICD-10 is not used. Instead, GP practices record diagnoses using Read Codes. These can be cross-mapped to ICD-10 codes through the NHS National Clinical Classifications Service at NHS Connecting for Health.

2.2 Quality performance

We extract data on practice quality performance from the QOF dataset. The QOF contains sets of indicators against which practices score points according to their level of achievement. These indicators are based on clinical evidence and designed to support NHS policies[4]. One of the clinical domains of the QOF is SMI and we focus our analysis on these indicators.

For each GP practice, we obtain information on the number of patients on the SMI register, i.e. the number of patients at risk of admission, and the practice's achievement on five SMI-related QOF indicators (see Table 2). A full description of the indicators can be found in Table 1 of the Appendix.

Table 2 about here

Achievement scores are calculated as the number of patients for which the indicator is met over all patients that were eligible to be included. Broadly speaking, higher scores equal higher achievements and lead to higher financial rewards for the practice[5]. Three of our five SMI QOF indicators apply to all patients on the practice SMI register, i.e. the number of patients at risk of admission. Conversely, for the remaining two SMI QOF indicators, MH4 and MH5, the relevant denominator is the number of patients on lithium therapy, which forms a sub-sample of the patients on the SMI register. To take account of this, we include the lithium 'prevalence' (based on the denominator of MH4) as a control variable in the MH4 and MH5 models.

Practices can 'exception report' patients from specific indicators for reasons such as extreme frailty, intolerance to a particular medication, or patients refusing treatment [22]. Therefore, reporting cases as 'exceptions' may reflect good quality care - GPs are carefully reviewing cases to establish their eligibility for treatment - but could alternatively reflect 'gaming' by GPs, who can increase the number of points they earn by reducing the eligible population [23]. Therefore, the legitimacy of exception reporting is ambiguous. As a conservative approach to assessing performance, we therefore include all patients in the denominator for each QOF indicator: those recorded as eligible, plus those who are potentially eligible but who were 'exception reported'.

The various SMI QOF indicators can be conceptualised as measuring different, but potentially correlated aspects of the quality of primary mental care provided. Hence, the association between individual QOF indicators and admissions may be different from an overall, combined effect. To explore this empirically, we derive a composite SMI QOF score, where the different QOF indicators are weighted by the number of points attached to each of them. These weights aim to reflect the relative importance given to each domain by the current reimbursement scheme.

We also extract data on disease prevalence for relevant co-morbidities from the QOF such as obesity, coronary heart disease, chronic obstructive pulmonary disease (COPD) and diabetes.

We link these data to the aggregate practice level admissions data derived from HES through the unique practice-year identifier. Practices are excluded from our sample if they do not report an SMI register or if the number of patients on this register is zero.

2.3 GP practice characteristics and other environmental factors

We control for a number of GP and practice characteristics from the General Medical Services (GMS) dataset and Attribution Data Set (ADS). These include the 2-year moving average practice list size[6] as well as the average age of GPs, proportion of male GPs, whether the practice operates single-handed, and whether the practice is contracted under the Personal Medical Services (PMS) scheme.

[4]There have been three revisions to the QOF since its introduction in 2004/05. The subset of indicators we examine from 2006/07 - 2010/11 have remained unchanged from their 1st revision.

[5]The QOF mental health indicators have upper payment thresholds of 50% or 90%. This means that practices can earn the maximum points on an indicator without necessarily achieving the target for all patients on the register.

[6]We drop observations (practice-year) with a practice list size with fewer than 1,000 patients.

To control for local population characteristics, we link data from the Neighbourhood Statistics Census (2001) and the Index of Multiple Deprivation (IMD, 2004) which is available at LSOA level. LSOAs are defined geographic units that cover an average population of 1,500. There are 32,482 LSOAs in England. GP practices typically care for patients residing in multiple LSOAs and the ADS provides a breakdown of the practice population by LSOA. Based on this information, we derive a weighted average of the local population characteristics of the practice and assign this to the practice. From the ADS dataset we obtain the average age and male proportions of each practice's registered patients. We also derive two measures of deprivation (the 2004 IMD overall deprivation index, categorised as quintiles; and the proportion of the population claiming incapacity benefit for mental health disorders - this variable is part of the IMD employment domain), a measure of ethnicity (% non-whites), and a measure of rurality (% living in urban areas). Finally, to reflect differences between practices and regions in terms of supply and access to care, we record the catchment population prevalence of NHS community psychiatric residential beds, the percentage of practice patients able to book an appointment within 48 hours (measured in the GP Patient Survey), and a measure of informal care provision (% of the catchment population providing informal care) based on Census data; the latter is intended to acknowledge that the level of informal care provided is often high for SMI patients and may be considered a substitute for inpatient care [24].

3 Empirical approach

The aim of our empirical analysis is to relate the number of patients admitted to hospital from a GP practice to the practice's quality performance, controlling for other factors that may drive admissions but are unrelated to the quality of care provided. The number of admissions per GP practice is a non-negative integer or count variable and we estimate both cross-sectional and panel data count models that acknowledge the data generating process [25, 26]. We estimate separate models for each QOF domain and the composite score.

Let adm_{it} be the number of patients in GP practice $i = 1, \ldots, I$ that are admitted to hospital at least once within the year $t = 1, \ldots, T_i$. The number of SMI patients at risk of admission is denoted as $risk_{it}$. We specify a Poisson regression model with:

$$E[adm_{it}] = V[adm_{it}] = risk_{it} * \gamma_i * \exp(\theta + q_{it}^{'}\delta + x_{it}^{'}\beta + \kappa_t) \quad (1)$$

where q_{it} is the measure of GP practice quality as measured by the QOF, x_{it} is a vector of covariates that capture differences in the practice patient population, as well as the supply of and access to other mental health care resources, θ denotes the common intercept, and κ_t is a vector of time dummy variables. We also introduce a GP practice-specific effect γ_i that captures unobserved, time-invariant differences between practices in terms of their admission propensity. The variance, $V[adm_{it}]$, and conditional mean, $E[adm_{it}]$, are constrained to be equal (equidispersion) and the model is inherently heteroscedastic. To allow for over- or underdispersed data, we derive robust / bootstrapped standard errors for all parameter estimates.

We estimate both fixed effects (FE) and random effects (RE) panel models [25, 27]. The RE estimator assumes that the γ_i are drawn from a gamma distribution with mean 1 and variance α and are uncorrelated with the regressors[7]. The FE estimator treats γ_i as parameters to be estimated and does not require such strong exogeneity assumptions[8]. The advantage of the RE estimator is that it makes use of both within and between practice variation to estimate the coefficients, whereas the FE estimator only utilises within practice variation. Hence, the FE estimator is less efficient, especially when the dependent and independent variables vary little over time. However, the RE estimator is inconsistent if the assumed exogeneity of the covariates does not hold. We use the Hausman test to screen for such bias [28]. We also estimate a pooled model with cluster-robust

[7] Alternatively, one can also assume a normal distribution for the random effects. However, the model with gamma distributed effects has a closed form solution and is therefore typically preferred [25].

[8] In contrast to many other non-linear models, the Poisson FE is not subject to incidental parameter bias and the coefficient estimates from both the conditional and unconditional Poisson FE are consistent.

standard errors and $\gamma_i \equiv 1$. In the cross-sectional models, time and practice effects are not identified and are hence excluded.

The coefficient estimates are on the log-linear scale and can be interpreted as semi-elasticities. To facilitate interpretation, we transform the estimates and present average marginal effects (AME) instead. For example, the AME of quality is given as:

$$\sum_{i=1}^{I}\sum_{t=1}^{T}\frac{\partial E[y_{it}|x_{it},q_{it},\kappa_t,\gamma_i]}{\partial q_{it}} = \sum_{i=1}^{I}\sum_{t=1}^{T}\delta * [risk_{it} * \gamma_i * \exp(\theta + q_{it}^{'}\delta + x_{it}^{'}\beta + \kappa_t)] \quad (2)$$

where all coefficients are replaced by their sample estimates and the practice-specific effect γ_i is set to one[9]. All models are estimated in Stata 11.

4 Results

4.1 Descriptive statistics

Our sample consists of 8,469 GP practices observed over a five year period. The panel is unbalanced because some practices either (i) do not report on the QOF in some years, (ii) report to have no SMI patients on their patient register, or (iii) are yet to be established or have ceased to exist. The overall panel consists of 40,066 year-practice observations.

Figure 1a shows the distribution of admissions per GP practice for each of the three different admission types for the financial year 2010/11[10]. Admissions are standardised by the number of patients at risk. Figure 1b presents the number of admissions (not standardised) broken down by financial year.

Figures 1a - 1b about here

In 2010/11, the median number of admissions per patient at risk per GP practice is 0.051 (IQR=0.022-0.085) for SMI, 0.047 (IQR=0.024-0.074) for elective physical care, and 0.1 (IQR=0.067-0.143) for emergency physical care. The distribution of admissions per practice is skewed to the right, with very few practices admitting more than 20% of their SMI patients for any of the three types of care. Interestingly, more GP practices admit at least one patient for emergency physical care than for elective physical care (95% vs. 84%).

The number of SMI patients admitted for physical care increased constantly over time. Indeed, the number of elective admissions nearly doubled since 2006/07. In contrast, the number of admissions with a main diagnosis of SMI remained relatively constant over time.

Figure 2 shows the distribution of QOF achievement scores on the five QOF domains and the composite measure for the financial year 2010/11[11].

Figure 2 about here

Both the number of practices reporting full achievement and the overall heterogeneity in achievement scores varies by QOF indicator. The highest level of full achievement is observed for MH4, where 67% of practices report a score of 1. In contrast, only about 5% of practices report full achievement on MH6 or MH9. The distribution of the composite score is similar to MH6 which has the highest number of points attached to it. Accordingly, variation in quality, as measured by the QOF, can be expected to be more pronounced for these indicators. MH7 is an anomaly as

[9] We use Stata's `margins` command with `predict(nu0)` as option to calculate these 'average' marginal effects.

[10] Admission patterns and, hence, the shape of the distribution in other years are comparable and are not presented.

[11] Across most indicators, QOF achievement improves steadily over time however the distributions remain relatively unchanged and are not presented here. MH7 has a different pattern: achievement is lower in 2007/8 and 2008/9. The reason is that a higher proportion of practices score zero in these years due to a potential problem of entering the READ codes for GPs. Once a specific code had been entered ('DNA'), it was not possible to change this back even if the patient was seen after follow-up. This has been resolved over time.

an indicator[12] since practices can only achieve if some patients did not attend (DNA) the annual review meeting (MH9). If all patients attend all meetings, which in itself would be an indicator of good process quality, no achievements can be made on MH7. Missing data could indicate that practices had no patients to follow up - there were no DNAs (good performance), or that practices did not follow up DNAs for their review (bad performance). However, MH7 is a potentially useful indicator as it assesses practice effort for 'hard to reach' patients.

We refer to Table 2 in the Appendix for descriptive statistics of the pooled dataset with all characteristics of the GP practice and their respective patient populations as well as other environmental factors.

4.2 Estimation results

Tables 3 - 5 present the calculated AMEs for the cross-sectional and panel data models. Because the focus is on the association between QOF achievement and admissions, we do not report marginal effects for the control variables[13].

Tables 3 - 5 about here

Several important findings emerge from these results. First, we find statistically significant associations between QOF achievement and admissions for the general care indicators (MH6, MH9 and the composite measure), but not for the two lithium indicators (MH4, MH5) or the DNA follow-up indicator (MH7). Second, the association is generally *positive*, implying that better QOF performance is associated with *more* admissions, not fewer. The estimated AME suggests that an additional percentage point in QOF achievement will lead to approximately 0.5 - 1.5 additional patients being admitted to hospital at least once within a financial year. Third, in the panel data models, only the estimates from the pooled or RE models are statistically significant. The Hausman test suggests bias in the RE estimates compared to those obtained from the FE estimator. However, the FE estimates are substantially larger than those obtained from the cross-sectional models and the other panel data models, casting doubt on their reliability. This is especially pronounced on the estimate of the AME for the composite measure of admissions for emergency physical care, where the FE estimates exceed the RE or pooled estimates by approximately the factor 100.

5 Discussion and conclusions

Our analysis contributes to the empirical evidence on the processes of health care for people with severe mental illness (SMI). Primary care plays a central role in the care of people with SMI. We examine whether better primary care quality as incentivised by the English Quality and Outcomes Framework (QOF) is associated with lower rates of emergency hospital admissions for (a) SMI, and (b) physical conditions in patients with SMI, and (c) is associated with higher rates of elective hospital admissions for physical conditions. Our analysis combines multiple routinely collected datasets on hospital care and characteristics of the GP practice, such as reported quality, practice composition and organisation. We use cross-sectional and panel data Poisson models to relate GP practice achievements on five QOF indicators and a composite measure to the number of patients per GP practice that have had at least one admission in a given year, controlling for other influences on admissions that are unrelated to QOF performance.

Our null hypothesis was that better primary care quality, as measured by the QOF, is not associated with lower emergency admissions. The results of our analysis suggest that, for some of the studied QOF indicators, achievements are positively associated with admissions. For other indicators, we do not find a statically significant association. Hence, not only do we fail to reject the null hypothesis for some QOF indicators, we also present evidence that the direction of association

[12] This is known by NICE.

[13] These are available from the authors on request.

between these indicators and emergency admissions is contrary to our initial expectation. For elective admissions, we observe a positive association between QOF achievement and hospital admissions, as expected *a priori*.

This unexpected result for emergency admissions requires further discussion. Several possible explanations are presented.

First, the association between QOF achievement and hospital emergency admissions for SMI patients is indeed positive. This may arise because GP practices first identify SMI patients and begin to provide adequate care after these patients have been admitted to, and subsequently discharged from, hospital. In this case, the estimated effect of QOF achievements on admissions is not causal. If anything, there is a reverse causality whereby admissions lead to a subsequent primary care review.

Second, SMI patients differ in severity and their responsiveness to primary care, and practices with good achievement rates may attract many high risk patients since they may be better at following up and reviewing 'hard-to-reach' patients. These patients may also be frequent users of emergency inpatient services. The applied risk-adjustment is incomplete and insufficiently controls for differences in practice population characteristics. Better quality of primary care, as reflected in the practice's QOF performance, does not offset the higher average propensity of admission brought about by the more severe case-mix. This leads to higher emergency admission rates in practices with higher QOF achievements and disguises the true relationship due to incomplete practice case-mix adjustment.

Third, practices with more admissions/more severe patients are better at recording and compiling SMI-relevant QOF information than practices with lower admissions/less severe patients. This leads to reporting bias in our key variables of interest and biased estimates of their association with admissions.

To test these hypotheses empirically, one would require access to patient-level data from GP practice registers and means to ensure data quality standards. Because our analysis makes use of data aggregated at GP practice level, we cannot ascertain whether those patients admitted are indeed those patients for whom the different QOF indicators have been achieved, nor can we address the problem of timing of events (for example whether SMI patients are reviewed in primary care and subsequently admitted, or vice versa) and thus causality. Furthermore, our risk-adjustment could be greatly enhanced by being able to directly control for individual patient characteristics instead of aggregate patient characteristics at LSOA level. Unfortunately, such data are not publicly available or otherwise easily accessible.

Based on the current results, we conclude that better quality of care, as measured by the QOF, does not help to reduce emergency admissions for SMI patients. Therefore, any payments associated with these QOF indicators are not offset by lower resource use in secondary emergency care. By lacking efficacy in this respect, the QOF indicators for serious mental illness are unlikely to be cost saving and policy makers should critically appraise the justification for paying bonuses for achievements. However, this consideration should include more than just the costs of hospital admissions. More research is required to establish the *causal effect* of QOF achievement on primary and secondary care utilisation, survival, and quality of life in patients with SMI.

We intend to conduct further analyses to test the appropriateness of our models and the robustness of our results and policy conclusions. First, we plan to test the sensitivity to re-coding of variables MH4, MH5 and MH7 into dummy variables (0/1) for achieved or not. A large proportion of practices fully achieve on these indicators, leading to a highly skewed distribution with limited within and between practice variability.

Second, we will explore how exclusions of patients from each QOF indicator affect results. Because GPs both control and report exception rates and can reap financial rewards by excluding difficult or hard-to-reach patients, there may be an incentive to misreport. The strength of this incentive is likely to vary between practices, depending on their level of achievement without exception reporting relative to the upper and lower reimbursement thresholds.

Third, we will construct additional measure of access to care, based on the distance between

GP practice and the nearest hospital. We will also control for the availability of crisis resolution and home treatment (CRHT) teams[14] that provide alternative home care in an emergency and mediate admissions to hospital [30, 31, 32].

Fourth, we will explore how performance on the two lithium-related indicators MH4 and MH5 relate to admissions for patients with bipolar disorder; a subset of all SMI patients. This can be justified by the observation that lithium therapy is indicated for treatment of bipolar disorder but rarely used in other SMI patients. In this way, our measure of admissions is more closely linked to the number of lithium users at risk of admission and the practice's achievement on the QOF lithium indicators.

Fifth, we will use dynamic panel models and include lagged achievement rates and admissions as explanatory variables to try to disentangle the causal effect of quality on admissions.

[14]Data on CRHTs has been collected as part of the Mental Health Services Mapping Data since 2000 at the level of 'Local Implementation Teams' (LITs) [29]. There is an almost one-to-one correspondence between LITs and PCTs. Since we were only able to obtain Service Mapping Data for two of our five study years (2008 and 2009), we instead used PCT level fixed effects as a way to model differences in service provision by CRHTs. This was feasible in the RE models but not the FE models. Provisional results on a select number of indicators suggest these made little difference, however we will expand these estimations to all models and also test the available Mental Health Services Mapping Data for two years.

Appendix

Table 1: Detailed description of QOF SMI indicators

Indicators	Description	Rationale	Thresholds
MH 4	The percentage of patients on lithium therapy with a record of serum creatinine and TSH in the preceding 15 months.	The number of points and indicators for Lithium have been reduced in recognition of the relatively small number of people this indicator applies to. It is important to check thyroid and renal function on an annual basis since there is a much higher than normal incidence of hypercalcaemia and hypothyroidism in patients on lithium, and of abnormal renal function tests.	40 - 90%
MH 5	The percentage of patients on lithium therapy with a record of lithium levels in the therapeutic range within the previous 6 months.	The therapeutic range for patients on lithium therapy is normally 0.6 - 1.0 mmol/l. Levels below 0.6 may be acceptable, depending on the clinical circumstances of the patient. There is no definitive evidence on the frequency of lithium level checks. Most practitioners would monitor lithium levels when stable every three to six months. Where a practice is prescribing, it has responsibility for checking that routine blood tests have been done (not necessarily by the practice) and for following up patients who default where responsibility has been accepted for administering treatment.	40 - 90%
MH 6	The percentage of patients on the register who have a comprehensive care plan documented in the records agreed between individuals, their family and/or carers as appropriate.	This indicator reflects good professional practice and is supported by national Clinical Guidelines. The plan will include information on the patients current health status and social care needs including how needs are to be met, by whom, and the patients expectations; how socially supported the individual is; co-ordination arrangements with secondary care; a documented care plan discussed with their community key worker if a patient is treated under the CPA; occupational status; early warning signs (relapse signature); the patients preferred course of action (discussed when well) in the event of a clinical relapse (who to contact and medication preferences).	25 - 50%
MH 7	The percentage of patients with schizophrenia, bipolar affective disorder and other psychoses who do not attend the practice for their annual review who are identified and followed up by the practice team within 14 days of non-attendance.	Poor compliance with medication is well recognised, and it is estimated that around 50% of people with schizophrenia do not always take their medication regularly. This may lead to relapse, hospitalisation and poorer outcomes. There is also evidence to suggest that non-attendance at appointments may be interpreted by some practices as irrationality, as part of having a serious mental illness, rather than recognising that not turning up for an appointment may be a sign of relapse. This indicator requires proactive intervention from the practice to contact the patient and enquire about their health status. This may be through telephone contact, letter or visit.	40 - 90%
MH 9	The percentage of patients with schizophrenia, bipolar affective disorder and other psychoses with a review recorded in the preceding 15 months. In the review there should be evidence that the patient has been offered routine health promotion and prevention advice appropriate to their age, gender and health status.	Patients with serious mental health problems are at considerably increased risk of physical ill-health, are less likely to be offered health promotion advice and far more likely to smoke than the general population (61% of people with schizophrenia and 46% of people with bipolar disorder smoke compared to 33% of the general population); premature death and smoking-related diseases (e.g. respiratory disorders and heart disease), are more common among people with serious mental illness who smoke than in the general population of smokers. People with schizophrenia appear to be at increased risk of impaired glucose tolerance and diabetes, and this is independent of treatment with the newer atypical antipsychotic drugs. The NICE clinical guideline on schizophrenia recommends physical health checks for diabetes, blood pressure, lipids, and smoking. The NICE clinical guideline on bipolar disorder recommends an annual physical health review for lipids, cholesterol in all patients over 40 even if there is no other indication of risk, plasma glucose levels, weight, smoking status, alcohol use, and blood pressure.	40 - 90%

Table 2: Descriptive statistics - pooled across years

Variable	Description	Source	Mean	SD (overall)	SD (within)	SD (between)	Min	Max
Admissions								
smi_admissions	Number of patients admitted with main diagnosis SMI	HES	2.95	3.14	1.70	2.62	0.0	52.0
phys_emer_admissions	Number of emergency patients admitted for physical care	HES	4.59	4.26	2.03	3.72	0.0	52.0
phys_elec_admissions	Number of elective patients admitted for physical care	HES	2.17	2.24	1.34	1.78	0.0	29.0
*QOF indicator achievements***								
mh4_achievement	Serum creatinine & TSH check <15mths	QOF	0.95	0.12	0.10	0.10	0.0	1.0
mh5_achievement	Lithium within range, <6mths	QOF	0.83	0.21	0.16	0.16	0.0	1.0
mh6_achievement	Comprehensive care plan documented	QOF	0.75	0.17	0.11	0.14	0.0	1.0
mh7_achievement	% DNA for annual review, follow-up <14dys	QOF	0.85	0.30	0.21	0.26	0.0	1.0
mh9_achievement	% reviewed <15mths	QOF	0.81	0.13	0.08	0.11	0.0	1.0
composite	Weighted measure of all other QOF indicators	QOF	0.81	0.11	0.07	0.10	0.1	1.0
GP practice organisational characteristics								
listsize	Number of patients on practice list	ADS	6713	4064	406	4052	1002	40766
gp_single_handed	=1, if one of less full-time equivalent GPs	GMS	0.16	0.37	0.16	0.35	0.0	1.0
gp_pms	=1, if reimbursed under PMS scheme	GMS	0.45	0.49	0.07	0.49	0.0	1.0
gp_mean_male	% of male GPs in practice	GMS	0.61	0.27	0.10	0.26	0.0	1.0
gp_mean_foreign	% of foreign-trained GPs in practice	GMS	0.33	0.38	0.10	0.37	0.0	1.0
gp_mean_age	Average age of GPs in practice	GMS	48.03	7.73	2.83	7.58	28.0	206.6
Practice population (area) characteristics								
lithium_prop	% of SMI patients on lithium therapy	QOF	0.14	0.09	0.03	0.09	0.0	1.0
chd_prevalence	Prevalence of chronic heart disease	QOF	0.03	0.01	0.00	0.01	0.0	0.4
diabetes_prevalence	Prevalence of diabetes	QOF	0.04	0.01	0.00	0.01	0.0	0.5
copd_prevalence	Prevalence of chronic obstructive pulmonary disease	QOF	0.02	0.01	0.00	0.01	0.0	0.2
obesity_prevalence	Prevalence of obese patients	QOF	0.08	0.03	0.01	0.03	0.0	1.1
pop_mean_age*	Average age of practice population	ADS	38.88	4.19	0.43	4.30	21.6	62.0
pop_mean_male*	% of male patients	ADS	50.29	2.47	0.55	2.56	0.0	85.8
imd_overall*	Index of multiple deprivation - summary measure	ONS	23.95	13.07	0.30	13.16	2.3	74.3
imd_mh*	Index of multiple deprivation - % claiming incapacity benefit for mental health disorders	ONS	1.89	1.05	0.03	1.06	0.2	10.0
ethnicity*	% of non-white population	ONS	0.11	0.16	0.00	0.16	0.0	0.8
urban*	% of patients living in urban areas	ONS	0.82	0.33	0.01	0.32	0.0	1.0
Access to care / Supply of care								
gp_48pct	% of patients reporting to be able to get access to GP within 48h	GPS	0.84	0.11	0.05	0.10	0.0	1.0
informal_care*	% of the catchment population providing informal care	ONS	0.10	0.01	0.00	0.01	0.0	0.2
comm_psych*	Number of community psychiatric beds per 1,000 inhabitants	ONS	0.21	0.52	0.08	0.51	0.0	17.5

***** based on LSOA characteristics and geographic distribution of practice population.

****** Range: 0 (no achievement) to 1 (full achievement).

Abbrevations: ADS = Attribution Dataset; GMS = General Medical Service; GPS = GP Survey; HES = Hospital Episode Statistics; LSOA = Lower Super Output Area; ONS = Office for National Statistics; QOF = Quality and Outcome Framework; SD = Standard deviation.

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Tables

Table 1: Diagnosis codes used to define severe mental illness

ICD-10 code	Description
F20	Schizophrenia
F21	Schizotypal disorder
F22	Persistent delusional disorders
F23	Acute and transient psychotic disorders
F24	Induced delusional disorder
F25	Schizoaffective disorders
F28	Other nonorganic psychotic disorders
F29	Unspecified nonorganic psychosis
F30	Manic episode
F31	Bipolar affective disorder

Table 2: QOF SMI indicators

Indicator	Description	Points attached
MH4	Serum creatinine & TSH check <15mths	1
MH5	Lithium within range, <6mths	2
MH6	Comprehensive care plan documented	6
MH7	% DNA for annual review, follow-up <14dys	3
MH9	% reviewed <15mths	2

Table 3: Results - SMI admissions

	MH4		MH5		MH6		MH7		MH9		Composite	
Model / Year	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE
Cross-sectional analysis												
2006/07	0.133	0.210	0.047	0.130	0.611	0.138***	-0.003	0.108	1.058	0.189***	1.185	0.293***
2007/08	-0.289	0.218	-0.202	0.131	0.341	0.164*	-0.134	0.088	0.696	0.218**	-0.043	0.255
2008/09	-0.549	0.210**	-0.413	0.128**	-0.058	0.173	-0.021	0.098	0.486	0.217*	-0.124	0.274
2009/10	0.190	0.249	-0.062	0.136	0.480	0.215*	0.113	0.119	0.336	0.247	0.773	0.331*
2010/11	-0.188	0.282	-0.024	0.144	0.480	0.221*	-0.049	0.124	0.415	0.221	0.372	0.348
Panel analysis												
pooled	-0.139	0.114	-0.133	0.068	0.408	0.107***	-0.023	0.056	0.671	0.127***	0.428	0.167*
RE	0.093	0.103	0.030	0.059	0.422	0.096***	-0.049	0.047	0.629	0.111***	0.439	0.160**
FE	0.991	1.740	0.857	1.450	0.908	1.570	-0.240	0.635	1.361	2.275	9.168	17.700
Hausman test statistic	101.98	***	118.28	***	91.11	***	130.14	***	91.87	***	135.69	***

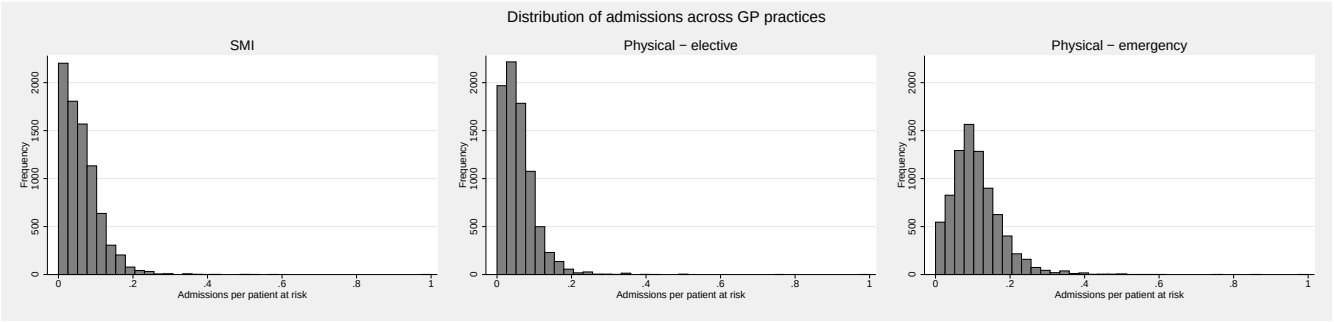
Table 4: Results - Admissions for physical emergency care

	MH4		MH5		MH6		MH7		MH9		Composite	
Model / Year	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE
Cross-sectional analysis												
2006/07	0.311	0.248	0.251	0.153	1.203	0.160 ***	-0.093	0.124	2.036	0.218 ***	2.037	0.352 ***
2007/08	0.136	0.263	0.115	0.154	1.003	0.183 ***	0.056	0.096	1.539	0.233 ***	1.182	0.282 ***
2008/09	-0.078	0.286	0.115	0.167	0.692	0.224 **	0.053	0.117	0.810	0.286 **	1.139	0.349 **
2009/10	0.096	0.296	-0.082	0.173	1.004	0.266 ***	0.126	0.137	1.152	0.285 ***	1.095	0.406 **
2010/11	-0.345	0.370	-0.062	0.188	0.641	0.277 *	-0.031	0.148	1.077	0.273 ***	0.780	0.436
Panel analysis												
pooled	0.057	0.147	0.068	0.088	0.994	0.138 ***	0.022	0.066	1.381	0.158 ***	1.294	0.216 ***
RE	0.105	0.127	0.099	0.073	0.864	0.118 ***	-0.008	0.055	1.011	0.132 ***	0.954	0.189 ***
FE	9.334	13.151	8.605	10.703	40.566	49.257	-1.907	8.159	17.656	21.798	119.404	168.559
Hausman test statistic	77.73	***	78.01	***	70.99	***	66.12	***	97.93	***	77.23	***

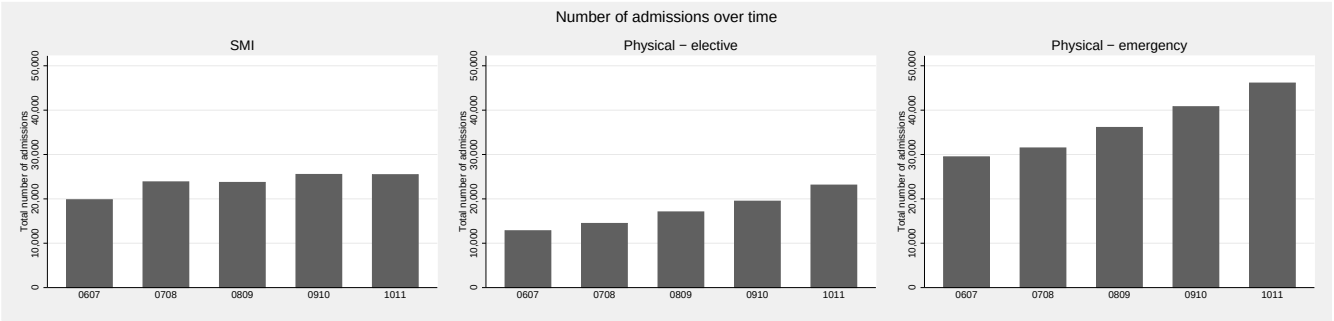
Table 5: Results - Admissions for physical elective care

	MH4		MH5		MH6		MH7		MH9		Composite	
Model / Year	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE
Cross-sectional analysis												
2006/07	0.098	0.155	0.029	0.096	0.541	0.093***	0.068	0.077	0.765	0.127***	0.885	0.195***
2007/08	0.111	0.161	0.101	0.096	0.573	0.109***	0.077	0.061	0.697	0.141***	0.733	0.172***
2008/09	0.106	0.187	-0.067	0.105	0.269	0.131*	0.072	0.072	0.552	0.166***	0.487	0.210*
2009/10	0.263	0.199	0.293	0.113**	0.524	0.158***	0.071	0.086	0.832	0.176***	0.914	0.245***
2010/11	-0.334	0.227	0.162	0.121	0.231	0.180	0.053	0.097	0.417	0.171*	0.231	0.280
Panel analysis												
pooled	0.055	0.087	0.100	0.053	0.474	0.077***	0.067	0.040	0.663	0.088***	0.674	0.122***
RE	0.032	0.080	0.107	0.048*	0.460	0.073***	0.050	0.037	0.599	0.084***	0.590	0.111***
FE	-0.349	1.072	0.988	1.603	3.079	4.601	-0.157	0.404	2.851	4.358	2.870	5.094
Hausman test statistic	30.17		28.54		25.14		28.69		39.14	*	28.95	

Figures



(a) Number of admissions per GP practice - year 2010/11



(b) Change in number of admissions over time

Figure 1: Histogram and time-series of SMI and physical care admissions

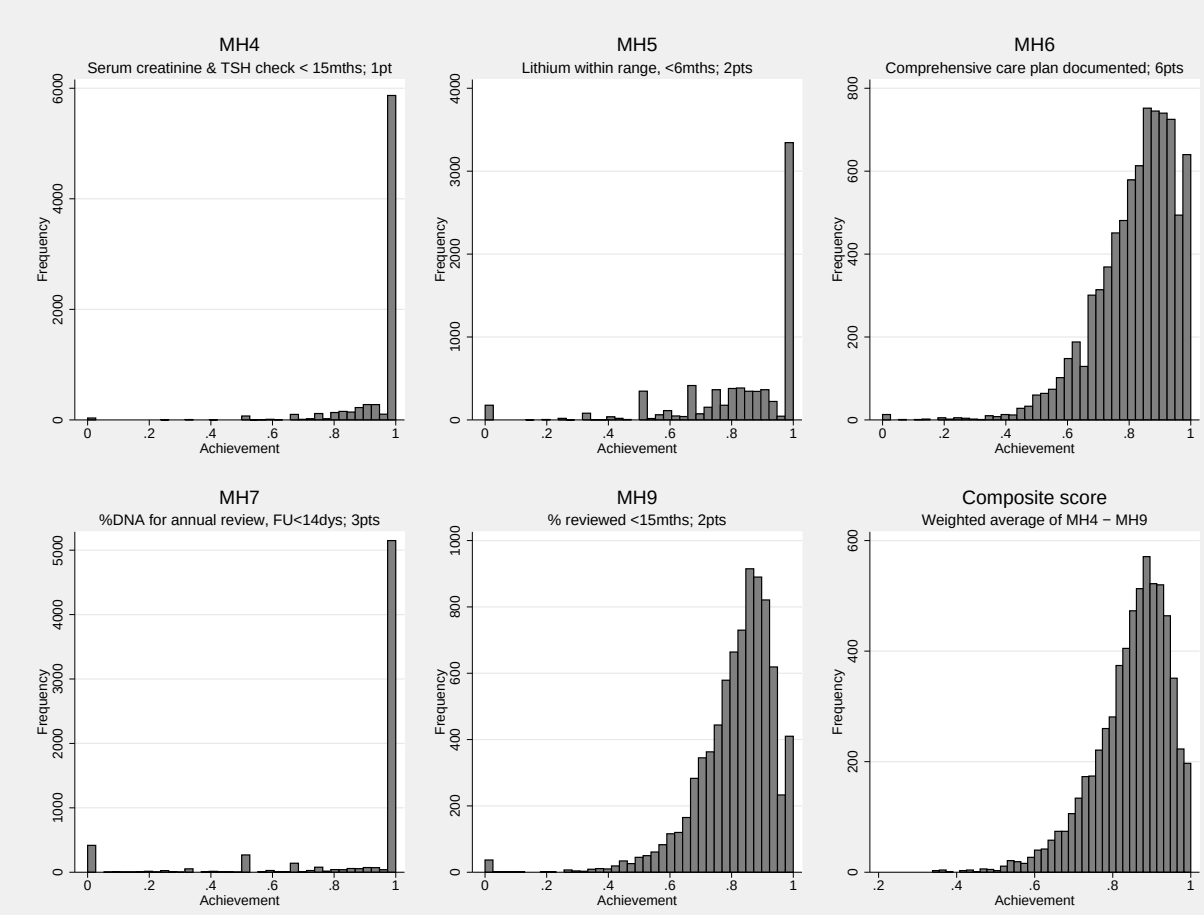


Figure 2: Distribution of QOF achievement rates across practices - year 2010/11