INTEGRATED CARE

The association of demographics, frailty and multiple health conditions with outcomes from acute medical admissions to hospitals in England: exploratory analysis of an administrative dataset

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ABSTRACT

Emergency and acute hospital services in England are under increasing pressure. The aim of this study was to investigate the association between key case-mix indicators and outcomes for adults admitted to hospital with an acute medical condition in England. All patients aged ≥16 years admitted to hospital in England as an acute unselected medical admission and who survived to discharge during the financial year 2021–2022 were included. Length of hospital stay was the primary outcome of interest. Data were available for 1,586,168 unique patients. A case-mix index was developed with a score that ranged from 0 to 12. Frailty was the most important variable in the index, followed by multiple health conditions and patient age. The mean case-mix score across hospital trusts in England ranged from 5.3 to 7.8. The case-mix index will support initiatives to better understand factors contributing to outcomes from acute medical admissions to hospital.

KEYWORDS: unwarranted variation, emergency care, quality improvement, case-mix

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Introduction

Emergency and acute hospital services in the NHS in England have been under increasing pressure in recent years as demand has escalated. Although this situation is longstanding, it has been exacerbated by the short- and longer-term effects of the Coronavirus 2019 (COVID-19) pandemic.[1,2] To try to overcome the challenges associated with increasing patient numbers, innovative models of emergency and acute care have been developed, including same-day emergency care (SDEC) units,[3] increased community and primary care management,[4] virtual wards[5] and setting up of dedicated, standalone emergency care facilities.[6] Initiatives to improve patient flow using outcome-based triage have been shown to be effective outside the UK.[7] To help inform the debate around new models of emergency care provision, it is important to understand the profile of patients being admitted acutely, which patient factors influence outcomes after an acute medical admission and how these factors vary across care providers. Given that no single model of care will be suitable for all settings, it is particularly important to understand how case-mix varies across hospital trusts and regions in England and also how this is associated with outcomes. Furthermore, it is important to have a mechanism that can identify patients who might be suitable for different models of care and to assess their outcomes in a meaningful way. Identifying which patient groups benefit most from new models of care will facilitate focussing of resources more effectively.

The Getting It Right First Time (GIRFT) programme is an NHS England quality improvement initiative focussed on unwarranted variation.[8] Understanding how and why care provision and outcomes vary across providers is seen as a key step in improving the quality of care provided by acute and general medicine services. Most initial care for patients presenting with acute medical illness is usually delivered within an acute medical unit (AMU) managed by those working within the specialty of acute internal medicine. However, most services also require input from general physicians and, to be truly effective, rapid input from relevant medical specialties.

Using data for the whole of England, we investigated factors associated with outcomes for patients admitted to hospital acutely who survived to discharge. As part of this, we developed a case-mix index that would summarise how the characteristics of patients varied across NHS trusts in England and to describe the extent of this variation.

Methods

Study design

This was an exploratory, observational, retrospective analysis of administrative data from the Hospital Episode Statistics (HES) database.

Ethics

Ethical approval was not sought for the present study because it did not directly involve human participants. The analysis and presentation of data follow current NHS Digital guidance on the use of HES data for research purposes and is anonymised to the level required by ISB1523 Anonymisation Standard for Publishing Health and Social Care Data.[9,10]

Study design and data collection

In England, NHS hospitals are run by trusts, which typically serve a geographically defined catchment population. A trust can run a single hospital site or many hospitals of varying size and purpose. The organisation of emergency and acute services varies widely between trusts. Some trusts have multiple admission sites, which operate largely autonomously, and others have a single site working as the 'hot' site (managing acute presentations) and the other sites working as 'cold' elective sites and specialist centres, with intersite transfer operating within a Trust as appropriate.

The HES dataset is collected by NHS Digital and includes data for NHS-funded hospital activity in England. Data are entered by trained coders in each hospital trust and data collection is mandatory.

Timing, case ascertainment, inclusion and exclusion criteria

We reviewed HES data for acute medical hospital admission spells in England with a discharge date from 1 April 2021 to 31 March 2022 for patients aged ≥16 years who survived to discharge. Data were extracted at an episode level, but only the first episode per spell was retained to avoid double counting. The data extraction process is summarised in Fig S1.

Patients admitted and discharged on the same day (ie length of stay=0 days) were excluded because administrative processes for these patients vary across hospital trusts in England, making their data unreliable. Moreover, these patients tend to have a less serious presentation. Patients were only included if they were admitted under the following treatment specialties: general medicine, gastroenterology, endocrinology, haematology, cariology, acute medicine, dermatology, respiratory medicine, infectious diseases, nephrology, medical oncology, neurology, rheumatology or geriatric medicine. Patients recorded as being admitted under emergency medicine were not included. Although practice varies across hospital trusts in England, patients admitted under emergency medicine usually attend a clinical decision unit (CDU) for further investigations rather than the main AMU and onward for treatment. Most patients admitted to a CDU are discharged the same day. As such, patients admitted under emergency medicine have a similar profile to patients with zero length of stay.

Patients who died during their stay were excluded because they could confound our outcome measures (see below); their length-of-stay profile tends to be very different compared with those who survive to discharge, and these patients clearly would not have been readmitted.

Where a patient had multiple admissions during the study period, only the chronologically first admission was included. This ensured that all admissions were independent of one another at a patient level and avoided complicating data on readmissions. Patients transferred to a different trust after admission were recorded under the care of the trust of the initial admission and only data for the first admission (before transfer) were included.

Outcomes

Length of stay for the whole spell (admission to discharge) was the primary measure of interest. Emergency readmission within 30 days (with a stay of at least 1 night) was the secondary measure of interest.

Covariates

Age: categorised as 16–44 years, 45–54 years, 55–64 years, 65–74 years, 75–84 years and ≥85 years. The age bands were selected to afford broadly similar numbers of patients in each group.

Sex: male or female.

Deprivation: recorded using the Index of Multiple Deprivation (IMD) for the Lower Super Output Area (LSOA) of the patient's home address, with scores categorised into quintiles based on national averages.

Charlson Comorbidity Index (CCI): there are 17 multiple health conditions used to construct the CCI (peripheral vascular disease, congestive heart failure, acute myocardial infarction, cerebrovascular disease, dementia, chronic pulmonary disease, connective tissue disease/rheumatic disease, peptic ulcer, liver disease (mild and moderate/severe), diabetes (with and without chronic complications), paraplegia/hemiplegia, renal disease, cancer (primary and metastatic) and HIV/AIDS).[11] The relevant multiple health condition was deemed present if it was recorded in HES as a secondary diagnosis in the index admission or as a primary or secondary diagnosis in any admission during the previous year, in accordance with the recommendations of Quan *et al*.[12] The items were weighted to give an overall score and this score was then categorised as: 0, 1, 2, 3 and ≥4. This was largely based on patient numbers in each group, although we observed a relatively stable median length of stay in patients with scores of ≥4, meaning there was little advantage in further categorisation.

Hospital Frailty Risk Score (HFRS): the HFRS uses ICD-10 codes over the previous 2 years to identify frailty and is calculated post hoc. For the purposes of this study, we did not limit this to patients aged over 65 years. The raw scores were then categorised into frailty bands (none, mild, moderate or severe).[13]

Ethnicity: ethnicity was coded in broad categories to reflect those used by NHS Digital: White, Mixed, Black or Black British, Asian or Asian British and other/not stated.

The following additional covariates were used in secondary analysis: admitting clinical specialty (see list above), month of discharge, NHS region (London, South-East, South-West, East of England, Midlands, North-West and North-East & Yorkshire) and the 17 individual CCI items (present or absent).

Statistical methods

Data were extracted onto a secure encrypted server controlled by NHS England. Analysis within this secure environment took place using standard statistical software: Stata (StataCorp LLC, College Station, TX, USA) and Alteryx (Alteryx Inc, Irvine, CA, USA). In descriptive analysis, data were categorised as detailed above and summarised in terms of frequency and percentage.

Length of stay was non-normally distributed and modelled using a negative binomial multivariable regression model. Emergency readmission within 30 days was modelled using a binary multivariable logistic regression model. Both of these exploratory models included all the covariates listed above forced into the model. Given the large size of the dataset, overfitting was not a concern. Model fit was assessed with reference to tolerance, eigenvalues and the spread of residual values.

The length-of-stay model is summarised in terms of incidence rate ratios (IRRs), the 30-day readmission model in terms of odds ratios (ORs); 95% confidence intervals (CIs) are also given. A 95% CI not crossing the value 1 was taken as an indication of statistical

Table 1. Demographic and frailty profile of patients and their associated outcomes

Characteristic	Number of patients	Median length of stay (days) (range)	Emergency readmission within 30 days
Age band			
16–44 years	243,398 (15.3%)	2 (1–5)	18,074 (7.4%)
45–54 years	153,173 (9.7%)	3 (1–6)	13,109 (8.6%)
55–64 years	218,026 (13.7%)	3 (2–7)	21,917 (10.1%)
65–74 years	291,607 (18.4%)	4 (2–9)	35,302 (12.1%)
75–84 years	376,835 (23.8%)	5 (2–11)	52,170 (13.8%)
85 years and over	303,129 (19.1%)	7 (3–14)	46,559 (15.4%)
Sex (missing 187)			
Female	811,175 (51.1%)	4 (2–9)	94,161 (11.6%)
Male	774,806 (48.9%)	4 (2–9)	92,952 (12%)
Deprivation quintile (missing 32,666)			
1 (most deprived)	355,041 (22.9%)	4 (2–9)	43,495 (12.3%)
2	323,192 (20.8%)	4 (2–9)	38,758 (12%)
3	311,605 (20.1%)	4 (2–9)	37,034 (11.9%)
4	295,122 (19%)	4 (2–9)	35,100 (11.9%)
5 (least deprived)	268,542 (17.3%)	4 (2–9)	31,530 (11.7%)
Ethnicity (missing 52,445)			
White	1,259,821 (82.1%)	4 (2–9)	156,639 (12.4%)
Asian or Asian British	75,215 (4.9%)	3 (1–7)	7,132 (9.5%)
Black or Black British	42,190 (2.8%)	4 (2–9)	3,949 (9.4%)
Mixed	10,860 (0.7%)	3 (1–7)	966 (8.9%)
Other/not stated	145,637 (9.5%)	4 (2–9)	13,942 (9.6%)
Charlson Comorbidity Index			
0	455,968 (28.7%)	2 (1–5)	36,126 (7.9%)
1	384,119 (24.2%)	4 (2–8)	39,898 (10.4%)
2	263,177 (16.6%)	5 (2–10)	33,547 (12.7%)
3	178,578 (11.3%)	6 (3–12)	25,816 (14.5%)
4 and over	304,326 (19.2%)	7 (3–14)	51,744 (17%)
Hospital Frailty Risk Score			
None	252,733 (15.9%)	2 (1–4)	15,398 (6.1%)
Mild	551,968 (34.8%)	3 (1–6)	50,721 (9.2%)
Moderate	555,287 (35%)	6 (3–12)	78,333 (14.1%)
Severe	226,180 (14.3%)	9 (4–18)	42,679 (18.9%)

Table 2. Admitting specialty, individual Charlson Comorbidity Index items, month of discharge and region of residence of patients and their associated outcomes

Characteristic	Number of patients	Median length of stay (days) (range)	Emergency readmission within 30 days
Admitting specialty			
General medicine	1,085,379 (68.4%)	4 (2–9)	127,917 (11.8%)
Gastroenterology	27,038 (1.7%)	5 (2–9)	3,193 (11.8%)
Endocrinology	17,926 (1.1%)	4 (2–9)	2,126 (11.9%)
Haematology	10,222 (0.6%)	5 (2–10)	1,299 (12.7%)
Cardiology	1,302 (0.1%)	6 (3–13)	167 (12.8%)
Hepatology	14,645 (0.9%)	4 (2–9)	1,867 (12.7%)
Diabetes medicine	89,968 (5.7%)	3 (2–6)	7,971 (8.9%)
Acute medicine	24,762 (1.6%)	3 (1–7)	2,634 (10.6%)
Stroke medicine	43,932 (2.8%)	4 (2–10)	3,526 (8%)
Transient ischaemic attack	706 (0.04%)	3 (1–9)	51 (7.2%)
Dermatology	423 (0.03%)	6 (3–12)	45 (10.6%)
Respiratory medicine	66,077 (4.2%)	5 (2–9)	7,964 (12.1%)
Infectious diseases	6,393 (0.4%)	5 (2–9)	570 (8.9%)
Nephrology	16,935 (1.1%)	5 (2–9)	2,206 (13%)
Medical oncology	13,064 (0.8%)	4 (2–8)	2,264 (17.3%)
Neurology	13,520 (0.9%)	3 (1–8)	1,039 (7.7%)
Rheumatology	2,715 (0.2%)	4 (2–9)	270 (9.9%)
Geriatric medicine	151,161 (9.5%)	6 (2–13)	22,022 (14.6%)
Individual Charlson Comorbidity Index items			
Peripheral vascular disease	84,792 (5.3%)	6 (3–13)	130,98 (15.4%)
Congestive heart failure	211,399 (13.3%)	7 (3–13)	34,191 (16.2%)
Acute myocardial infarction	170,759 (10.8%)	5 (2–10)	22,836 (13.4%)
Cerebrovascular disease	176,236 (11.1%)	7 (3–15)	22,873 (13%)
Dementia	137,663 (8.7%)	7 (3–15)	20,978 (15.2%)
Chronic pulmonary disease	390,876 (24.6%)	5 (2–9)	53,992 (13.8%)
Connective tissue disease/rheumatic disease	70,292 (4.4%)	5 (2–11)	9,978 (14.2%)
Peptic ulcer	16,170 (1%)	6 (3–13)	2,058 (12.7%)
Mild liver disease	91,754 (5.8%)	6 (3–12)	12,569 (13.7%)
Moderate or severe liver disease	18,761 (1.2%)	7 (4–15)	3,294 (17.6%)
Diabetes without chronic complications	316,052 (19.9%)	5 (2–10)	43,596 (13.8%)
Diabetes with chronic complications	46,636 (2.9%)	6 (3–13)	7,534 (16.2%)
Paraplegia and hemiplegia	35,699 (2.3%)	7 (3–17)	4,575 (12.8%)
Renal disease	261,538 (16.5%)	6 (3–13)	41,552 (15.9%)
Primary cancer	138,027 (8.7%)	6 (3–12)	23,038 (16.7%)
Metastatic carcinoma	67,756 (4.3%)	6 (3–12)	12,528 (18.5%)
HIV	2,173 (0.1%)	6 (3–13)	0
Month of discharge			
April 2021	176,153 (11.1%)	4 (2–9)	26,872 (15.3%)
May 2021	158,661 (10%)	4 (2–9)	21,281 (13.4%)
June 2021	149,122 (9.4%)	4 (2–9)	18,327 (12.3%)
July 2021	144,342 (9.1%)	4 (2–9)	17,171 (11.9%)

Table 2. Admitting specialty, individual Charlson Comorbidity Index items, month of discharge and region of residence of patients and their associated outcomes (Continued)

Characteristic	Number of patients	Median length of stay (days) (range)	Emergency readmission within 30 days
August 2021	133,230 (8.4%)	4 (2–9)	15,035 (11.3%)
September 2021	128,860 (8.1%)	4 (2–8)	14,219 (11%)
October 2021	126,249 (8%)	4 (2–9)	13,635 (10.8%)
November 2021	122,914 (7.7%)	4 (2–9)	13,026 (10.6%)
December 2021	122,552 (7.7%)	4 (2–9)	13,108 (10.7%)
January 2022	110,090 (6.9%)	4 (2–9)	12,166 (11.1%)
February 2022	101,742 (6.4%)	4 (2–9)	10,732 (10.5%)
March 2022	112,253 (7.1%)	4 (2–9)	11,559 (10.3%)
Region (non-NHS providers 6,874)			
South-East	220,589 (14.0%)	4 (2–9)	26,008 (11.8%)
South-West	165,165 (10.5%)	4 (2–9)	18,595 (11.3%)
London	204,387 (12.9%)	4 (2–9)	21,478 (10.5%)
East of England	184,482 (11.7%)	4 (2–9)	21,544 (11.7%)
Midlands	315,206 (20.0%)	4 (2–9)	36,817 (11.7%)
Yorkshire and North-East	273,666 (17.3%)	4 (2–8)	34,808 (12.7%)
North-West	215,799 (13.7%)	4 (2–9)	26,807 (12.4%)

significance. Adjusted mean length of stay for each NHS hospital trust was calculated from the models using marginal estimation. Marginal estimation was preferred over conditional (eg at the covariate mean) estimation to better reflect the wider data structure. For this part of the analysis, non-NHS trusts, specialist trusts and trusts with fewer than 100 patients during the study period were excluded.

The extent of the variation between Trusts is presented as a funnel plot of adjusted mean length of stay for each trust. Adjustment for overdispersion due to unmeasured variables (eg presenting condition or illness severity) was made using the multiplicative method discussed by Spiegelhalter with winsorisation of the most extreme upper and lower 10% of values based on naïve Z-scores.[14] Finally, the model coefficients were used to establish weights for a case-mix adjustment tool according to well-established methods of scaling and rounding described by the Framingham Study Group and others.[15]

Missing data were rare and, given the large sample size, no attempt was made to impute missing values. Where data were missing, the numbers involved are stated. For the covariate ethnicity, several patients chose not to state their ethnicity and these data were combined with the 'other' category.

Results

The extraction process yielded data for 1,586,168 unique patients across 149 NHS trusts. The demographic profile of patients is shown in Table 1. Over 60% of patients were aged 65 years or over, there were slightly more females than males and a disproportionately high number of patients from more deprived areas. Length of stay and emergency readmission rates increased with increasing age, multiple health conditions and frailty. There was no obvious trend in outcomes with regard to deprivation. Patients of Asian and Mixed ethnicity had a slightly shorter length of stay compared with other ethnic groups. Patients of White ethnicity had higher readmission rates, although this was likely to be confounded by age; patients of White ethnicity had a median age of 73 years (IQR 57–83) compared with 59 years (IQR 42–74) in patients of Asian ethnicity, 56 years (IQR 41–71) in patients of Black ethnicity and 48 years (IQR 32–64) in patients of Mixed ethnicity. Table 2 summarises outcomes for patients according to the treatment speciality they were admitted under. Over two-thirds of patients were admitted under general medicine. Longer stays were most notable for patients admitted under cardiology, dermatology and geriatric medicine. Thirty-day emergency readmissions were more common for patients admitted under oncology and geriatric medicine and less common for patients admitted for stroke and transient ischaemic attack. Table 2 also presents data for patients with the individual health conditions that comprise the CCI. In general, longer stays and a higher 30-day emergency readmission rate were more common in patients with all these multiple health conditions compared with patients without them. Outcomes were relatively stable across the 12 months and across regions (Table 2).

The results of regression modelling are presented in Table 3. It is notable the extent to which factors associated with longer stay were also associated with 30-day emergency readmissions and to a similar degree. To a large extent, the IRRs for length of stay mirrored the ORs for 30-day emergency readmission for the covariates age, sex, deprivation, comorbidity and frailty. The pattern only diverged for ethnicity, with greater IRR values for patients of Black and Mixed ethnicity relative to those of White ethnicity, but lower ORs for all other ethnic groups relative to patients of White ethnicity. Increasing age was associated with a modest increase in risk of poorer outcomes, but with a plateau after the age of 65 years. Sex and deprivation were not strongly

Table 3. Coefficients, odds ratios and incidence rate ratios for regression models of the outcomes length of stay and emergency readmission within 30 days

Characteristic	Length of stay (incidence rate ratio) (95% confidence interval)	Emergency readmission within 30 days (Odds ratio) (95% confidence interval)
Age band		
16–44 years	1 (reference)	1 (reference)
45–54 years	1.15 (1.14–1.15)	1 (0.98–1.03)
55–64 years	1.19 (1.19–1.2)	1.07 (1.04–1.09)
65–74 years	1.2 (1.2–1.21)	1.16 (1.13–1.18)
75–84 years	1.18 (1.18–1.19)	1.19 (1.16–1.21)
85 years and over	1.19 (1.18–1.2)	1.21 (1.18–1.23)
Sex (missing 171)		
Female	1 (reference)	1 (reference)
Male	1.05 (1.05–1.05)	1.07 (1.06–1.09)
Deprivation quintile		
5 (least deprived)	1 (reference)	1 (reference)
4	1.00 (1.00–1.01)	1.02 (1.00–1.03)
3	1.01 (1.00–1.01)	1.04 (1.02–1.06)
2	1.00 (0.99–1.00)	1.07 (1.05–1.09)
1 (most deprived)	0.99 (0.99–1.00)	1.10 (1.08–1.12)
Ethnicity (missing 49,533)		
White	1 (reference)	1 (reference)
Asian or Asian British	1.01 (1–1.01)	0.85 (0.83–0.88)
Black or Black British	1.12 (1.11–1.13)	0.87 (0.84–0.9)
Mixed	1.09 (1.07–1.11)	0.92 (0.85–0.98)
Other/not stated	1.09 (1.08–1.09)	0.87 (0.86–0.89)
Charlson Comorbidity Index		
0	1 (reference)	1 (reference)
1	1.14 (1.13–1.14)	1.16 (1.14–1.18)
2	1.23 (1.22–1.23)	1.3 (1.28–1.32)
3	1.3 (1.3–1.31)	1.39 (1.36–1.42)
4 and over	1.39 (1.38–1.4)	1.68 (1.65–1.71)
Hospital Frailty Risk Score		
None	1 (reference)	1 (reference)
Mild	1.45 (1.44–1.46)	1.4 (1.37–1.42)
Moderate	2.65 (2.63–2.66)	2 (1.96–2.04)
Severe	3.74 (3.72–3.77)	2.61 (2.55–2.66)

associated with poorer outcomes. Increasing frailty and, to a lesser extent, multiple health conditions were both associated with poorer outcomes. After adjusting for case-mix, the adjusted variability in mean length of stay across NHS trusts in England was summarised (Fig 1). Although four trusts fell outside the control limits, all but one point was relatively close to the limit. Thus, there was no clear evidence of any outliers.

The model coefficients for the length-of-stay outcome were used to derive a scoring system for the risk of longer stay with age band, CCI score and HFRS band as the key items (Table 4). Including ethnicity did not improve the accuracy of the scoring system. Deprivation and sex were excluded from the scoring system because the coefficients were zero for all items. Applying this scoring system to the data resulted in an index from 0 to 12, which showed moderate correlation with length of stay (Spearman's $r=0.421$, $p<0.001$) and weak corelation with 30-day emergency readmission (point biserial $r=0.136$, $p<0.001$). Including the additional items admitting treatment specialty, month of discharge and region, and replacing the total CCI score items with the 17 individual items did not substantially change the

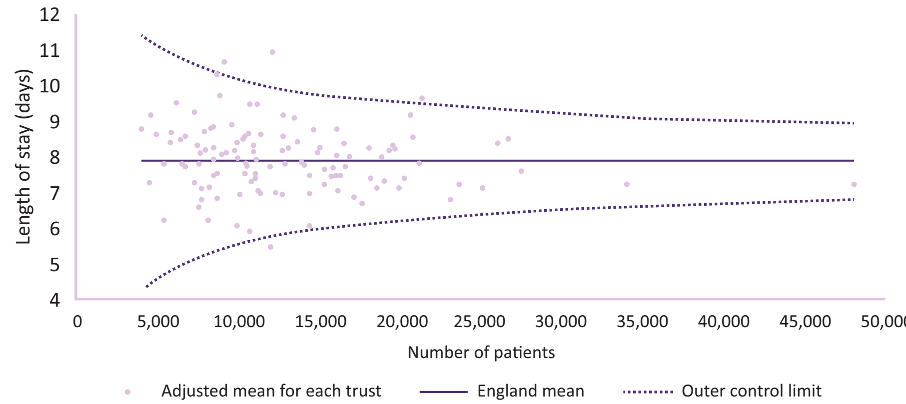

Fig 1. Funnel plot of adjusted mean length of stay in NHS hospital trusts in England for patients with a discharge date from 1 April 2021 to 31 March 2022.

performance of the index. The mean case-mix score was 6.6 for the entire cohort. There was little variation in the case-mix score regionally, with the lowest score being 6.4 in the South-West and the highest score being 6.9 in the South-East. The mean case-mix score for each trust is shown in Fig 2, with mean scores ranging from 7.8 to 5.3.

Discussion

Here, we present data on the variation in outcomes for patients who survived to discharge following acute medical admission to hospitals in England. The strongest predictors of both length of stay and 30-day emergency readmission were frailty and multiple health conditions. Although there was some variation in adjusted outcomes across NHS hospital trusts, there was little evidence that this variation was unwarranted. Our study is one of few that have looked at factors associated with outcomes of acute medical admissions using a national dataset or have not focussed on a particular patient population.[16,17,20,21] Using a national dataset allowed us to consider variation in case-mix and outcomes across providers and the key components of the case-mix that influence outcomes.

Table 4. Length-of-stay model coefficients and scoring system for the case-mix index

Characteristic	Model coefficient	Score
Age band		
16–44 years	0	0
45–54 years	0.14	1
55–64 years	0.18	1
65–74 years	0.18	1
75–84 years	0.17	1
85 years and over	0.17	1
Charlson Comorbidity Index		
0	0	0
1	0.13	1
2	0.20	1
3	0.26	2
4 and over	0.33	2
Hospital Frailty Risk Score		
None	0	0
Mild	0.37	3
Moderate	0.97	7
Severe	1.32	9

It is notable that both frailty and multiple health conditions were strongly associated with length of stay and 30-day emergency readmissions after adjusting for demographic factors through multivariable modelling. Although both measures are age related, our findings emphasise that multiple health conditions and frailty are different constructs and should not be viewed as synonymous.[18] It was also notable that, after adjusting for frailty and multiple health conditions, the association of age with outcomes was relatively small. Frailty and multiple health conditions have been shown to be strongly associated with outcomes following hospitalisation in several studies across a range of settings.[19,22–24] Although this is perhaps unsurprising, our analysis allows us to quantify the extent of the association within our broadly defined cohort and has allowed us to develop a case-mix index.

The lack of association of either of our outcomes with sex, deprivation and the weak and inconsistent association with ethnicity are of note and reassuring. Black and Mixed ethnicity were weakly associated with longer stay and all ethnicities other than White were weakly associated with lower 30-day emergency readmissions. Adding ethnicity to the case-mix index did not improve its performance. Likewise, month of admission was only weakly associated with outcomes and did not improve the performance of the index.

Several studies have sought to predict hospital admission following emergency department attendance.[25–27] The Glasgow Admissions Prediction Score (GAPS) tool aimed to predict emergency hospital admission at the point of triage and was published in 2015.[28] The study used data for 322,846 attendances and identified age, triage category, National Early Warning Score (NEWS), arrival by ambulance, referral source and previous admission within the past year as being significantly associated with admission. In the context of our work, the importance of variables associated with presentation in the GAPS is of note. Although the HES dataset allowed us to compare trusts nationally, HES lacks clinical details,

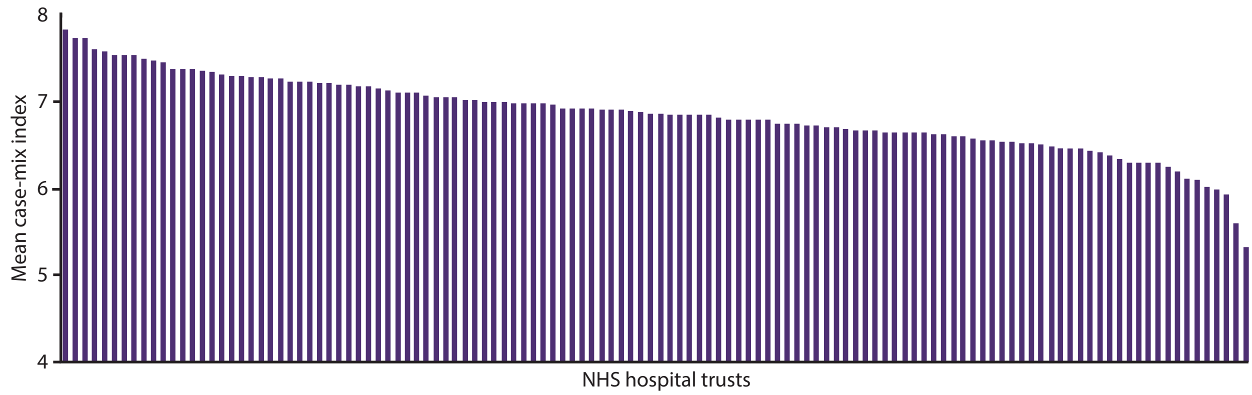

Fig 2. Mean emergency admission case-mix index score across NHS hospital trusts in England for patients with a discharge date from 1 April 2021 to 31 March 2022.

particular regarding illness severity at presentation. As well as predicting the admission following attendance, such data are likely to be important in determining outcomes of emergency admission. As such, our case-mix index is unlikely to be of value as a predictive tool at the point of triage. The value of the index may lie in informing any discussion of the relative performance of hospital trusts, allowing the case-mix of trusts to be compared when assessing outcome metrics. The Summary Acute Medicine Indicator Table (SAMIT) was recently developed by the GIRFT programme as a tool for trusts to monitor performance. The SAMIT summarises acute medical activity across four domains: demand, capacity, flow and outcomes. The demand domain includes the case-mix index developed here. The values used in the case-mix index can be updated as appropriate as new data become available. The Model Health System initiative has been developed by NHS England to allow the relative performance of trusts to be evaluated in a similar way.[29]

Our study has several strengths and limitations. We used a national dataset with data entry by clinical coders trained to a national standard. Thus, collider biases are likely to be small.[30] Nevertheless, as with any research study, we emphasise that our findings should not be extrapolated beyond our specific setting without due care. We were able to follow patients across different providers, meaning that our readmissions data are likely to be relatively accurate.

Our study timeframe includes a period toward the end of the COVID-19 pandemic in England. Our dataset will contain patients admitted as an emergency with COVID-19. However, by April 2021, the most vulnerable in the population and all healthcare staff had been offered at least one vaccination and the severe pressures on the NHS in England experienced during the two major waves of cases (March 2020–June 2020 and November 2020–February 2021) had eased to a large extent.[10,31] As such, our findings are unlikely to be substantially biased by the period chosen.

Although much of the difference in outcomes between trusts in our study will be due to random variation, there are several factors not accounted for in our analysis that could explain some of the observed variation. These include factors relating to presentation, such as disease severity at admission, and organisational factors related to delivery of care at each trust. Collecting additional data on clinical presentation on presentation and health status during hospital stay (eg The Royal College of Physicians' NEWS2) would be invaluable to researchers.[32] However, because HES is primarily an administrative, rather than a research, dataset, the costs and benefits of including additional data would have to be weighed. We only included data for the first admission for each patient in the study period. Thus, for patients transferred to another trust for further investigation or treatment, only data for the first, pretransfer admission is included. The main impact on our data of this will be on the recorded length of stay. Although patient numbers are likely to be small, this could have created some bias. Finally, clinical coders rely on patient notes for information entered into the HES database. Only if this is recorded accurately will HES data be reliable.[33,34]

Conclusions

Frailty and multiple health conditions were strongly associated with outcomes of acute medical hospital admission in our dataset. Clinicians should be aware of the relatively limited importance of biological age and other demographic factors when evaluating the likely outcomes from emergency admission to hospital. At an organisational level, health service managers should be aware of how the frailty and multiple health condition profile of patients will impact resource requirements and how future changes to patient profile could impact these requirements. ■

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Supplementary material

Additional supplementary material may be found in the online version of this article at https://www.rcpjournals.org/content/futurehosp
S1. Summary of the data extraction process.

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