The effect of Primary Medical Service contracts on admission rates

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Abstract

1998/9 saw the introduction of PMS contracts under which practices negotiate for a total practice income in exchange for delivering the services they previously provide under their GMS contract plus a range of agreed additional services. By 2002/3 34% of practices had switched to PMS from GMS. Little is know about the effect of switching to a PMS contract apart from the resulting increase in GP income. We investigate the effect of switching to PMS on practice admission rates for ambulatory care sensitive conditions which are often used as a negative indicator of access to good quality primary care. Using data from 1997/8 to 2002/3 and difference in difference methods we find that on switching to PMS practices increased their ACSCs admission rates and that the increase was greater the longer the time they had been PMS. We also find that PMS practices also increased their non-ACSCs admission rates on becoming PMS.

1. Introduction

Until recently all general practitioners worked under the same nationally negotiated General Medical Services (GMS) contract. Under GMS GPs were reimbursed through a mixture of capitation, item of service payments, target payments for screening and immunisation and fixed sums for seniority and other GP or practice characteristics. The GMS contract was modified substantially in April 2004 to include payments for meeting a range of quality targets (Roland, 2004)

It was felt that the old GMS contract was an obstacle to the improvement of quality and accessibility to primary care – particularly in deprived inner city areas. It was suggested that the national GMS contract's remuneration and incentive systems was too bureaucratic and did not provide incentives for GPs to provide services to meet local priorities.

Personal Medical Service (PMS) contracts were introduced by the National Health Service (Primary Care) Act 1997. The Act enabled primary care organisations (first Health Authorities and later Primary Care Trusts) to negotiate a voluntary contract with local practices to provide a specified range of primary and community health services (Lewis, Jenkins and Gillam, 1999). It made it easier for practices to employ salaried GPs, community nurses and other non-medical professionals, as well allowing new providers such as community trusts to enter the market for primary care. The services provided under the PMS contract had to include all those previously provided under the GMS contract and some additional locally negotiated services for particular population groups. PMS practices are paid an income equal to what they obtained under their previous GMS contract plus extra payments for extra services. From April 2004 PMS practices were required to take part in the Quality and Outcomes Framework introduced in the new GMS contract. Our concern in this paper is a comparison of the behaviour of practices under the old GMS contract and the PMS contract.

By 2002/3 around 34% of practices were under the PMS contract. Very little is known about the effects of practices switching from the old GMS contract to the PMS contract. The few published evaluations of the PMS scheme were based on the experience of the small number of first wave of PMS practices in 1998/9. Campbell et al (2005) found that PMS led to improved management of angina and better care for the elderly, but it had no effect on the management of chronic conditions such as asthma and diabetes and it did not improve access. PMS was associated with rising expenditure on the practice and with poorer patient continuity of care. Gosden et al (2003) found small and insignificant effects of PMS. PMS practices spent less time on administration and had higher rates of consultation, although consultation length was shorter. PMS practices provided fewer targeted services (e.g. immunisation and screening) and overall quality of care as assessed by patients was lower in PMS practices. Carter (2002) found that PMS pilots were successful in improving access to vulnerable groups such as the homeless, ethnic minorities and patients with a mental illness. There was no evidence for staff expansion amongst the PMS practices.

One of the difficulties in establishing the effect of PMS contracts is that the contracts were introduced with the promise that they would cut the bureaucracy associated with the GMS contract. This has meant that when practices became PMS there was no requirement for central collection of data on the activities they had previously had to report to claim their target payments. Thus when practices become PMS the proportion of them reporting achieving the targets for immunisations and cervical screens falls dramatically (Gravelle and Hann, 2005). It seems the only clear real effects of PMS reported so far are that GPs in PMS practices have incomes £7500 higher after practice expenses than those in GMS practices and that GPs in PKMS practices have higher job satisfaction (Whalley et al, 2004).

One aspect of practice activity which is routinely reported and does not rely on self report is the practice hospital admission rate. In this paper we investigate whether switching from GMS to PMS changes practice admission rates. In particular we are interested in admissions for complications of conditions which ought to be managed in primary care, for example admissions for complications of diabetes. Admissions for such ambulatory care sensitive conditions (ACSCs) are commonly used in the US to measure (negatively) access to good quality primary care. They have also been used in the UK as a performance indicator (Giuffrida et al, 1999; http://www.performance.doh.gov.uk/performanceratings/). Our study is exploratory since a priori it is not clear whether PMS contracts would lead to increased or reduced ACSC admission rates. Since the policy objective of PMS contracts was to improve care in underserved areas or for poorly served population groups it might be expected that practices switching to PMS would have reduced ACSCs admission rates. On the other hand the fact that PMS contracts have rather vague monitoring of practice performance (Sheaff, 1999) may mean that practices have reduced incentives to provide good quality care.

2. Data

Data were collated from three main sources: Hospital Episodes Statistics (HES) for admissions, General Medical Statistics census for practice characteristics, and the database assembled for the AREA project (Sutton et al, 2002) for socio-economic characteristics and provider characteristics.

2.1. Admission rates

Admissions for ACSCs are hospitalisations resulting from diseases sensitive to prophylactic or therapeutic interventions deliverable in a primary health care setting (Jackson and Tobias, 2001). Examples are admissions for vaccine preventable diseases, melanoma, late stage breast cancer, and complications of diabetes. Approximately one-quarter of pediatric hospitalizations and 1 in 10 of adult hospital admissions are classified as avoidable in the U.S. (Dafnya and Gruber, 2005).

We used the ICD-10 classification of disease codes in the HES diagnostic fields (*diag_nn*). We based our definitions of ACSCs on the Victorian Ambulatory Care Sensitive Conditions Study (2004) and Jackson and Tobias (2001). The full list and definitions of these conditions are in Table 1. Diabetes accounts for 21% of all ACSC admissions and flu complications, chronic obstructive pulmonary disorder and ENT related conditions for a further 18%. We calculated three types of admission rates for practices for ACSC and non-ACSC (all admissions not categorised as an ACSC): all admissions, elective, and emergency admissions. The admission rates are for all finished consultant episodes.

We had data on practice characteristics from the annual (October) GMS census. including numbers and characteristics of GPs, PMS status, and practice patient list (demographic) characteristics. We used a two year moving average of the practice list to smooth the effects of measurement error in the lists and to align the data better with the financial years used by HES.

2.2. Selection criteria

We dropped practices with duplicated observations and with non-matching identifiers. We excluded 296 practices that had switched contracts twice, from GMS to PMS and then back to GMS. We also dropped outlier practices with less than 1000 patients in any one year, with few (under 30) admissions in any year, and those with very high (over 500 per 1000) admission rates. This left a balanced panel of 6933 practices. The final estimation sample was 48448 because of some missing items for some practices.

3. Estimation

The PMS contract was rolled out in waves starting at the beginning of each financial year from 1998/9. To identify the effect of PMS on practice admission rates we compared the change in the admission rates for practices which became PMS before and after they switched to PMS with the change in admission rates over the same period for practices that had not yet switched or never switched. We did not estimate separate effects for each wave because of the small numbers in early waves. Our treatment effect variables are six dummy variables that indicate the number of years the practice has been PMS. Our data set covers seven years (1997/8 to 2003/4) so that the maximum number of years a practice can have had a PMS contract is six (the first wave PMS practices), and the smallest is one (for wave 6 PMS practices that became PMS in 2003/04).

Since a disproportionate number of ex-fundholder practices switched to a PMS contract (Gravelle and Hann, 2005) it is necessary to allow for the abolition of fundholding in April 1999. We interact a variable indicating whether or not a practice had been a fundholder in 1997/8 with financial year dummy variables.

We specify a pooled DID model for the dynamic effect of the number of years in which a practice has been under a PMS contract:

$$a_{it} = \beta_0 + \beta_{1t}Y_t + \beta_2 P_i + \beta_{3t}P_iY_t + \beta_4 F_i + \beta_{5t}F_iY_t + \beta_{6s}L_{sit} + \beta_7 x_{it} + \alpha_i + \varepsilon_{it} \qquad (1)$$

where Y_t are year t = 1998/9, …....., 2003/4 dummy variables, P_i is an indicator of whether the practice was ever PMS or not. F_i is an indicator of whether the practice was ever a fundholder, L_{sit} are dummy variables indicating the number of years (length of time) s = 1, 2, ……,6 for which a practice has been a PMS practice in year t. It takes a value of 1 if the practice has been PMS for s years in year t and zero otherwise. Note that if $P_i = 0$ then $L_{sit} = 0$ for all s and t. x_{it} is a vector of covariates, α_i is a practice specific effect (either fixed or random) and ε_{it} is an idiosyncratic practice and time specific error term.

The interaction between Y and P allows for different trends for practices which were ever PMS and those which were never PMS. The coefficient β_{6s} identifies the effect for the number of years s a practice has had a PMS contract. It is a difference in

difference estimate of the effect of treatment (years a practice has been PMS) in a year t' when a practice has been PMS for s years (post treatment) compared to a year t when it is not yet PMS (pre-treatment):

$$DID_s = \left\{ E\left[a_{it'} \mid P_i = 1, L_{sit'} = 1, Y_{t'}, F_i, x_{it'}, \alpha_i, \varepsilon^1_{it'} \right] - E\left[a_{it} \mid P_i = 1, L_{sit} = 0, Y_t, F_i, x_{it}, \alpha_i, \varepsilon^1_{it} \right] \right\}$$

$$- \left\{ E\left[a_{it'} \mid P_i = 0, L_{sit'} = 0, Y_{t'}, F_i, x_{it'}, \alpha_i, \varepsilon^0_{it'} \right] - E\left[a_{it} \mid P_i = 0, L_{sit} = 0, Y_t, F_i, x_{it}, \alpha_i, \varepsilon^0_{it} \right] \right\}$$

$$= \left(\beta_{3t'} - \beta_{3t} \right) + \beta_{6s} + \left[E\left(\varepsilon^1_{it'} \right) - E\left(\varepsilon^0_{it'} \right) \right] - \left[E\left(\varepsilon^1_{it} \right) - E\left(\varepsilon^0_{it} \right) \right] \qquad (2)$$

β_{6s} will be an unbiased DID estimate of the average treatment effect of being a PMS practice for a given number of years s under two conditions. First, the differential trend in unobservable variables that influence the admission rates for PMS practices remains the same in the pre and post treatment periods. In other words, practices that become PMS must not experience a change in the way their admission rates trend over time in the post PMS period, relative to what they would have been if they had not selected into the PMS contract.

Second, on average, the difference between unobserved idiosyncratic (practice specific) time varying characteristics that might affect admissions for practices which are ever PMS are the same in the post and pre-treatment periods as that for practices which are never PMS. This implies that if practices base their decision to become PMS on the expectation that they are going to experience markedly different admission rates in future periods then our estimate of the average treatment effect will be biased. We can think of no reason why this should be so – unlike fundholding practices whose decision to become a fundholder could have been affected by their expectations of future admissions.

We estimate (2) with fixed practice effects. We are also interested in the effects of time invariant factors such as local deprivation measures and also estimate a random effects model. To avoid the bias arising from correlation between time varying factors and practice effects we adopt a variant of the Mundlak (1978) approach. Rather than entering time varying variables x_{it} we partition them into a time invariant practice mean $\bar{x}_{it}$ and the time varying deviation $x_{it} - \bar{x}_{it}$ and enter them separately in

the regression. The hope is that because we have included $\bar{x}_{it}$ the time varying deviation $x_{it} - \bar{x}_{it}$ will not be correlated with the unobserved practice effect and so its coefficient will be unbiased. The coefficient on the time varying deviation $x_{it} - \bar{x}_{it}$ is known as the within estimate and should be similar to the coefficient on the x_{it} variable from the fixed effects regression. The coefficient on the practice mean $\bar{x}_{it}$ is known as the between effect.

4. Results

The first wave of PMS was introduced at the start of the financial year 1998/99 with tenders of interest having been made and approved in 1997/98. Table 1 gives a breakdown of the number of practices switching contract in each of the 6 waves of PMS we observe in our data. The first three waves had 194 practices (8% of PMS practices in our sample). The last wave which started in 2003/04 had nearly half our PMS practices (1070 practices). Out of our sample of 6933 practices, 2357 (34%) had switched to a PMS contract by the start of the financial year 2003/04.

Tables 2 and 3 provide summary statistics for ACSC and non-ACSC admission rates. The average ACSC practice admission rate was 34 per 1000, 65% of which were emergencies. The average non-ACSC admission rate was 176 per 1,000, 50% of which were emergencies. In our estimation sample, ACSC admissions were 19% of all hospital admissions. Table 2 presents average ACSC and non-ACSC admission rates over time by wave of PMS practice and for practices which never became PMS. The emboldened cells are admission rates when the practices were PMS. The data shows that both ACSC and non-ACSC admission rates are higher for practices when they have a PMS contract compared to practices who have remained under GMS. However, with the exception of wave 2 and wave 3 PMS practices, practices which become PMS also had higher admission rates before they became PMS.

The data in Tables 2 and 3 suggest that a separate dynamic analysis for each wave comparing the change in the difference in admissions before and after the introduction of PMS would not have enough power to detect an effect. For early waves we have only limited information pre-PMS and for later waves only a limited amount post-

PMS. With a pooled regression we gain power by combining all PMS practices, and classifying them according to the number of years they have been PMS in each year.

4.1. Fixed effects results

Table 4 reports fixed effects estimates of the effect of the number of years a practice has been PMS contract for all ACSCs admission rates and all non-ACSC admission rates as well as by emergency and elective admissions of ACSC and non-ACSC admissions. The coefficients (β_{6s}) on all the Year PMS variables (1-6) for all models are positive and significant. Thus practices which become PMS have higher admissions for all ACSCs and non-ACSCs relative to practices which are not yet PMS or will never be PMS. This is after allowing for unobserved practice fixed effects, differential trends for GMS and ever PMS practices and observed time varying characteristics (such as patient demographics and practice waiting times).

Table 5 presents proportionate effects from the fixed effects regression estimates enabling a comparison across different types of admissions. The effects tend to increase with the number of years in which a practice has been PMS contract, but level off after four years. For all ACSCs the effect increase from 3% in the first year of PMS to 18% for practices who have been PMS for 4 years. For all non-ACSCs, the effect increases from 3% in the first year under a PMS contract, to 13% for practices who have been PMS for 4 years. There is no significant difference between the proportionate effects on ACSC and non-ACSC admissions. There is also no significant difference in PMS effects on emergency and elective admission rates.

4.2. Random effects results

Effects of PMS. Table 5 reports estimates from GEE (random effects) models. Since the estimates for all non-ACSC admissions did not converge we only report those for emergency and elective non-ACSCs admissions. The coefficient on the ever becoming a PMS practice is positive for all three ACSC admission rate models and significant in the models for all ACSCs admissions and for emergency ACSCs. This suggests that unobserved time invariant characteristics of practices which chose to become PMS are associated with higher ACSC admission rates. The effects of ever

being PMS for non-ACSC admissions are not all positive and are not statistically significantly different from zero.

The effects of being PMS for a number of years have a similar pattern to the fixed effects estimates but are smaller. For example, the estimated effect of being PMS for 3 years is to increase admissions by 5% compared to 11% in the fixed effects model.

Socio-economic characteristics. We find the proportion of patients from ethnic minorities has a significant and positive effect on all ACSCs and elective ACSCs. However, the effect on all elective non-ACSCs is negative and significant. The effect is negative but insignificant for emergency admissions. Practices with more patients claiming incapacity benefit or disability allowance, as well as with more patients over 17 who did not attend university, and with a higher proportion of dependents with no carer are associated with significantly higher admissions for all ACSCs and all non-ACSCs. Finally, practices with a higher proportion of residents who have changed address in the last 12 months are associated with significantly greater admissions of all ACSCs, and for emergency ACSCs and non-ACSCs, however, significantly lower elective admissions for non-ACSCs. Practices with a higher proportion of rural patients compared to the average practice (between effect) are associated with significantly lower hospital admissions for all types of admissions (ACSC and non-ACSCs for both elective and emergency admissions). However the within effect indicates that practices who experience an increase in the proportion of rural patients experience significantly higher admissions.

Practice characteristics. Practices with larger list sizes and more patients per WTE GP have lower hospital admissions for all ACSCs and non-ACSCs. The within effects are larger than the between effects, and the between effects are not statistically significant for elective ACSCs. Single handed GPs have significantly lower admission rates for all ACSCs, elective ACSCs and elective non-ACSCs. The within effect shows that practices who become single handed experience an increase in elective ACSCs and elective non ACSCs. Practices with a higher proportion of GPs permitted to use deputising services have no significant difference in admission rates of any type (between effect). There is a significant positive within effect for all ACSCs and for both elective and emergency non-ACSCs.

We find no significant between effect of training status but there is a significant positive within effect on all ACSCs and on all elective non-ACSC admissions. Dispensing practices and those with a higher proportion of female and UK qualified GPs have fewer ACSC admissions. Practices with a higher proportion of GPs under 40 have significantly higher rates of hospital admissions for all types of admissions, whereas GP practices with a higher proportion of GPs between the age of 50 and 60, and over the age of 60 (relative to GPs aged between 40 and 50) have significantly lower elective ACSC and non-ACSC admission rates.

Attributed supply characteristics and waiting times. Some of the effects of supply variables are plausible. Others are surprising. Increases in median waits reduce elective admissions, both ACSCs and non-ACSCs and have no significant effects on emergencies. Practices whose population are further away from their five nearest NHS providers have significantly lower admission rates for all ACSCs and non-ACSCs. A greater number of residential nursing home places reduces admissions. But more beds at the nearby NHS providers reduces admission rates and more beds at nearby private providers increases them.

Fundholding status. Fundholding was abolished from 1999/2000 onwards. We expect from other work (Dusheiko et al, 2003) that the abolition of fundholding will increase ex-fundholders elective admissions relative to ex-nonfundholders. There is a trend increase in both ACSC electives and non-ACSC electives for fundholders relative to nonfundholders over the whole period. There is no trend for fundholder ACSC emergencies. Non-ACSC emergencies show some signs of an upward trend but the effect is proportionately very small.

5. Discussion

This preliminary analysis presents evidence that after practices switch to a PMS contract they have a significant increase in ACSCs admisisons. Admission rates for ACSCs increase with the number of years a practice has been PMS. The effects on combined elective and emergency ACSC admissions seem large: 1%-4% (from fixed and random effects models) in their first year as PMS and 7% - 18% after 4 to 6 years. Non-ACSC admissions are also increased when practices become PMS and increase

more the longer the practice has been PMS. Although the effects are smaller than for ACSCs the difference in the effects are not statistically significant at 5%.

If admissions for ACSCs are higher the worse the quality, availability and timeliness of primary care, these results are worrying. However it may be that PMS has resulted in improvements in quality which are not adequately captured by ACSCs so that on balance patient care has improved as a result of PMS. There may also be explanations for the increase in admissions which are more favourable to the policy of using PMS to improve patient care.

It may be that the rise in admissions is an indicator of improving quality for patients in PMS practices. If the new contract improved access to primary care which led to previously undiagnosed health problems being referred to hospital then we would expect an increase in admissions after a practice switched to PMS. But whilst this may explain the increase in non-ACSCs it is less convincing for ACSC admissions which are admissions for conditions which ought to be treatable in primary care. The suggestion is also less plausible as an explanation for the increase in emergency non-ACSCs which do not require GP referral.

Another possible explanation is measurement error associated with becoming a PMS practice. Most practice lists are inflated: the total number of registered patients exceeds the total Census based estimates of total population. GPs who are paid by capitation have an incentive to keep their lists inflated by rapidly registering new patients and being tardy in deregistering patients who die or move away. But for PMS practices the link between list size and practice income is weakened. Hence after becoming PMS a practice's registered list may fall relative to its true list. Since admissions depend on the true list the effect is to increase the measured admission rate. By including listsize as an explanatory variable, we have tried to allow for this possibility.

We welcome suggestions for explanations for the apparent increase in admissions when practices become PMS.

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Results appendix

Table 1: Description of ACSC classification

Condition	ICD-10 class	Description	Share
Flu; COPD and ENT	Both primary and secondary diagnoses: J10; J11; J14; J15; J16; J18; J20; J21; J06; J00. Excludes D57; Age < 3 months. Primary diagnosis: J20 & (J41; J42; J43; J44; J47); J41; J42; J43; J44 ; J47. Primary diagnosis: H66; H67; J02; J03; J06; J31	Influenza due to identified influenza virus; Influenza, virus not identified; Pneumonia due to Hemophilus influenzae; Bacterial pneumonia, not elsewhere classified; Pneumonia due to other infectious organisms, not elsewhere classified; Bronchopneumonia, unspecified; Acute bronchitis; Acute bronchiolitis; Acute upper respiratory infections of multiple and unspecified sites; excludes Sickle-cell disorders; Simple and mucopurulent chronic bronchitis; Unspecified chronic bronchitis; Emphysema; Other chronic obstructive pulmonary disease; Bronchiectasis. Suppurative and unspecified otitis media; Acute pharyngitis; Acute tonsillitis; Chronic rhinitis, nasopharyngitis, and pharyngitis	0.18
Vaccine	Both primary and secondary diagnoses: A35; A36; A37; A80; B05; B06; B16; B18; B26; G00;	Other tetanus; Diphtheria; Whooping cough; Acute poliomyelitis; Measles; Rubella; Acute hepatitis B; Mumps; Bacterial meningitis, not elsewhere classified	0.006
Asthma	Primary diagnosis: J45; J46	Asthma; Status asthmaticus	0.04
CHF and hypertension	Primary diagnosis: I50; I11; J81. Primary diagnosis: I10; I11	Heart failure; Hypertensive heart disease; Pulmonary edema; Essential (primary) hypertension	0.04
Diabetes	Both primary and secondary diagnoses: E10; E11; E13; E14	Insulin-dependent diabetes mellitus; Noninsulin-dependent diabetes mellitus; Other specified diabetes mellitus; Unspecified diabetes mellitus	0.21
Angina	Primary diagnosis: I20; I24	Angina pectoris; Other acute ischemic heart diseases	0.06
Anaemia	Primary diagnosis: D50	Iron deficiency anemia	0.01
Nutrition	Primary diagnosis: E40; E41; E42; E43 E55; E64	Kwashiorkor; Nutritional marasmus; Marasmic kwashiorkor; Unspecified severe protein-energy malnutrition; Vitamin D deficiency; Sequelae of malnutrition and other nutritional deficiencies	0.0001
Dehydration	Primary diagnosis: E86	Volume depletion	0.003
Gastroenteritis	Primary diagnosis: K52	Other noninfective gastroenteritis and colitis	0.04
Pyelonephritis	Primary diagnosis: N39; N10; N12; N11; N13	Other disorders of urinary system; Acute tubulo-interstitial nephritis; Tubulo-interstitial nephritis, not specified as acute or chronic; Chronic tubulo-interstitial nephritis; Obstructive and reflux uropathy	0.06
Ulcer	Primary diagnosis: K25; K26; K27; K28	Gastric ulcer; Duodenal ulcer; Peptic ulcer, site unspecified; Gastrojejunal ulcer	0.02
Cellulitis	Primary diagnosis: L03; L04; L08; L98; L88	Cellulitis; Acute lymphadenitis; Other local infections of skin and subcutaneous tissue; Other disorders of skin and subcutaneous tissue, not elsewhere classified; Pyoderma gangrenosum	0.04
Pelvic Inflammation	Both primary and secondary diagnoses: N71; N72; N73; N74	Inflamatory diseases of uterus, except cervix; Inflammatory disease of cervix uteri; other female pelvic inflammatory diseases;	0.008
Epilepsy	Primary diagnosis: O15; G40; G41; R56	Eclampsia; Epilepsy; Status epilepticus; Convulsions, not elsewhere classified	0.04
Gangrene	Both primary and secondary diagnoses: R02	Gangrene, not elsewhere classified	0.004
Appendix	Primary diagnosis: K35	Acute appendicitis	0.02

Hernia	Primary diagnosis: K40; K41	Inguinal hernia; Femoral hernia	0.05
Thyroid	Primary diagnosis: E03; E04; E05	Other hypothyroidism; Other nontoxic goiter; Thyrotoxicosis [hyperthyroidism]	0.005
Rheumatic fever	Primary diagnosis: I00; I01; I02; I05; I06; I08; I07; I09	Rheumatic fever without mention of heart involvement; Rheumatic fever with heart involvement; Rheumatic chorea; Rheumatic mitral valve diseases ; Rheumatic aortic valve diseases; Rheumatic tricuspid valve diseases; Other rheumatic heart diseases	0.003
Skin cancer	Primary diagnosis: C00; C43; C44	Malignant neoplasm of lip; Malignant melanoma of skin; Other malignant neoplasms of skin	0.03
Breast cancer	Primary diagnosis: C50	Malignant neoplasm of breast	0.07
Cervical cancer	Primary diagnosis: C53	Malignant neoplasm of cervix uteri	0.005
Stroke	Primary diagnosis: I61; I62; I63; I64	Intracerebral hemorrhage; Other nontraumatic intracranial hemorrhage; Cerebral infarction; Stroke, not specified as hemorrhage or infarction	0.05

Table 2. Admission rates for PMS and non-PMS practices

		1997/8	1998/9	1999/0	2000/1	2001/2	2002/3	2003/4
Wave 1	ACSCs	32.20	**33.88**	**37.24**	**35.12**	**36.88**	**36.94**	**39.86**
(N = 47)	Non ACSC	168.94	**178.20**	**187.56**	**189.10**	**190.86**	**192.39**	**195.04**
Wave 2	ACSCs	26.06	31.21	**33.30**	**35.47**	**36.76**	**37.31**	**39.57**
(N = 83)	Non ACSC	141.17	163.93	**177.99**	**186.70**	**191.69**	**194.17**	**199.72**
Wave 3	ACSCs	23.48	23.92	24.16	**24.48**	**34.00**	**35.01**	**38.09**
(N = 64)	Non ACSC	127.39	136.13	140.68	**143.18**	**178.16**	**176.68**	**182.41**
Wave 4	ACSCs	29.72	31.71	33.38	33.27	**33.97**	**35.66**	**37.97**
(N = 549)	Non ACSC	159.47	168.86	175.87	179.50	**178.75**	**182.65**	**188.93**
Wave 5	ACSCs	31.78	33.41	35.50	35.17	36.22	**37.86**	**40.10**
(N = 544)	Non ACSC	166.56	174.57	182.15	181.86	184.16	**188.21**	**193.27**
Wave 6	ACSCs	32.63	34.37	34.99	34.89	35.08	36.38	**38.44**
(N = 1070)	Non ACSC	171.05	181.21	184.73	184.41	183.16	188.99	**195.55**
Never PMS	ACSCs	29.26	31.76	32.99	32.62	33.12	34.84	36.81
(N =4576)	Non ACSC	157.39	169.13	174.15	174.23	174.63	180.11	185.25
Not yet PMS	ACSCs	29.94	32.21	33.45	33.23	33.73	35.13	36.81
	Non ACSC	171.10	171.05	176.28	176.90	176.94	181.79	185.25
	N practices	6933	6886	6803	6739	6190	5646	4576

Table 3. Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
All ACSCs per 1000	33.64	11.93	0	125.56
Emergency ACSCs per 1000	21.87	8.39	0	89.15
Elective ACSCs per 1000	11.77	5.45	0	96.71
All non-ACSCs per 1000	175.98	48.40	4.97	442.60
Emergency ACSCs per 1000	86.29	26.70	0	271.83
Elective ACSCs per 1000	89.68	29.00	1.41	333.07

1 Year PMS	0.05	0.22	0	1
2 Year PMS	0.03	0.16	0	1
3 Year PMS	0.02	0.12	0	1
4 Year PMS	0.00	0.06	0	1
5 Year PMS	0.00	0.05	0	1
6 Year PMS	0.00	0.03	0	1
Ever PMS	0.34	0.47	0	1
Standard Fundholder	0.43	0.49	0	1
Median elective waiting time	43.68	16.52	1	371.50
Practice listsize	6.11	3.66	1.00	34.27
Listsize per WTE GP	2.08	0.50	0.68	8.59
Training practice	0.26	0.44	0	1
Proportion of rural patients	0.09	0.18	0	1
Proportion of female GPs	0.29	0.27	0	1
Proportion of UK GPs	0.70	0.40	0	1
Proportion of under 40 GPs	0.26	0.28	0	1
Proportion of GPs aged 40 -50	0.36	0.33	0	1
Proportion of GPs aged 50 -60	0.31	0.36	0	1
Proportion of GPs over 60	0.07	0.21	0	1
Proportion of minor surgey GPs	0.79	0.33	0	1
Proportion of GPs allowed deputising	0.76	0.39	0	1
Single handed GP	0.24	0.43	0	1
Dispensing practice	0.15	0.36	0	1
Proportion ethnic minority	0.08	0.12	0.00	0.68
Proportion dependants without carer	0.15	0.04	0.02	0.37
Proportion with change of address	0.10	0.03	0.04	0.31
Distance to 5 nearest hospitals	25.08	11.07	11.77	109.09
Average beds at 5 nearest hospitals	5.05	1.35	1.74	9.97
Av beds at 5 nearest private hospitals	39.20	16.33	8.52	124.78
Percentage not going to university	85.01	6.62	44.81	98.33
Residential places	0.09	0.07	0	1.22
Incapacity/severe disability allowance	100.06	52.46	13.77	434.16

Table 4. Effect of length of time practice has been PMS - fixed effects model

	ACSCs			Non-ACSCs		
	All	Elective	Emergency	All	Elective	Emergency
1 Year PMS	1.10	0.52	0.58	5.01	3.14	1.87
	[4.610]**	[4.006]**	[3.495]**	[5.169]**	[5.709]**	[3.462]**
2 Years PMS	2.81	1.31	1.50	9.16	5.02	4.14
	[6.980]**	[6.399]**	[5.385]**	[5.346]**	[5.335]**	[4.386]**
3 Years PMS	3.82	1.68	2.14	14.09	7.28	6.81
	[6.652]**	[6.037]**	[5.224]**	[5.691]**	[5.457]**	[4.902]**
4 Years PMS	5.98	2.14	3.83	22.99	11.15	11.84
	[6.264]**	[5.119]**	[5.527]**	[5.742]**	[5.452]**	[5.085]**
5 Years PMS	5.32	1.88	3.44	23.19	10.97	12.22
	[5.499]**	[3.825]**	[4.874]**	[5.284]**	[4.554]**	[4.902]**
6 Years PMS	5.77	1.64	4.13	18.73	9.53	9.20
	[4.140]**	[1.838]	[4.135]**	[3.089]**	[2.897]**	[2.489]*
Observations	48448	48448	48448	48448	48448	48448
Adj R2:	0.6869	0.529	0.6981	0.6851	0.7023	0.6845

Robust t statistics in brackets. * significant at 5%; ** significant at 1%

Model estimated with Stata 8. Estimated using the *areg* command allowing for robust standard errors and relaxing within practice independence of errors. Model contains practice population age and gender proportions, waiting time, listsize, listsize per WTE GP, training status, rural patients, female

GPs, UK GPs, GPs under 40, GPs 50-60, GPs over 60, minor surgey GPs, GPs using deputising, single handed GP, dispensing practice

Table 5. Proportionate effects for the number of PMS years (Fixed effects estimation)

	ACSCs			Non-ASCs		
	All	Emergency	Elective	All	Emergency	Elective
1 year PMS	0.033	0.026	0.044	0.028	0.022	0.035
2 years PMS	0.084	0.069	0.111	0.052	0.048	0.056
3 years PMS	0.114	0.098	0.143	0.080	0.079	0.081
4 years PMS	0.178	0.175	0.182	0.131	0.137	0.124
5 years PMS	0.158	0.157	0.160	0.132	0.142	0.122
6 years PMS	0.171	0.189	0.139	0.106	0.107	0.106

Table 6. Admission rates – GEE random effects model

		ACSCs		Non-ACSCs	
	All	Electives	Emergencies	Electives	Emergencies
Year 1998	2.730	1.351	1.383	10.022	3.980
	[18.275]**	[17.055]**	[12.749]**	[30.666]**	[10.800]**
Year 1999	3.913	1.951	1.950	11.851	6.513
	[21.342]**	[20.074]**	[15.187]**	[26.395]**	[14.346]**
Year 2000	3.640	1.834	1.810	11.690	6.668
	[17.826]**	[18.005]**	[12.655]**	[24.129]**	[13.712]**
Year 2001	4.377	1.699	2.700	10.877	8.257
	[20.524]**	[16.039]**	[17.917]**	[20.501]**	[15.824]**
Year 2002	6.121	2.416	3.736	14.322	10.800
	[27.153]**	[21.725]**	[23.057]**	[26.657]**	[20.330]**
Year 2003	8.052	3.089	4.998	15.994	14.527
	[32.959]**	[24.580]**	[29.084]**	[28.520]**	[25.865]**
Standard Fundholder	-0.549	-0.361	-0.181	-3.657	0.209
	[2.326]*	[3.553]**	[1.034]	[6.603]**	[0.371]
Standard Fundholder*Year 1998	-0.125	-0.033	-0.090	-2.305	-1.283
	[0.656]	[0.318]	[0.650]	[5.584]**	[2.723]**
Standard Fundholder*Year 1999	-0.410	-0.081	-0.327	-1.346	-2.001
	[1.698]	[0.634]	[1.955]	[2.285]*	[3.281]**
Standard Fundholder*Year 2000	-0.087	0.009	-0.099	0.636	-1.403
	[0.334]	[0.072]	[0.540]	[0.986]	[2.167]*
Standard Fundholder*Year 2001	0.070	0.055	0.013	2.359	-0.561
	[0.259]	[0.413]	[0.067]	[3.474]**	[0.830]
Standard Fundholder*Year 2002	0.442	0.339	0.100	3.199	-0.391
	[1.584]	[2.481]*	[0.495]	[4.673]**	[0.578]
Standard Fundholder*Year 2003	0.527	0.416	0.106	3.056	-0.590
	[1.770]	[2.719]**	[0.504]	[4.379]**	[0.832]
Ever a PMS practice	0.524	0.131	0.408	0.533	-0.024
	[2.118]*	[1.233]	[2.218]*	[0.918]	[0.041]
Ever PMS*Year 1998	-0.609	-0.203	-0.408	-0.737	-0.721
	[3.022]**	[1.898]	[2.748]**	[1.721]	[1.457]
Ever PMS*Year 1999	-0.492	-0.288	-0.207	-0.757	0.250
	[1.943]	[2.180]*	[1.169]	[1.247]	[0.391]
Ever PMS*Year 2000	-0.307	-0.150	-0.161	-0.449	0.551

	[1.126]	[1.118]	[0.831]	[0.678]	[0.814]
Ever PMS*Year 2001	-0.044	0.046	-0.102	-0.031	0.478
	[0.150]	[0.315]	[0.493]	[0.042]	[0.660]
Ever PMS*Year 2002	-0.603	-0.152	-0.465	-0.203	-0.282
	[1.867]	[0.932]	[2.015]*	[0.266]	[0.377]
Ever PMS*Year 2003	-0.761	-0.398	-0.376	-0.289	0.179
	[1.925]	[1.942]	[1.343]	[0.315]	[0.202]
1 Year PMS	**0.350**	**0.115**	**0.233**	**0.580**	**0.198**
	[1.875]	**[1.102]**	**[1.795]**	**[1.460]**	**[0.528]**
2 Years PMS	**1.349**	**0.584**	**0.753**	**0.966**	**1.276**
	[4.643]**	**[3.734]****	**[3.677]****	**[1.521]**	**[2.146]***
3 Years PMS	**1.819**	**0.666**	**1.149**	**1.409**	**2.661**
	[4.499]**	**[3.222]****	**[3.922]****	**[1.565]**	**[3.108]****
4 Years PMS	**2.592**	**0.837**	**1.779**	**2.210**	**4.585**
	[4.420]**	**[2.885]****	**[3.987]****	**[1.826]**	**[3.293]****
5 Years PMS	**2.221**	**0.577**	**1.645**	**1.635**	**5.056**
	[3.092]**	**[1.559]**	**[3.104]****	**[0.992]**	**[2.935]****
6 Years PMS	**2.663**	**0.424**	**2.168**	**0.488**	**2.548**
	[2.556]*	**[0.673]**	**[2.758]****	**[0.222]**	**[1.019]**
Median elective wait (between)	-0.034	-0.034	0.000	-0.230	0.080
	[3.816]**	[8.772]**	[0.033]	[10.030]**	[3.988]**
Median elective wait (within)	-0.014	-0.010	-0.005	0.015	-0.093
	[1.455]	[2.402]*	[0.681]	[0.646]	[4.163]**
Practice listsize (between)	-0.067	-0.017	-0.050	-0.139	-0.188
	[2.807]**	[1.650]	[2.840]**	[2.442]*	[3.343]**
Practice listsize (within)	-2.335	-0.757	-1.522	-6.203	-5.487
	[15.287]**	[12.549]**	[14.225]**	[16.410]**	[15.909]**
Listsize per WTE GP (between)	-0.572	0.006	-0.600	-0.398	-2.300
	[2.944]**	[0.081]	[4.095]**	[0.885]	[5.055]**
Listsize per WTE GP	-0.850	-0.608	-0.263	-3.053	-0.277
	[2.528]*	[3.930]**	[1.122]	[3.975]**	[0.356]
Training practice (between)	-0.001	-0.079	0.062	-0.474	0.123
	[0.005]	[1.091]	[0.498]	[1.175]	[0.321]
Training practice (within)	0.770	0.523	0.240	1.663	-0.140
	[2.471]*	[3.159]**	[1.088]	[2.242]*	[0.204]
Proportion of rural patients (between)	-2.850	-0.870	-2.007	-7.514	-5.274
	[4.749]**	[3.368]**	[4.439]**	[5.392]**	[3.668]**
Proportion of rural patients (within)	5.344	1.626	3.610	10.074	12.329
	[3.871]**	[2.115]*	[3.680]**	[3.257]**	[4.425]**
Proportion of female GPs	-0.497	-0.342	-0.162	-2.882	-0.061
	[1.834]	[2.823]**	[0.820]	[4.705]**	[0.103]
Proportion of UK GPs	-1.112	-0.080	-0.924	0.908	-0.640
	[4.624]**	[0.736]	[5.283]**	[1.670]	[1.210]
Proportion GPs under 40 (between)	1.662	0.694	0.946	3.648	1.547
	[4.455]**	[4.495]**	[3.341]**	[4.180]**	[1.765]
Proportion GPs under 40 (within)	-1.508	-0.665	-0.860	-3.279	-1.461
	[3.355]**	[3.032]**	[2.603]**	[3.040]**	[1.383]
Proportion of GPs 50 -60 (between)	-0.145	-0.396	0.290	-2.396	1.235
	[0.418]	[2.692]**	[1.106]	[2.934]**	[1.562]
Proportion of GPs 50 -60 (within)	-0.084	0.252	-0.384	1.565	-0.773
	[0.204]	[1.263]	[1.261]	[1.621]	[0.828]
Proportion of GPs over 60 (between)	0.091	-0.528	0.658	-4.356	1.515
	[0.176]	[2.663]**	[1.659]	[3.758]**	[1.294]

Proportion of GPs over 60 (within)	-0.937	0.185	-1.212	2.047	-1.959
	[1.470]	[0.598]	[2.564]*	[1.479]	[1.418]
Prop minor surgey GPs (between)	-0.790	-0.174	-0.593	-0.839	-1.058
	[2.912]**	[1.611]	[2.834]**	[1.337]	[1.732]
Prop minor surgey GPs (within)	-0.865	-0.753	-0.263	-1.448	0.778
	[2.018]*	[2.975]**	[0.921]	[1.594]	[0.846]
Prop GPs able use deputies (between)	0.403	0.168	0.233	0.914	-0.688
	[1.519]	[1.491]	[1.138]	[1.455]	[1.037]
Prop GPs able use deputies (within)	2.273	0.966	1.354	6.392	6.700
	[3.880]**	[3.612]**	[3.393]**	[4.131]**	[4.520]**
Single handed GP (between)	-0.569	-0.345	-0.199	-3.028	-0.376
	[2.134]*	[3.104]**	[0.991]	[4.737]**	[0.606]
Single handed GP (within)	0.624	0.425	0.263	1.989	-0.162
	[1.595]	[2.237]*	[0.920]	[2.188]*	[0.178]
Dispensing practice	-0.573	-0.336	-0.261	-2.152	-1.828
	[2.390]*	[3.144]**	[1.464]	[3.850]**	[3.365]**
Proportion ethnic minority	3.024	2.549	0.447	-11.702	-4.728
	[2.328]*	[5.215]**	[0.434]	[4.170]**	[1.553]
Proportion dependants without carer	11.852	3.800	7.695	23.347	47.343
	[3.323]**	[2.629]**	[2.801]**	[2.830]**	[5.599]**
Proportion with change of address	11.361	-1.802	13.183	-29.861	34.016
	[2.632]**	[1.030]	[3.962]**	[2.952]**	[3.419]**
Distance to 5 nearest hospitals	-0.031	0.005	-0.036	-0.075	0.033
	[1.762]	[0.676]	[2.630]**	[1.866]	[0.705]
Average beds at 5 nearest hospitals	-0.516	-0.180	-0.327	-0.827	-0.488
	[5.677]**	[4.641]**	[4.745]**	[3.799]**	[2.355]*
Av beds at 5 nearest private hospitals	0.024	0.009	0.015	0.017	0.061
	[4.054]**	[3.522]**	[3.519]**	[1.129]	[4.621]**
Percentage not going to university	0.262	0.079	0.183	0.643	0.451
	[15.090]**	[10.712]**	[13.736]**	[15.374]**	[11.291]**
Residential home places	-1.342	-0.241	-1.169	1.490	-3.818
	[1.148]	[0.478]	[1.294]	[0.546]	[1.260]
Incapacity/severe disability allow.	0.054	0.005	0.049	0.044	0.113
	[13.624]**	[3.398]**	[15.794]**	[5.089]**	[12.273]**
Constant	487.866	84.050	394.322	742.868	2319.278
	[6.024]**	[2.557]*	[6.353]**	[3.946]**	[11.561]**
Observations	48448	48448	48448	48448	48448
Number of practices	6933	6933	6933	6933	6933

z statistics in brackets. * significant at 5%; ** significant at 1%

Practice population age-gender proportions also included. Estimated using *xtgee* command. Allows for robust standard errors and serial correlation in the errors.

Table 7. Proportionate effects for the number of PMS years (GEE estimation)

	ACSCs			Non-ASCs	
	All	Emergency	Elective	Emergency	Elective
1 year PMS	0.010	0.010	0.011	0.002	0.006
2 years PMS	0.040	0.050	0.034	0.015	0.011
3 years PMS	0.054	0.057	0.053	0.031	0.016
4 years PMS	0.077	0.071	0.081	0.053	0.025
5 years PMS	0.066	0.049	0.075	0.059	0.018
6 years PMS	0.079	0.036	0.099	0.030	0.005