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TITLE

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ABSTRACT

BACKGROUND Non-urgent emergency department (ED) attendances are common among children. Primary care management may not only be more clinically appropriate, but also improve patient experience and cost-effectiveness.

AIM To determine the impact of integrating a general practitioner (GP) into a paediatric ED, on admissions, waiting times, antibiotic prescribing, and treatment costs.

DESIGN & SETTING Retrospective cohort study of non-urgent ED-presentations in an English paediatric ED.

METHOD From October-2015-September-2017, a GP was situated within the ED, from 2pm-10pm, seven-days-a-week. All children triaged green using the Manchester Triage System (non-urgent) were considered 'GP-appropriate'. In cases of GP non-availability, non-urgent children were managed by ED staff. We compared clinical and operational outcomes, and healthcare costs, of children managed by GPs and ED-staff over the same timeframe (2pm-10pm), over a two-year period.

RESULTS Of 115,000 children attending the ED over the study period, 13,099 children were designated 'GP appropriate', 8,404 (64.2%) managed by GPs and 4,695(35.8%) by ED staff. Median duration of ED-stay was 39min (IQR 16-108) in the GP-group and 165min (IQR 104-222) in the ED-group(p<0.001). The GP-group were less likely to: be admitted as inpatients (OR 0.16, 95%CI 0.13-0.2) and wait longer than four-hours (OR 0.1, 95%CI 0.08-0.13), but more likely to receive antibiotics (OR 1.42, 95%CI 1.27-1.58). Treatment costs were 18.4% lower in the GP-group, p<0.0001.

CONCLUSION Based on retrospective observational data, children seen by the GP in the emergency department waited less time, had fewer inpatient admissions and lower costs, but experienced higher antibiotic prescribing. Given rising demand for children's emergency services, 'GP in ED' care models may improve the management of non-urgent ED presentations, however further research incorporating causative study designs is required.

KEYWORDS

HOW THIS FITS IN

- Many emergency department attendances are non-urgent, putting pressure on services and increasing caseload.
- Having a GP available in the emergency department to manage non-urgent cases has previously been shown to improve efficiency and patient satisfaction, but it is unclear whether this shows value-for-money.
- This large non-randomized observational study shows that children seen by the GP in the emergency department waited less time, had fewer inpatient admissions and lower costs, but experienced higher antibiotic prescribing than those managed by ED teams
- Given rising demand for children's emergency services, 'GP in ED' care models may improve the management of non-urgent ED presentations, however further research incorporating causative study designs is required.

INTRODUCTION

The total number of visits to EDs in England exceeded 24 million in 2018, [1] a rise of 42% over the last 12 years, [2] with two-thirds [3] of attendances taking place without GP referral or transfer by ambulance. While these attendances may result from an acute medical problem, they may not always require immediate specialized emergency medical care; with 20-40% of ED visits classified as non-urgent. [4,5] Increased concern regarding the potential severity of conditions, [6] parental anxiety, and a perceived need for urgent treatment, [7-10] exacerbate this problem in children's emergency medicine; with confidence in the quality and investigative ability of ED care, [7] and difficulty in obtaining primary care appointments also playing a role [11]. As such, it is estimated that one-in-two attendances for acute paediatric care, could feasibly be managed in the community. [12]

A major challenge for paediatric emergency care is to recognize seriously ill children, however the increasing use of EDs for non-urgent conditions makes this difficult; making ED overcrowding a major patient safety concern, [13,14] which can result in suboptimal patient outcomes and even death [15-16].

Given that an increasing number of non-urgent ED attendances are amenable to treatment in primary care, one of the key recommendations of the Royal College of Emergency Medicine is to co-locate primary care services within ED settings. [17] While the benefits of introducing GPs in EDs for managing non-urgent cases are well documented, and include increased patient satisfaction, [18-21] reduced waiting times, [19,20] and reductions in invasive examinations; [19,22] it is unclear whether this represents an efficient use of NHS resources, with the only economic analysis to date taking place in 1996 [23]. Building on our previous findings in a 6-month pilot scheme of this initiative [20] assessing clinical and process outcomes, this retrospective observational study assesses the impact of ED co-location of a primary care service on waiting times, admissions, antibiotic prescribing rates and healthcare costs; to determine the cost-effectiveness of ED co-location of GP services.

MATERIALS & METHODS

Study setting, population, and design

The study was conducted retrospectively in the ED of a large paediatric hospital located in the Northwest of England. From 1st October 2015 to 31st September 2017, a GP employed by a Liverpool-based Social Enterprise delivering NHS services (Primary Care 24, formerly Urgent Care 24), was available in the ED as a separate but co-located service. The service ran from 14:00-22:00h, seven-days-a-week.

All children were initially evaluated by a qualified ED nurse using the Manchester Triage System (MTS) [24]. Low-acuity children triaged as non-urgent (MTS Green without comorbidities), were

labelled "GP appropriate" and allocated to be seen by the GP during its operational hours of 2pm to 10pm. Parents were not given a choice of allocation to the GP or otherwise but were informed, at which point they could refuse the service. Children referred to the ED by their own GP or a walk-in centre were ineligible for allocation to the GP in the ED service.

In instances of GP non-availability, namely, GP sickness and holidays, children triaged as GP appropriate who would otherwise have been managed by onsite GPs, were instead managed by ED clinical staff, following the standard procedures of the service (the comparator group). This intervention presented an opportunity to evaluate a "natural experiment" comparing both outcomes (antimicrobial prescribing, waiting times, admission rates and achievement of Department of Health and Social Care four-hour target), and costs of children presenting to our paediatric ED with the same clinical urgency (MTS Green), over the same time period (2pm-10pm, 7-days a week). Differing only in terms of who provided treatment, ED teams or the co-located GP service. Study recruitment is detailed in Figure 1.

Due to the retrospective observational nature of the study, in addition to primary outcome data, data concerning potential confounders were collected for all patients, from both ED and GP services databases. For all cases, information on arrival and discharge date and time, final diagnosis, discharge status, antimicrobial prescribing, and attending physician were available. Demographic (age, gender, home postcode, Index of Multiple Deprivation-2015 score) and clinical data (oxygen saturation, temperature and pulse) were also collected. For patients presenting with fever who received antibiotics, an assessment of whether antibiotic prescribing was clinically necessary was made, details of which are provided in Supplementary Box 1.

Box S1: Details of febrile illness phenotyping for those receiving antibiotics

Figure 1: Flow diagram of study recruitment

Statistical analysis

Patients triaged as "GP appropriate" and managed by the GP service (exposed group) were compared with patients triaged as "GP appropriate" and managed by ED staff over the same time period (control group), using an intention-to-treat approach. Descriptive statistics were generated for both groups. Differences in proportions were analysed using the Chi-square test, with differences in continuous outcomes assessed via the Mann-Whitney U-test. Multivariate logistic regression was used to estimate odds ratios for binary outcomes, adjusted for baseline covariates which may have impacted outcomes, including whether children were re-attending the ED within a five-day period, or whether they had previously sought care from their community GP. Sub-group analyses were performed to account for covariates previously shown to impact the outcomes under consideration, including patient age [26], working diagnosis [26], and deprivation. [27] All statistical analyses were conducted using STATA 12 (Stata Corporation, College Station, TX, USA), with statistical significance defined at the 5% level.

Costing and resource-use analysis

Healthcare resource use was calculated using a time-driven activity-based costing (TDABC) approach, as used in previous health economic analyses conducted in the ED. [26] TDABC identifies all instances and durations of interaction with health service personnel during a treatment episode and assigns time-dependent costs to each (triage, consultation, cannulation etc), based on stopwatch timing combined with the hourly salaries of the staff involved. Timing estimates and unit costs used for the patient-level healthcare costing are provided in Supplementary Tables 1 and 2. Finally, adding unit costs of consumables including medicines, and tariff-based items including investigations, radiography and inpatient admission spells, provides an estimation of total resource use during a treatment episode. Further details of the methodology for the costing exercise are provided elsewhere [26]. Societal costs to parents of waiting in the ED were also estimated, by cross-referencing each

respondent's postcode with hourly income data matched per lower layer super output area, which was obtained from the Office for National Statistics. [28]

Supplementary Table 1: Staff time associated with components of the paediatric febrile illness pathway

Supplementary Table 2: Unit costs by component of paediatric febrile illness pathway

All unit costs were in 2019 prices, with non-parametric bootstrapping (percentile method) used to generate 95% confidence intervals. Discounting of costs and outcomes was not required due to the short analysis timeframe. Probabilistic sensitivity analysis was also performed to test for robustness of conclusions regarding the impact of GP-led care on healthcare costs and outcomes. The distributions employed to explore parametric uncertainty are provided in Supplementary Table 3.

Supplementary Table 3: Distributions used for probabilistic sensitivity analysis.

RESULTS

Baseline characteristics & recruitment

Between October 1st, 2015 and September 30th, 2017, 120,000 children visited our emergency department, of which 14,444 were triaged GP appropriate (MTS Green) between 14:00 and 22:00 hours, when the on-site GPs were in operation. Of these children, 1,345 had incomplete or missing

data, resulting in a complete dataset of 13,099 observations. Table 1 shows the personal characteristics of both groups, with no significant differences observed in any of the demographic or clinical baseline characteristics.

Table 1: Characteristics of patients triaged as 'GP appropriate', attending the ED

Prescription of antibiotics

Rates of antibiotic prescribing were 15.1% in the GP group and 10.8% in the ED group, p<0.001, (OR 1.42; 95% CI 1.27 to 1.58; p<0.001). Compared to children managed by ED teams, children managed by the GP who were seen and discharged within 1 hour had an odds ratio of 3.32 (95% CI 2.2-5.0) for being prescribed antibiotics, as shown in Supplementary Figure 1. Children managed by the GP group with fever at presentation experienced a 10.4% increase in antibiotic prescribing (27.1% vs. 16.7%). Approximately 89.9% of children with fever receiving antibiotics in the GP group, compared to 75.9% in the ED group, displayed no evidence of bacterial foci (Supplementary Table 4).

Supplementary Figure 1: Odds-ratios for antibiotic prescribing by age and time until discharge

Supplementary Table 4: Antibiotic use differentiated by aetiology of fever and treatment group

Being seen within the UK Department of Health and Social Care 4-hour target

The median duration of stay in the ED was 39min (IQR 16–108) for the GP group compared with 165 min (IQR 104–222) for the ED group (p<0.005). Management by the onsite GP was associated with significantly reduced odds of breaching the Department of Health and Social care four-hour waiting standard (OR 0.10; 95% CI 0.084 to 0.125; p<0.001), with 98.6% of children in the GP group and 88.4% in the ED group discharged or admitted within four hours.

Admission to hospital

The odds of being admitted were significantly lower (84%) for children managed by the GP (OR 0.16; 95% CI 0.13 to 0.20; p<0.001). Short stay admissions of <6 hours were reduced by 84.7%, 6-24-hour admissions by 86.5% and admissions exceeding 1 day by 78.7% for those seen by the GP. Children in all age groups and diagnostic groups were statistically significantly more likely to be admitted to hospital if managed by ED clinical teams (all p<0.001). The grade of the ED clinician managing the child had no impact on admission rates.

Discharge status

In total, 95.9% of children in the GP group were discharged with no further action, or advised to seek follow-up with their own GP, compared to 76% in the ED group. Outpatient referrals were equivalent across groups with 107 (1.3%) of the GP group and 103 (2.2%) of the ED group referred. However, 9.7% of those in the ED group left before being seen, compared to 1.2% in the GP group (Table 2).

Table 2: Discharge status of children by treatment group

Healthcare and societal costs of ED management

The mean cost of treatment episodes for the GP group was £115.24 (95% CI £20.50-£351.67), compared to £141.16 (95% CI £11.78-£539.94) among those managed by ED clinicians, p<0.001. Both groups recorded similar costs attributable to medications prescribing, and investigations (Table 3). Costs associated with staff salaries (receptionist, nurse, doctor) were much higher in the GP group while inpatient admission costs were significantly lower, p<0.001, owing primarily to a 75.3%

reduction in median inpatient duration (0.22 days vs. 0.89 days). Societal costs were increased 2.38-fold (£46.87 vs. £18.53) in the ED group.

Table 3: Breakdown of cost-types per patient in the GP and ED treatment groups

Sub-group analyses

Sub-group analyses for all outcomes are provided in Table 4 and Supplementary Box 2.

Box S2: Sub-group analyses

Sensitivity analysis

Probabilistic sensitivity analysis utilising the distributions provided in Supplementary Table 3, suggested an 86% probability that GP-led care would result in a saving of at least £30 per patient. Similarly, there was a 98.3% probability that treatment by GPs in the ED would increase antibiotic prescribing by at least 3% (Figure 2).

Table 4: Comparative costs and outcomes by subgroup

Figure 2: Variability in health service savings and antibiotic use following introduction of GP to emergency department

DISCUSSION

Summary

During a two-year natural experiment, in which a GP service was co-located in a busy paediatric ED for non-urgent admissions; children managed by GPs experienced reductions in treatment costs, admittance to hospital, and in the number exceeding the 4-hour waiting target, but also increases in antimicrobial prescribing. These findings corroborate those of our previous much smaller study, which did not include a health-economic analysis. [20]

To the best of our knowledge, this study, conducted among a large and representative ED cohort over a two-year period, is the first to assess the combined clinical, process-based and economic impact of introducing a GP service within a paediatric ED in the United Kingdom. We have made use of a natural experiment, and routinely collected data, to pragmatically evaluate the impact of GP co-location in one of Europe's largest and busiest specialist paediatric EDs. Although this was a retrospective observational study, the treatment groups were almost identical in terms of demographics and case mix, which have been previously shown to affect the outcomes under consideration. [26] This limited the likelihood of confounding bias, thereby providing generalisable insights regarding the management of non-urgent presentations to EDs. Furthermore, although observational, the approach taken to the estimation of costs was highly thorough and representative of real-world management, including details such as nursing time required to prepare and provide medications, and clinical time required to order and interpret investigations.

Strengths & limitations

Our study also has limitations. Firstly, we did not collect data on several factors which may have affected both ED and GP staff workload, including how busy the department was at any given time, the number of staff on-shift and the availability and capacity of connected departments, such as pathology and radiology, which may have affected the ability for GPs and ED clinicians to treat and

investigate the children included efficiently. Secondly, although every effort was made to eliminate sources of bias, including the large patient numbers and balanced baseline characteristics, the retrospective nature of the study, and lack of randomisation does leave the opportunity for unknown causes of bias, which could not be adjusted for. Thirdly, higher rates of incomplete data capture and exclusion for the ED group very likely have not impacted our findings. These seem to be missing at random in verification samples and they appear to occur during busy times and are related to the electronic system used. Yet, inevitably, we cannot confirm this with certainty, nor determine how these patients would have affected the detailed findings of the study. Finally, the operational hours of the GP service only covering one-third of the operating hours of the ED (2pm-10pm), means that generalisability of our findings could be limited; as we cannot guarantee that similar patterns of care would be observed over night when services, diagnostics and access to radiography are limited.

Comparison with existing literature

Prior interventional analyses and systematic reviews have suggested that co-location of GPs in EDs may not have a significant impact on reducing the cost per patient [29,30], but may in fact increase costs due to extra personnel. [30] Our findings, in the largest cohort to date, suggest otherwise. Despite personnel costs increasing, non-urgent children managed by GPs experienced significant reductions in total costs of management, predominantly resulting from reductions in inpatient admission, investigations, and radiography; as observed in similar studies. [22,31-32] This difference was most pronounced among younger children, where healthcare costs were reduced by almost 60%, and where understandably, ED staff are known to be most cautious. [26]

In EDs which are frequently overcrowded, the significant reduction in activities associated with waiting (observation, investigations, radiography) as observed in the GP group, may have a significant effect on patient flow through the ED, resulting in reductions in waiting times, and increases in patient satisfaction. This could have significant implications for NHS trusts, as breaching the target of resolving at least 95% of the attendances within 4 hours can have serious negative

economic consequences for hospitals. [33] The increase in achievement of the four-hour standard from 88.4% in the ED group to 98.6% in the GP group, therefore, also has the potential to save NHS trusts money in the short to medium term, which were not captured in this analysis. However, a potential limitation, observed in both this study and our previously published pilot study, [20] is that a substantial number of patients managed by GPs were subsequently referred to their own GP for further follow-up; which may simply shift some of the burden to primary care. As such, the impact on the whole system of GP in the ED models of care still requires further investigation.

Finally, although GP-led care for non-urgent attendances resulted in several significant benefits, the resulting increase in antibiotic prescription was also significant. There are considerable clinical policy pressures on GPs not to miss sepsis, meningitis, or other serious-but-rare illnesses, often a result of diagnostic uncertainty, [26] which may push practitioners to prescribe as a precaution. [26,34-35] A previous study found that 44% of GPs might prescribe antibiotics to terminate a consultation, [36] and implicit in this finding is the potential effect of the increasingly tight time constraints under which GPs work, and the number of children seen over relatively short periods of time. In this study, children who were managed by the GP who were seen and discharged within 1 hour were 3 times more likely to be prescribed antibiotics, compared to children seen and discharged within a similar period who were managed by ED clinicians. Consultation time and GP workload have been shown to be associated with higher antibiotic prescription rates, [37] and it is worth noting that in this study, the GP managed almost twice as many non-urgent cases as ED clinicians over the same period. In Norway, a study found that GPs who saw more patients per year prescribed more antibiotics than those with fewer patients [38], and this was echoed in a qualitative study of GPs and nurse prescribers in the UK. [39]

Advances in diagnostic technologies such as rapid point-of-care (POC) testing may play a role in reducing unnecessary antibiotic prescribing. POC C-reactive protein (CRP) CRP testing has been shown to reduce antibiotic prescribing in UK primary care clinics for patients with COPD [40] Prior studies have also suggested community antibiotic stewardship by pharmacists, [41] and prescribing or

social norm feedback as part of continued GP education [42-43] or primary care accreditation schemes [44], as means of reducing antimicrobial prescribing. Given the success of these initiatives in reducing antibiotic use in routine practice, coupled with low expected costs of implementation and GPs being easily accessible in a single hospital setting, there is every possibility to reduce antibiotic use.

Implications for research and/or practice

Given the increasing demands on emergency care, integrative care approaches are a plausible means to increase capacity and manage caseload, particularly given the non-urgent nature of many attendees. The results of this large-scale natural experiment showed that children seen by the GP in the emergency department waited less time, had fewer inpatient admissions, and lower costs, but experienced higher antibiotic prescribing than those treated by ED teams. However, further research incorporating causative study designs are required.

TABLES & FIGURES

Table 1: Characteristics of patients triaged as 'GP appropriate', attending the ED

Variable		GP group (n=8,404)	ED group (n=4,695)	Total (n=13,099)	Significance
Gender					p=0.206*
	Male	4,268 (50.8%)	2,541 (54.1%)	6,809 (52%)	
	Female	4,136 (49.2%)	2,154 (45.9%)	6,290 (48%)	

Age Category					p=0.785*
	<3 months	613 (7.3%)	319 (6.8%)	932 (7.1%)	
	3-6 months	538 (6.4%)	291 (6.2%)	829 (6.3%)	
	6-12 months	1,277 (15.2%)	714 (15.2%)	1,991 (15.2%)	
	1-3 years	3,177 (37.8%)	1,779 (37.9%)	4,956 (37.8%)	
	4-10 years	2,017 (24%)	1,174 (35%)	3,191 (24.5%)	
	11+ years	782 (9.3%)	418 (8.9%)	1,200 (9.1%)	
Age (years)					p=0.624#
	Median (IQR)	2.2 (0.9-5.5)	2.15 (0.87-5.5)	2.17 (0.88-5.5)	
Deprivation quintiles					p=0.656*
	1 (least deprived)	208 (2.7%)	106 (2.4%)	314 (2.6%)	
	2	456 (5.9%)	253 (5.7%)	709 (5.8%)	
	3	833 (10.7%)	504 (11.4%)	1,337 (10.9%)	
	4	898 (11.6%)	528 (11.9%)	1,426 (11.7%)	
	5 (most deprived)	5,378 (69.2%)	3,058 (68.7%)	8,436 (69%)	
Diagnosis					N/A
	Respiratory Conditions	2070 (24.6%)	1076 (22.9%)	3,146 (24%)	
	Gastrointestinal Conditions	1410 (16.8%)	695 (14.8%)	2,105 (16.1%)	
	Infectious Disease	1194 (14.2%)	695 (14.8%)	1,889 (14.4%)	
	Diagnosis Not Classifiable	530 (6.3%)	946 (20.1%)	1,476 (11.3%)	
	ENT Conditions	679 (8.1%)	227 (4.8%)	906 (6.9%)	
	Local Infection	561 (6.7%)	305 (6.5%)	866 (6.6%)	
	Dermatological Conditions	302 (3.6%)	99 (2.1%)	401 (3.1%)	
	Urological Conditions (Including Cystitis)	256 (3%)	128 (2.7%)	384 (2.9%)	
	Allergy (Including Anaphylaxis)	263 (3.1%)	100 (2.1%)	363 (2.8%)	
	Head Injury	190 (2.3%)	45 (1%)	235 (1.8%)	
	Fever	1,289 (15.3%)	643 (13.7%)	1,932 (14.7%)	
Pulse (Beats per minute)					p=0.864#
	Median (IQR)	127 (109-143)	125 (109-140)	126 (109-142)	
Temperature					p=0.767#

	Median (IQR)	37 (36.6-37.6)	37 (36.6-37.6)	37 (36.6-37.6)	
Oxygen saturation (O$_2$ Sats)					p=0.558#
	Median (IQR)	99 (97-100)	99 (97-100)	99 (97-100)	
Attended emergency department in last 5 days?					p=0.14*
	Yes	160 (1.9%)	103 (2.2%)	263 (2%)	
	No	8,244 (98.1%)	4,592 (97.8%)	12,836 (98%)	
Attended emergency department on a weekday?					p=0.84*
	Yes	5,824 (69.3%)	3,301 (70.3%)	9,125 (69.7%)	
	No	2,580 (30.7%)	1,394 (29.7%)	3,974 (30.3%)	
Attended emergency department during holiday period? **					p=0.134*
	Yes	2,958 (35.2%)	1,592 (33.9%)	4,550 (34.7%)	
	No	5,446 (64.8%)	3,103 (66.1%)	8,450 (65.3%)	

* χ

Mann-Whitney U test

** Holidays followed the English academic year and included half terms, Easter, Christmas, and winter holidays.

Table 2: Discharge status of children by treatment group

Discharge	GP group	ED group	Total
Own GP follow-up	2,312 (27.5%)	287 (6.1%)	2,599 (19.8%)
Discharged	5,745 (68.4%)	3,282 (69.9%)	9,127 (69.7%)
Admitted	117 (1.4%)	374 (8%)	491 (3.7%)
Outpatient	107 (1.3%)	103 (2.2%)	210 (1.6%)
ED clinic	3 (<0.1%)	59 (1.3%)	62 (0.5%)
Community follow-up	1 (<0.1%)	0 (0%)	1 (<0.1%)
Left before seen	100 (1.2%)	455 (9.7%)	555 (4.2%)
Left following advice	1 (<0.1%)	5 (0.1%)	6 (<0.1%)
Left refusing treatment	6 (<0.1%)	117 (2.5%)	123 (1%)
Other	5 (<0.1%)	13 (0.3%)	18 (0.1%)

Table 3: Breakdown of cost-types per patient in the GP and ED treatment groups

	GP (n=8404)	ED (n=4695)	Difference	Significance*
Staff salaries	£82.81	£46	£36.81	p<0.001
Observation/Inpatient	£28.86	£89.28	-£60.42	p<0.001
Prescribed medications	£3.09	£3.29	-£0.20	p=0.385
Investigations	£0.43	£2.77	-£2.34	p<0.001
Societal[#]	£19.69	£46.87	-£28.34	p<0.001

*Mann Whitney U-test

Calculated as a function of total time in the ED, expressed in terms of forgone wages and productivity by parents and carers.

Table 4: Comparative costs and outcomes by sub-group

	Costs (£)				Antibiotics (%)				4-hour target (%)				Inpatient (%)			
	GP	ED	All	Sig.	GP	ED	All	Sig.	GP	ED	All	Sig.	GP	ED	All	Sig
Working diagnosis																
Fever (n=1,926)	£93.78	£69.76	£86.69	p<0.001	27.1%	16.7%	23.5%	p<0.001	98.5%	87.5%	94.6%	p<0.001	1.1%	4.5%	2.3%	p<0.001
Infectious Disease (n=1,889)	£92.18	£123.29	£103.94	p<0.001	5.7%	5.9%	5.7%	p=0.578	98.7%	89.1%	94.7%	p<0.001	0.7%	9.9%	4.4%	p<0.001
Gastrointestinal (n=2,105)	£89.49	£120.77	£104.76	p<0.001	0.5%	0.6%	0.6%	p=0.891	98.8%	86.2%	94.4%	p<0.001	1.0%	8.6%	3.9%	p<0.001
Respiratory (n=3,146)	£87.52	£89.40	£88.16	p=0.897	16.2%	10.2%	14.3%	p<0.001	98.9%	86.3%	94.3%	p<0.001	0.5%	6.5%	2.7%	p<0.001
Local Infection (n=866)	£92.97	£88.26	£91.34	p=0.521	40.3%	39.9%	40.2%	p=0.978	98.4%	86.4%	93.9%	p<0.001	0.7%	4.1%	2%	p<0.001
Ear, Nose and Throat (n=906)	£86.78	£111.90	£92.30	p<0.001	41.5%	35.7%	40.1%	p=0.298	97.8%	86.8%	95%	p<0.001	0.0%	2.8%	0.7%	p<0.001
Age																
<3 months (n=932)	£99.49	£242.54	£152.88	p<0.001	5.2%	5.6%	5.4%	p=0.947	99.2%	87.9%	95.2%	p<0.001	1.2%	14.3%	6.2%	p<0.001
3-6 months (n=829)	£135.55	£196.38	£162.38	p<0.001	8.8%	8.2%	8.6%	p=0.935	98.5%	90.1%	95.2%	p<0.001	2.3%	7.1%	4.5%	p<0.001
6-12 months (n=1,991)	£101.04	£95.29	£100.60	p<0.001	13.1%	8.6%	11.5%	p=0.012	98.4%	89.5%	94.4%	p<0.001	1.6%	7.8%	4.2%	p<0.001
1-3 years (n=4,956)	£99.83	£116.47	£109.70	p<0.001	18.2%	11.5%	15.7%	p<0.001	98.6%	87.6%	94.2%	p<0.001	1.1%	7.1%	3.6%	p<0.001
4-10 years (n=3,191)	£118.36	£130.14	£132.08	p<0.001	16.8%	13.4%	15.5%	p=0.037	98.6%	89.5%	94.6%	p<0.001	1.4%	5.7%	3.3%	p<0.001
11+ years (n=1,200)	£115.39	£238.72	£157.93	p<0.001	13.9%	10.4%	12.9%	p=0.07	98.5%	86.0%	93.8%	p<0.001	1.6%	7.7%	3.9%	p<0.001
Deprivation quintile#																
1 (n=8,436)	£111.56	£150.61	£126.23	p<0.001	15.40%	10.30%	13.50%	p<0.001	98.60%	87.30%	94.30%	p=0.005	1.40%	7.80%	3.80%	p<0.001
2 (n=1,426)	£108.43	£150.48	£124.33	p<0.001	16.60%	11.50%	14.70%	p=0.009	99.40%	88.60%	95.40%	p<0.001	1.20%	8.90%	4.20%	p=0.003
3 (n=1,337)	£94.17	£170.70	£124.10	p<0.001	14.80%	11%	13.30%	p=0.047	98.30%	88.80%	94.60%	p<0.001	1.70%	7.70%	4%	p<0.001
4 (n=709)	£104.17	£92.69	£99.98	p<0.001	12.70%	12.90%	12.80%	p=0921	98.20%	88.90%	94.80%	p<0.001	1.50%	5.70%	3.10%	p<0.001
5 (n=314)	£115.55	£189.99	£141.29	p<0.001	14.90%	17.30%	15.70%	p=0.582	97.60%	89.10%	94.70%	p<0.001	1.40%	10.90%	4.70%	p<0.001

* Significance determined via Mann Whitney U-test

1 (most deprived), 5 (least deprived)

Figure 1: Flow diagram of study recruitment

14,444 Triaged GP appropriate during GP working hours (2pm-10pm)		

8,707 Allocated to GP group

5,737 Allocated to ED group

303 Excluded due to incomplete data

1,042 Excluded due to incomplete data

8,404 Included in study (GP group)
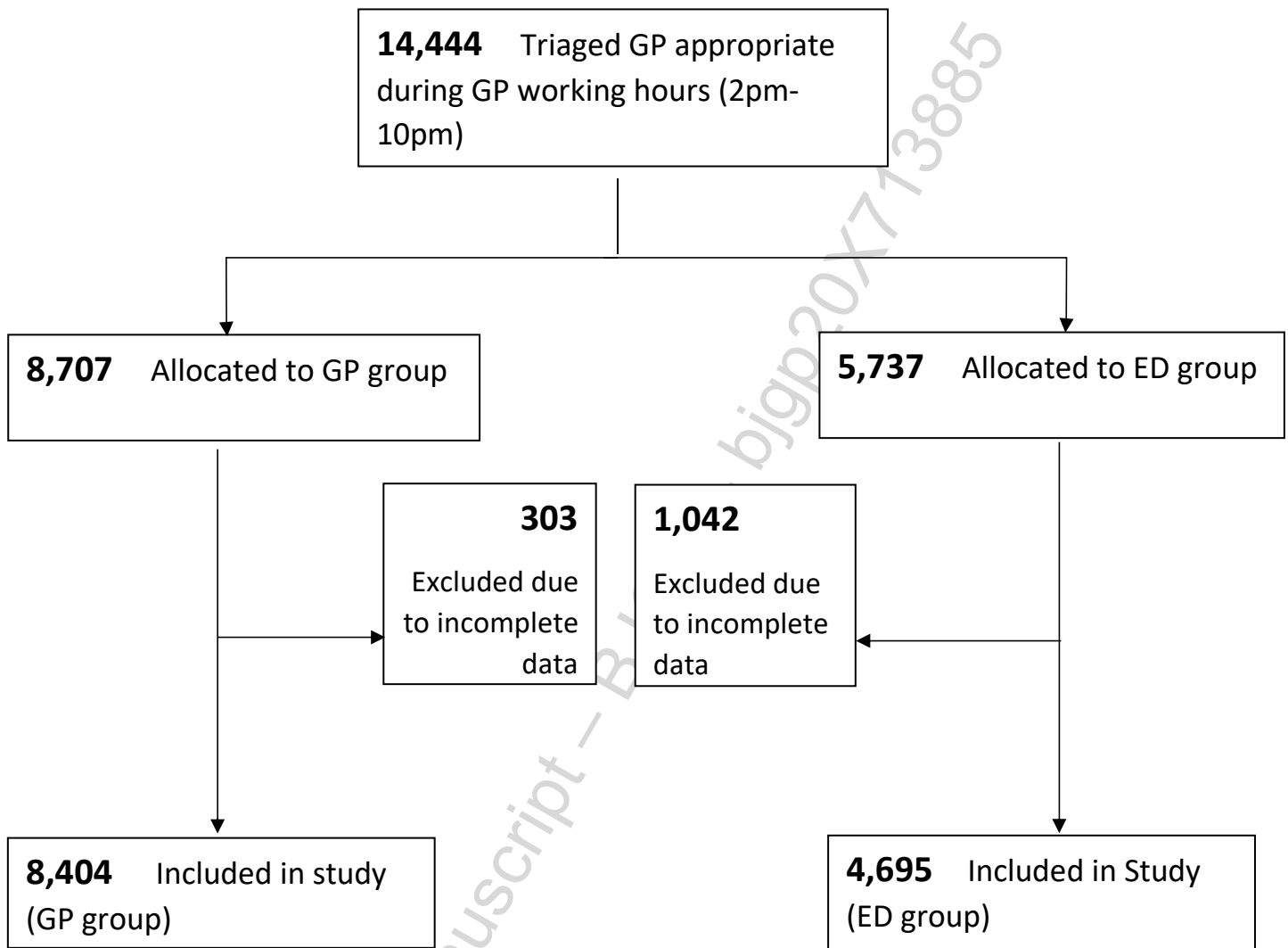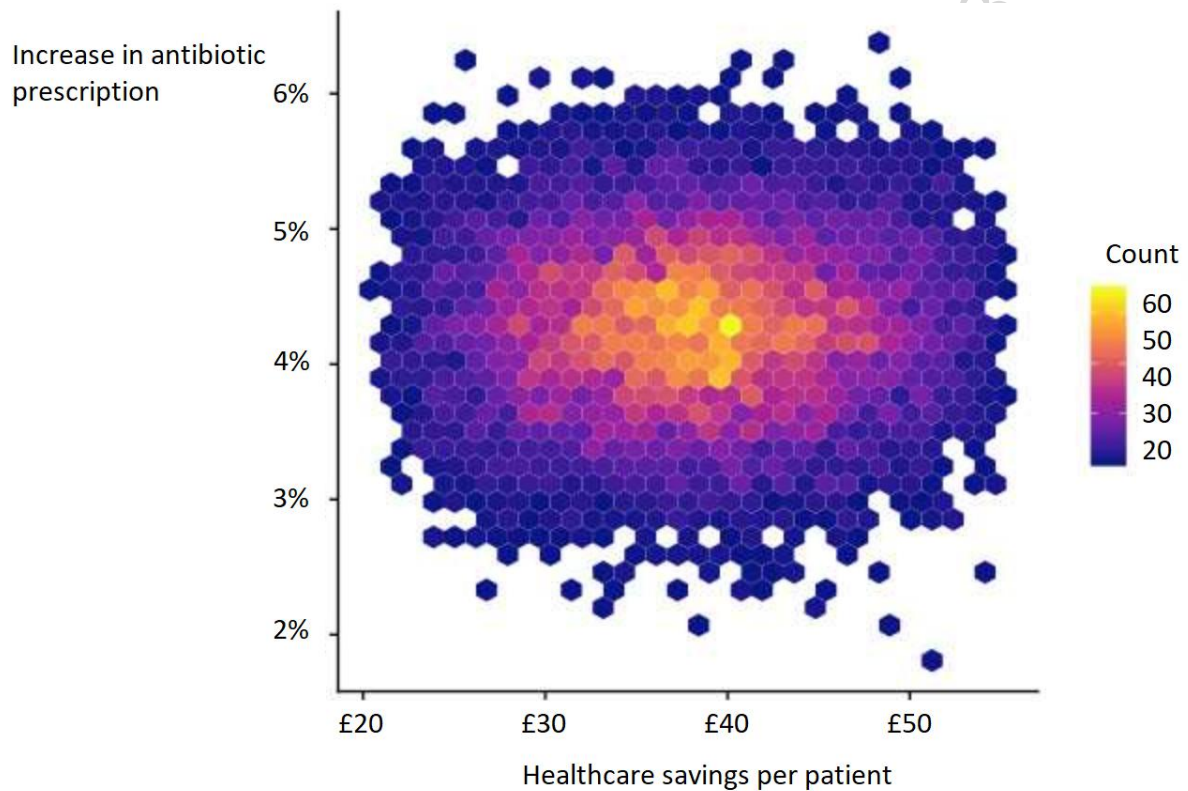
4,695 Included in Study (ED group)

Figure 2: Variability in health service savings and antibiotic use following introduction of GP to emergency department

Each hexagon represents a point in the joint distribution of paired healthcare savings and increases in antibiotic use, resulting from 10,000 Monte Carlo simulations. The colour represents the frequency/likelihood of each pairing occurring.

ADDITIONAL INFORMATION

Funding

Ethical approval

Approval to conduct the study was granted by the Quality and Governance Team at Alder Hey Children's NHS Foundation Trust (reference number 5511).

Competing interests

We have read and understood the BMJ Group policy on declaration of interests and declare the following interests: none

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N/A

REFERENCES

[1] Kmietowicz, Z. A&E attendances in England are growing twice as fast as population. BMJ 2018; 362:k3921.

[2] Available at:

https://www.health.org.uk/sites/default/files/Briefing_Emergency%2520admissions_web_final.pdf.

Last accessed: 11th December 2019.

[3] Hospital episode statistics accident and emergency attendances in England – 2014-15. Hospital Episode Statistics Analysis HSCIC, 2016

[4] Morris, T, Mason, SM, Moulton, C et al. Calculating the proportion of avoidable attendances at UK emergency departments: analysis of the Royal College of Emergency Medicine's Sentinel Site Survey data. Emerg Med J 2018; 35, 2:114-119.

[5] NHS-England. High quality care for all, now and for future generations: Transforming urgent and emergency care services in England - Urgent and Emergency Care Review End of Phase 1 Report 2013. Available from: www.nhs.uk/NHSEngland/keogh-review/Documents/UECR.Ph1Report.FV.pdf. Accessed 17th October 2019.

[6] Penson R, Coleman P, Mason S, et al. Why do patients with minor or moderate conditions that could be managed in other settings attend the emergency department? Emerg Med J 2012; 29:487–91

[7] Butun, A, Linden, M, Lynn, F et al. Exploring parents' reasons for attending the emergency department for children with minor illnesses: a mixed methods systematic review. Emerg Med J 2019; 36, 1:39-46.

[8] Smith JK, Roth S. Paediatric A&E attendances; findings and consequences. Arch Dis Child 2008; 93:812–3.

[9] Truman CD, Reutter L. Care-giving and care-seeking behaviours of parents who take their children to an emergency department for non-urgent care. Can J Public Health 2002; 93:41–6.

[10] Williams A, O'Rourke P, Keogh S. Making choices: why parents present to the emergency department for non-urgent care. Arch Dis Child 2009; 94:817–20.

[11] Steele, L, Coote, N, Klaber, R, et al. Understanding case mix across three paediatric services: could integration of primary and secondary general paediatrics alter walk-in emergency attendances? Arch. Dis. Child 2019; 104, 5:432-436.

[12] Zhou, Y, Abel, G, Warren, F. Do difficulties in accessing in-hours primary care predict higher use of out-of-hours GP services? Evidence from an English National Patient Survey. Emerg Med J 2015; 32, 5:373-8.

[13] Hitti EA, Lewin JJ, Lopez J, et al. Improving door-to-antibiotic time in severely septic emergency department patients. J Emerg Med 2012; 42:462–9.

[14] Carter, EJ, Pouch, SM, Larson, EL. The relationship between emergency department crowding and patient outcomes: a systematic review. J Nurs Scholarsh 2014; 46, 2:106-15.

[15] Depinet HE, Iyer SB, Hornung R, et al. The effect of emergency department crowding on reassessment of children with critically abnormal vital signs. Acad Emerg Med. 2014; 21(10):1116-20.

[16] Richardson DB. Increase in patient mortality at 10 days associated with emergency department overcrowding. Med J Aust 2006; 184(5):213-6.

[17] Medicine TRCoE. Acute and emergency care: prescribing the remedy, 2014. Available at: https://www.rcpch.ac.uk/resources/acute-emergency-care-prescribing-remedy. Accessed 17th August 2019.

[18] Kmietowicz Z. GP triage could reduce attendances at emergency departments, study finds. BMJ 2014; 349:g7525

[19] Goodman, C, Gordon, AL, Martin, F, et al. Effective health care for older people resident in care homes: the optimal study protocol for realist review. Syst Rev 2014; 3:49.

[20] Smith, L, Narang, Y, Ibarz Pavon, AB. To GP or not to GP: a natural experiment in children triaged to see a GP in a tertiary paediatric emergency department (ED). BMJ Qual Saf 2018; 27, 7:521-528.

[21] Bosmans JE, Boeke AJ, van Randwijck-Jacobze ME, et al. Addition of a general practitioner to the accident and emergency department: a cost-effective innovation in emergency care. Emerg Med J 2012; 29:192–6.

[22] Khangura, JK, Flodgren, G, Perera, R, et al. Primary care professionals providing non-urgent care in hospital emergency departments. Cochrane Database Syst Rev 2012; 11:CD002097.

[23] Dale J, Lang H, Roberts J, et al. Cost effectiveness of treating primary care patients in accident and emergency: a comparison between general practitioners, senior house officers, and registrars. BMJ 1996; 312:1340–4.

[24] Zachariasse JM, Seiger N, Rood PPM. Validity of the Manchester Triage System in emergency care: A prospective observational study, PLoS One 2017; 12(2): e0170811

[25] Herberg JA, Kaforou M, Wright VJ et al. Diagnostic Test Accuracy of a 2-Transcript Host RNA Signature for Discriminating Bacterial vs Viral Infection in Febrile Children, JAMA 2016; 316 (8):835–45

[26] Leigh S, Grant A, Murray N et al. The cost of diagnostic uncertainty: a prospective economic analysis of febrile children attending an NHS emergency department. BMC Med 2019; 17, 1:48.

[27] Wise, J. Antibiotic prescribing is higher in deprived areas of England. BMJ 2015; 351:h6117.

[28] Office for National Statistics. Postcode to Output Area to Lower Layer Super Output Area to Middle Layer Super Output Area to Local Authority District (February 2018) Lookup in the UK. Available at: https://geoportal.statistics.gov.uk/datasets/postcode-to-output-area-to-lower-layer-super-output-area-to-middle-layer-super-output-area-to-local-authority-district-february-2018-lookup-in-the-uk. Accessed 3rd September 2019

[29] Ramlakhan S, Mason S, O'Keeffe C, et al. Primary care services located with EDs: a review of effectiveness. Emerg Med J 2016; 33.

[30] Salisbury C, Hollinghurst S, Montgomery A, et al. The impact of co-located NHS walk-in centres on emergency departments. Emerg Med J 2007; 24:265–9.

[31] Kool RB, Homberg DJ, Kamphuis HC. Towards integration of general practitioner posts and accident and emergency departments: a case study of two integrated emergency posts in the Netherlands. BMC Health Serv Res 2008; 8:225.

[32] Murphy AW, Bury G, Plunkett PK, et al. Randomised controlled trial of general practitioner versus usual medical care in an urban accident and emergency department: process, outcome, and comparative cost. BMJ 1996; 312:1135–42.

[33] The Kings Fund. How is the health and social care system performing? quarterly report. 2013 Available at: https://www. kingsfund. org.uk/ publications/ how- health- and- social- care- system- performing january-2014. Accessed 5th October 2019.

[34] Limper M, Eeftinck Schattenkerk D, de Kruif MD et al. One-year epidemiology of fever at the emergency department, Netherlands J Med 2011; 69 (3): 124–8.

[35] Wilkes JJ, Leckerman KH, Coffin SE et al. Use of antibiotics in children hospitalized with community-acquired, laboratory-confirmed influenza., J Pediatr 2009; 154 (3): 447–9

[36] Cole A. GPs feel pressurised to prescribe unnecessary antibiotics, survey finds. BMJ 2014; 349.

[37] Williams SJ, Halls AV, Tonkin-Crine S et al. General practitioner and nurse prescriber experiences of prescribing antibiotics for respiratory tract infections in UK primary care out-of-hours services (the UNITE study). J Antimicrobial Chemother 2018; Mar 1;73(3):795-803

[38] Gjelstad S, Straand J, Dalen I, et al. Do general practitioners' consultation rates influence their prescribing patterns of antibiotics for acute respiratory tract infections? Journal of Antimicrobial Chemotherapy. 2011; 66(10):2425-33.

[39] Jabaley CS, Blum JM, Groff RF, et al. Global trends in the awareness of sepsis: insights from search engine data between 2012 and 2017. Critical care (London, England). 2018; 22(1):7-.

[40] Butler CC, Gillespie D, White P, et al. C-Reactive Protein Testing to Guide Antibiotic Prescribing for COPD Exacerbations. N Engl J Med. 2019 Jul 11;381(2):111-120.

[41] Saha SK, Hawes L, Mazza D. Effectiveness of interventions involving pharmacists on antibiotic prescribing by general practitioners: a systematic review and meta-analysis. J Antimicrob Chemother. 2019 Jan 28.

[42] Williams SJ, Halls AV, Tonkin-Crine S, et al. General practitioner and nurse prescriber experiences of prescribing antibiotics for respiratory tract infections in UK primary care out-of-hours services (the UNITE study). J Antimicrob Chemother. 2018 Mar 1;73(3):795-803.

[43] Hallsworth M, Chadborn T, Sallis A, et al. Provision of social norm feedback to high prescribers of antibiotics in general practice: a pragmatic national randomised controlled trial. Lancet. 2016 23;387(10029):1743-52.

[44] van der Velden AW, Kuyvenhoven MM, Verheij TJ. Improving antibiotic prescribing quality by an intervention embedded in the primary care practice accreditation: the ARTI4 randomized trial. J Antimicrob Chemother. 2016

Table 4: Comparative costs and outcomes by sub-group

	Costs (£)				Antibiotics (%)				4-hour target (%)				Inpatient (%)			
	GP	ED	All	Sig.	GP	ED	All	Sig.	GP	ED	All	Sig.	GP	ED	All	Sig
Working diagnosis																
Fever (n=1,926)	£93.78	£69.76	£86.69	p<0.001	27.1%	16.7%	23.5%	p<0.001	98.5%	87.5%	94.6%	p<0.001	1.1%	4.5%	2.3%	p<0.001
Infectious Disease (n=1,889)	£92.18	£123.29	£103.94	p<0.001	5.7%	5.9%	5.7%	p=0.578	98.7%	89.1%	94.7%	p<0.001	0.7%	9.9%	4.4%	p<0.001
Gastrointestinal (n=2,105)	£89.49	£120.77	£104.76	p<0.001	0.5%	0.6%	0.6%	p=0.891	98.8%	86.2%	94.4%	p<0.001	1.0%	8.6%	3.9%	p<0.001
Respiratory (n=3,146)	£87.52	£89.40	£88.16	p=0.897	16.2%	10.2%	14.3%	p<0.001	98.9%	86.3%	94.3%	p<0.001	0.5%	6.5%	2.7%	p<0.001
Local Infection (n=866)	£92.97	£88.26	£91.34	p=0.521	40.3%	39.9%	40.2%	p=0.978	98.4%	86.4%	93.9%	p<0.001	0.7%	4.1%	2%	p<0.001
Ear, Nose and Throat (n=906)	£86.78	£111.90	£92.30	p<0.001	41.5%	35.7%	40.1%	p=0.298	97.8%	86.8%	95%	p<0.001	0.0%	2.8%	0.7%	p<0.001
Age																
<3 months (n=932)	£99.49	£242.54	£152.88	p<0.001	5.2%	5.6%	5.4%	p=0.947	99.2%	87.9%	95.2%	p<0.001	1.2%	14.3%	6.2%	p<0.001
3-6 months (n=829)	£135.55	£196.38	£162.38	p<0.001	8.8%	8.2%	8.6%	p=0.935	98.5%	90.1%	95.2%	p<0.001	2.3%	7.1%	4.5%	p<0.001
6-12 months (n=1,991)	£101.04	£95.29	£100.60	p<0.001	13.1%	8.6%	11.5%	p=0.012	98.4%	89.5%	94.4%	p<0.001	1.6%	7.8%	4.2%	p<0.001
1-3 years (n=4,956)	£99.83	£116.47	£109.70	p<0.001	18.2%	11.5%	15.7%	p<0.001	98.6%	87.6%	94.2%	p<0.001	1.1%	7.1%	3.6%	p<0.001
4-10 years (n=3,191)	£118.36	£130.14	£132.08	p<0.001	16.8%	13.4%	15.5%	p=0.037	98.6%	89.5%	94.6%	p<0.001	1.4%	5.7%	3.3%	p<0.001
11+ years (n=1,200)	£115.39	£238.72	£157.93	p<0.001	13.9%	10.4%	12.9%	p=0.07	98.5%	86.0%	93.8%	p<0.001	1.6%	7.7%	3.9%	p<0.001
Deprivation quintile#																
1 (n=8,436)	£111.56	£150.61	£126.23	p<0.001	15.40%	10.30%	13.50%	p<0.001	98.60%	87.30%	94.30%	p=0.005	1.40%	7.80%	3.80%	p<0.001
2 (n=1,426)	£108.43	£150.48	£124.33	p<0.001	16.60%	11.50%	14.70%	p=0.009	99.40%	88.60%	95.40%	p<0.001	1.20%	8.90%	4.20%	p=0.003
3 (n=1,337)	£94.17	£170.70	£124.10	p<0.001	14.80%	11%	13.30%	p=0.047	98.30%	88.80%	94.60%	p<0.001	1.70%	7.70%	4%	p<0.001
4 (n=709)	£104.17	£92.69	£99.98	p<0.001	12.70%	12.90%	12.80%	p=0921	98.20%	88.90%	94.80%	p<0.001	1.50%	5.70%	3.10%	p<0.001
5 (n=314)	£115.55	£189.99	£141.29	p<0.001	14.90%	17.30%	15.70%	p=0.582	97.60%	89.10%	94.70%	p<0.001	1.40%	10.90%	4.70%	p<0.001

* Significance determined via Mann Whitney U-test

 # 1 (most deprived), 5 least deprived)