UNIVERSITY of York

RESEARCH

CHE

Centre For Health Economics

The role of payment reform in influencing Accident and Emergency Department attendances: variation across Clinical Commissioning Groups

Martin Chalkley
Hugh Gravelle
Nikita Jacob
Rita Santos
Luigi Siciliani

CHE Research Paper 191

The role of payment reform in influencing Accident and Emergency Department attendances: variation across Clinical Commissioning Groups

Martin Chalkley[a]
Hugh Gravelle[a]
Nikita Jacob [a]
Rita Santos [a]
Luigi Siciliani[b]

[a] Centre for Health Economics, University of York, UK
[b] Department of Economics and Related Studies, University of York, UK

April 2023

Background to series

CHE Discussion Papers (DPs) began publication in 1983 as a means of making current research material more widely available to health economists and other potential users. So as to speed up the dissemination process, papers were originally published by CHE and distributed by post to a worldwide readership.

The CHE Research Paper series takes over that function and provides access to current research output via web-based publication, although hard copy will continue to be available (but subject to charge).

Acknowledgements

This research is funded by the National Institute for Health and Care Research (NIHR) Policy Research Programme, conducted through the NIHR Policy Research Unit in Economics of Health Systems and Interface with Social Care (reference PR-PRU-1217-20301). The views expressed are those of the authors and not necessarily those of the NIHR or the Department of Health and Social Care. This work uses data provided by patients and collected by the NHS as part of their care and support. The Hospital Episodes Statistics A&E data are copyright © 2015/16-2020/21 , NHS England. Re-used with the permission of NHS England. All rights reserved. This project was undertaken on the Data Safe Heaven, which is an ISO 27001 certified environment for handling sensitive data and is provided by the University of York. We are grateful for support by the York Data Safe Heaven team and the Research Computing team.

Conflicts of interest
No ethical approval was required.

Centre for Health Economics
Alcuin College
University of York
York,
YO10 5DD, UK
www.york.ac.uk/che

The role of payment reform in influencing Accident and Emergency Department attendances: variation across Clinical Commissioning Groups*

This paper constitutes the third output of the ESHCRU2 project 3.1 "Analysis of purchaser-provider contracts: modelling risk sharing and incentive implications". The project has focused on the implications of payment reform for what is termed blended payment for emergency care. In Output 1, we set out a theoretical model which had a distinguishing feature of allowing for payment reform to influence the incentives of purchasers, who at that time were Clinical Commissioning Groups. The theoretical insight was that differences between purchasers in terms of their inherent willingness to expend costly effort in order to reduce attendance at Accident and Emergency Departments was an important part of the analysis of payment reform and likely to influence the results of that reform. This paper sets out an empirical examination of those differences as reflected in the determinants for individuals to attend an Accident and Emergency Department, using GP practice level data to consider the variation on population socioeconomic characteristics and disease profiles within the Clinical Commissioning Groups. We draw preliminary conclusions from our analysis regarding the implication of the payment reform across purchasers with different levels of AED attendances.

* This research is funded by the National Institute for Health and Care Research (NIHR) Policy Research Programme, conducted through the NIHR Policy Research Unit in Economics of Health Systems and Interface with Social Care (reference PR-PRU-1217-20301). The views expressed are those of the authors and not necessarily those of the NIHR or the Department of Health and Social Care. This work uses data provided by patients and collected by the NHS as part of their care and support. The Hospital Episodes Statistics A&E data are copyright © 2015/16-2020/21 , NHS England. Re-used with the permission of NHS England. All rights reserved. This project was undertaken on the Data Safe Heaven, which is an ISO 27001 certified environment for handling sensitive data and is provided by the University of York. We are grateful for support by the York Data Safe Heaven team and the Research Computing team.

1. Introduction

A common concern regarding the functioning of emergency care systems is the cost they incur and their use of hospital resources. Most often, this concern focuses on patients that are admitted to hospital for emergency treatment. In England these admissions cost £14bn in 2015-16 and have increased by 10% in volume over 10 years (National Audit Office, 2018). There is typically less focus on the treatments that patients receive within Accident and Emergency Departments (AED)[1] and yet these account for around 25 million instances a year in England (NHS Digital, 2022) and cost more than £3.5bn[2].

The cost of emergency care has brought financing arrangements under scrutiny. Payment for emergency care in the English NHS has previously followed the mechanism for hospital services as set out in the National Tariff Payment System (NTPS)[3]. However, funding was reformed starting in 2019 and both admissions and attendance at AED is now funded through a mixture of a national tariff, with adjustments to the price for treatments above an indicative volume, and some element of a fixed budget agreed between commissioners and hospitals[4] [5]. This approach, which is referred to as *blended payment*, allows local discretion in terms of setting a price for each unit of activity and establishes a two-part tariff in which the prices of activity are reduced below the previously mandated national price and the hospital is compensated for that by a fixed budget. This payment reform encapsulates a more general desire in the English NHS to move away from pure activity-based payment and in particular towards an approach where many hospitals receive a lump-sum transfer possibly conditional on other performance targets (NHS England and NHS Improvement, 2019).

In previous research (Chalkley et al., 2022a, 2022b) we have established a framework for examining the joint determination of attendances at AED and the subsequent admissions to a hospital, and conducted an empirical examination of variation in the propensity to admit across hospitals. This framework suggests that it is also important to understand how much variation exists in relation to

[1] There is a variety of terminology used to describe the hospital facilities that receive and treat individuals who arrive or are delivered in an unplanned way and who require emergency medical care. Throughout this paper, as in (Chalkley et al., 2022b), we adopt the term Accident and Emergency Department and use the acronym AED. In respect of the NHS the term Accident and Emergency is frequently used without the qualifier department and is abbreviated to AED. In other jurisdictions Emergency Department (ED) or Emergency Room (ER) are used.

[2] It is difficult to establish overall costs of these attendances but using an average price of £166 for each attendance (see Chalkley et al., 2022b) and applying this to aggregate attendances suggest a figure in excess of this for 2017-18.

[3] NTPS is summarised here: https://www.england.nhs.uk/pay-syst/national-tariff/#:~:text=The%20national%20tariff%20is%20a,cost%20effective%20care%20to%20patients.

[4] Throughout we use the term hospital. In the English NHS the more general term provider captures the idea that a single organisation may supply a great variety of healthcare services, not only those delivered in a hospital. In the setting, we study however the term hospital seems more descriptive and appropriate.

[5] See https://www.england.nhs.uk/wp-content/uploads/2021/02/20-21_National-Tariff-Payment-System.pdf

AED attendances and how that may be ascribed to the agencies that are charged with funding alternative care.

Therefore, in the present study we focus on a hitherto neglected aspect of the emergency care process and consider the variation in AED attendances across Clinical Commissioning Groups (CCGs)[6] in England. To meet that aim we consider a CCG as an aggregation of its constituent GP practices and utilise data derived from those practices to control for variation in their population characteristics, thereby measuring variation in AED attendance having adjusted for proxies of underlying population health needs.

To guide our empirical approach, we use an economic framework that indicates that variations in outcome under the existing payment system may be informative as to the priorities being pursued by CCGs in respect of avoiding attendance at AEDs. We seek to establish how, other things equal, attendances vary across CCGs because a knowledge of this variation can be used to assess how the payment reform might, or might not, achieve a different outcome regarding attendances and subsequent admissions.

The structure of this paper is as follows. We start with a brief review of previous studies that have sought to explain attendances at AEDs. Those studies provide guidance as to what factors should be included in order to establish the distinctive contribution of CCGs to AED attendance patterns. We next summarise the conceptual framework that establishes the link between a CCG's AED attendances and the subsequent propensity to admit patients into hospital. This framework establishes both the importance of variation across CCGs and how it can be interpreted from the perspective of the imperative payment reform. Section 4 describes our empirical approach, the underlying data it uses and the institutional context from which those data are derived. Section 5 summarises the results of the analysis and is followed by a discussion in Section 6.

[6] CCGs were in existence for the period of our analysis (2018-19), however on 1 July 2022, integrated care systems (ICSs) became legally established through the Health and Social Care Act 2022 and replaced CCGs. ICSs are partnerships of organisations that work together to plan and pay for health and care services to improve the lives of people who live and work in their area. These partnerships comprising of the NHS, GPs, local councils, community and voluntary sector, plan how best to deliver services that are affordable and of high quality, such that the needs of the local people are met. Each integrated care system has two statutory elements comprising of an integrated care partnership (ICP) and integrated care board (ICB).

2. Previous studies of AED attendance

There is an extensive literature that is predominantly focused on examining the characteristics of individuals who attend emergency services. Downing and Wilson (2002) use data from the A&E minimum dataset (which is collected in computerised Acute Trusts A&E departments). They restrict attention to a sample of 13 hospitals for the financial year 1999-2000 and explore the variations in AED attendance patterns across the NHS West Midlands region by hour, day, month, age and sex of patients. They found no differences with respect to sex. Attendances by children below 15 years peaked in the evenings. Out of hours attendances were highest for infants (58.5%) followed by those in the age group 15-24 (57%) and those aged 24-44 (54.6%). The highest proportion of patients attended the AED on a Monday while the percentage of weekend attendances decreased with age. Children aged 14 years or below reported more attendances in the summer than the winter, while attendances from infants and the elderly peaked in the winter months, with December having the highest AED attendances.

The relationship between AED attendance and distance, socio-economic deprivation and proximity to an alternative care setting is examined by Rudge et al. (2013). They analyse AED visits made by residents of the West Midlands region to the NHS hospitals during the period 2007-08. They also found a significant interaction between distance and deprivation and conclude that AED attendances in deprived neighbourhoods reduces with distance to a greater degree than in less deprived ones for both adults and children attendance. Proximity to alternative care was significant and both child and adult attendances were higher in populations who lived further away from them, which suggests that the presence of alternative care may reduce AED demand. Moreover, AED use was related to both deprivation and distance with the effect of distance is augmented by deprivation.

The relevance of alternative provision in reducing AED attendance is further examined by (Arain et al., 2015) who investigate the impact of GP-led walk-in centres in the Sheffield area of England using short questionnaires post visit to the GP. They found that the GP-led urgent care centre produced small changes to day time attendances at the local AED. This somewhat contrasts with an international literature which shows evidence regarding decreases in AED attendances in the presence of better primary care services (Christakis et al., 2001) but does accord with UK evidence on NHS nurse-led walk-in provision which did not show any significant impact on AED attendance (Chalder et al., 2003). Recent changes aimed at improving primary care access in the UK have provided a rich set of natural experiments, analysis of which has suggested that extended provision of primary care might have a marked effect on AED attendance (Dolton & Pathania, 2016; Whittaker, et al., 2016).

Our empirical approach is focused on data at the level of GP practices rather than individual patients. This is also the approach adopted by (Scantlebury et al., 2015) who provide a detailed analysis to identify population and primary care characteristics associated with AED attendance rates, especially those that may be subject to change by primary care services. Using a cross-sectional analysis of general practices in England for 2011-12, they found that demographic factors such as deprivation, population morbidity, ethnic group and age were the strongest predictors of AED attendances. Measures of primary care, including Quality Outcome Framework score, practice characteristics or measures of patient experiences of primary care derived from General Practice Population Survey (GPPS) only made a small contribution to higher AED attendance rates.

A specific focus within studies on AED attendances are individuals who attend frequently. For example, (Daniels et al., 2018) examine the characteristics and needs of patients who regularly attend the AED, from a patient and staff perspective and assessed the procedures. Consistent with previous findings they conclude that the majority of frequent attenders were experiencing higher levels of pain that they interpreted as life threatening or in urgent need of intervention. They also found that attendances by males and female were equally spread and a majority of the frequent attenders in their study were below the age of 40 which is in contrast to evidence from (Jelinek et al., 2008; Kirby et al., 2011; Pines et al., 2011) who all report the highest attendances in the middle-age category with mean age of 48-49. In relation to the frequency of attendance, using data on all attendances from the Hospital Episode Statistics at all major AEDs across England for 2016-17, (Greenfield et al., 2020) found that 9.5% of those appearing at AED attended three times or more in a period of one year and accounted for 27% of the AED attendances. In their analysis, patients who attended three times or more were classified as *frequent* attenders. The groups with the most frequent attendances were infants and the elderly. Frequent attenders had a higher probability of hospital admission.

In summary, this literature provides a rich source of potential explanatory variables in relation to AED attendances, and we use it to that end. However, the focus of our approach is on examining how much variation remains across CCGs after these explanatory variables have been accounted for.

3. Conceptual framework

We utilise the framework developed in (Chalkley et al., 2022a). This conceptualises an emergency care system as being comprised of a purchaser (a CCG) and a provider (hospital) – who make decisions that influence respectively the proportion of a population that attends an Accident and Emergency Department (AED) and the proportion of those patients that are subsequently admitted for emergency inpatient care. These decisions are interdependent and both are influenced by the payment mechanism between the purchaser and provider. The framework can be summarised in a diagram as in Figure 1.

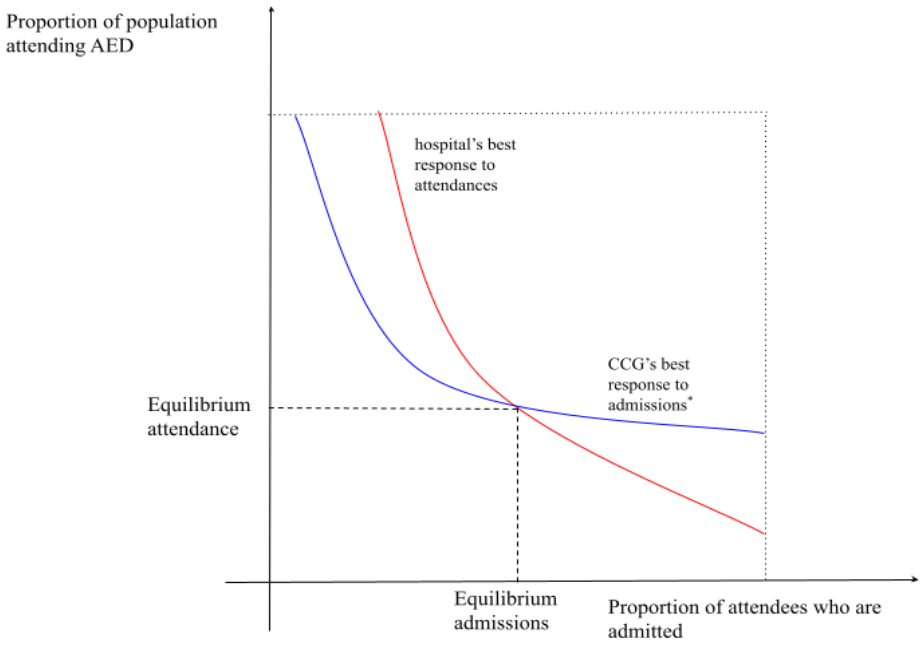

Figure 1: Equilibrium between attendances and admissions

In figure 1, the blue curve represents the consequences of the CCG's best decisions (given its own objectives and constraints) for any admission proportion - that being the outcome of the hospital's decisions in the face of attendances at its AED. Overall (Nash) equilibrium in this system is given by the intersection of the two best responses. Chalkley et al. (2022b) analyses hospitals best decisions, represented by the red curve in figure 1, showing the variation of the propensity to admit across hospitals.

The detailed derivation of the blue curve and its dependency on payment is set out in (Chalkley et al., 2022a) and the starting point for our empirical investigation is the conclusion that the position of

the blue curve will depend upon the preferences and constraints of a CCG. Hence, the imperative for any policy intervention, such as payment reform, will vary according to the underlying heterogeneity of CCGs. This is captured in Figure 2.

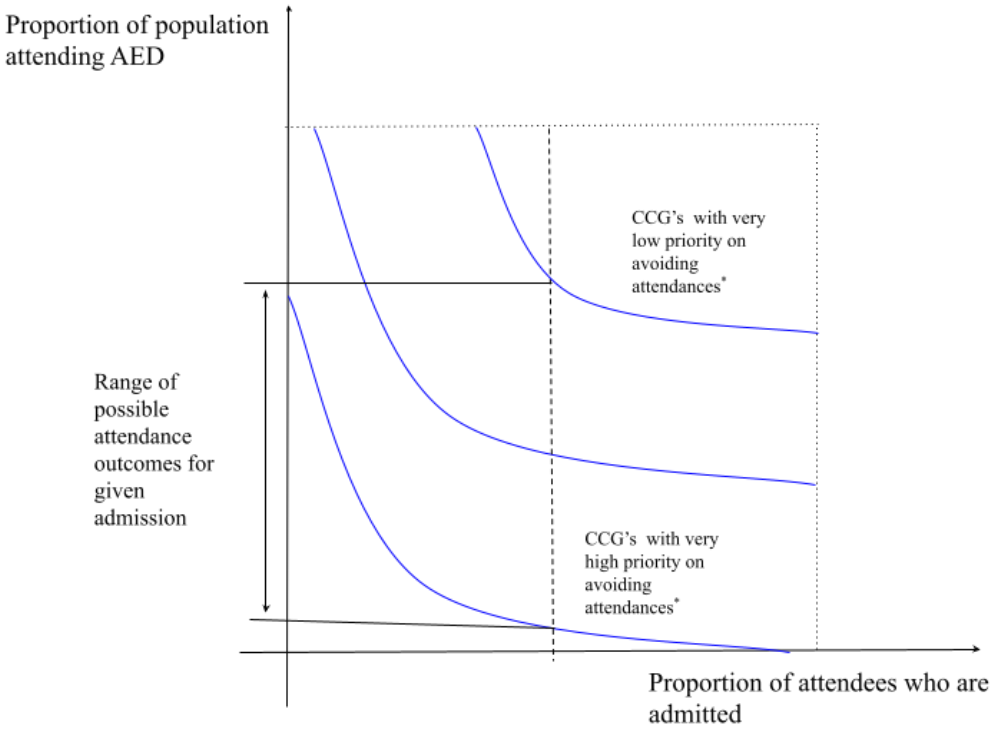

Figure 2: Variation across CCGs

A CCG which places a very low priority on reducing attendances, or has a very high implicit cost of reducing attendances would operate off a blue schedule towards the upper right in the figure, and vice versa for CCG that has a high priority for reducing attendances. This results, for any given degree of admissions, in a range of attendance outcomes shown by the arrowed line in the figure. Our empirical investigation in this paper is intended to assess the extent of this CCG variation.

This is potentially valuable information for the implementation of payment reform since in cases where a CCG lies at the lower end of the range in Figure 2 there may be considered a low risk even if such a reform is likely to increase attendances. As shown in (Chalkley et al., 2022a) a reduction in the price of hospital admissions that is implied by the move towards blended payment is, other things equal, likely to increase attendances. Hence, our analysis is a tool for identifying where this might be a matter of concern due to the priorities of the CCG.

A key underlying assumption in drawing Figure 2 is that the blue schedules are drawn with other things equal. CCGs may have very different populations, with inherently different healthcare needs which will be reflected in their inherent propensity to attend AEDs. They may also have very different resources in terms of alternative healthcare provision with which to influence attendances. Our

empirical strategy as set out below is intended to control for these other factors and therefore to give a sense of the role of CCGs influencing attendances, purged of these other factors.

To operationalise our empirical approach and to account for as many potential exogenous factors as possible we model a CCG as the combination of General Practices (GP practices) that fall within it. The GP practice level analysis allows us to consider more detailed information on the population health need and accessibility to other health care services, capturing the heterogeneity of those factors within CCGs. We empirically model the proportion of patients registered with a GP practice that attend an AED and interpret the CCG fixed effects as the CCGs prioritisation decision on avoiding attendances.

4. Empirical Model

Data

We conducted a retrospective cohort study using routinely collected data. Our main sources of data are the Accident and Emergency (A&E). HES A&E collects data on all attendances to National Health Service (NHS) AEDs and includes basic information such as diagnosis, investigation, treatment, age, sex, area of residence and time and method of arrival and departure (NHS Digital, 2022; Blunt, 2014). Most AEDs in England can be broadly characterised as either 'minor' or 'major' types. Major AEDs are consultant-led 24-hour services with full resuscitation facilities, while minor ones are designed to treat less serious cases. Other AEDs units are either consultant-led mono speciality A&E service, minor injury services or NHS walk-in centres.

We analyse all 2018/19 A&E attendances to 'major' English NHS Trusts AEDs[7] from patients residing in England for which the clinical commissioner was one of 191 Clinical Commission Groups (CCGs). We restrict our analysis to all Type 1 A&E departments since attendances to types 2, 3 and 4 are less likely to be converted into admissions[8].

We model the purchaser (CCG) as a combination of General Practices (GP practices) that fall within it since this will allow us to account for detailed information on population health needs and accessibility to alternative health care services. Therefore, we count the total number of A&E attendances at a type 1 AED from any patient registered at an English GP practice. To adjust for GP practice characteristics, we use data from several sources (in Appendix Table A.1.), on patient list demographics, life expectancy and disease registers, practice workforce, clinical quality, patient satisfaction and extended hours provision. We identify 6,468 English GP practices with information on all the relevant sources and with sensible patient lists and Full Time Equivalent GPs (Table 1). This is consistent with the number of active practices reported by NHS Digital for March 2019 (NHS Digital, 2019).

[7] The provision of 'minor' AED services varies across the country and these services cater to a patient population that is typically not at risk of admission to inpatient care, it is important that is, a population that is not the focus of this analysis.

[8] Type 2 AEDs are for single specialities such as ophthalmology or dentistry and Type 3 and 4 AEDs, are, respectively, minor injury units and NHS walk in centres, which treat minor illnesses and conditions. Type 99 is used for an unknown type of AED unit.

Table 1. Sample selection criteria Model 2: A&E Attendances

Selection criteria	*Observations*
Number of A&E attendances at a Type 1 AED after excluding those who died in the department.	16,001,011
Excluding patients cared for by CCG's or GP practices outside England	15,469,684
Excluding Specialist Trusts (women/children care Trusts)	15,189,516
Number of GP practices codes with at least one Type 1 A&E attendance	9,802
Excluding GP practices with total patients either missing or less than equal to 1000 patients	6,909
Excluding GP practices with FTE GPs equal to 0	6,779
All English GP practices with information on patient list, life expectancy, disease registers, practice workforce, clinical quality, patient satisfaction and extended hours provision.	6,468
Clinical Commissioning Groups	191
Number of A&E attendances at a Type 1 AED	14,781,624

The outcome variable is the GP practice total number of A&E attendances to a type 1 AED by 100 patients registered with the practice.

The total number of patients registered with the practice is measured at the midpoint (September) of the financial year (April to March). We control for practice and patient characteristics which may affect quality and could be correlated with practice list size. We include the proportions of the practice list size in age bands 0–4, 5–14, 15–44, 45–64, 65–74, 75–84, 85 and over and the proportion of female patients.

We also account for patient socioeconomic status, namely deprivation using the Index of Multiple Deprivation (IMD)[9] of patients' Lower Super Output Area (LSOA). The attribution of deprivation from LSOAs to GP practices was done using the proportion of patients registered with a GP practice from each LSOA. We calculated the percentage of patients registered with a GP practice living in each of

[9] The IMD is the official measure of relative deprivation in England following an established framework that encompasses seven areas of deprivation, including income, employment, and health and disability. For the years in which the IMD score was not measured, we interpolated their values based on the closest years for which they were available.

the deprivation quartiles. We used the same attribution strategy to calculate the percentage of patients living in urban areas.[10]

We collect primary care level data for accessibility and quality which allow us to consider for detailed information within the CCGs.

Some patient characteristics and practice quality and accessibility indicators were derived from the General Practice Patient Survey. Practice accessibility is proxied by the proportion of patients that were aware that their practice had extended hours during the week (morning or afternoon) or during Saturdays and the ability to see a GP the next day or the same day. The proportion of patients that are very and fairly satisfied with the practice overall care is a further proxy for practice quality. We also use the proportion of patient by ethnical group (white, mixed, Asian, Black, or unknown ethnicity) and percentage of patients unemployed and regular smokers available from the survey.

We incorporate information on whether the GP practice operates weekday and/or weekend extended hours and if they are in the group of GP practices that operate extended hours. Since in 2018/19 not all GP practices offered extended hours access, we include binary variables to take into account if the practice or the group was offering extended hours - which are in the early morning (6:30 am to 8 am), evenings (6 pm to 8 pm) and/or weekends. This allows us to capture if the patients have greater access to primary care due to the funding that the practices receive from their respective CCGs to function at extended hours.[11]

Given that practice accessibility is conditional on the practice workforce, we also include the practice workforce as the number of full-time equivalent (FTE) GPs, nurses and other direct staff per 1000 patients. We account for the various nature of the contracts for the workforce: whether APMS, PMS, GMS, APMS by Ltd Company, PMS by limited Company and we use the proportion of the GPs that are female, those salaried by practices, by country of qualification (UK, European and non-European) and their age bands (GP's under age 30, 30-34, 35-39, 30-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70 plus and those of unknown age).

General practice clinical quality is measured using the Quality Outcome Framework. Almost all practices take part in the QOF which rewards practices for achievement on a large number of quality indicators. Better achievement increases the number of QOF points and thus increases practice revenue. We use the percentage of clinical points which the practice achieved for each condition group as a measure of clinical quality that is observed by both physicians and patients. We also use

[10] We use the Attribution Data Set (ADS) that has information on the number of patients registered with each GP practice from each LSOA.

[11] Since not all GP practices offered extended hours access - which are pre-bookable appointments in early morning (6:30am to 8am), evenings (6pm to 8pm) and weekends - in 2018/19, we consider if the practice was open when the patient attended the AED, including these extended hours access.

the QOF information on the practice prevalence rate of 16 major conditions which were covered by the QOF over the period 2018-19 (asthma, atrial fibrillation, cancer, cardiovascular disease, chronic kidney disease, COPD, dementia, diabetes, epilepsy, heart failure, hypertension, mental health, peripheral arterial disease, rheumatoid arthritis, secondary prevention of coronary heart disease, stroke and transient ischaemic attack) as proxies for practice list morbidity. The practice prevalence rates are by 100 patients registered with the practice. Additionally, we use the practice average life expectancy at birth for female and male patients.

Furthermore, we calculated the minimum weighted distance from patient's LSOA to the nearest GP practice surgery in distance bands (less than 1 km, 1-2 km and over 2 km)[12], as a measure of geographical access to primary care, and the minimum distance from GP practice to all AEDs as a measure of geographical access to secondary care. Since the provision of 'minor' AED services can affect the number of patients attending 'major' AED services, we include controls for whether the nearest AED provider to the GP practice is a type 1/ 2/ 3/ 4 or type 99, and binary indicators for whether a GP practice is within 10 km radius of a type 1/ 2/ 3/ 4 or type 99 AED.

Modelling Strategy

We estimate linear multivariate regression model of General Practice AED attendances rate:

$$NAE_{gc}/Pop_{gc} = \alpha + L_{gc}\beta_L + Q_{gc}\beta_Q + W_{gc}\beta_W + S_{gc}\beta_s + D_{gc}\beta_D + \nu_c + \varepsilon_{gc} \quad (1)$$

Where NAE_{gc} is the number of Type 1 A&E attendances from GP practice *g* in CCG *c.* Pop_{gc} is the number of patients registered with a GP practice g located in CCG c. Therefore, NAE_{gc}/Pop_{gc} is the AED attendance rate of GP practice g in CCG c. $L_{gc}$is the set of GP practice list characteristics such as proportion of patients by age group, gender, ethnicity, deprivation quintile and rurality/ urbanicity. We also consider the patients' life expectancy, the prevalence rates of 16 major conditions and the percentage of patient unemployed and regular smokers.

Q_{gc} is the set of GP practice quality indicators, such as clinical QOF points per disease group, percentage of patients (fairly or very) satisfied with practice overall provision of care, with ability to book urgent and routine appointments. We also consider the percentage of patients that were aware that their practice had extended hours during the week and/or weekend. S_{gc} is the distance from the GP practice to the nearest 'major' AED, the weighted distance from patients LSOA of residence to the GP practice, the number of surgeries per GP practice. Also, if practice is providing extended hours. We also consider if the GP practice of the group it belongs to provides extended hours access before or after the regular weekly timetable or during the weekend. W_{gc}represents the GP practice

[12] Distances are measured as the straight-line distance between the LSOA geographical centroid and the nearest AED site and GP practice surgery.

workforce characteristics such as the number of FTE per 1000 patients of GPs, nurses and other direct care staff, the practice contract type, the percentage of GPs per gender, age group and by country of qualification and by salaried status.

$D_{gc}$is the set of indicators of the provision of 'minor' AED services near the GP practice, such as if the nearest AED provider to the GP practice is a type 1/ 2/ 3/ 4 or type 99, and whether a GP practice is within 10 km radius of a type 1/ 2/ 3/ 4 or type 99 AED.

The CCG fixed effect denoted by ν_c captures the purchaser specific optimal proportion of individuals that seek care through the hospital emergency department. ε_{gc} is the idiosyncratic error term. $\beta_L, \beta_Q, \beta_W, \beta_S$ and β_D are the vectors of coefficients and measure the impact of the variables in L, Q, W, S and D, respectively, on the GP practice number of attendances per 100 patients.

Equation (1) represents our baseline model. Further, we test the stability of our results by not controlling for GP practice extended access and 'minor' AED accessibility. The later, can be seen as CCG investment indicators on greater accessibility to primary care and 'minor' emergency services in the area. The CCG fixed effect captures the idiosyncratic influence of a CCG on attendance rate. Therefore, provided that our control variables fully account for external influences on the CCG, the estimated CCG fixed effects are a reflection of the factors, such as the priorities placed on reducing attendance. Higher values of fixed effects will shift the curve in Figure 2 to the left-down corner.

5. Results

Descriptive statistics

In Table 2, we report summary statistics on A&E attendances for the analytical sample. The average A&E attendance rate across English GP practices is 26%. The practice list is on average almost 50% of women. Those in the age range of 15-44 constitute the largest share of the patient list (40%), 25% constitute those between 45-64 and 17% comprise of those in the age group of over 65 plus and 12% between 5 and 14 years, while 5% consist of those between 0-4 years of age. Using the patient characteristics from the GPPS, on average, 82% of the practice list are from a white ethnic group, while those of Asian, Black, Mixed and other ethnic backgrounds constitute 10%, 3.8%, 1.5% and 2.2% respectively. Nearly 4% of those on the practice list are unemployed, on average. In terms of smoking behaviours, 58% are non-smokers and 8% smoke regularly, while 26% identify as former smokers and 7% smoke occasionally. The highest average prevalence is for hypertension, 14%, followed by depression and obesity, with 10.5% and 10.6% of patients, in average. Patients' average life expectancy is 81 years and on average practices have over 8000 patients registered with them. Most of the practice list patients reside in urban areas and, on average, a practice has 28% of their patients living in the most deprived quartile.

Table 2: Summary statistics GP practice patient characteristics

Variable	*Mean*	*Std. dev.*	*Min*	*Max*
AED attendances:				
AED attendances (number)	2203.75	1449.59	36	21211
AED attendance rate (%)	25.75	8.18	1.47	142.81
Patient list demographics:				
Practice List size 2018 (1000 patients)	8.78	5.44	1.03	73.37
Aged 0-4 (%)	5.52	1.44	0	16.49
Aged 5-14 (%)	11.88	2.56	0	29.80
Aged 15-44 (%)	39.19	9.17	15.76	97.06
Aged 45-64	25.92	4.13	1.35	40.64
Aged 65 plus	17.49	6.81	0.19	49.41
Female patients (%)	49.85	2.14	16.75	56.73
Ethnicity:				
White (%)	82.45	22.45	0	100.00
Mixed (%)	1.48	2.04	0	17.75
Asian (%)	9.99	16.55	0	98.92
Black (%)	3.79	7.04	0	64.09
Other ethnic groups (%)	2.20	3.84	0	65.58
Employment status:				
Unemployed	4.30	4.12	0	51.17
Smoking status:				

Never smoker (%)	58.55	8.64	5.57	92.89
Former smoker (%)	26.51	7.33	0	51.15
Occasional smoker (%)	6.95	3.72	0	31.57
Regular smoker (%)	7.99	4.65	0	68.86
QOF - GP practice disease prevalence (% of practice list)				
Atrial fibrillation	1.96	0.87	0.01	5.71
Asthma	6.07	1.33	0.80	14.87
Cancer	2.96	1.12	0.10	8.06
Coronary heart disease	3.16	1.08	0.03	8.07
Chronic kidney disease (18+)	4.13	2.02	0.03	15.05
Chronic obstructive pulmonary disease	1.99	0.93	0.01	7.00
Cardiovascular disease- primary prevention (30-74)	1.14	0.53	0	9.30
Dementia	0.77	0.44	0.01	8.92
Depression	10.65	4.10	0.66	41.79
Diabetes mellitus (17+)	7.27	2.08	0.43	18.97
Epilepsy (18+)	0.80	0.26	0.04	2.86
Heart failure	0.93	0.45	0.01	4.18
Hypertension	14.28	3.65	0.44	29.41
Learning disability	0.51	0.28	0.01	4.13
Mental health	0.98	0.44	0.16	14.70
Obesity	10.49	3.89	0.56	30.79
Osteoporosis	0.69	0.67	0	4.25
Peripheral arterial disease	0.61	0.30	0.01	2.63
Palliative care	0.41	0.41	0	9.38
Rheumatoid arthritis (16+)	0.78	0.26	0.02	2.54
Stroke and transient ischaemic attack	1.78	0.68	0.03	5.56
Life expectancy:				
Life expectancy at birth for GP practice patient list (years)	81.28	2.07	73.74	89.19
Deprivation[2]:				
Percentage of practice patients living in least deprived quartile of LSOAs	21.70	24.29	0	99.21
Percentage of practice patients living in second least deprived quartile of LSOAs	24.07	18.17	0	99.46
Percentage of practice patients living in second most deprived quartile of LSOAs	25.84	18.60	0	100
Percentage of practice patients living in most deprived quartile of LSOAs	28.39	28.80	0	99.615
Urbanicity:				

Percentage of practice patients living in urban areas	82.51	32.47	0	100

[1] There are three GP practices with more AED attendances than patients. This is due to their small patient list (less than 1500 patients) and likely frequent attenders among their patient, i.e., patients who have 5 or more AED attendances in a year.

[2] Deprivation is measured at LSOA level and attributed to GP practices as a percentage of patient list. Therefore, the average percentage of practice patients living in each deprivation quartile of LSOAs is different from the expected 25%.

Table 3 reports the summary statistics of other GP practice characteristics. On average GP practices achieve 96% of the total QOF clinical score, with highest achievement (99.7%) for Atrial fibrillation QOF clinical score and the lowest for Diabetes mellitus (92.3%). Practices are usually within a small distance from their patients, with 61% of GP practices having most of their patients living within 1 to 2 kms. Over 80% of patients report being satisfied with the care received at their practice, almost half of them are satisfied with the ability to see their preferred practitioners and over 30% with the ability to see their GP on the same day. Regarding extended hours, 30% of GP practices provide weekday morning extended hours while 56% provide evening extended hours and 26% provide weekend extended hours. Roughly 65% and 66% of practices are within the group of GP practices that provide weekday evening and weekend extended access and only 7% are within the group that provides early morning extended access. GP Practices workforce is centred on GPs, with on average 0.46 full-time equivalent (FTE) GPs, 0.26 FTE nurses and 0.18 FTE direct staff per 1000 patients. Over 70% of the contracts are GMS, while 27% are from PMS. Just over half of GPs are females and over 70% have a qualification within the UK. In terms of age, 19% of GPs are between 40-44 years, 18% between 45-49 and 17% between 50-54 and a lower percentage of 16% between 35-39 and 11% between 30-34 years of age. The geographical accessibility to AEDs, proxied by the distance from GP practice to AEDs, is quite good. Nearly 77% of GP practices are within 10km of a type 1 A&E, while almost 17% and 6% of practices are within 10-20 km and over 20 km from the A&E, respectively. Regarding other AED types, more than 39% are nearest to a type 3 and 5% are nearest to a type 2. Over 34% of GP practices are within a 10km radius of a type 2 AED and 64% are within a 10km radius of a type 3 AED.

Table 3: Summary statistics of GP practices characteristics (N= 6,468)

Variable	*Mean*	*Std. dev.*	*Min*	*Max*
QOF Clinical Scores: (in %)				
Atrial fibrillation	99.711	3.032	58.621	100
Asthma	98.591	6.456	33.156	100
Cancer	97.865	8.415	45.455	100
Coronary heart disease	96.523	6.771	23.171	100
Chronic obstructive pulmonary disease	97.15	8.02	22.86	100
Dementia	98.10	9.24	10	100
Depression	94.31	20.26	0	100
Diabetes mellitus(17+)	92.37	9.69	18.30	100
Heart failure	98.83	5.07	13.79	100
Hypertension	98.03	5.81	32.12	100
Learning disability	100	0	100	100
Mental health	94.81	10.27	21.23	100
Osteoporosis	95.34	12.78	33.33	100
Peripheral arterial disease	97.92	5.06	33.33	100
Palliative care	99.20	6.42	0	100
Rheumatoid arthritis (16+)	96.92	13.02	16.67	100
Stroke and transient ischaemic attack	97.85	4.98	22.93	100
Total Clinical QOF points	96.63	5.51	36.84	100
Accessibility to primary care:				
The average distance from patient LSOA to GP practices:				
Distance to GP practice of less than 1 km	0.16	0.37	0	1
Distance to GP practice between 1 and 2 kms	0.61	0.49	0	1
Distance to GP practice of more than 2 kms	0.23	0.42	0	1
Number of surgeries within GP practice	2.18	1.13	1	14
Patient awareness and satisfaction from GPPS:				
Patients aware that GP practice has extended AM hours	9.87	9.34	0	63.849
Patients aware that GP practice has extended PM hours	12.46	8.65	0	61.775
Patients aware that GP practice has Sat extended hours	8.42	9.61	0	72.304
Patients able to see preferred GP practice (always or a lot)	49.65	17.85	0	99.053
Patients able to see GP practice the same day	32.30	13.85	1.56	87.320
Patients able to see GP practice the next day	11.92	6.42	0	59.005
Patients very or fairly satisfied with GP practice care	84.29	9.55	37.26	100

Extended access information:				
GP practice provides Weekday AM extended hours	0.30	0.46	0	1
GP practice provides Weekday PM extended hours	0.56	0.50	0	1
GP practice provides Weekend extended hours	0.26	0.44	0	1
Group of GP practices: weekday AM extended hours	0.07	0.25	0	1
Group of GP practices: weekday PM extended hours	0.65	0.48	0	1
Group of GP practices: weekend extended hours	0.66	0.47	0	1
GP practice contract:				
APMS	0.02	0.13	0	1
PMS	0.27	0.44	0	1
GMS	0.71	0.45	0	1
PMS by Ltd Company	0.00	0.04	0	1
APMS by Ltd Company	0.01	0.08	0	1
Primary Care workforce:				
FTE GPs per 1000 patients	0.46	0.18	0.01	3.131
FTE nurses per 1000 patients	0.26	0.15	0	2.233
FTE other direct per 1000 patients	0.18	0.21	0	2.321
Proportion of female GPs	51.34	25.73	0	100
Proportion of GPs salaried	1.87	2.13	0	31
Proportion of GPs with UK qualification	64.80	30.81	0	100
Proportion of GPs with European (non-UK) qualification	4.26	11.36	0	100
Proportion of GPs with Non-European qualification	33.13	32.59	0	100
GPs per age band (%):				
GPs under 30 years old	0.98	4.69	0	100
GPs aged 30-34	10.95	15.38	0	100
GPs aged 35-39	16.62	19.22	0	100
GPs aged 40-44	19.22	21.32	0	100
GPs aged 45-49	17.94	21.60	0	100
GPs aged 50-54	17.40	21.16	0	100
GPs aged 55-59	15.93	21.21	0	100
GPs aged 60-64	7.74	16.67	0	100
GPs aged 65-69	4.58	15.18	0	100
GPs aged 70 plus	4.30	16.25	0	100
GPs of unknown age	0.61	6.19	0	100
Accessibility to AED:				
GP practice less than 10 km from A&E type 1	0.77	0.42	0	1
GP practice between 10 and 20 km from A&E type 1	0.17	0.38	0	1
GP practice more than 20 km from A&E type 1	0.06	0.24	0	1

Nearest AED type 1 provider to GP practice	0.50	0.50	0	1
Nearest AED type 2 provider to GP practice	0.05	0.22	0	1
Nearest AED type 3 provider to GP practice	0.39	0.49	0	1
Nearest AED type 4 provider to GP practice	0.06	0.23	0	1
Nearest AED type 99 provider to GP practice	0.01	0.08	0	1
GP practice is within a 10km radius of a type1 AED	0.76	0.43	0	1
GP practice is within a 10km radius of a type2 AED	0.34	0.47	0	1
GP practice is within a 10km radius of a type3 AED	0.64	0.48	0	1
GP practice is within a 10km radius of a type4 AED	0.24	0.43	0	1
GP practice is within a 10km radius of a type99 AED	0.05	0.22	0	1

Figure 3 shows the skewed distribution of A&E attendance rates by GP practices with the average attendance rate being 25.8% and a right-hand tail of rates over 50%.

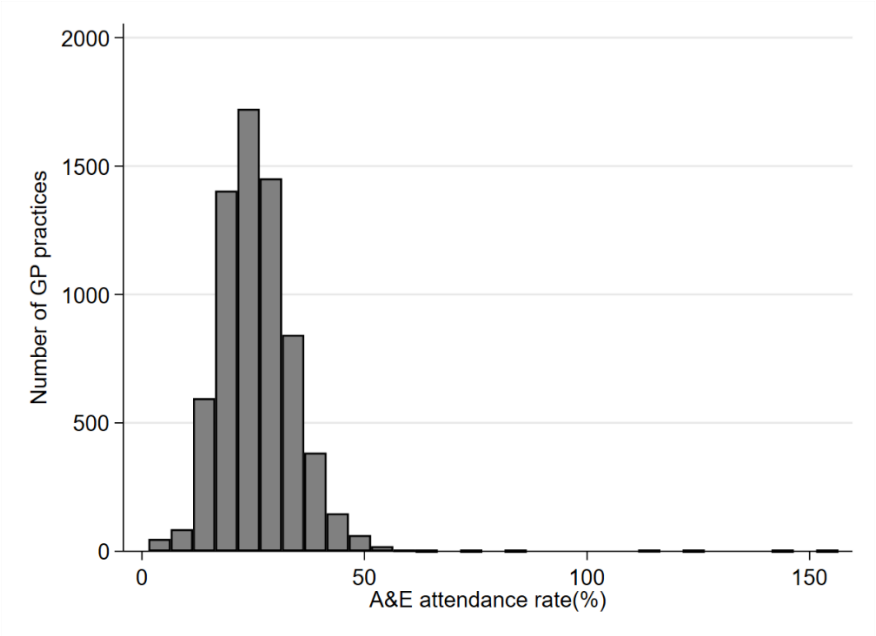

Figure 3: AED attendance rate by GP practices

The distribution of CCG level AED attendance rates is roughly similar to the distribution across general practice, as shown in Figure 4, which suggests that CCGs tend to contain practices with roughly similar attendance rates.

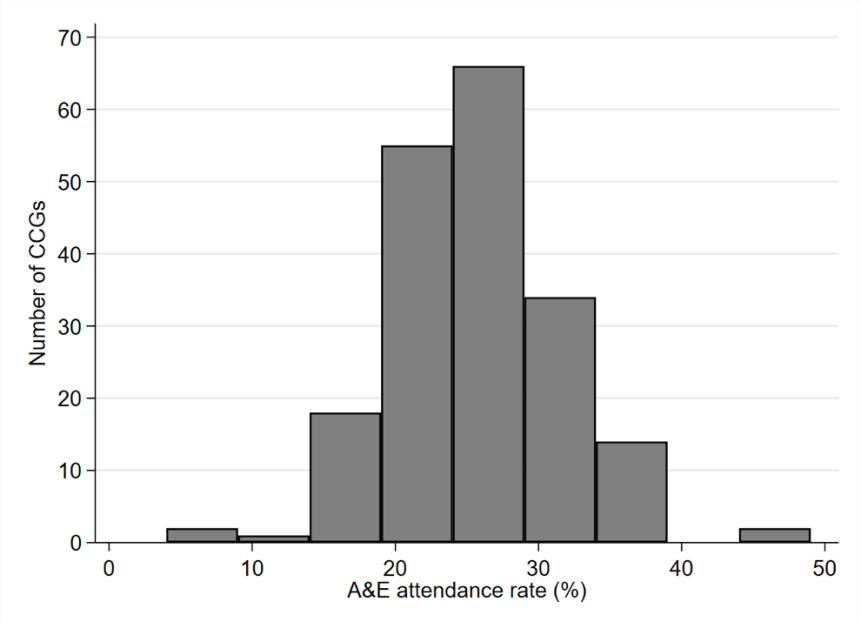

Figure 4: AED attendance rate by CCGs

The spatial pattern of GP practice AED attendance rates is illustrated in Figure 5. There is a three-fold variation across practices with higher AED attendance rates in areas nearest to the AEDs.

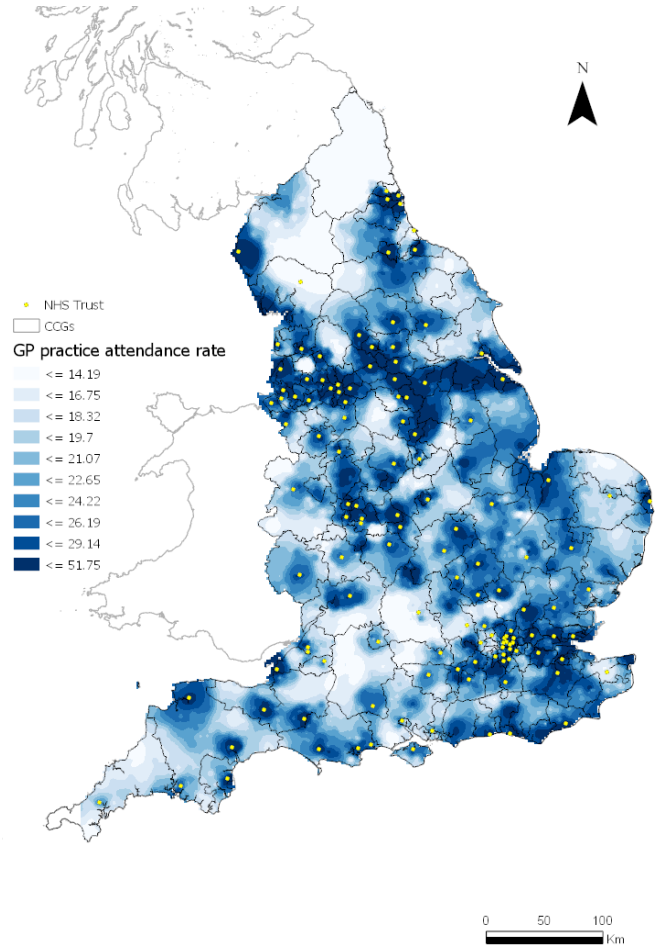

Figure 5: Spatial pattern of GP practices' AED attendances rates

Regression Results

Regression estimates are reported in Table 4. Column (1) presents estimates for the main equation (1) set out above, while columns (2) and (3) models exclude GP extended hours and accessibility to other AEDs. Our estimates are consistent across the three specifications.

We find that practices with a higher percentage of children between the ages of 0-4 years and adults between the ages of 45-64 years have higher AED attendance rate, compared to practices with a higher percentage of patients in the age group of 15-44 years. An increase of one percent on patients between the ages of 0-4 years will increase the practice attendance rate by 0.6%. In terms of ethnicity, practices with higher percentage of patients from mixed, Asian or other ethnic groups have lower AED attendances. Practices with a higher percentage of unemployed individuals and those who are regular smokers have higher AED attendances. Similarly practices with a higher percentage of patients living in the lowest (most deprived) income quartile have higher AED attendance rate, compared to practices where patients reside in affluent areas. In terms of patient satisfaction,

practices with higher levels of satisfaction regarding the ability of patients to see their GP the next day and levels of satisfaction with GP care have smaller AED attendances rates.

In terms of the workforce, an increase in the proportion of female GP doctors leads to a significant reduction in the practice AED attendances rate. Practices with the APMS or and the APMS by Limited Company contract have a higher AED attendance rate. We did not find any significant effects with respect to the GP's age.

We also find some significant effects in terms of the disease prevalence from the GP practice lists. Practices with a higher prevalence of coronary heart disease, chronic obstructive pulmonary disease, dementia, epilepsy, mental health problems and rheumatoid arthritis have a higher AED attendance rate. On the other hand, practices with a higher prevalence of heart failure, learning disability and palliative care have smaller AED attendance rates. With respect to the QOF scores on the clinical domain, lower AED attendance rates are associated with better scores for asthma, diabetes, coronary heart disease and heart failure, while better scores for hypertension are associated with an increase in AED attendances rate. Practices which patients have a higher average life expectancy at birth have lower AED attendance rates.

Better primary care accessibility is overall associated with lower AED attendance rates. Practices futher away from their patients, more than 1km, have higher AED attendance rates, while the practices that provide weekday morning extended hours, have patients satisfied with their ability to see GP the next day and satisfied with GP care have lower AED attendances rate.

We also observe significantly less attendances for patients whose GP practice is within a 10 km radius of another AED, with the exception of type 4 (Walk-in Centre). We also observe a reduction in type 1 AED attendance rates if the patients are registered at a GP practice that is nearest to another AED provider.

To test the robustness of our results, we also report estimates in column (2) where we do not control for the GP providing extended hours in their respective CCGs. Furthermore, in column (3) we present estimates where we also exclude (along with GP extended hours) binary controls the availability of other AEDs near to the GP practice. In both cases, we do not observe any major differences in the reported estimates. Accounting for these factors which combine a patient's characteristics as well as GP factors, the models explain over 50% of the variation in attendance, which implies that the remaining variation can be attributed to the differences between CCGs.

Table 4. Regression results on AED attendance rate models

Variables	Baseline model (1)	Without GP practice extended access (2)	Without other emergency services availability (3)
GP practice patient list characteristics:			
% Aged 0-4 (Ref: Age 15-44)	0.619***	0.617***	0.637***
	(8.32)	(8.30)	(8.45)
Aged 5-14 (Ref: Age 15-44)	-0.0703	-0.0714	-0.0616
	(-1.65)	(-1.68)	(-1.43)
Aged 45-64 (Ref: Age 15-44)	0.0960***	0.0954***	0.0853**
	(3.66)	(3.63)	(3.20)
Aged 65 plus (Ref: Age 15-44)	-0.0768	-0.0755	-0.0624
	(-1.94)	(-1.91)	(-1.55)
% Female patients	-0.0465	-0.0449	-0.0517
	(-1.20)	(-1.16)	(-1.31)
% Mixed ethnicity (Ref: White ethnicity)	-0.0749*	-0.0757*	-0.0798*
	(-2.40)	(-2.42)	(-2.52)
% Asian ethnicity (Ref: White ethnicity)	-0.0225**	-0.0224**	-0.0191*
	(-2.66)	(-2.65)	(-2.22)
% Black ethnicity (Ref: White ethnicity)	0.0243	0.0244	0.0260
	(1.82)	(1.83)	(1.93)
% Other ethnic groups (Ref: White ethnicity)	-0.0572**	-0.0559**	-0.0658***
	(-2.91)	(-2.85)	(-3.30)
% of Unemployed	0.112***	0.112***	0.114***
	(6.15)	(6.16)	(6.13)
% Regular smoker	0.119***	0.119***	0.121***
	(8.01)	(8.02)	(8.08)
Patients living in second least deprived quartile of LSOAs	0.00841	0.00856	0.00730
	(1.80)	(1.83)	(1.54)
Patients living in second most deprived quartile of LSOAs	0.00525	0.00559	0.00504
	(1.12)	(1.19)	(1.06)
Patients living in most deprived quartile of LSOAs	0.0357***	0.0362***	0.0316***
	(5.60)	(5.69)	(4.90)
Patients living in urban areas	0.00351	0.00364	0.000644
	(1.23)	(1.28)	(0.22)
Weighted average life expectancy at birth	-0.353***	-0.348***	-0.362***
	(-5.23)	(-5.17)	(-5.31)

List size 2018	-0.0655***	-0.0696***	-0.0677***
	(-4.52)	(-4.84)	(-4.63)
Accessibility of primary care:			
Average distance to GP between 1 and 2 kms	0.500**	0.500**	0.529**
	(2.84)	(2.84)	(2.96)
Average distance to GP of more than 2 kms	-0.176	-0.183	-0.129
	(-0.71)	(-0.74)	(-0.51)
Number of GP practice surgeries	-0.0199	-0.0185	-0.0451
	(-0.37)	(-0.35)	(-0.83)
Patients aware that GP has extended AM hours	0.0175*	0.00828	0.00797
	(2.28)	(1.37)	(1.30)
Patients aware that GP has extended PM hours	-0.0134	-0.0128	-0.0127
	(-1.68)	(-1.85)	(-1.80)
Patients aware that GP has Sat extended hours	0.00914	0.00701	0.00530
	(1.21)	(1.13)	(0.84)
Patients able to see GP the same day	-0.00415	-0.00424	-0.00418
	(-0.98)	(-1.00)	(-0.97)
Patients able to see GP the next day	-0.0240**	-0.0241**	-0.0278**
	(-2.62)	(-2.63)	(-2.99)
Patients very or fairly satisfied with GP care	-0.0681***	-0.0674***	-0.0657***
	(-9.59)	(-9.51)	(-9.14)
GP practice provides Weekday AM extended hours	-0.326*		
	(-2.08)		
GP practice provides Weekday PM extended hours	-0.0443		
	(-0.33)		
GP practice provides Weekend extended hours	-0.138		
	(-0.85)		
Group of GP practices: weekday AM extended hours	-0.116		
	(-0.48)		
Group of GP practices: weekday PM extended hours	0.0731		
	(0.27)		
Group of GP practices: weekend extended hours	0.146		
	(0.52)		
Accessibility to AED:			
GP practices within 10 to 20km of AED type 1	-3.761***	-3.738***	-3.444***
	(-18.74)	(-18.65)	(-18.14)
GP practices more than 20km of AED type 1	-4.802***	-4.795***	-4.499***
	(-15.50)	(-15.49)	(-14.88)

Nearest AED provider to GP practice is a type 2	-1.789***	-1.789***	
	(-6.51)	(-6.51)	
Nearest AED provider to GP practice is a type 3	-1.051***	-1.046***	
	(-7.41)	(-7.38)	
Nearest AED provider to GP practice is a type 4	-0.596*	-0.580	
	(-2.00)	(-1.95)	
Nearest AED provider to GP practice is a type 99	-0.655	-0.665	
	(-0.89)	(-0.91)	
GP practice is within a 10km radius of a type2 AED	-0.430	-0.436	
	(-1.82)	(-1.85)	
GP practice is within a 10km radius of a type3 AED	-1.253***	-1.235***	
	(-6.81)	(-6.72)	
GP practice is within a 10km radius of a type4 AED	1.140***	1.148***	
	(4.29)	(4.33)	
GP practice is within a 10km radius of a type99 AED	-2.033***	-2.049***	
	(-4.56)	(-4.60)	
Primary care workforce:			
FTE GPs per 1000 patients	0.784*	0.795*	0.810*
	(2.26)	(2.30)	(2.31)
FTE nurses per 1000 patients	0.396	0.403	0.307
	(0.90)	(0.91)	(0.69)
FTE other direct per 1000 patients	0.656*	0.664*	0.579
	(2.00)	(2.03)	(1.74)
Proportion of female GPs	-0.00637**	-0.00634**	-0.00607*
	(-2.73)	(-2.72)	(-2.57)
Proportion of GPs salaried	0.0518	0.0490	0.0433
	(1.48)	(1.40)	(1.21)
Proportion of GPs with European qualification (non-UK)	-0.00684	-0.00686	-0.00718
	(-1.40)	(-1.41)	(-1.45)
Proportion of GPs with Non-European qualification	0.00617**	0.00597**	0.00667**
	(3.01)	(2.92)	(3.22)
GPs under age 30	0.0200	0.0201	0.0198
	(1.75)	(1.75)	(1.70)
GPs aged 30-34	0.000343	0.000369	-0.000434
	(0.09)	(0.10)	(-0.11)
GPs aged 35-39	0.00381	0.00391	0.00406
	(1.22)	(1.26)	(1.29)
GPs aged 40-44	0.00303	0.00312	0.00366

	(1.04)	(1.08)	(1.25)
GPs aged 50-54	0.00253	0.00268	0.00343
	(0.86)	(0.92)	(1.16)
GPs aged 55-59	-0.00285	-0.00275	-0.00253
	(-1.00)	(-0.97)	(-0.88)
GPs aged 60-64	-0.00361	-0.00338	-0.00279
	(-1.04)	(-0.97)	(-0.79)
GPs aged 65-69	0.00259	0.00266	0.00331
	(0.67)	(0.69)	(0.84)
GPs aged 70 plus	0.000156	0.000456	-0.000824
	(0.04)	(0.11)	(-0.20)
GPs of unknown age	-0.00459		
	(-0.51)		
GP practice contracts:			
Contract: APMS (Ref: GMS)	1.837***	1.854***	1.950***
	(4.12)	(4.16)	(4.31)
Contract: PMS (Ref: GMS)	0.0745	0.0728	0.0712
	(0.49)	(0.48)	(0.46)
Contract: PMSbyLtdCo (Ref: GMS)	2.471	2.437	2.310
	(1.62)	(1.60)	(1.50)
Contract: APMSbyLtdCo (Ref: GMS)	2.000**	1.921**	2.238**
	(2.79)	(2.69)	(3.09)
GP practice disease prevalence			
Atrial fibrillation	0.470	0.461	0.482
	(1.93)	(1.89)	(1.95)
Asthma	0.105	0.105	0.0888
	(1.55)	(1.54)	(1.29)
Cancer	-0.211	-0.210	-0.201
	(-1.52)	(-1.51)	(-1.42)
Coronary heart disease	0.735***	0.724***	0.754***
	(4.34)	(4.28)	(4.39)
Chronic kidney disease (18+)	-0.0383	-0.0364	-0.0537
	(-0.85)	(-0.81)	(-1.18)
Chronic obstructive pulmonary disease	0.616***	0.613***	0.602***
	(4.63)	(4.62)	(4.46)
Cardio vascular disease- primary prevention (30-74)	0.161	0.166	0.206
	(1.44)	(1.49)	(1.82)
Dementia	0.444*	0.443*	0.414*

	(2.31)	(2.31)	(2.12)
Depression	0.0271	0.0272	0.0365
	(1.39)	(1.40)	(1.85)
Diabetes mellitus(17+)	0.0965	0.0987	0.106
	(1.37)	(1.40)	(1.49)
Epilepsy (18+)	2.649***	2.636***	2.813***
	(7.47)	(7.44)	(7.82)
Heart failure	-0.649**	-0.634**	-0.639**
	(-2.87)	(-2.81)	(-2.79)
Hypertension	-0.0654	-0.0678	-0.0879*
	(-1.50)	(-1.56)	(-1.99)
Learning disability	-0.531*	-0.527*	-0.591*
	(-2.09)	(-2.08)	(-2.30)
Mental health	3.764***	3.767***	3.747***
	(21.40)	(21.43)	(21.01)
Obesity	-0.00696	-0.00614	-0.00620
	(-0.32)	(-0.29)	(-0.28)
Osteoporosis	-0.0181	-0.0230	-0.00710
	(-0.18)	(-0.23)	(-0.07)
Peripheral arterial disease	-0.0508	-0.0626	-0.0588
	(-0.15)	(-0.18)	(-0.17)
Palliative care	-0.337*	-0.344*	-0.370*
	(-2.07)	(-2.11)	(-2.24)
Rheumatoid arthritis (16+)	0.769*	0.776*	0.965**
	(2.43)	(2.45)	(3.01)
Stroke and transient ischaemic attack	0.0862	0.0829	0.105
	(0.35)	(0.34)	(0.42)
GP practice quality:			
Atrial fibrillation	0.0288	0.0295	0.0248
	(1.31)	(1.34)	(1.11)
Asthma	-0.0256*	-0.0251*	-0.0242
	(-2.06)	(-2.02)	(-1.92)
Cancer	0.00219	0.00209	0.00173
	(0.25)	(0.24)	(0.20)
Coronary heart disease	-0.0377*	-0.0381*	-0.0321*
	(-2.40)	(-2.43)	(-2.02)
Chronic obstructive pulmonary disease	0.00861	0.00827	0.00732
	(0.81)	(0.78)	(0.68)
Dementia	-0.00412	-0.00398	-0.00582

	(-0.48)	(-0.46)	(-0.66)
Depression	-0.000641	-0.000634	0.000252
	(-0.16)	(-0.16)	(0.06)
Diabetes mellitus (17+)	-0.0197*	-0.0198*	-0.0213*
	(-2.33)	(-2.35)	(-2.49)
Heart failure	-0.0521***	-0.0524***	-0.0508***
	(-3.94)	(-3.96)	(-3.78)
Hypertension	0.0300*	0.0297*	0.0306*
	(2.27)	(2.25)	(2.28)
Mental health	0.0117	0.0110	0.0120
	(1.47)	(1.39)	(1.48)
Peripheral arterial disease	0.0131	0.0134	0.0150
	(0.93)	(0.95)	(1.05)
Palliative care	0.00142	0.00114	-0.00103
	(0.17)	(0.13)	(-0.12)
Rheumatoid arthritis (16+)	0.00468	0.00461	0.00220
	(0.68)	(0.67)	(0.32)
Stroke and transient ischaemic attack	0.00624	0.00709	-0.00119
	(0.34)	(0.38)	(-0.06)
Constant	51.09***	50.70***	51.73***
	(8.24)	(8.18)	(8.23)
Observations	6277	6277	6277
R-squared	0.52	0.519	0.503
Number of CCGs	191	191	191

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Our main focus is on the degree of variation between CCGs after controlling for the observed differences in the population healthcare needs and accessibility factors. In summary terms, the explained variation is almost the same for the models with and without the GP extended hours (R^2= 52%). The CCG fixed effects indicate a large variation in attendance rates after other factors have been accounted for. The variation across CCG fixed effects, which we interpret as variation across the priority of CCGs on avoiding attendances, is shown in Figure 6. The observed wide variation is also observed for the unadjusted AED attendances rates in Figure A.1. In the alternative model shown in columns (2) and (3) of Table 4, where we exclude GP extended hours and location indicators for accessibility for type 2, 3, 4, 5 and 99, we observe that the explained variation decreases slightly. The resulting variation across CCGs are quite similar has shown in Figures 7 and 8.

The CCGs in the right-hand side of Figure 6 place low priority on avoiding AED attendances, which are represented by the curves more on the left down hand side of Figure 2. On the other hand, the CCGs in the left-hand side of Figure 6 place high priority on avoiding AED attendances, which are in turn represented by the curves in the upper right side of Figure 2.

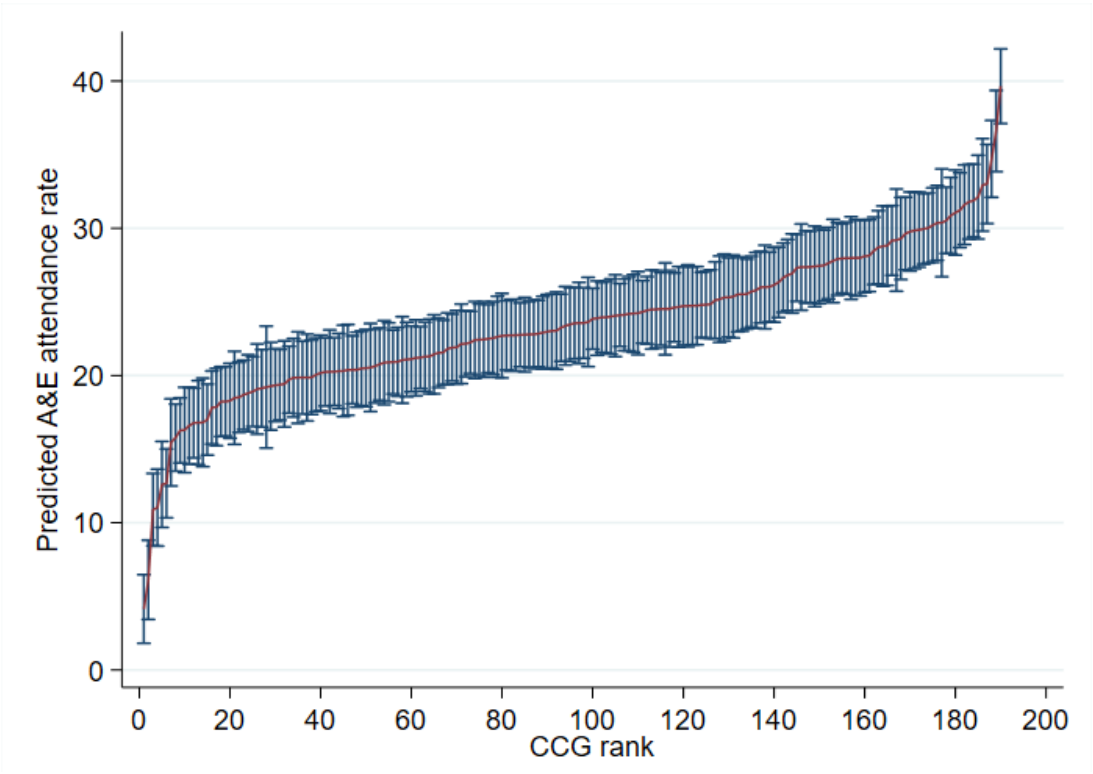

Figure 6: Differences in AED attendance rates between Clinical Commissioning Groups (CCGs) (Baseline model- 1)

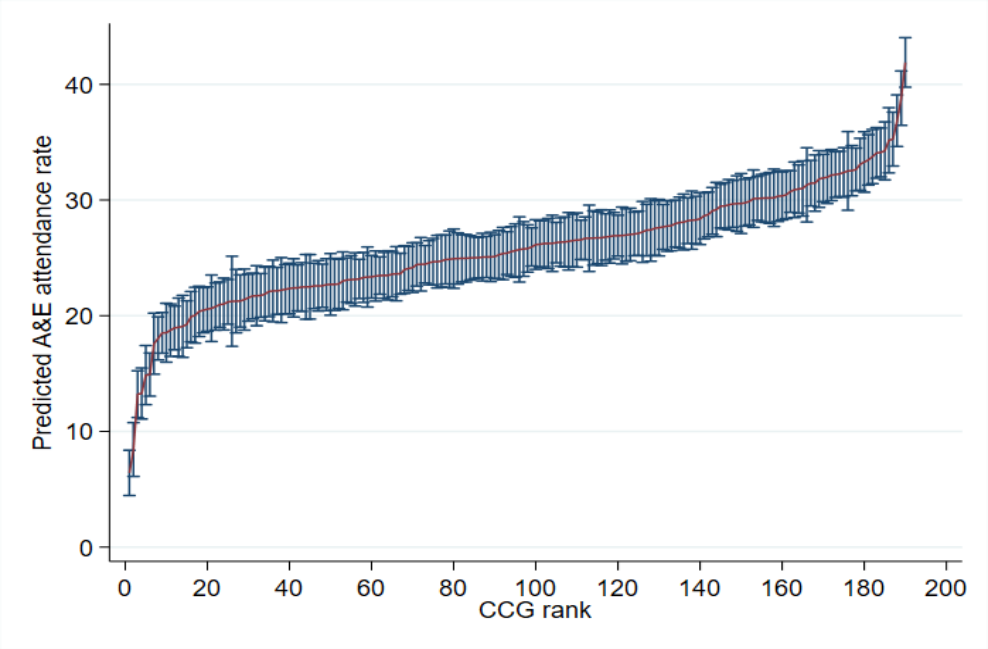

Figure 7: Differences in AED attendance rates between Clinical Commissioning Groups (CCGs) (Without GP practice extended access- 2)

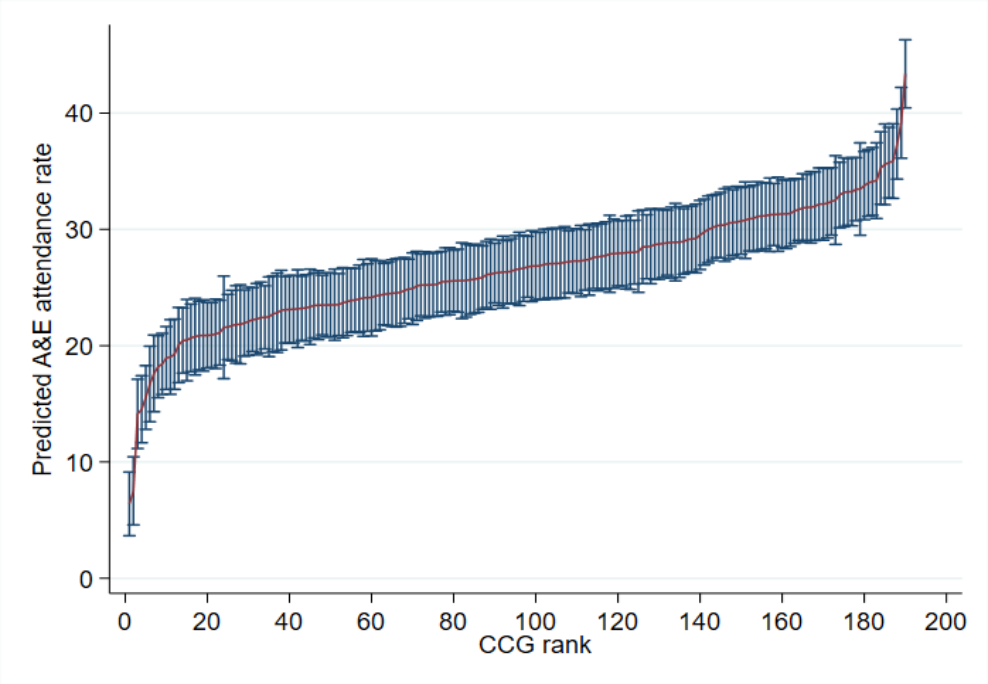

Figure 8: Differences in AED attendance rates between Clinical Commissioning Groups (CCGs) (Without other emergency services availability - 3)

We map the observed and predicted CCG attendance rates in Figure 9a and 9b, respectively, to inspect the spatial pattern. In both figures the highest AED attendance rate is represented in dark blue and the intervals set as standard deviations from the mean. Before adjusting for local characteristics, CCGs in the central area of England, between Liverpool and Hull, presented the highest rates of AED attendances. After adjusting for the local characteristics, CCGs in the South East show one of the higher adjusted rates.

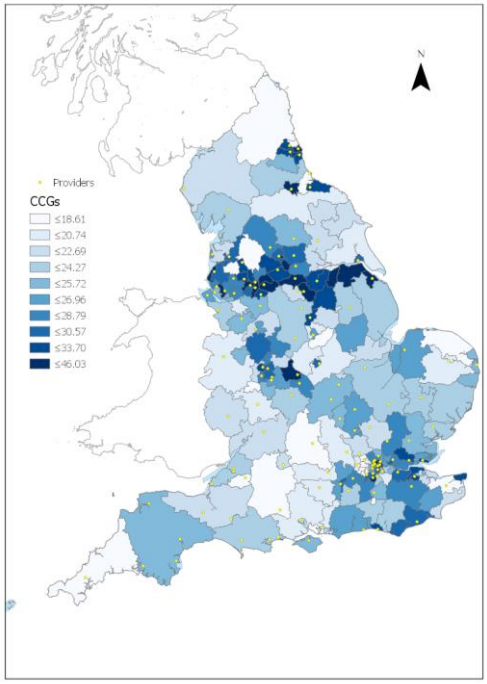

Figure 9a: Spatial pattern of Clinical Commissioning Groups (CCGs) AED attendances rate

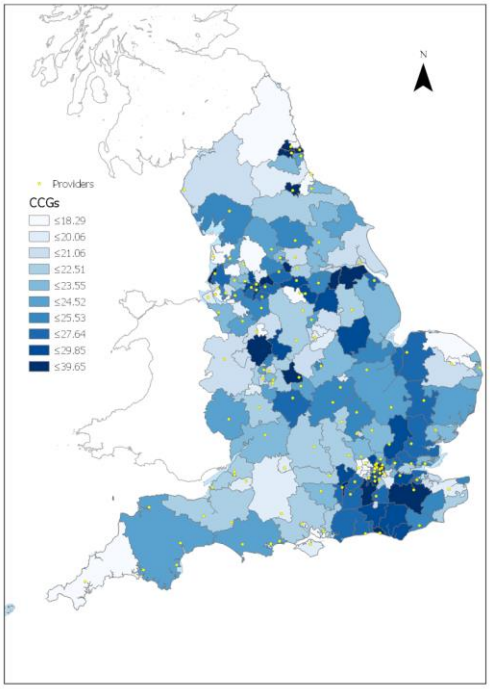

Figure 9b: Spatial pattern of Clinical Commissioning Groups (CCGs) AED adjusted attendances rate

Results in relation to the conceptual framework

The regression analysis permits us to consider the AED attendance rate of each CCG's other things equal and hence in terms of Figure 2 we are able to determine displacements in the blue schedule across CCGs. Figure 10 shows we expect hospitals and purchasers to interplay in the emergency care system when we combine the analysis of variation in CCGs AED attendance rates with the one undertaken in Chalkley et al. (2022b) examining the variation in the propensity to admit across hospitals.

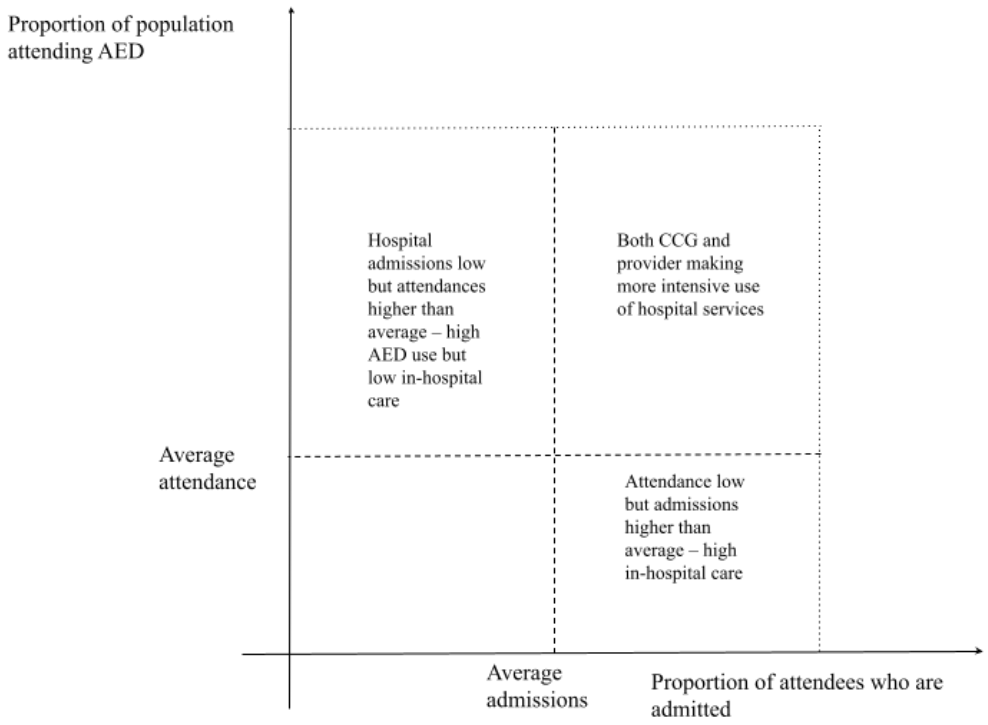

Figure 10: The interplay between purchasers and hospitals (CCGs and NHS Trusts) in the emergency care system

For most locations in England there are multiple hospitals providing services for CCGs but in a substantial number of cases a single hospital provides the great majority of care. We restrict attention to those instances where a single hospital accounts for more that 85% of the emergency admissions for a given CCG and a single CCG is responsible for more than 50% of the hospital attendances. For these, we plot the combination of the CCG's adjusted attendance rate and the associated hospital's adjusted admission rate from Chalkley et al. (2022b) in Figure 11.

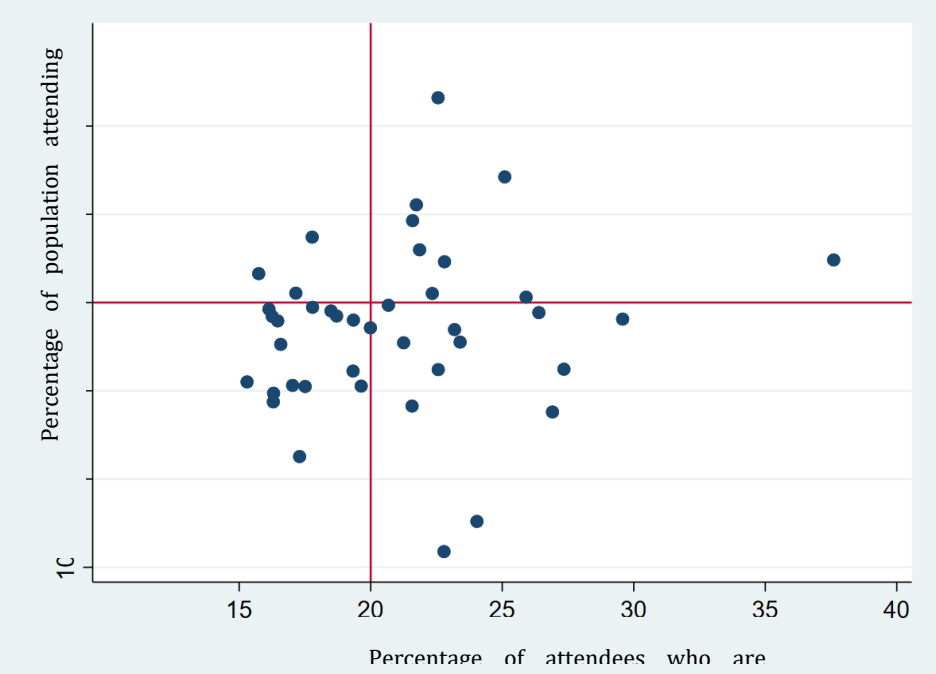

Figure 11: Scatter plot of hospital-CCG pairs of attendance and admission rates

Each point in the figure can be interpreted as a reflection of the performance of a local emergency healthcare system in terms of the two dimensions – attendance and admission rates. The x-axis denotes the adjusted provider fixed effects (from the analysis in Chalkley et al 2022b) and the y-axis denotes adjusted CCG fixed effects from our current analysis. Systems represented by points close to the origin make use of fewer hospital resources for emergency care than those towards the top right in the figure. Points towards the top of the figure correspond to CCGs that have high attendance rates at AED after having accounted for the characteristics of their populations and the characteristics of GPs providing services, i.e., have a low priority on avoiding AED attendances.

The figure can be combined with the theoretical model set out in Chalkley et al. (2022a) to consider the likely impact of the adoption of blended payment and where that system may give rise to either benefits or risks. The blended payment reduction in the price paid for admitted patients will potentially reduce hospitals' incentives to admit patients but also reduces the CCGs incentive to avoid AED attendances. CCGs with lower and higher priority on avoiding attendances will likely have quite different responses, with a potential increase on the variation across CCGs AED attendance rates. Moreover, those CCGs that we have identified as having already high attendance rates, in Figure 10 and 11 upper gradients, such a policy may risk increased use of hospital resources and cost.

6. Discussion

A distinction is often made between treating individuals within a hospital or in a community or primary care setting. Hospital care tends to be resource-intensive and there are perceived gains from ensuring that population healthcare needs are met outside of hospitals if it is possible and beneficial to them. We have previously considered how admissions to hospitals may be determined simultaneously with attendances at AEDs and how decisions made regarding out-of-hospital care may therefore be affected by payment reforms that target hospital admissions. It becomes important to understand how much variation exists in relation to attendances and how that may be ascribed to the agencies that are charged with funding alternative care. To meet that aim, in this study we analyse the outcome of decisions made by purchasing agencies in the NHS (CCGs) after accounting for variation in their underlying populations and primary care characteristics within their area.

We have demonstrated that there remains substantial CCG specific variation in attendance rates – ranging from around 10% to nearly 40%. This represents a very substantial variation in the demands being made on hospital AEDs and hence on expensive hospital resources. Understanding that variation and what might reduce (e.g. provision of other emergency services, primary care quality and accessibility) it is clearly important for policy in general since there is strong evidence that 'one size does not fit all'.

Whilst interpretable in their own right, the analysis and results presented here also contribute to a broader goal of our research in understanding the role and effects of payment reform being undertaken in the NHS in England. The movement towards blended payment implies a reduction in the price paid for admitted patients. Intuitively, and supported by theoretical analysis, this reduces hospitals' incentives to admit patients but also reduces the incentive to avoid A&E attendances. For those CCGs that we have identified as having already high attendance rates, such a policy may risk increased use of hospital resources and cost.

As shown in (Chalkley et al., 2022a) a reduction in the price of hospital admissions that is implied by the move towards blended payment is, other things equal, likely to increase attendances and admissions. Hence, our analysis is a tool for identifying how the priorities of CCGs and providers to avoid attendances and admissions will influence the impact of the contract change. CCGs with lower and higher priority on avoiding attendances will likely have quite different responses, with a potential increase on the variation across CCGs AED attendance rates.

References

Arain, M., Campbell, M.J., Nicholl, J.P., 2015. Impact of a GP-led walk-in centre on NHS emergency departments. Emerg. Med. J. 32, 295–300. https://doi.org/10.1136/emermed-2013-202410

Blunt, I., 2014. Focus on: A&E attendances. Why are patients waiting longer? Quality Watch. The Health Foundation and the Nuffield Trust. ISBN: 1-978-905030-85-9

Chalder, M., Sharp, D., Moore, L., Salisbury, C., 2003. Impact of NHS walk-in centres on the workload of other local healthcare providers: time series analysis. BMJ 326, 532. https://doi.org/10.1136/bmj.326.7388.532

Chalkley, M., Gravelle, H., Jacob, N., Santos, R., Siciliani, L., 2022b. The potential for payment reform to influence emergency admissions: the case of blended payment in the English NHS (Discussion Paper No. TBC), CHE Research Paper. University of York.

Christakis, D.A., Mell, L., Koepsell, T.D., Zimmerman, F.J., Connell, F.A., 2001. Association of Lower Continuity of Care With Greater Risk of Emergency Department Use and Hospitalization in Children. Pediatrics 107, 524–529. https://doi.org/10.1542/peds.107.3.524

Daniels, J., Osborn, M., Davis, C., 2018. Better safe than sorry? Frequent attendance in a hospital emergency department: an exploratory study. Br. J. Pain 12, 10–19. https://doi.org/10.1177/2049463717720635

Dolton, P. and Pathania, V., 2016. Can increased primary care access reduce demand for emergency care? Evidence from England's 7-day GP opening. *Journal of Health Economics*, *49*, pp.193-208.

Downing, A., Wilson, R., 2002. Temporal and demographic variations in attendance at accident and emergency departments. Emerg. Med. J. 19, 531–535. https://doi.org/10.1136/emj.19.6.531

Greenfield, G., Blair, M., Aylin, P.P., Saxena, S., Majeed, A., Hoffman, M., Bottle, A., 2020. Frequent attendances at emergency departments in England. Emerg. Med. J. 37, 597–599. https://doi.org/10.1136/emermed-2018-208189

Jelinek, G.A., Jiwa, M., Gibson, N.P., Lynch, A.-M., 2008. Frequent attenders at emergency departments: a linked-data population study of adult patients. Med. J. Aust. 189, 552–556. https://doi.org/10.5694/j.1326-5377.2008.tb02177.x

Kirby, S.E., Dennis, S.M., Jayasinghe, U.W., Harris, M.F., Kirby, S.E., Dennis, S.M., Jayasinghe, U.W., Harris, M.F., 2011. Frequent emergency attenders: is there a better way? Aust. Health Rev. 35, 462–467. https://doi.org/10.1071/AH10964

National Audit Office, 2018. Reducing emergency admissions - National Audit Office (NAO) Press release [WWW Document]. Natl. Audit Off. URL https://www.nao.org.uk/press-release/reducing-emergency-admissions/ (accessed 1.26.22).

NHS Digital, 2022. Hospital Accident & Emergency Activity 2018-19 [WWW Document]. NHS Digit. URL https://digital.nhs.uk/data-and-information/publications/statistical/hospital-accident--emergency-activity/2018-19 (accessed 1.26.22).

NHS Digital, 2019. Patients registered at a GP practice. URL https://digital.nhs.uk/data-and-information/publications/statistical/patients-registered-at-a-gp-practice/march-2019 (accessed 10.10.22).

NHS Digital (2022) Hospital Episode Statistics Data Dictionary. Available at: https://digital.nhs.uk/data-and-information/data-tools-and-services/data-services/hospital-episode-statistics/hospital-episode-statistics-data-dictionary (Accessed: 9 November 2022).

NHS England and NHS Improvement, 2019. 2020/21 National Tariff Payment System – a consultation notice Guidance on blended payments.

Pines, J.M., Asplin, B.R., Kaji, A.H., Lowe, R.A., Magid, D.J., Raven, M., Weber, E.J., Yealy, D.M., 2011. Frequent Users of Emergency Department Services: Gaps in Knowledge and a Proposed Research Agenda. Acad. Emerg. Med. 18, e64–e69. https://doi.org/10.1111/j.1553-2712.2011.01086.x

Rudge, G.M., Mohammed, M.A., Fillingham, S.C., Girling, A., Sidhu, K., Stevens, A.J., 2013. The Combined Influence of Distance and Neighbourhood Deprivation on Emergency Department Attendance in a Large English Population: A Retrospective Database Study. PLOS ONE 8, e67943. https://doi.org/10.1371/journal.pone.0067943

Scantlebury, R., Rowlands, G., Durbaba, S., Schofield, P., Sidhu, K., Ashworth, M., 2015. Socioeconomic deprivation and accident and emergency attendances: cross-sectional analysis of general practices in England. Br. J. Gen. Pract. 65, e649–e654. https://doi.org/10.3399/bjgp15X686893

Whittaker, William, Laura Anselmi, Søren Rud Kristensen, Yiu-Shing Lau, Simon Bailey, Peter Bower, Katherine Checkland et al., 2016 Associations between extending access to primary care and emergency department visits: a difference-in-differences analysis. *PLoS medicine* 13, no. 9 e1002113.

Appendix

Table A.1 Data Sources			
Dataset	**Reporting level**	**Period**	**Source**
Accident and Emergency attendances	Patient	2018-19	Hospital Episode Statistics Accidents and Emergency
Emergency admissions	Patient	2018-19	Hospital Episode Statistics Admitted Patient Care
General Practice Patient Survey (GPPS)	Practice	2018-19	https://www.gp-patient.co.uk/
General and Personal Medical Services (GMS) practice characteristics	GP practice	2018-19	GMS- https://www.england.nhs.uk/gp/investment/gp-contract/
Quality Outcomes Framework (QOF points, disease prevalence)	GP practice	2018-19	Quality and Outcomes framework- https://digital.nhs.uk/data-and-information/publications/statistical/quality-and-outcomes-framework-achievement-prevalence-and-exceptions-data
Income deprivation	Patient LSOA	2018-19	Indices of multiple deprivation- https://www.gov.uk/government/collections/english-indices-of-deprivation; NHS digital attribution dataset
Rurality	Patient LSOA	2011	Office of National Statistics; NHS digital attribution dataset
Attribution Data Set	Patient LSOA	2018-19	Numbers of Patients Registered at a GP Practice: LSOA Level
Mortality data	GP practice	2013-17	Public Health England, based on ONS mortality data- https://fingertips.phe.org.uk
GP Extended Opening Hours	GP practice	2018-19	Hospital Episode Statistics Outpatient data
GP extended dataset	GP practice	2018-19	https://www.england.nhs.uk/statistics/statistical-work-areas/extended-access-general-practice/
GP practice location	GP practice	2018-19	NHS Choices
LSOA centroid data	Patient LSOA	2011	https://geoportal.statistics.gov.uk/
AED location data	Hospital Trust	2018-19	NHS Choices

Appendix figures

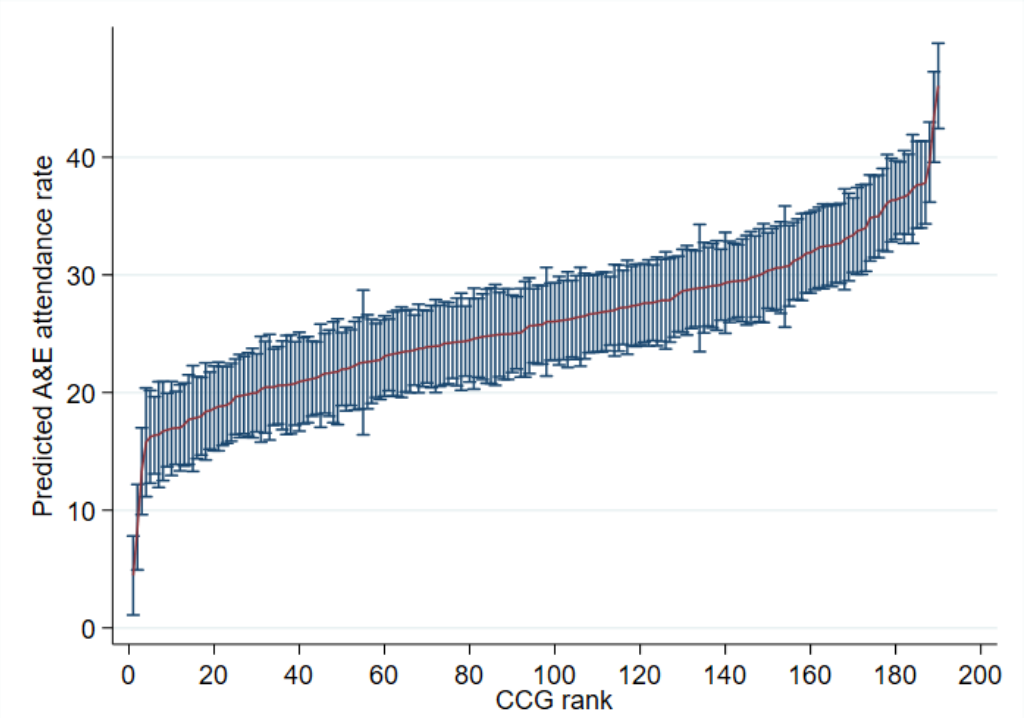

Figure A.1.: Differences in AED attendance rates between Clinical Commissioning Groups (CCGs) (unadjusted)