EDITOR'S CHOICE

Characteristics of general practices associated with emergency admission rates to hospital: a cross-sectional study

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ABSTRACT

Objectives To identify characteristics of general practices associated with emergency hospital admission rates, and determine whether levels of performance and patient reports of access are associated with admission rates.

Design A cross-sectional study.

Setting Two primary care trusts (Leicester City and Leicestershire County and Rutland) in the East Midlands of England.

Participants 145 general practices.

Methods Hospital admission data were used to calculate the rate of emergency admissions from 145 practices, for two consecutive years (2006/7 and 2007/8). Practice characteristics (size, distance from principal hospital, quality and outcomes framework performance data, patient reports of access to their practices) and patient characteristics (deprivation, ethnicity, gender and age), were used as predictors in a two-level hierarchical model, developed with data for 2007/8, and evaluated against data for 2006/7.

Results Practice characteristics (shorter distance from hospital, smaller list size) and patient characteristics (higher proportion of older people, white ethnicity, increasing deprivation, female gender) were associated with higher admission rates. There was no association with quality and outcomes framework domains (clinical or organisation), but there was an association between patients reporting being able to see a particular general practitioner (GP) and admission rates. As the proportion of patients able to consult a particular GP increased, emergency admission rates declined.

Conclusions The patient characteristics of deprivation, age, ethnicity and gender are important predictors of admission rates. Larger practices and greater distance from a hospital have lower admission rates. Being able to consult a particular GP, an aspect of continuity, is associated with lower emergency admission rates.

In this paper, we report a study of the characteristics of general practices associated with the rate of emergency hospital admissions. The definition of emergency admissions in this study is that used in the English health service as including all non-elective admissions, including those via emergency departments, general practitioners, outpatient departments and other providers. In England in 2008–9 there were 14.1 million new hospital admissions, of which 5.0 million (35.4%) were emergency admissions, an increase of 22% on the 3.9 million emergency admissions in 2000–1.[1 2]

In England, patients may be admitted to hospital as emergencies if, when they fall acutely ill or are injured: (1) they or their carers take them to the emergency department of a hospital; (2) they are taken to an emergency department by an ambulance; (3) a general practitioner (GP; including out-of-hours services) arranges emergency admission via an emergency department or directly to a hospital ward; (4) or by other routes, for example, through an outpatient department if a patient attends a clinic when seriously ill. In England, the dominant model for primary care out-of-hours services is a general practice deputising service, in contrast to the rota groups or cooperatives found in Germany, or the emergency department model found in France.[3] Although there are differences between countries in emergency department systems, departments in England receive severely ill or injured patients, as well as patients who present with minor injuries or illnesses, although the latter may be directed to primary care centres.

A variety of policies has been introduced in order to help control admission rates, including enhanced management of patients with ambulatory care-sensitive conditions, community matron services, single point of access schemes and systems to identify patients at increased risk of admission. However, as initiatives such as these have had little impact, investigation is required of the characteristics of primary care that influence admission rates. A recent review of emergency services in England highlighted how small shifts in the proportion of patients with urgent conditions who use primary rather than secondary care could have a large impact on secondary care ('gearing').[4]

Factors found to explain variation in admission rates between practices include patient socio-demographic characteristics and measures of ill health, with practice characteristics, including markers of quality of care, contributing little to the variance.[5] Higher admission rates for asthma have been associated with smaller practice size and higher rates of night visiting.[6] For diabetes, socio-economic deprivation and morbidity were associated with higher admission rates, and the provision of specialist diabetes services in primary care with reduced admissions for diabetes.[7] A lower supply of GPs per 10 000 population has been associated with increased hospital admissions for acute and chronic conditions.[8] In California, hospitalisation rates were higher among patients who rated their access to care as poor, but the findings may not be applicable to a universal access system such as the

NHS.[9] There is also evidence from the USA of an association between continuity and admission rates.[10]

Until recently, only limited routine data have been available about the quality of clinical care and organisational features such as continuity and access. In England, from 2004, data on practice performance have been available through the quality and outcomes framework incentive scheme,[11] and from 2006, surveys of patient experience of access to general practices have also been undertaken.[12] The practice level findings of the quality and outcomes framework and the patient survey are publicly available. We undertook a study to test the hypothesis that emergency admission rates are associated with levels of access and performance of general practices.

METHOD

Setting

The study took place in Leicestershire, primarily served by a large, central acute hospital trust with an emergency department, although there are alternative hospitals in neighbouring cities potentially more accessible for people living at the periphery of the county. Leicester is a large city surrounded by relatively rural areas served by small market towns. There are two primary care trusts (Leicester City and Leicestershire County and Rutland), 145 general practices, a walk-in centre in one small town outside Leicester and several minor injuries units. The total population is approximately 940 000 people, with wide socioeconomic diversity and a large ethnic minority population in Leicester city and three other areas of the county.

Admission rates

Anonymised admissions data to all acute hospitals for the 2 years 1 April 2006 to 31 March 2008 were available to the primary care trusts. We included emergency admissions only. Maternity-related admissions were excluded, and the analysis was restricted to patients registered with practices of the two primary care trusts, giving 86 586 admissions for 2006/7 and 90 183 for 2007/8. We developed the predictive model using the more recent data (2007/8), and evaluated the model using the 2006/7 data. The number of emergency admissions to any hospital per practice was divided by the practice's list size to create a rate per person per year.

Practice characteristics

In the English national health system, almost everyone is registered with a general practice, each practice having a team of medical, nursing and administrative staff. There is a national contract with practices that defines their responsibilities, and a key part of the contract is the pay for performance scheme called the 'quality and outcomes framework'.[11] The scheme offers financial rewards to practices according to the quality of care they provide, quality being defined by indicators covering the care of chronic conditions, and organisational features of practices including records, preventive activities and staff education. Achievement of the performance indicators of the framework are recognised by the allocation of points that determine the level of incentive payment to practices. The performance data for every practice are publicly available. As we were interested in total emergency admission rates rather than rates for specific conditions, we used total points awarded for clinical performance and total organisational points (see table 1). We used the 2006/7 and 2007/8 quality and outcomes framework data for the two admission years, respectively.

The patient access survey is a national survey of samples of patients registered at each practice. In the first 2 years of the survey, it included questions on five aspects of access—whether the patient was: able to get an appointment within 2 days, able to book an appointment more than 2 days in advance, able to make an appointment with a particular doctor, satisfaction with getting through to the practice by telephone and satisfaction with practice opening hours. We used the 2006/7 and 2007/8 surveys in this study.[12] We obtained the distance of each practice in miles from the hospital from a route planner,[13] and used the practice index of multiple deprivation 2007 as the indicator of deprivation for both analyses,[14] and from the primary care trust obtained information on the total number of patients registered with each practice (list size), numbers of patients per practice aged 65 years or older, numbers of patients per practice by ethnic group classified into white or other and numbers of male patients.

Statistical methods

Descriptive statistics and univariable analyses of admission rates and candidate predictors were carried out for each year separately. The data were expected to be overdispersed counts, so an appropriate analysis method was negative binomial regression, using the log of the practice list size as an offset to adjust for the fact that practice list sizes vary and therefore the number at risk also varies from practice to practice.[15] The sample size was dictated by the number of practices of the two primary care trusts. The aim was to test the association between emergency admission rates and access and practice performance using the 2007/8 admissions year, and applying the model developed to

Table 1 The quality and outcomes framework and access survey measures

Measure	Description
Quality and outcomes framework	
Clinical domain	80 Indicators relating to 19 clinical areas (coronary heart disease, stroke, hypertension, diabetes, chronic obstructive pulmonary disease, epilepsy, hypothyroidism, cancer, palliative care, mental health, asthma, dementia, depression, chronic kidney disease, atrial fibrillation, obesity, learning disabilities, smoking) worth up to 655 points.
Organisational domain	43 Indicators relating to five organisational areas (records and information, information for patients, education and training, practice management, medicines management) worth up to 181 points.
Access survey	
Telephone access	The proportion who were, in general, satisfied with how easy it is to get through to someone on the phone at their doctor's surgery.
An appointment within 2 days	Of those who tried in the past 6 months to get an appointment with a doctor fairly quickly (on the same day or on the next 2 days the surgery was open), the proportion who were able to get this appointment.
Able to book an appointment in advance	Of those who, in the past 6 months, have wanted to book ahead (more than 2 full days in advance) for an appointment with a doctor, the proportion who were able to get this appointment.
Able to make an appointment with a particular doctor	Of those who, in the past 6 months, have ever wanted to make an appointment with a particular doctor at their practice, the proportion who were able to.
Satisfaction with opening hours	The proportion who, over the past 6 months or so, were satisfied with their GP surgery opening hours.

GP, general practitioner.

Table 2 Descriptive statistics for predictors used in the statistical models

Period	2006–7	2007–8
Total admissions	86 586	90 183
Variable	**Mean (SD) or median (IQR)**	**Mean (SD) or median (IQR)**
Total clinical points	647 (630–654)	651 (637–654)
Total organisational points	175 (165–178)	176 (167–179)
% Satisfied with phone access	87 (75–94)	87 (78–94)
% Able to book 2 days ahead	71 (52–85)	73 (58–87)
% Able to get appointment in 48 h	89 (83–94)	89 (83–94)
% Able to book with a specific GP	88 (80–93)	88 (79–92)
% Satisfied with opening hours	84 (78–88)	81 (76–85)
Distance from hospital (miles)	4.3 (2.3–10.6)	4.3 (2.3–10.6)
% of Practice male	50 (49–51)	50 (49–51)
Age (% of practice patients aged 65+ years)	15 (12–18)	15 (12–18)
Practice deprivation score	16 (10–32)	16 (10–32)
% of Practice white ethnicity	91 (71–98)	91 (71–98)
Coronary heart disease prevalence (proportion with CHD)	0.034 (0.03–0.04)	0.033 (0.03–0.04)
% Response rate to access survey	0.51 (0.43–0.57)	0.47 (0.39–0.52)

N=145 for all variables.
IQR, (quartile1, quartile3).
CHD, coronary heart disease; GP, general practitioner.

the data for 2006/7 as a test of validity. We expected certain variables to predict admission rates, and therefore used a two-level hierarchical (sequential) multiple negative binomial regression model, implementing a backward stepwise procedure in level 2. Analyses were undertaken using SAS version 9.1. Level 1 included variables assumed to have a major impact on hospital admissions, as indicated by previous studies and informed by univariable models. The level 1 variables were: deprivation[5]; practice size[5 6]; the proportion of the practice population aged 65 years or over; the proportion of the practice population of white ethnic group[5]; the proportion of male patients and the distance of the practice from the hospital. We intended to use the proportion of people on practice quality and outcomes framework coronary heart disease registers as an indicator of the level of morbidity in practices; however, this variable was very highly correlated with the proportion aged 65 years and over (r for 2007/8=0.82, r for 2006/7=0.77) and it was omitted to reduce multicollinearity.

Level 2 variables were chosen to test our hypotheses that practice performance and access would influence admission rates. They were the two quality and outcomes framework points domains, and the five measures of access from the access survey. These level 2 variables were then entered into the model along with all level 1 predictors. A backward stepwise phase was undertaken in which non-significant level 2 variables were sequentially removed in order to determine which of the level 2 variables were significant multivariable predictors of the admissions rate.[16 17] We also investigated the correlation between the access measures. Internal model validation was undertaken by bootstrapping. The model derived from 2007/8 was tested on the previous year's data (2006/7) to evaluate the generalisability of the model. The distance of practices from the hospital, the deprivation score and the proportion of white individual, were the same in both years, otherwise all variables were specific to each year. Running a longitudinal model was also considered, in which differences in counts between the 2 years would be modelled as a function of differences in predictors, but this was not carried out as two of the strongest predictors, deprivation and white individuals, were available only for a single year. p Values of less than 0.05 were considered statistically significant.

RESULTS

The mean rate of emergency admissions for people registered with the included general practices in 2007/8 was 0.093, and in 2006/7 it was 0.091, similar to the national rate.[1] Rates within each of the two periods were normally distributed. Table 2 presents descriptive information for the variables included in the study for each year, and tables 3 and 4 set out the univariable analysis of associations between the variables and practice emergency admission rates for 2006/7 and 2007/8, respectively. As overdispersion was detected in the data, all models were negative binomial regressions. Significant univariable associations were found (in both years) between admission rates and four access variables (satisfaction with telephone access, being

Table 3 Univariable analyses of predictor variables of practice admission rate (n=145) 2006/2007

Variable	IRR (95% CI)	% Change	p Value
Total clinical points	0.999 (0.997 to 1.001)	−0.1%	0.15
Total organisational points	0.997 (0.995 to 0.999)	−0.3%	0.005
% Satisfied with phone access	0.996 (0.992 to 0.999)	−0.4%	0.01
% Able to book 2 days ahead	0.997 (0.994 to 0.999)	−0.3%	0.005
% Able to get appointment in 48 h	0.992 (0.986 to 0.997)	−0.8%	0.002
% Able to book with a specific GP	0.993 (0.988 to 0.998)	−0.7%	0.005
% Satisfied with opening hours	1.001 (0.994 to 1.008)	0.1%	0.83
Distance from hospital (miles)	0.984 (0.977 to 0.991)	−1.6%	<0.0001
% of Practice male	0.99 (0.966 to 1.014)	−1.0%	0.38
Age (% of practice patients 65+ years)	1.01 (1.00 to 1.03)	1.0%	0.01
Practice deprivation score	1.01 (1.008 to 1.016)	1.0%	<0.0001
% of Practice white ethnicity	0.999 (0.996 to 1.002)	−0.1%	0.29
Size of practice (no of patients)	0.99998 (0.99997 to 0.99999)	−0.002%	0.0005
Coronary heart disease prevalence	1.11 (1.04 to 1.18)	11%	0.0004
% Response rate to access survey	0.995 (0.98 to 1.01)	−0.5%	0.053

N=145 for all variables.
Figures in the second column are incident rate ratios (IRR). Subtracting 1 from the IRR and then multiplying by 100 gives the percentage change in the expected admissions count for a 1 unit increase in the predictor. So for practice deprivation score, for every extra deprivation point, the expected admissions count increases by 1%. For distance, for every mile more distant from the practice, the expected admissions count decreases by 1.6%. IRR less than 1.0 represent decreases and IRR greater than 1.0 represent increases in the count. Statistical model: negative binomial regression, using log of the list size as the offset.
GP, general practitioner.

Table 4 Univariable analyses of predictor variables of practice admission rate (n=145) 2007/8

Variable	IRR (95% CI)	% Change	p Value
Total clinical points	0.998 (0.99 to 0.999)	−0.2%	0.02
Total organisational points	0.998 (0.99 to 0.999)	−0.2%	0.04
% Satisfied with phone access	0.995 (0.99 to 0.998)	−0.5%	0.003
% Able to book 2 days ahead	0.996 (0.99 to 0.999)	−0.4%	0.0008
% Able to get appointment in 48 h	0.99 (0.98 to 0.997)	−1.0%	0.0007
% Able to book with a specific GP	0.99 (0.98 to 0.996)	−1.0%	0.0001
% Satisfied with opening hours	0.99 (0.98 to 1.01)	−1.0%	0.21
Distance from hospital (miles)	0.98 (0.97 to 0.99)	−2.0%	<0.0001
% of Practice male	0.99 (0.97 to 1.02)	−1.0%	0.46
Age (% of practice patients 65+ years)	1.01 (0.99 to 1.02)	1.0%	0.1
Practice deprivation score	1.01 (1.009 to 1.02)	1.0%	<0.0001
% of Practice white ethnicity	0.998 (0.995 to 0.999)	−0.2%	0.02
Size of practice (no of patients)	0.99998 (0.99997 to 0.99999)	−0.002%	0.0003
Coronary heart disease prevalence	1.09 (1.03 to 1.16)	9.0%	0.002
% Response rate to access survey	0.99 (0.98 to 0.998)	−1.0%	0.006

N=145 for all variables.
Figures in the second column are incident rate ratios (IRR). Subtracting 1 from the IRR and then multiplying by 100 gives the percentage change in the expected admissions count for a 1 unit increase in the predictor. So for practice deprivation score, for every extra deprivation point, the expected admissions count increases by 1%. IRR less than 1.0 represent decreases and IRR greater than 1.0 represent increases in the count. Statistical model: negative binomial regression, using log of the list size as the offset.
GP, general practitioner.

able to get an appointment within 2 days, booking an appointment in advance and being able to get an appointment with a particular GP). There were also significant associations with deprivation, distance from hospital, prevalence of coronary heart disease and size of the practice. (In 2006/7 practice performance (quality and outcomes framework clinical and organisational points) and age of the respondent were also associated with acute admission rates).

In level 1 of the hierarchical model for 2007/8 (table 5), practice admission rates were lower in practices that were further from the hospital, were larger, with fewer patients aged 65 years or older, with lower levels of deprivation and with fewer female patients and fewer white patients. All the level 1 variables were then forced into the model at level 2. At level 2, neither of the quality and outcomes variables were significant, but a lower proportion of patients able to consult a particular GP was associated with higher admission rates. All level 1 variables that were significant in the level 1 analysis remained so in this second level model. None of the other access or performance variables were significant predictors in the multivariable model. The final model derived from the 2007/8 data (table 5) was then fitted to the 2006/7 data. Comparing the coefficients across the 2 years, each predictor had the same coefficient sign (either positive or negative) and the size of the coefficient was comparable. In particular, the variable 'proportion of patients able to consult a particular GP' had a similar coefficient, CI and p value across the 2 years. Bootstrapping, a method for generating robust CI in small samples by repeatedly drawing random samples from the original sample and basing statistical inference on these 'bootstrapped samples' instead of using the original sample for this purpose, was then used to support the internal validity of the multivariable models (95% bootstrapped CI for

Table 5 Significant multivariable predictors, 2007/8

Variable	IRR (95% CI)	% Change	p Value
Practice deprivation score	1.016 (1.012 to 1.02)	1.6%	<0.0001
Distance from hospital (miles)	0.99 (0.985 to 0.995)	−1.0%	0.0001
Size of practice (no of patients)	0.99999 (0.9998 to 0.999999)	−0.001%	0.0001
Age (% of practice patients aged 65+ years)	1.03 (1.02 to 1.04)	3.0%	<0.0001
% of Practice white ethnicity	1.003 (1.001 to 1.005)	0.3%	<0.0001
% of Practice male	0.98 (0.96 to 0.99)	−2.0%	0.004
% Able to book with a specific GP	0.995 (0.991 to 0.998)	−0.5%	0.0006
Backward stepwise evictions		**p Value when removed from model**	
% Able to book 2 days ahead		0.95	
% Response rate to access survey		0.69	
Total QOF organisational points		0.63	
Total QOF clinical points		0.74	
% Satisfied with phone access		0.48	
% Satisfied with opening hours		0.24	
% Able to get appointment in 48 h		0.06	

N=145 for all variables.
Final multivariable model after backward selection process has been implemented for level 2 variables. Figures in the second column are incident rate ratios (IRR). Subtracting 1 from the IRR and then multiplying by 100 gives the percentage change in the expected admissions count for a 1 unit increase in the predictor. So for practice deprivation score, for every extra deprivation point, the expected admissions count increases by 1.6%. IRR less than 1.0 represent decreases and IRR greater than 1.0 represent increases in the count. Statistical model: negative binomial regression, using log of list size as the offset.
GP, general practitioner; QOF, Quality and Outcomes Framework.

Table 6 Significant multivariable predictors, 2006/7

Variable	IRR (95% CI)	% change	p Value
Practice deprivation score	1.016 (1.01 to 1.02)	1.6%	<0.0001
Distance from hospital (miles)	0.99 (0.98 to 0.996)	−1.0%	0.0008
Size of practice (no of patients)	0.998 (0.997 to 0.999)	−0.2%	0.0002
Age (% of practice patients aged 65+ years)	1.03 (1.02 to 1.04)	3.0%	<0.0001
% of Practice white ethnicity	1.005 (1.003 to 1.008)	0.5%	<0.0001
% of Practice male	0.98 (0.96 to 0.99)	−2.0%	0.04
% Able to book with a specific GP	0.993 (0.990 to 0.996)	−0.7%	0.0001

Backward stepwise evictions	p Value when removed from model
% Response rate to access survey	0.95
% Able to book 2 days ahead	0.92
Total QOF clinical points	0.39
Total QOF organisational points	0.48
% Satisfied with opening hours	0.32
% Satisfied with phone access	0.31
% Able to get appointment in 48 h	0.09

N=145 for all variables.
Final multivariable model after backward selection process has been implemented for level 2 variables. Figures in the second column are incident rate ratios (IRR). Subtracting 1 from the IRR and then multiplying by 100 gives the percentage change in the expected admissions count for a 1 unit increase in the predictor. So for practice deprivation score, for every extra deprivation point, the expected admissions count increases by 1.6%. IRR less than 1.0 represent decreases and IRR greater than 1.0 represent increases in the count.
Statistical model: negative binomial regression, using log of list size as the offset.
GP, general practitioner; QOF, Quality and Outcomes Framework.

the estimate for satisfaction with particular GP being −0.009 to −0.002 for the year 2007/8, and −0.011 to −0.004 for the year 2006/7).[18]

Having confirmed that the model developed using the 2007/8 data was applicable to the 2006/7 data, thus providing some generalisability for our 2007/8 model, we then applied the same hierarchical modelling procedure to the 2006/7 data to see if the same model would be derived. The model identified the same predictors (table 6).

DISCUSSION

This study has confirmed associations between emergency admission rates of practices and practice characteristics (list size, being able to consult a particular GP), patient characteristics (age, deprivation and ethnicity) and distance from hospital. The association with age is not unexpected, and may reflect the greater complexity of managing older people's health and social care. Our study also shows a modest association with being able to consult a particular GP, an aspect of interpersonal continuity.[19] The analyses indicate that for a 5% increase in patient reports of being able to consult a particular doctor there would be a corresponding 3.5% decrease in admissions in 2006/7 (2.5% decrease in 2007/8). This finding is important because small changes in admission rates have substantial economic consequences, and it points to potential interventions to reduce emergency admission rates.

Several limitations to our study should be noted. We may have omitted one or more variables that could help to explain admission rates. The study involved only one county in the East Midlands, and the findings may not necessarily be directly applicable to other settings. We are not aware, however, of any peculiarities of the setting that make the findings unlikely to be applicable to at least some other locations. The patient access survey is an imperfect measure of access. First, it is composed of patient reports of access rather than an objective measure of the availability of appointments. Nevertheless, patient perceptions of access will influence the decisions of patients and carers on how to seek help. Second, the survey addresses only some aspects of access. Issues such as the supply and comprehensiveness of services were not addressed by the survey questionnaire. Third, the response rate to the survey was only 44%, and there was variation between practices in the response rate. However, the response rate has been shown not to influence questionnaire scores assigned to practices,[20] and did not predict admission rates in the multivariable models. It should also be noted that the study identifies an association between patient-reported interpersonal continuity and practice emergency admission rates, but does not establish causation.

Our findings confirm those of other studies in which age was associated with the risk of hospital admission, and therefore support the development and evaluation of admission avoidance initiatives for older people. The finding that white ethnicity is associated with an increased risk of admission may indicate the persistence of barriers to care for the South Asian population of Leicestershire, or reflect a preference for care to be provided by families whenever possible. The relationship between deprivation and admission rates may be a reflection of higher levels of illness among deprived populations, or fewer resources available to devote to keeping patients at home. As we included all emergency admissions irrespective of the hospital of admission, the effect of distance is not explained by admissions to alternative nearby hospitals. Distance may deter some patients from attending hospital if it entails substantial travelling for them or their families. The explanation for lower admission rates from larger practices may be a reflection of (better) patient management in larger practices as other studies have shown that larger practices, with more GPs, are more likely to undertake additional activities and perform well in the quality and outcomes framework.[21 22] However, the finding may also be a consequence of the characteristics of patients of small practices that have not been investigated in our study.

An association between continuity and admission rates has been identified in a US study,[10] and our findings give further support to the role of continuity in avoiding admission. Patients with worrying problems tend to prefer to see someone they know and trust,[23] and it is possible that, in situations in which the patient's condition is serious enough to make admission a management option but not mandatory, being able to consult a trusted GP gives patients the confidence to avoid an admission, or it could facilitate consistent clinical management that helps to prevent the need for admission. The finding also raises the possibility that the introduction of the quality and outcomes framework, through reducing levels of continuity, has caused a small increase in the number of emergency admissions.[24]

CONCLUSION

The rate of emergency admissions to hospital is associated not only with patient age, ethnicity, deprivation, distance of the practice from hospital and practice list size, but also with patient reports of being able to consult a particular GP; this latter finding supporting our first hypothesis: better access is associated with fewer admissions. However, no evidence was found for an association between quality and outcomes framework data and admission rates, so our second hypothesis was not confirmed. Steps to reduce emergency admission rates should concentrate on older patient groups and consider improvement of continuity in general practice.

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Competing interests RB has received support from the National Institute for Health Research (NIHR) for the submitted work; AR and MH are employees of Leicestershire County and Rutland Trust, and MH and JB are employees of the University Hospitals of Leicester Trust that might have an interest in the submitted work in the previous 3 years.

Ethics approval The study was an analysis of routinely collected administrative data only. NHS ethics committee approval was not required, but approval was sought and obtained from the University of Leicester Ethics Committee.

Contributors AR and RB jointly conceived the study. MJGB and RB designed the study. MJGB conducted the analyses. The first draft of the paper was prepared by RB and MJGB. MJGB, RB, AR, MH, JB, RH, SA and AW all contributed to study design, interpretation of the findings and revision and approval of the final manuscript. MJGB was the guarantor.

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