British Journal of Medicine & Medical Research
18(6): 1-23, 2016, Article no.BJMMR.29208
ISSN: 2231-0614, NLM ID: 101570965

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Using Social Groups to Locate Areas with High Emergency Department Attendance, Subsequent Inpatient Admission and Need for Critical Care

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Authors' contributions

This work was carried out in collaboration between both authors. Author NB designed the study. Author RPJ performed the analysis, managed the literature searches and wrote the first draft of the manuscript. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJMMR/2016/29208
Editor(s):
(1) Faris Q. B. Alenzi, Department of Medical Laboratories, College of Applied Medical Sciences Salman bin Abdulaziz University (Al-Kharj), Saudi Arabia.
Reviewers:
(1) Ramona Anthonie, Stellenbosch University, South Africa.
(2) Gift Mulima, Kamuzu Central Hospital, Lilongwe, Malawi.
Complete Peer review History: http://www.sciencedomain.org/review-history/16693

Original Research Article

Received 29th August 2016
Accepted 19th October 2016
Published 27th October 2016

ABSTRACT

Aims: To study the role of social group and deprivation on the proportion of patients admitted via the emergency department who then progress to the critical care unit.
Study Design: Two large data bases were compared using the output area code of the patient's home address.
Place and Duration of Study: Patients attending the emergency department (ED) and admitted into the general surgical and medical critical care unit (CCU) at the King's College University Hospital, London, during a three-year period (2013/14 to 2015/16).
Methodology: The output area of the patient's home address was used to link ED attendances with CCU admissions. Each output area has an associated social group and deprivation score. Various ratios were calculated such as the proportion admitted in each social group, and a method based on Poisson statistics was used to measure statistical significance. Each output area contains around 300 persons of roughly similar social and demographic characteristics. The Cartesian co-ordinates (distance east and north of the UK reference point as the X- and Y-axis

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respectively) for each output area have been used to map ED attendances without resort to GIS software.

Results: Output area social grouping, via the London Output Area Classification (LOAC) and deprivation (Index of Multiple Deprivation) are shown to affect the attendance rates at the ED, the proportion admitted from the ED, and conversion rates for patients admitted via the ED into an adult general surgical and medical CCU. The overall conversion rate from an admitted inpatient to the CCU was 6.6%, however, higher than average conversion rates of 14.3% were associated with the 'Settled Asians' Super Group, while lower conversion rates of 3.3% were associated the with the 'Ageing City Fringe' Super Group and other 'Affluent Suburbs' Super Groups. Social group rather than deprivation *per se* appeared to delineate high and low conversion rates.

Conclusion: Small areas characterised by particular social groups (and relative deprivation) were identified having either high/low rates of attendance at the ED, high/low conversion to an inpatient from an ED attendance, and high/low conversion into CCU admission. This will enable Primary Care Organisations to target admission avoidance and/or appropriate end-of-life care to those social groups yielding the greatest benefit.

Keywords: Emergency department; critical care; social groups; deprivation; population segmentation; output area classification; end-of-life care; admission avoidance.

ABBREVIATIONS

CCU : Critical Care Unit.
ED : Emergency Department.
LOAC : London Output Area Classification (an area/social classification similar to the Output Area Classification (OAC) which covers the whole of England).

1. INTRODUCTION

In the UK the National Health Service (NHS) provides taxation-funded primary, secondary and tertiary care to UK residents, which is free-of-charge. Dental care is not covered and there is a fixed fee for each pharmaceutical prescription (with those over the age of 60, and those with a long-term condition exempt from the prescription charge). Hence, unlike in the USA there are no distortions in access to health care based on insurance status or poverty.

Persons who are unwell or have experienced an accident may choose to go either to their General Practitioner (GP) or attend an emergency department (ED) using their own transport or with the assistance of an emergency ambulance. Outside of working hours' persons can still access a GP via GP-run out-of-hours services. Once at the ED they will be treated and either discharged or admitted to a hospital bed for further acute care. Patients whose condition has deteriorated to the point of being life-threatening will be admitted direct to the CCU from the ED, or will access the CCU after a period of inpatient care.

At 4.7-times the daily cost of a general ward, admission into the CCU represents a very high-cost aspect of acute services [1]. In an era of increasing focus on health care costs it is no longer acceptable to assume that critical care admissions are unavoidable.

In 2006 some 27% of Medicare costs in the USA were devoted to persons in the last year of life [2], and 11% of total costs were for the last month of life [3]. Approximately 40% of this was for ineffective stays in the CCU with the patient dying in the CCU or shortly after [3,4]. The simplest method for estimating CCU costs remains the number of CCU available or occupied beds [4,5]. In the UK this number has been rising by around 2.8% per annum [6], which is around double the level expected from demographic trends, but equal to the level of growth in emergency admissions [7,8]. These trends are being matched by an increasing interest in risk stratification tools to predict those most at risk of death either in the CCU or subsequent to discharge [9-13].

The King's College University hospital (KCH) is a large specialist teaching hospital situated in the Denmark Hill area of London. The hospital contains around 1,000 beds and 65 critical care beds dedicated to surgical and medical admissions. There are around 40 other critical care beds dedicated to more specialised tertiary care. In 2015 planning began for a dedicated and large critical care facility. While such expansion may be required to match increasing demand [6], it is also necessary to identify possibilities for demand reduction. This paper reports on the use

of the social groups (as determined by the London Output Area Classification (LOAC)), and deprivation (as measured by the Index of Multiple Deprivation (hereafter called the 'deprivation index')), to segregate the population into locations with high ED attendance, or high rates of inpatient admission from the ED, or high rates of admission into the CCU.

In the UK, all census data is aggregated at the primary level of an Output Area. In London, each Output Area contains an average of 336 persons (interquartile range 276 to 385), and is chosen based on similarity of the social and demographic characteristics of the residents, based on data collected at each Census [14]. Due to its unique social and ethnic composition London has its own London Output Area Classification (LOAC) [15], which is used in this study. The LOAC divides London into 48 sub-groups.

Each output area is then aggregated to a Lower Super Output Area containing around 1,500 persons, and then to higher geographies including electoral wards and local authorities. Each Lower Super Output Area has a measure of deprivation called the Index of Multiple Deprivation (deprivation index), which as the name suggests measures 'deprivation' across multiple domains such as income, crime, and access to services, health, etc [16]. The deprivation index ranges between 1 and 100, with 1 being least deprived and 100 most deprived. The deprivation index is known to correlate well with all manner of health behaviours (smoking, obesity, etc), and consequent poor health outcomes such as emergency admissions, mental health and chronic poor health [17-23].

This paper presents a simple method for allocating the deprivation index values to the smaller Output Areas using the LOAC, and relative population sizes. Patient attendance at the ED and any subsequent admissions, and admissions to the CCU are then allocated to an Output Area with its associated LOAC or deprivation index to determine the factors indicating high utilisation in any of the three steps in the patient journey. Population weighted Output Area geographic centroids (Easting, Northing) were used to plot the location of admissions using simple Excel charts. In this context the Output Area code has the huge advantage of removing patient identifiable features such as postcode from any associated analysis.

In this study, a large database of Emergency Department attendances was linked with another large database of CCU admissions via the Output Area code associated with the patient's home address (and associated LOAC codes), and the conversion rate from one to the other evaluated.

A novel method based on Poisson statistics is used to delineate statistically significant deviations from the average. This simple method which calculates the difference from actual to expected ED admissions as a standard deviation equivalent allows non-academic NHS managers to rapidly sort social groups in order of increasing statistical significance without recourse to statistical tools.

2. MATERIALS AND METHODS

2.1 Data Sources

All data sources are given in the Appendix at the end of the document.

2.2 Conversion of Post Code to Output Area Code

To maintain patient confidentiality, the conversion of post code to Output Area code was conducted independently of this project. In the UK, each Output Area has geographic Cartesian coordinates measured in meters East and North (Easting, Northing) of the UK reference point. On this occasion the Easting and Northing of the population-weighted centroid, rather than the geometric centroid, has been used to measure distances, and to position each output area using an X and Y axis on a chart.

2.3 Estimating Deprivation Index at Output Area Level

As mentioned in the Introduction, the deprivation index is measured at Lower Super Output Area level. In London each Lower Super Output Area comprises a median number of 5 Output Areas (range 2 to 12). Given that the wealthy and poor can live within close proximity the Lower Super Output Area-based deprivation index is insufficiently accurate for precise identification of deprivation in small social groups seen at Output Area level.

The deprivation index for each Output Area in London was estimated from published Lower Super Output Area-based deprivation index data in the following way. First, the Lower Super Output Area deprivation index was averaged

across all LOAC sub-groups, and this data is presented in Table A1 in the Appendix. This enables all LOAC sub-groups to be ranked by relative deprivation index. For example, all B2b sub-groups have an average deprivation index of 43 (being the most deprived sub-group), while all H1c sub-groups have an average deprivation index of 7 (least deprived).

However, not all similar sub-groups experience the same level of deprivation across the whole of London. Adjusted values of deprivation index for each Output Area were then further refined as follows. All Output Area were grouped according to their respective Lower Super Output Area. The Lower Super Output Area-based value of the deprivation index was then modified as the population weighted average across all Output Areas using the LOAC sub-group deprivation index averages calculated above. For example, say a Lower Super Output Area has a deprivation index value of 10, but has two LOAC subgroups with averaged deprivation index scores of 9 (population 1,200) and 15 (population 900). Hence the adjusted deprivation index scores will be for LOA1 = [(10 x 1,200 + 10 x 900)/(9 x 1,200 + 15 x 900)] x 9, and for LOA2 = [10 x (1,200 + 900)/(9 x 1,200 + 15 x 900)] x 15. This process adjusts the LOAC sub-groups to their respective local deprivation index value. For example, the range in deprivation index across all B2b sub-groups is 23 to 71, while the range across all H1c sub-groups is 1 to 15.

2.4 Standard Deviation (Poisson)

The standard deviation associated with the proportion admitted or progressing to CCU can be approximated using Poisson statistics, where by definition one standard deviation is equal to the square root of the average. The statistical significance associated with the different proportions can therefore be converted into standard deviation equivalents away from the overall average (all patients from all locations). Hence expected admissions can be calculated as average proportion admitted times number of attendances, which gives the average number of expected admissions. The actual number of admissions is then compared to the estimated average and the difference between the two is then divided by the square root of the expected average number of attendances/admissions to give the difference between actual and expected as standard deviation equivalents. In Poisson statistics anything beyond ± 2 STDEV is equivalent to better than the 95% confidence interval (CI), while ± 3 STDEV is equivalent to better than the 99% CI.

2.5 Proportions Admitted or Entering CCU

The LOAC or deprivation index for each Output Area was used to group patients with similar social characteristics, ratios were calculated for each group (proportion of attendances admitted as an inpatient or proportion of admissions via ED who require treatment in CCU), and the statistical significance determined as described above.

2.6 Data Manipulation

Data manipulation was performed using Microsoft Excel, with data extracts via the Pivot Table facility within Excel. All charts and tables were created within Excel.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Location of persons attending the ED

The KCH receives visits to the emergency department from local residents, persons commuting within and into London for work, leisure and tourism during work days and weekends. Fig. A1 takes the Eastings and Northings of the population centroid of each Output Area for persons attending the ED and displays location using a simple Excel graph. Eastings and Northings are the distance in meters from the UK reference point (0,0) located off the coast of Cornwall. All national geographies including OA, post codes, electoral wards have an Easting and Northing for the population centroid. This map comprises the 15,114 Output Area from which Londoners attended the KCH emergency department. Using the Output Area code rather than the post code has the huge advantage that individuals cannot be identified and that individuals with similar characteristics can then be aggregated into groups via the LOAC.

Clearly seen to the right hand side of Fig. A1 is the mouth of the Thames River and its course through London, while other areas with no data points represent parks, nature reserves and other green belt, either Heathrow or City of London airports, or other larger commercial and industrial areas. Note that in a minority of cases

the Output Area population centroid may fall outside of the boundary of the Output Area especially where the shape of the Output Area is highly non-symmetric.

This map is to demonstrate the utility of using Output Areas and their associated Easting and Northing since geographical information can be displayed without the need for expensive GIS software. This figure also demonstrates that Londoners are highly mobile and can be in the vicinity of the KCH ED for a wide range of reasons.

3.1.2 Deprivation and proportion admitted via the ED

Fig. 1 shows the relationship between the proportion admitted from the ED and the Index of Multiple Deprivation (deprivation index) score of each Output Area. As can be seen the proportion admitted is highest at lowest deprivation score and falls to a plateau around a deprivation index value of 20 units (approximately the national average for the deprivation index). It would seem that the lower proportion admitted via the ED in the areas with higher deprivation may arise from higher non-essential use of the ED. In addition, the proportion admitted is highly dependent on age and lower deprivation is usually associated with fewer children, while higher deprivation is usually associated with more children, including single parent families [24].

Since deprivation and social group are often inter-related Table 1 lists the average deprivation index score of each social group (plus standard deviation associated with the deprivation index scores expressed as a percentage of the average) for persons attending the Kings College emergency department. In this table the average deprivation index is determined over the total number of attendances, hence will be most influenced by those Output Areas closest to KCH.

As can be seen areas of 'comfortable' retirement generally have the lowest deprivation scores (which also includes retired Asians), however, the Bangladeshi sub-group is generally characterized by the highest levels of deprivation, along with the 'Disadvantaged Diaspora' who will generally have high unemployment, tend to be on benefits and live in

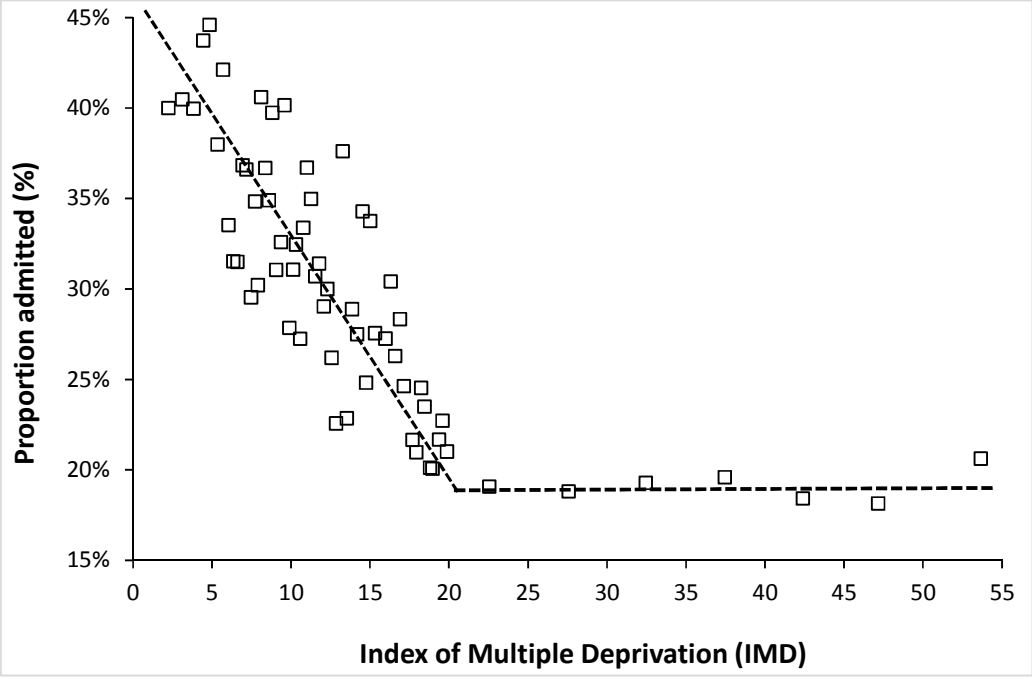

Fig. 1. Effect of deprivation on the proportion admitted from the emergency department
Each data point (up to deprivation index =20) is an average of 100 Output Area ranked by increasing deprivation index, above a deprivation index of 20 the average proportion admitted is calculated by increments of 5 units of deprivation index. In England, the national average for deprivation index is around 22 units

Table 1. Average index of multiple deprivation score (deprivation index) for different social groups (LOAC) attending the emergency department at Kings College

LOAC	Super group	Sub-group	Attendances	Average deprivation index	±STDEV (%)
H1c	Ageing City Fringe	Detached retirement	10,462	4.5	41%
H1b	Ageing City Fringe	Detached retirement	7,617	7.8	31%
H1a	Ageing City Fringe	Detached retirement	1,027	8.1	34%
H2a	Ageing City Fringe	Not quite Home Counties	9,999	8.6	36%
F1a	London Life-Cycle	City enclaves	10,757	8.8	24%
H2b	Ageing City Fringe	Not quite Home Counties	18,394	9.5	42%
F1b	London Life-Cycle	City enclaves	6,035	10.0	25%
F2b	London Life-Cycle	Affluent suburbs	8,764	10.9	27%
F2a	London Life-Cycle	Affluent suburbs	12,474	11.5	22%
D2d	Urban Elites	City central	159	12.9	21%
D2c	Urban Elites	City central	509	13.2	34%
C4a	Settled Asians	Elderly Asians	240	14.1	20%
D2a	Urban Elites	City central	1,009	14.3	30%
C4b	Settled Asians	Elderly Asians	662	14.6	23%
A2b	Intermediate Lifestyles	Suburban localities	6,172	15.8	26%
C1b	Settled Asians	Asian owner occupiers	1,026	16.3	15%
D2b	Urban Elites	City central	2,508	16.9	27%
C3e	Settled Asians	East End Asians	99	18.5	16%
C1a	Settled Asians	Asian owner occupiers	2,381	18.8	20%
D1a	Urban Elites	Educational advantage	1,029	20.0	20%
E2a	City Vibe	Graduation occupation	34,034	20.2	17%
D1b	Urban Elites	Educational advantage	589	21.4	22%
A1a	Intermediate Lifestyles	Struggling suburbs	10,864	21.7	20%
C2b	Settled Asians	Transport service workers	405	23.4	21%
E1b	City Vibe	City & student fringe	22,545	23.7	19%
C3d	Settled Asians	East End Asians	122	24.6	20%
D1c	Urban Elites	Educational advantage	4,705	25.2	21%
C2a	Settled Asians	Transport service workers	222	25.4	21%
C3c	Settled Asians	East End Asians	125	26.6	19%
G1b	Multi-ethnic Suburbs	Affordable transitions	6,189	28.3	24%
C3a	Settled Asians	East End Asians	128	28.5	22%
E1a	City Vibe	City & student fringe	87,237	29.0	20%
C3b	Settled Asians	East End Asians	103	29.2	9%
A2a	Intermediate Lifestyles	Suburban localities	7,497	29.5	23%
E2b	City Vibe	Graduation occupation	16,942	30.2	19%
G1a	Multi-ethnic Suburbs	Affordable transitions	1,527	32.6	19%
A2c	Intermediate Lifestyles	Suburban localities	10,497	34.3	20%
B3a	High Density & High Rise	Students & minority mix	22,452	36.2	16%
G2a	Multi-ethnic Suburbs	Public sector & service	4,624	38.0	18%
B3b	High Density & High Rise	Students & minority mix	10,064	38.2	14%
A1b	Intermediate Lifestyles	Struggling suburbs	20,603	39.5	19%
B2a	High Density & High Rise	Bangladeshi enclaves	540	40.6	12%
B1c	High Density & High Rise	Disadvantaged diaspora	49,597	41.9	12%
B1a	High Density & High Rise	Disadvantaged diaspora	4,599	42.0	18%
G2b	Multi-ethnic Suburbs	Public sector & service	21,214	42.6	16%
B1b	High Density & High Rise	Disadvantaged diaspora	43,087	42.7	15%
B2b	High Density & High Rise	Bangladeshi enclaves	349	47.2	18%
B2c	High Density & High Rise	Bangladeshi enclaves	614	47.8	13%

state-funded accommodation. Also seen in Table 1 is the fact that by far the most ED attendances (87,237) occur in social group E1a (City Vibe: City and student fringe), while a further 92,684 occur in the two highly deprived groups B1b and B1c (High Rise: Disadvantaged diaspora). Hence over 50% of ED attendances occur from areas with a deprivation index >29.3 units (interquartile range 18.9 to 38.8) – with 22 units being the national population weighted average for deprivation index.

3.1.3 Social group and proportion admitted via the ED

To investigate potential interactions between social group and deprivation, the Output Area deprivation index was divided into five groups with deprivation index values 0-15, 15-25, 25-35, 35-40 and 40+ respectively. Tables 2 and A1 (in the Appendix) present information regarding the proportion admitted as an inpatient (emergency) via the ED while Tables 3 and A2 present information regarding the proportion of inpatients who progress to admission into the general surgical and medical CCU. The first table in each set gives data regarding social group while the second table shows each social group sub-divided into deprivation index bands.

Data in each table only includes groups where the actual admissions versus expected admissions exceed the 95% CI, i.e. > 2 STDEV equivalents.

As can be seen in Table 2 lower proportion admitted appear to be related to more disadvantaged social groups while higher proportion admitted mainly occurs in older and more affluent social groups. As expected from Fig. 1, Table A1 demonstrates that a lower proportion admitted is generally associated with higher deprivation index bands, however even low deprivation index Asian social groups show low proportion admitted as opposed to high proportion among largely white affluent social groups.

The situation regarding conversion from admitted via the ED to care in the CCU reveals high conversion for Asian and mixed ethnic groups and low conversion in the older and more affluent groups (Table 3) while Table A2 demonstrates that the effect in Asians (high conversion) is largely independent of deprivation index while in groups with lower conversion rates, social group (LOAC) also seems to have a stronger influence than deprivation index per se.

3.1.4 Social group and proportion who die in the ED

Table provides details of the social groups with statistically significant higher/lower proportions of persons who die in the ED. Social groups with a higher proportion of deaths in the ED generally have elder people and fewer persons from high deprivation areas. The latter group have a lower proportion who die by virtue of higher numbers of attendances for primary care treatable conditions.

3.1.5 Social group and length of stay in the CCU

The average length of stay (LOS) in the CCU will be influenced by patient acuity and the case-mix for the presenting condition(s). Table 5 details social groups with significantly different average LOS in the CCU. Social groups with higher proportions of older people appear to have a higher average LOS probably due to both age and a more acute case-mix.

The issue of case-mix and complexity can be explored using the days of specialist nursing input assigned to each stay in the CCU, i.e. respiratory, cardiovascular, renal, etc, and the results of such analysis are presented in Table A3. Patients in the CCU can have multiple instances of specialist input delivered on the same day or throughout their entire stay. Hence the ratio of total days of specialist input to the LOS in the CCU gives a measure of case complexity. Results in Table A3 are ranked by the number of admissions to the CCU from each social group (highest at the top). This table gives the number of admissions from each social group into the CCU, the average length of stay (LOS), the ratio of total care days to average LOS, and the ratio of actual care days to that expected from the all-London average for each care type. As is expected the volatility in the ratio of actual care days to that expected from the average increases as size reduces.

For social groups with more than 100 admissions the maximum and minimum ratio of actual to expected days of input from different types of care are highlighted. For example, the amount of specialist dermatological input ranges from 69% lower than expected for social group H1C (Ageing City Fringe: Detached Retirement) through to 64% above average for social group B3a (High Density& High Rise: Students & Minority Mix). This latter group being an obvious target for dermatological primary care preventative intervention.

As seen in Fig. 2 there is an approximate linear relationship between average length of stay and the ratio of specialist days per day stay, such that LOAC with a higher average LOS tend to have a higher ratio of specialist input, i.e. the patient is more complex and therefore stays in the CCU for a longer time.

Table 2. Social groups split by deprivation index band having statistically significant higher/lower proportion admitted from the ED

LOAC	Super group	Sub group	Deprivation index	Attended	Admitted	Expected	Difference as STDEV	Proportion admitted
B1c	High Density & High Rise	Disadvantaged diaspora	40+	31,026	4,499	6,947	-29.4	15%
B1c	High Density & High Rise	Disadvantaged diaspora	35-40	15,286	2,182	3,423	-21.2	14%
B3a	High Density & High Rise	Students & minority mix	25-35	10,111	1,311	2,264	-20.0	13%
B1b	High Density & High Rise	Disadvantaged diaspora	40+	31,456	5,432	7,043	-19.2	17%
E1a	City Vibe	City & student fringe	25-35	51,594	9,533	11,552	-18.8	18%
E2a	City Vibe	Graduation occupation	15-25	30,235	5,261	6,770	-18.3	17%
E1b	City Vibe	City & student fringe	15-25	13,028	2,073	2,917	-15.6	16%
B1b	High Density & High Rise	Disadvantaged diaspora	25-35	5,510	785	1,234	-12.8	14%
E2b	City Vibe	Graduation occupation	25-35	11,342	1,962	2,539	-11.5	17%
E1b	City Vibe	City & student fringe	25-35	8,772	1,476	1,964	-11.0	17%
B1c	High Density & High Rise	Disadvantaged diaspora	25-35	3,285	443	736	-10.8	13%
E1a	City Vibe	City & student fringe	15-25	23,788	4,540	5,326	-10.8	19%
B1b	High Density & High Rise	Disadvantaged diaspora	35-40	6,123	1,001	1,371	-10.0	16%
G1b	Multi-ethnic Suburbs	Affordable transitions	25-35	3,175	493	711	-8.2	16%
B3b	High Density & High Rise	Students & minority mix	25-35	2,814	437	630	-7.7	16%
B3a	High Density & High Rise	Students & minority mix	35-40	6,278	1,138	1,406	-7.1	18%
B3a	High Density & High Rise	Students & minority mix	40+	5,952	1,104	1,333	-6.3	19%
D1c	Urban Elites	Educational advantage	15-25	2,244	364	502	-6.2	16%
G1b	Multi-ethnic Suburbs	Affordable transitions	15-25	2,244	364	502	-6.2	16%
D1a	Urban Elites	Educational advantage	15-25	840	105	188	-6.1	13%
E2a	City Vibe	Graduation occupation	1-15	1,826	288	409	-6.0	16%
G2b	Multi-ethnic Suburbs	Public sector & service	40+	13,520	2,730	3,027	-5.4	20%
E2b	City Vibe	Graduation occupation	35-40	2,764	489	619	-5.2	18%
E2a	City Vibe	Graduation occupation	25-35	1,973	334	442	-5.1	17%
D1c	Urban Elites	Educational advantage	25-35	2,365	415	530	-5.0	18%
B3b	High Density & High Rise	Students & minority mix	35-40	4,112	774	921	-4.8	19%
G2b	Multi-ethnic Suburbs	Public sector & service	35-40	5,025	966	1,125	-4.7	19%
E2b	City Vibe	Graduation occupation	15-25	1,710	298	383	-4.3	17%
G2a	Multi-ethnic Suburbs	Public sector & service	40+	1,760	316	394	-3.9	18%
G1a	Multi-ethnic Suburbs	Affordable transitions	25-35	745	118	167	-3.8	16%
G1a	Multi-ethnic Suburbs	Affordable transitions	35-40	450	65	101	-3.6	14%
C1a	Settled Asians	Asian owner occupiers	15-25	1,859	348	416	-3.3	19%
G1b	Multi-ethnic Suburbs	Affordable transitions	35-40	344	48	77	-3.3	14%
C3c	Settled Asians	East End Asians	25-35	75	4	17	-3.1	5%
G2a	Multi-ethnic Suburbs	Public sector & service	35-40	1,484	276	332	-3.1	19%
D1b	Urban Elites	Educational advantage	15-25	364	54	81	-3.0	15%

LOAC	Super group	Sub group	Deprivation index	Attended	Admitted	Expected	Difference as STDEV	Proportion admitted
G2b	Multi-ethnic Suburbs	Public sector & service	25-35	2,571	509	576	-2.8	20%
D1a	Urban Elites	Educational advantage	25-35	110	11	25	-2.7	10%
G1a	Multi-ethnic Suburbs	Affordable transitions	40+	133	15	30	-2.7	11%
B2a	High Density & High Rise	Bangladeshi enclaves	25-35	40	1	9	-2.7	3%
C1a	Settled Asians	Asian owner occupiers	1-15	387	63	87	-2.5	16%
E1a	City Vibe	City & student fringe	1-15	287	44	64	-2.5	15%
B2c	High Density & High Rise	Bangladeshi enclaves	40+	559	97	125	-2.5	17%
D2b	Urban Elites	City central	15-25	1,372	264	307	-2.5	19%
E1b	City Vibe	City & student fringe	35-40	228	34	51	-2.4	15%
C3b	Settled Asians	East End Asians	25-35	103	12	23	-2.3	12%
B2b	High Density & High Rise	Bangladeshi enclaves	25-35	30	1	7	-2.2	3%
E2b	City Vibe	Graduation occupation	1-15	338	57	76	-2.1	17%
C3d	Settled Asians	East End Asians	15-25	81	9	18	-2.1	11%
B2a	High Density & High Rise	Bangladeshi enclaves	40+	378	65	85	-2.1	17%
D2c	Urban Elites	City central	15-25	158	23	35	-2.1	15%
E2b	City Vibe	Graduation occupation	40+	788	149	176	-2.1	19%
C2b	Settled Asians	Transport service workers	25-35	122	17	27	-2.0	14%
F1b	London Life-Cycle	City enclaves	15-25	132	41	30	2.1	31%
A1a	Intermediate Lifestyles	Struggling suburbs	35-40	23	10	5	2.1	43%
H2a	Ageing City Fringe	Not quite Home Counties	15-25	333	100	75	2.9	30%
D2a	Urban Elites	City central	1-15	457	135	102	3.2	30%
A1b	Intermediate Lifestyles	Struggling suburbs	25-35	3,597	901	805	3.4	25%
A1a	Intermediate Lifestyles	Struggling suburbs	25-35	2,265	591	507	3.7	26%
F2a	London Life-Cycle	Affluent suburbs	15-25	1,272	348	285	3.7	27%
A1b	Intermediate Lifestyles	Struggling suburbs	15-25	448	142	100	4.2	32%
H1b	Ageing City Fringe	Detached retirement	15-25	21	14	5	4.3	67%
A2b	Intermediate Lifestyles	Suburban localities	25-35	234	84	52	4.4	36%
F1a	London Life-Cycle	City enclaves	15-25	26	17	6	4.6	65%
A1b	Intermediate Lifestyles	Struggling suburbs	35-40	8,130	2,036	1,820	5.1	25%
G2b	Multi-ethnic Suburbs	Public sector & service	15-25	106	49	24	5.2	46%
H1a	Ageing City Fringe	Detached retirement	1-15	1,027	311	230	5.3	30%
F2b	London Life-Cycle	Affluent suburbs	15-25	785	293	176	8.8	37%
A2c	Intermediate Lifestyles	Suburban localities	15-25	805	300	180	8.9	37%
A2a	Intermediate Lifestyles	Suburban localities	35-40	1,480	516	331	10.1	35%
F2a	London Life-Cycle	Affluent suburbs	1-15	11,204	3,080	2,509	11.4	27%
A1b	Intermediate Lifestyles	Struggling suburbs	40+	8,428	2,463	1,887	13.3	29%
A2b	Intermediate Lifestyles	Suburban localities	1-15	2,933	1,000	657	13.4	34%
A2c	Intermediate Lifestyles	Suburban localities	40+	2,644	930	592	13.9	35%

LOAC	Super group	Sub group	Deprivation index	Attended	Admitted	Expected	Difference as STDEV	Proportion admitted
A2c	Intermediate Lifestyles	Suburban localities	35-40	1,949	736	436	14.3	38%
H2b	Ageing City Fringe	Not quite Home Counties	15-25	2,005	798	449	16.5	40%
A2b	Intermediate Lifestyles	Suburban localities	15-25	3,005	1,122	673	17.3	37%
A2a	Intermediate Lifestyles	Suburban localities	15-25	2,166	969	485	22.0	45%
A2a	Intermediate Lifestyles	Suburban localities	25-35	3,632	1,446	813	22.2	40%
A2c	Intermediate Lifestyles	Suburban localities	25-35	5,099	1,911	1,142	22.8	37%
F2b	London Life-Cycle	Affluent suburbs	1-15	7,980	2,774	1,787	23.4	35%
H2a	Ageing City Fringe	Not quite Home Counties	1-15	9,666	3,431	2,164	27.2	35%
H1c	Ageing City Fringe	Detached retirement	1-15	10,462	4,306	2,342	40.6	41%
H1b	Ageing City Fringe	Detached retirement	1-15	7,596	3,382	1,701	40.8	45%
H2b	Ageing City Fringe	Not quite Home Counties	1-15	16,389	6,925	3,669	53.7	42%

Table 3. Conversion rates for social groups (with additional banding by deprivation score) admitted via the ED and then progressing to the general surgical and medical critical care unit

LOAC	Super group	Sub group	Deprivation index	Admitted via the ED	CCU admitted	CCU expected	Difference as STDEV	Conversion
C2b	Settled Asians	Transport service	15-25	59	13	4	4.6	22.0%
C2a	Settled Asians	Transport service	25-35	25	7	2	4.2	28.0%
C1a	Settled Asians	Asian owner occupiers	1-15	63	12	4	3.9	19.0%
B2c	High Density & High Rise	Bangladeshi enclaves	25-35	11	4	1	3.8	36.4%
A1a	Intermediate Lifestyles	Struggling suburbs	1-15	107	16	7	3.4	15.0%
G2a	Multi-ethnic Suburbs	Public sector & service	40+	316	35	21	3.1	11.1%
D1a	Urban Elites	Educational advantage	15-25	105	14	7	2.7	13.3%
C2a	Settled Asians	Transport service	15-25	19	4	1	2.5	21.1%
D1b	Urban Elites	Educational advantage	25-35	47	7	3	2.2	14.9%
C1a	Settled Asians	Asian owner occupiers	15-25	348	33	23	2.1	9.5%
G1a	Multi-ethnic Suburbs	Affordable transitions	40+	15	3	1	2.0	20.0%
E2b	City Vibe	Graduation occupation	35-40	489	21	32	-2.0	4.3%
F1b	London Life-Cycle	City enclaves	1-15	1,256	64	83	-2.1	5.1%
A1b	Intermediate Lifestyles	Struggling suburbs	35-40	2,036	108	134	-2.3	5.3%
B3b	High Density/High Rise	Students & minority mix	35-40	774	34	51	-2.4	4.4%
B3a	High Density/High Rise	Students & minority mix	40+	1,104	52	73	-2.4	4.7%
E2b	City Vibe	Graduation occupation	25-35	1,962	99	129	-2.7	5.0%
A2a	Intermediate Lifestyles	Suburban localities	35-40	516	18	34	-2.7	3.5%
F2b	London Life-Cycle	Affluent suburbs	15-25	293	7	19	-2.8	2.4%

LOAC	Super group	Sub group	Deprivation index	Admitted via the ED	CCU admitted	CCU expected	Difference as STDEV	Conversion
F1a	London Life-Cycle	City enclaves	1-15	2,429	122	160	-3.0	5.0%
A2c	Intermediate Lifestyles	Suburban localities	35-40	736	27	48	-3.1	3.7%
E2a	City Vibe	Graduation occupation	15-25	5,261	285	347	-3.3	5.4%
B1b	High Density & High Rise	Disadvantaged diaspora	35-40	1,001	39	66	-3.3	3.9%
A2b	Intermediate Lifestyles	Suburban localities	15-25	1,122	44	74	-3.5	3.9%
B1b	High Density & High Rise	Disadvantaged diaspora	40+	5,432	288	358	-3.7	5.3%
A2b	Intermediate Lifestyles	Suburban localities	1-15	1,000	34	66	-3.9	3.4%
B1c	High Density & High Rise	Disadvantaged diaspora	40+	4,499	226	296	-4.1	5.0%
A2a	Intermediate Lifestyles	Suburban localities	15-25	969	31	64	-4.1	3.2%
E1a	City Vibe	City & student fringe	25-35	9,533	524	628	-4.2	5.5%
H2b	Ageing City Fringe	Not quite Home Counties	15-25	798	19	53	-4.6	2.4%
H2a	Ageing City Fringe	Not quite Home Counties	1-15	3,431	153	226	-4.9	4.5%
F2a	London Life-Cycle	Affluent suburbs	1-15	3,080	129	203	-5.2	4.2%
A2a	Intermediate Lifestyles	Suburban localities	25-35	1,446	39	95	-5.8	2.7%
A2c	Intermediate Lifestyles	Suburban localities	25-35	1,911	58	126	-6.1	3.0%
A2c	Intermediate Lifestyles	Suburban localities	40+	930	12	61	-6.3	1.3%
F2b	London Life-Cycle	Affluent suburbs	1-15	2,774	91	183	-6.8	3.3%
H1c	Ageing City Fringe	Detached retirement	1-15	4,306	123	284	-9.5	2.9%
H1b	Ageing City Fringe	Detached retirement	1-15	3,382	77	223	-9.8	2.3%
H2b	Ageing City Fringe	Not quite Home Counties	1-15	6,925	242	456	-10.0	3.5%

Table 4. Social group and the proportion of persons who die in the ED

LOAC	Super group	Sub group	Attended	Died	Expected	Difference as STDEV	Proportion
B1b	High Density/High Rise	Disadvantaged diaspora	43,089	22	43	-3.2	0.05%
B1c	High Density/High Rise	Disadvantaged diaspora	49,597	31	50	-2.6	0.06%
E1b	City Vibe	City & student fringe	22,545	11	23	-2.4	0.05%
G1b	Multi-ethnic Suburbs	Affordable transitions	6,189	1	6	-2.1	0.02%
A1b	Intermediate Lifestyles	Struggling suburbs	20,603	30	21	2.1	0.15%
F1a	London Life-Cycle	City enclaves	10,757	18	11	2.2	0.17%
H1c	Ageing City Fringe	Detached retirement	10,462	18	10	2.3	0.17%
A2b	Intermediate Lifestyles	Suburban localities	6,172	13	6	2.8	0.21%
H1b	Ageing City Fringe	Detached retirement	7,617	18	8	3.8	0.24%

Table 5. Social group (LOAC) and length of stay in the CCU

LOAC	Super group	Sub group	CCU admissions	Bed days	Expected	Difference as STDEV	AvLOS
B1b	High Density & High Rise	Disadvantaged diaspora	382	2579	2913	-6.2	6.8
B3b	High Density & High Rise	Students & minority mix	106	655	808	-5.4	6.2
D2b	Urban Elites	City central	30	151	229	-5.1	5.0
D1a	Urban Elites	Educational advantage	14	56	107	-4.9	4.0
C1a	Settled Asians	Asian owner occupiers	47	267	358	-4.8	5.7
F2a	London Life-Cycle	Affluent suburbs	144	941	1098	-4.7	6.5
E2b	City Vibe	Graduation occupation	148	998	1129	-3.9	6.7
H1c	Ageing City Fringe	Detached retirement	123	830	938	-3.5	6.7
G2a	Multi-ethnic Suburbs	Public sector & service	77	512	587	-3.1	6.6
G1a	Multi-ethnic Suburbs	Affordable transitions	19	110	145	-2.9	5.8
E2a	City Vibe	Graduation occupation	327	2356	2494	-2.8	7.2
E1a	City Vibe	City & student fringe	963	7120	7344	-2.6	7.4
D2a	Urban Elites	City central	17	101	130	-2.5	5.9
G2b	Multi-ethnic Suburbs	Public sector & service	308	2453	2349	2.1	8.0
B1c	High Density & High Rise	Disadvantaged diaspora	366	2924	2791	2.5	8.0
C1b	Settled Asians	Asian owner occupiers	18	167	137	2.5	9.3
A1a	Intermediate Lifestyles	Struggling suburbs	197	1661	1502	4.1	8.4
F2b	London Life-Cycle	Affluent suburbs	98	861	747	4.2	8.8
E1b	City Vibe	City & student fringe	234	1975	1784	4.5	8.4
H1a	Ageing City Fringe	Detached retirement	25	279	191	6.4	11.2
H2b	Ageing City Fringe	Not quite Home Counties	261	2303	1990	7.0	8.8
H1b	Ageing City Fringe	Detached retirement	77	847	587	10.7	11.0

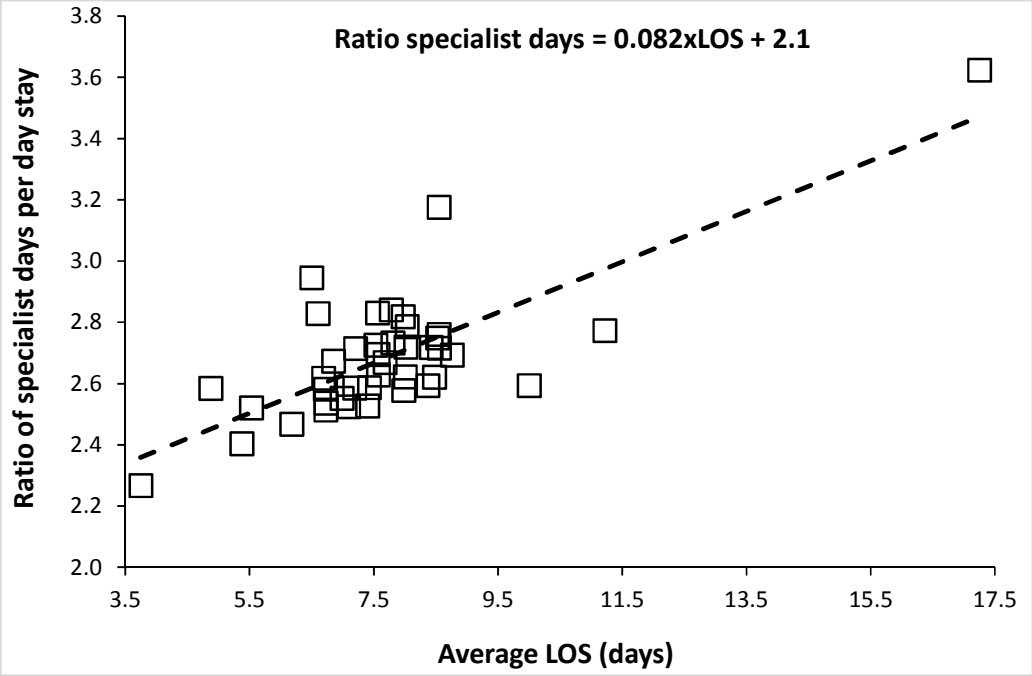

Fig. 2. Relationship between average LOS and the ratio of specialist days per day stay

3.2 Discussion

The aim of this study was to locate small area geographies where the proportions are statistically different, i.e. top or bottom rank in the various tables in this study. To achieve this purpose no age-standardization is required, i.e. an old but affluent population is likely to have an equally high rate of attendance/admission to a younger Asian population (with known disposition to heart disease). From an attendance/admission avoidance perspective both are equally important.

This study is part of a wider series investigating the use of social groups as a means of segmenting the population with a view to targeted preventative health care interventions [24]. Social grouping is widely used in the marketing industry to identify groups of people most likely to purchase particular items (or groups of items). To our knowledge this is the first study which uses social groups to follow the flow of patients via the emergency department to inpatient admission and time in the CCU.

For the purpose of this type of study the Output Area code (separately derived from the postcode) has the huge advantage that all addresses are effectively anonymized and individual persons cannot be identified. By virtue of the Output Area code it is then possible to create additional social groupings via links with other data collected at Output Area level, hence the Lower Super Output Area-deprivation index groupings created for Table 1. In the UK, the Output Area Classification (OAC) and London Output Area Classification (LOAC) have the added advantage that they are free of charge for non-commercial use and hence NHS organizations such as Clinical Commissioning Groups are able to make use of these powerful segmentation tools without recourse to very expensive commercial alternatives. Further sub-division of social groups into broad deprivation index bands (Table A2) was shown to sharpen the specificity of the method to identifying precise Output Area to target for admission avoidance strategies.

The simple statistical test used in this study relies on the fact that the standard deviation of a Poisson distribution is by definition equal to the square root of the average. Hence any deviation from the population average can be converted into a standard deviation equivalent difference. Differences from the average can then be ranked from highest to lowest standard deviation equivalent difference. The advantage is that NHS managers can quickly rank results in order of standard deviation equivalents. Precise tests for statistical significance are not needed since this

method initiates a process of further evaluation for those social groups that may look to be of interest.

Deprivation is well known for its relationship with poor health, and higher deprivation is known to be associated with higher levels of depression, multi-morbidity, mortality and overall health care costs [25]. As has been demonstrated in the US, composite measures of deprivation are far better at detecting health inequalities than just poverty alone [26], and hence the UK Index of Multiple Deprivation (deprivation index) which uses 37 indicators across seven domains of deprivation is a balanced tool [27]. For example, one study of CCU admissions in England, using the deprivation index demonstrated that persons in the most deprived quintile had a 19% higher (adjusted odds ratio) risk of dying in the CCU [28].

However, from Table 1 it was apparent that social group and deprivation are strongly related. London is very cosmopolitan with a diverse racial mix. Racial factors are known to predispose certain groups to particular diseases [29], and the LOAC should be sensitive to these subtle racial (and cultural) differences. An interesting example is the apparent need for far higher levels of dermatological input into CCU patients coming from group B3a (High Density & High Rise: Students & Minority Mix) identified in Table A3. Of particular relevance in London is the known disposition of Asians to diabetes and heart disease [30], and consequent diabetes-associated end stage renal failure [31]. Group C is mainly comprised of Asians, while B2 is further characterized by Bangladeshi descent. Hence it is social group (LOAC) rather than deprivation which tends to drive the ranking in Tables 2 and 3.

The role of social group in the proportion admitted as an inpatient (Tables 1 and 2) or who die in A&E (Table 5) is a mix of competing forces. Average age will increase the proportion admitted [24], while higher deprivation will increase the number of lower acuity attendances (Tables 1 and 2) [24]. In this respect any Clinical Commissioning Group seeking to target vulnerable social groups will also be looking at those groups with the highest number of attendances/admissions, and hence the greatest opportunity for attendance/admission avoidance. Hence by virtue of sheer weight of numbers groups E1a (87,000 attendances), B1c (50,000 attendances) and B1b (43,000) attendances would be a primary focus in attempts to reduce A&E attendance, etc.

The results presented in Tables 5 and A3 regarding the role of social group on length of stay and resource input in the CCU are of interest. In a study of adult general critical care units in the UK it was established that non-survivors tended to stay longer in the CCU but had shorter total hospital length of stay [32]. In Table 5 it was noted that certain social groups had statistically higher average LOS in the CCU, especially certain members of Super Group H (affluent retirement). Table A3 further identified social groups with high/low input from specialist nursing for particular body systems (respiratory, cardiovascular, etc). For example, group F2a (London City life cycle: Affluent suburbs) had 66% higher input for liver function, while B3a (High density/High Rise: Students & Minority Mix) had 52% higher neurological input, and E1b (City Vibe: City & Student Fringe) had 70% higher dermatological input.

All of the above point to the fact that social group plays a major role in the flows of patients to the ED, then admission and (for some) time in the CCU. Social group is far more powerful than deprivation alone, in that deprivation is unable to segment based on the subtler ethnic (and cultural, including diet and nutrition) differences between areas with apparently similar deprivation.

4. LIMITATIONS OF THE STUDY AND FURTHER RESEARCH

This study is limited to the patients attending/admitted to just one London hospital. As a consequence, many LOAC have too few attendances/admissions to establish statistical significance. Indeed, this study has too few attendances/admissions to evaluate the role of deprivation within different social groups, i.e. are some social groups more sensitive to differences in deprivation than others. A London-wide study would seem justified.

Given the role of ethnicity in disease prevalence, and the known role of lifestyle factors such as diet on the progress of various diseases it would seem relevant that a health care specific version of the Output Area Classification be developed with groups and subgroups derived from ethnic, dietary, obesity, smoking prevalence data. Such a health care specific Output Area Classification would need to be developed in cooperation with

major supermarket chains making use of the information available via customer loyalty cards.

5. CONCLUSIONS

The Output Area Classification and associated measure of deprivation provide a readily accessible way to segment the population into small areas (approximately 300 persons) with a high proportion of admission via the ED or risk of CCU admission following admission via the ED. The method is also more widely applicable to emergency admissions in general, i.e. not just via the ED, where deprivation is also associated with higher admission rates [33].

The Output Area Classification has the advantage over the deprivation index in that it contains social groups with particular ethnic/racial characteristics (cultural, dietary, genetic) which are relevant to health care utilization. Combinations of the Output Area Classification and the deprivation index (as illustrated in this study) may also be used to identify specific geographic areas with very high utilization arising from high-risk health behaviors or due to ethnic origin or cultural factors.

As expected, different social groups display different patterns of acute utilization as measured by attendance rates at the ED, proportion admitted as an inpatient and the case mix and average length of stay in the CCU. Use of this method to target different groups with specific health education and primary care support requires further investigation.

This study needs to be repeated using a larger population sample (possibly the whole of London) in order to quantify all types of social groups available via the LOAC, and to further quantify the sensitivity of different LOAC (social) groups to deprivation.

CONSENT

It is not applicable. This study only uses administrative data.

ETHICAL APPROVAL

It is not applicable. No patient identifiable data was used in this study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

Data Sources

The London Output Area Classification was obtained from the Greater London Authority, London Datastore website http://data.london.gov.uk/dataset/london-area-classification
Accessed 8 May 2016.
The 2011 Output Area (OA) population weighted centroids (Easting and Northing) were obtained from the Office for National Statistics (ONS) website http://www.ons.gov.uk/ons/guide-method/geography/products/census/spatial/centroids/index.html
Accessed 8 May 2016.
The 2011 Output Area to lower super output area (Lower Super Output Area) lookup was obtained from the ONS website, sub-section 'Lookups between 2011 Census output areas and other geographies'
http://www.ons.gov.uk/ons/guide-method/geography/products/census/lookup/2011/index.html
Accessed 8 May 2016.
The 2015 Deprivation index was obtained from the GOV.UK website https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015
Accessed 8 May 2016.
Mid-2013 population estimates for London OA's were obtained from the ONS website http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-367629
Accessed 8 May 2016.
Postcode to output area code lookup tables were obtained from the NHS England website https://data.england.nhs.uk/dataset/ods-data-supplied-by-the-office-of-national-statistics/resource/9685b3fa-b498-4148-91b3-a02d99b9021b
Accessed 8 May 2016.

Table A1. Social groups having statistically significant higher/lower proportion of persons admitted via the emergency department

LOAC	Super group	Sub group	Attended	Admitted	Expected	Difference as STDEV	Proportion admitted
B1c	High Density & High Rise	Disadvantaged diaspora	49,597	7,124	11,105	-37.8	14%
B1b	High Density & High Rise	Disadvantaged diaspora	43,089	7,218	9,648	-24.7	17%
B3a	High Density & High Rise	Students & minority mix	22,452	3,571	5,027	-20.5	16%
E1a	City Vibe	City & student fringe	87,248	16,697	19,535	-20.3	19%
E2a	City Vibe	Graduation occupation	34,034	5,883	7,620	-19.9	17%
E1b	City Vibe	City & student fringe	22,545	3,704	5,048	-18.9	16%
E2b	City Vibe	Graduation occupation	16,942	2,955	3,793	-13.6	17%
G1b	Multi-ethnic Suburbs	Affordable transitions	6,189	1,009	1,386	-10.1	16%
D1c	Urban Elites	Educational advantage	4,705	793	1,053	-8.0	17%
G2b	Multi-ethnic Suburbs	Public sector & service	21,222	4,254	4,752	-7.2	20%
D1a	Urban Elites	Educational advantage	1,029	128	230	-6.7	12%
B3b	High Density & High Rise	Students & minority mix	10,064	1,942	2,253	-6.6	19%
G1a	Multi-ethnic Suburbs	Affordable transitions	1,527	232	342	-5.9	15%
G2a	Multi-ethnic Suburbs	Public sector & service	4,624	894	1,035	-4.4	19%
C1a	Settled Asians	Asian owner occupiers	2,381	448	533	-3.7	19%
C3c	Settled Asians	East End Asians	125	12	28	-3.0	10%
D2c	Urban Elites	City central	509	86	114	-2.6	17%
C3d	Settled Asians	East End Asians	122	14	27	-2.5	11%
B2b	High Density & High Rise	Bangladeshi enclaves	349	56	78	-2.5	16%
B2a	High Density & High Rise	Bangladeshi enclaves	540	94	121	-2.4	17%
B2c	High Density & High Rise	Bangladeshi enclaves	614	110	137	-2.3	18%
C3b	Settled Asians	East End Asians	103	12	23	-2.3	12%
D2b	Urban Elites	City central	2,508	508	562	-2.3	20%
A1a	Intermediate Lifestyles	Struggling suburbs	10,865	2,585	2,433	3.1	24%
H1a	Ageing City Fringe	Detached retirement	1,027	311	230	5.3	30%
F2a	London Life-Cycle	Affluent suburbs	12,476	3,428	2,793	12.0	27%
A1b	Intermediate Lifestyles	Struggling suburbs	20,603	5,542	4,613	13.7	27%
A2b	Intermediate Lifestyles	Suburban localities	6,172	2,206	1,382	22.2	36%
F2b	London Life-Cycle	Affluent suburbs	8,765	3,067	1,962	24.9	35%
H2a	Ageing City Fringe	Not quite Home Counties	9,999	3,531	2,239	27.3	35%
A2c	Intermediate Lifestyles	Suburban localities	10,497	3,877	2,350	31.5	37%
A2a	Intermediate Lifestyles	Suburban localities	7,497	2,989	1,679	32.0	40%
H1c	Ageing City Fringe	Detached retirement	10,462	4,306	2,342	40.6	41%
H1b	Ageing City Fringe	Detached retirement	7,617	3,396	1,705	40.9	45%
H2b	Ageing City Fringe	Not quite Home Counties	18,394	7,723	4,118	56.2	42%

Table A2. Conversion rates for social groups admitted via the ED and then progressing to the general surgical and medical critical care unit

LOAC	Super group	Sub group	ED admitted	CCU admitted	CCU expected	Difference as STDEV	Conversion
C2a	Settled Asians	Transport service workers	45	17	3	8.2	37.8%
C2b	Settled Asians	Transport service workers	78	16	5	4.8	20.5%
C1a	Settled Asians	Asian owner occupiers	448	47	30	3.2	10.5%
C3a	Settled Asians	East End Asians	22	5	1	2.9	22.7%
All C above	**Settled Asians**		**593**	**85**	**39**	**7.3**	**14.3%**
G2a	Multi-ethnic Suburbs	Public sector & service	894	77	59	2.4	8.6%
A1a	Intermediate Lifestyles	Struggling suburbs	2,585	197	170	2.0	7.6%
D1c	Urban Elites	Educational advantage	793	67	52	2.0	8.4%
D1b	Urban Elites	Educational advantage	113	13	7	2.0	11.5%
F1b	London Life-Cycle	City enclaves	1,297	67	85	-2.0	5.2%
B3a	High Density & High Rise	Students & minority mix	3,571	200	235	-2.3	5.6%
A1b	Intermediate Lifestyles	Struggling suburbs	5,542	315	365	-2.6	5.7%
E2a	City Vibe	Graduation occupation	5,883	327	388	-3.1	5.6%
F1a	London Life-Cycle	City enclaves	2,446	122	161	-3.1	5.0%
E2b	City Vibe	Graduation occupation	2,955	148	195	-3.3	5.0%
E1a	City Vibe	City & student fringe	16,697	963	1100	-4.1	5.8%
B1b	High Density & High Rise	Disadvantaged diaspora	7,218	382	476	-4.3	5.3%
B1c	High Density & High Rise	Disadvantaged diaspora	7,124	366	469	-4.8	5.1%
H2a	Ageing City Fringe	Not quite Home Counties	3,531	156	233	-5.0	4.4%
F2a	London Life-Cycle	Affluent suburbs	3,428	144	226	-5.4	4.2%
A2b	Intermediate Lifestyles	Suburban localities	2,206	79	145	-5.5	3.6%
F2b	London Life-Cycle	Affluent suburbs	3,067	98	202	-7.3	3.2%
A2a	Intermediate Lifestyles	Suburban localities	2,989	90	197	-7.6	3.0%
A2c	Intermediate Lifestyles	Suburban localities	3,877	116	255	-8.7	3.0%
H1c	Ageing City Fringe	Detached retirement	4,306	123	284	-9.5	2.9%
H1b	Ageing City Fringe	Detached retirement	3,396	77	224	-9.8	2.3%
H2b	Ageing City Fringe	Not quite Home Counties	7,723	261	509	-11.0	3.4%
All H above	**Ageing City Fringe**		**18,956**	**617**	**1,249**	**-17.9**	**3.3%**

Table A3. Case-mix differences in the CCU as measured by different types of specialist nursing input. Proportion of care days are relative to the all-admissions average

LOAC	Admissions	Av LOS	Ratio	Basic respiratory	Advanced respiratory	Basic cardiovascular	Advanced cardiovascular	Renal	Neurological	Liver	Dermatological	Gastrointestinal
Grand Total	8,360	7.6	2.7	100%	100%	100%	100%	100%	100%	100%	100%	100%
London	5,580	7.6	2.6	102%	99%	100%	96%	91%	88%	71%	89%	100%
Non-London	2,780	7.6	2.8	97%	102%	100%	108%	119%	124%	158%	122%	101%
E1a	966	7.4	2.5	104%	94%	100%	77%	74%	70%	**38%**	80%	97%
B1b	384	6.7	2.5	86%	82%	90%	92%	97%	**66%**	63%	56%	78%
B1c	369	8.0	2.6	94%	113%	109%	93%	97%	89%	78%	51%	106%
E2a	328	7.2	2.6	105%	90%	94%	84%	82%	67%	61%	109%	95%
A1b	317	7.4	2.6	120%	90%	101%	78%	72%	96%	62%	64%	99%
G2b	310	8.0	2.6	113%	100%	107%	91%	92%	74%	63%	103%	105%
H2b	265	8.8	2.7	119%	122%	112%	**128%**	100%	118%	61%	71%	**122%**
E1b	238	8.6	2.7	109%	120%	113%	125%	117%	80%	85%	**170%**	112%
A1a	204	8.4	2.7	101%	**128%**	107%	105%	95%	137%	93%	61%	118%
B3a	201	7.7	2.7	84%	99%	101%	102%	84%	**152%**	65%	**164%**	99%
H2a	158	7.5	2.7	101%	97%	92%	114%	119%	100%	64%	101%	104%
F2a	155	6.7	2.6	82%	85%	89%	92%	81%	90%	**166%**	41%	82%
E2b	150	6.7	2.5	**80%**	91%	93%	75%	**43%**	82%	89%	117%	81%
H1c	128	6.7	2.6	108%	**70%**	86%	116%	78%	73%	42%	**31%**	91%
F1a	124	7.8	2.7	106%	115%	105%	118%	86%	93%	38%	71%	108%
A2c	117	7.2	2.7	86%	93%	90%	137%	**124%**	96%	62%	77%	88%
B3b	106	6.2	2.5	93%	71%	**82%**	**65%**	**48%**	97%	66%	50%	**74%**
F2b	103	8.5	2.6	**139%**	89%	**116%**	94%	91%	117%	114%	101%	117%
A2a	91	7.8	2.8	95%	118%	103%	128%	81%	89%	80%	216%	113%
G2a	87	6.9	2.7	74%	96%	93%	94%	77%	134%	44%	9%	91%
G1b	85	7.1	2.5	78%	104%	84%	99%	93%	61%	79%	87%	84%
A2b	83	8.0	2.8	85%	124%	104%	124%	129%	64%	107%	67%	116%

LOAC	Admissions	Av LOS	Ratio	Basic respiratory	Advanced respiratory	Basic cardiovascular	Advanced cardiovascular	Renal	Neurological	Liver	Dermatological	Gastrointestinal
H1b	78	11.2	2.8	147%	141%	144%	182%	204%	119%	49%	170%	157%
B1a	76	7.0	2.6	91%	87%	113%	31%	47%	66%	42%	203%	91%
D2(a-d)	72	4.9	2.6	72%	62%	64%	80%	86%	28%	128%	26%	47%
F1b	71	8.0	2.8	129%	88%	108%	84%	158%	161%	67%	26%	112%
D1c	67	8.0	2.7	120%	95%	103%	76%	109%	120%	109%	289%	107%
C1a	49	5.5	2.5	46%	78%	70%	91%	76%	34%	149%	70%	59%
H1a	29	10.0	2.6	231%	117%	129%	117%	43%	57%	44%	37%	157%
B2(a-c)	27	8.4	2.6	90%	123%	128%	35%	17%	198%	0%	0%	128%
G1a	24	5.4	2.4	52%	73%	56%	89%	75%	24%	132%	0%	64%
C1b	21	8.5	2.7	48%	155%	109%	169%	129%	55%	76%	0%	116%
C2a	20	8.6	2.8	73%	148%	89%	154%	87%	63%	270%	146%	131%
C2b	20	8.6	3.2	107%	122%	108%	177%	240%	58%	493%	305%	104%
D1a	16	3.8	2.3	42%	50%	56%	8%	18%	49%	79%	0%	38%
D1b	15	6.6	2.8	60%	104%	96%	49%	71%	181%	106%	0%	96%
C4(a,b)	14	6.5	2.9	72%	92%	76%	138%	121%	132%	272%	95%	78%
C3(a-e)	12	17.3	3.6	343%	216%	200%	423%	790%	32%	318%	708%	288%

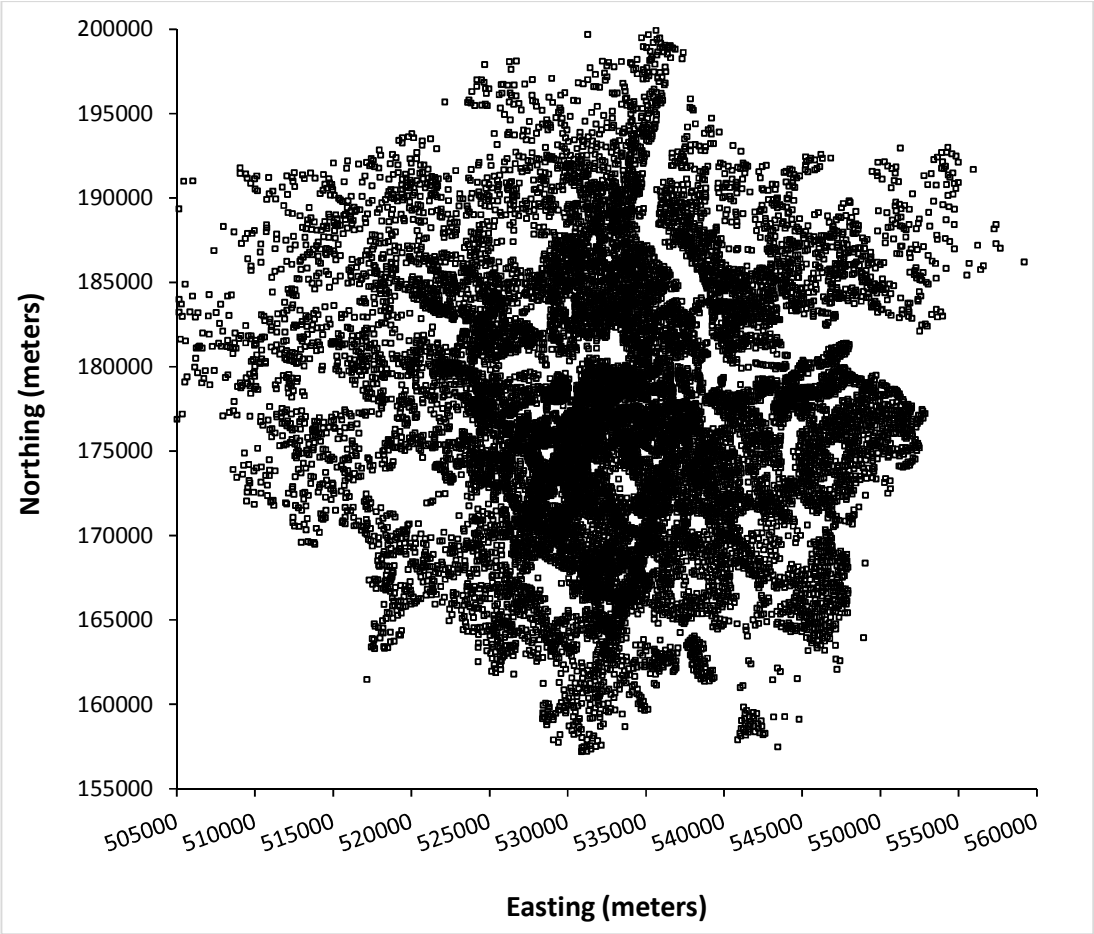

Fig. A1. Spatial co-ordinates (Easting, northing) for the home address of Londoners attending the KCH emergency department over a three-year period

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/16693