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Factors influencing unspecified chest pain admission rates in England

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Abstract

Background: Unspecified chest pain is an important and potentially avoidable cause of emergency hospital admission. We aimed to examine inter-hospital variation in admission rates with unspecified chest pain and identify population characteristics, services and technologies that might explain this variation.

Methods: We used Hospital Episodes Statistics data from 152 acute trusts in England to calculate a direct standardised annual admission rate per 100,000 population for each trust. Regression analysis was used to identify factors explaining variation, firstly using routinely available data relating to the hospital catchment area and service, and then using responses to a survey of emergency department (ED) management.

Results: The best predictors of admission rate using routine data were total beds per 1000 population ($p=0.001$), rapid access chest pain clinic (RACPC) attendances per year ($p<0.001$) and percentage of households in poverty ($p=0.01$). Including data from 105/142 (74%) survey responses the best predictors of admission rate were total beds ($p<0.001$), RACPC attendances ($p=0.001$), mean ED waiting time ($p=0.049$) and percentage of households in poverty ($p<0.001$). All associations were positive (higher variable predicts higher rate). We found no significant associations between factors relating to acute chest pain management and admission rate.

Conclusion: Hospitals with higher admission rates for unspecified chest pain have greater bed provision, more RACPC attendances and serve populations with a higher percentage of households in poverty. These findings may be explained by services responding to demand in populations with greater need. We found no evidence that chest pain management influenced admission rates.

Introduction

In common with many health care systems around the world, the United Kingdom (UK) National Health Service (NHS) is facing a progressive rise in emergency hospitals admissions.[1] Chest pain is responsible for a substantial proportion of emergency medical admissions [2] and an increasing burden.[3] In 2012-2013 there were 237,832 emergency admissions to hospitals in England with International Classification of Diseases (10th edition, ICD-10) codes R07.2 (precordial pain), R07.3 (other chest pain) or R07.4 (chest pain unspecified), representing 4.5% of all emergency admissions.[4] It is not clear how these patients benefit from admission since chest pain admissions diagnosed with angina, myocardial infarction and other serious causes will be categorised under other ICD-10 codes. These admissions with unspecified chest pain could therefore be considered avoidable.

The Emergency Admissions Study aimed to identify modifiable system factors that explain avoidable emergency admissions.[5] The study identified 14 admission codes (including unspecified chest pain) that were judged by expert opinion to be rich in avoidable admissions and accounted for 22% of emergency admissions to English hospitals in 2008-2011. These admissions data were used to calculate a standardised avoidable admission rate (SAAR) for 150 emergency and urgent care systems in England. Routinely available data on population and hospital characteristics were then used to identify factors that explained variation in the SAAR. There was a 3.4-fold variation in the SAAR between geographical regions, which was mainly explained by deprivation but also influenced by rates of emergency department (ED) attendances, conversion from ED attendance to admission, short-stay admissions, ambulance calls not transported to hospital and perceived access to general practice. A further analysis by 129 acute hospital trusts showed a 3-fold variation in admission rate between hospitals and also identified acute bed availability as a predictive factor.[6]

Inter-hospital variation in admission rates with chest pain has previously been shown in a survey of reported practice [7] and a multicentre study.[8] There are a number of technologies and services

for people with chest pain that vary in their use between hospitals and may explain variation in hospital admission rates for chest pain. For example, high sensitivity troponin assays are currently used at some hospitals but not others. They may reduce admissions through early rule-out of myocardial infarction or may increase admissions through an increased positive yield.[9] It would be helpful to know whether technologies or services for people with chest pain are associated with admission rates for chest pain. We therefore aimed to examine inter-hospital variation in admission rates with unspecified chest pain and identify population characteristics, services and technologies that might explain this variation.

Methods

We used routine administrative data to estimate a standardised admission rate for chest pain at each acute hospital trust in England and a questionnaire survey to measure the use of chest pain technologies and services. Hospital Episode Statistics (HES) data for England are collected and managed by the Health and Social Care Information Centre.[4] The aim is to collect information on every 'episode' of patient care in England. Hospitals routinely collect and submit data to the Health and Social Care Information Centre. Data are then transformed into an annual database for the secondary use by a number of different parties including local commissioners and researchers. The data are collected monthly from the secondary uses service and released annually for each financial year. The data do not contain any personal patient information but are coded with anonymous patient identifier to enable tracking through the database.

HES data were obtained for admissions with unspecified chest pain for 2008-2011. We selected admissions with the ICD-10 coding of R07.2, R07.3 and R07.4. A direct standardised rate (DSR) was then calculated for chest pain expressed as an annual rate per 100,000 of the population age ≥20 years. The rate was age sex standardised using 14 five-year age bands. We included data for 142 hospital trusts that provided acute adult general medical care.

We used data from the Emergency Admissions Study to measure general hospital trust level factors (i.e. those not specific to chest pain). Data were compiled from readily available published statistics and taken for the year 2009-2010, the middle year in our dataset. These included number of ED first attendances, total beds available, proportion of beds occupied, total acute beds, proportion of acute beds occupied, mean duration in the ED (minutes) and number of patients seen in a rapid access chest pain clinic (RACPC). RACPCs provide rapid cardiology outpatient review for patients presenting to primary care with potentially cardiac chest pain and, as such, could offer an alternative to ED attendance and hospital admission. A deprivation score of percentage of households in poverty was calculated from the middle super output area in which the ED is based for each acute hospital, or an average where there was more than one ED. Full details of the process have been published.[6]

We conducted a survey of major EDs in England to obtain more detailed hospital-level data on chest pain management. A questionnaire was drawn up that included 15 questions and an open space for comments (see Appendix 1). The questions focussed on the use of chest pain related guidelines and technologies in the emergency department. It was endorsed by the UK College of Emergency Medicine and the first postal mail out was conducted in December 2012. The survey was sent to a named doctor at each department in the hospital trusts for which we held HES data, this was preferably the lead clinician. A second postal mailing was conducted at the end of January 2013. Email follow up was then used for those that did not respond.

Analysis was undertaken to identify which variables best explained variation in the standardised admission rate for unspecified chest pain. The first stage of analysis included all 142 trusts with HES data. Univariate linear regression was used to determine the association between each routinely available variable and standardised admission rate. Stepwise linear regression was then used to identify which of these variables best predicted admission rate. The second stage of analysis was conducted using data only for those trusts with a questionnaire response. Linear regression, a t-test or one-way analysis of variance was used to determine the association between each survey variable

and standardised admission rate. Stepwise linear regression was then used to identify which factors best predicted admission rate.

The project was approval by the University of Sheffield School of Health and Related Research Ethics Committee.

Results

HES data showed that variation existed in the rate of admissions for unspecified chest pain. The mean DSR for unspecified chest pain admissions was 621 admissions per 100,000 population per year with a standard deviation of 191. The range of values shows a 4.2 fold difference (305 to 1285).

Table 1 shows the summary statistics and results of the univariate analysis for general factors based on routinely available data from all 142 trusts. The unstandardised coefficients indicate the increase in the DSR per unit increase in each predictor variable and R^2 the fraction of variance explained by each predictor variable. A higher rate of admission was associated with deprivation, shorter ED waiting times, more ED attendances, more rapid access chest pain clinic attendances, more acute beds and more total beds per 1000 population.

Table 1: Summary statistics and univariate linear regression for general variables (all trusts)

	Mean (SD)	Min-max	Unstandardised coefficient	R^2	P-value
Percentage of households in poverty	23.19 (8.37)	9.00-54.90	6.795	0.089	<0.001
Proportion of total beds occupied	0.85 (0.05)	0.74-0.96	129.219	0.001	0.766

Proportion of acute beds occupied	0.86 (0.05)	0.72-0.97	-5.592	0.000	0.989
Mean duration in ED (mins)	138.21 (20.52)	97.94-203.15	-1.792	0.038	0.049
ED first attendances per year per 1000 of trust population	391.86 (120.84)	197.22-855.48	0.533	0.105	0.001
Total beds per 1000 of trust population	3.00 (0.57)	1.91-4.99	126.312	0.141	<0.001
Acute beds per 1000 of trust population	2.40 (0.53)	0.55-4.01	105.566	0.080	0.004
Number seen in RACPC per year per 1000 of trust population	0.85 (0.38)	0.27-3.03	165.66	0.104	0.001

Table 2 shows the results of stepwise linear regression. The standardised coefficients indicate how many standard deviations the DSR increases by per standard deviation increase in each predictor variable. The best predictors of standardised admission rate were total beds per 1000 population ($p<0.001$), RACPC attendances ($p=0.001$) and percentage of households in poverty ($p=0.01$).

Table 2: Results of stepwise linear regression using general factors (all trusts)

Model variable	Unstandardised Coefficient	Standard Error	Standardised Coefficient	P value

Total beds per 1000 of trust population	125.982	24.183	0.379	<0.001
Number seen in RACPC per year per 1000 of trust population	125.723	37.118	0.249	0.001
Percentage of households in poverty	4.458	1.695	0.196	0.010

R^2 for model = 0.29

Survey data were returned for 105 of the 142 trusts (74%). There were no significant differences between trusts with and without a response in terms of the DSR or any of the general factors measured, with the exception of ED attendances per 1000 of the trust population. Responding trusts tended to have more ED attendances (mean difference 56 per 1000 population per year, 95% confidence interval 11 to 101, p=0.014).

Table 3 summarises the responses and the results of univariate analysis for categorical survey variables. The majority of trusts have guidelines, a service to avoid social admissions and use NICE biochemical rule out criteria for myocardial infarction. The majority do not have specific chest pain units, use point of care testing or have access to either computer tomographic (CT) coronary angiography or stress testing within the ED. There were roughly equal numbers with and without clinical decision units, use of a formalised risk score, senior review of all cases and specialist chest pain nurses. The mean daily number of hours of consultant presence in the department was 14.1 hours (standard deviation (SD) 3.2, range 4-24) and the mean daily number of hours of a social admission avoidance service was 13.4 hours (SD 5.9, range 7-24). Standardised admission rates tended to be higher in trusts that used specific chest pain related services and technologies, but none of the variables were significantly associated with admission rate. Consultants were available for a mean of 14.1 hours per day (SD 3.2, range 4-24), but linear regression showed no association

with admission rate (R^2=0.012, p=0.268). A service to avoid social admissions was available for a mean of 13.4 hours per day (SD 5.9, range 7-24), but linear regression showed no association with admission rate (R^2=0.007, p=0.443).

Table 3: Summary statistics and univariate analysis for categorical survey variables (responding trusts only)

Factor	Response	Count (%)	Mean DSR	P-value
Guidelines in use	Yes	97 (94.2%)	628	0.80
	No	6 (5.8%)	606	
Unit allowing decision making beyond the 4 hour target	Yes	49 (48.0%)	648	0.27
	No	53 (52.0%)	605	
Specific chest pain unit	Yes	17 (16.5%)	640	0.68
	No	86 (83.5%)	619	
Point of care troponin use	Yes	17 (16.3%)	659	0.45
	No	87 (83.7%)	619	
Biochemical criteria used to rule out myocardial infarction	Nice Guidance	66 (63.5%)	622	0.60
	ESC Guidance	12 (11.5%)	586	
	Other	26 (25.0%)	653	
Use of formalised risk scoring system	Yes	58 (56.9%)	627	0.95
	No	44 (43.1%)	630	
Routine access to CT coronary angiography	Yes	7 (6.9%)	648	0.80
	No	94 (93.1%)	628	
Routine access to exercise	Yes	26 (25.5%)	628	0.99

stress testing	No	76 (74.5%)	628	
All patients reviewed by a doctor with at least 3 years post-registration experience	Yes	53 (53.5%)	646	0.37
	No	46 (46.5%)	609	
Specialist chest pain nurses	Yes	47 (46.1%)	636	0.69
	No	55 (53.9%)	621	

Table 4 shows the results stepwise linear regression including the survey variables and limited to responding trusts. The results were very similar to the analysis of all trusts, with the best predictors of admission rate being total beds ($p<0.001$), RACPC attendances ($p=0.001$), mean ED waiting time ($p=0.017$) and percentage of households in poverty ($p=0.02$). All relationships were positive (i.e. associated with higher admission rates) except for ED waiting times.

Table 4: Results of stepwise linear regression using general and survey variables (responding trusts only)

Model variable	Unstandardised Coefficients	Standard error	Standardised Coefficient	P-value
Total beds per 1000 of trust population	107.157	28.782	.318	<0.001
Number seen in RACPC per year per 1000 of trust population	154.844	43.621	.304	0.001
Mean duration in ED (mins)	-1.872	.771	-.203	0.017
Percentage of households in poverty	4.994	2.113	.206	0.020

R^2 for model = 0.33

Discussion

Variation exists in the admission rates of unspecified chest pain with a 4.2 fold difference between the highest and lowest rates for acute hospital trusts. The best predictors of admission rate are total beds per 1000 population, the percentage of households in poverty and the number of patients seen in RACPC per 1000. Together these factors explained 29% of the variation in admission rates. Findings were similar when analysis was repeated limited to trusts responding to the survey of chest pain management, but with some evidence that longer ED waiting times were associated with higher admission rates.

The variable 'households in poverty' was included as a measure of deprivation which is closely linked to ill health in a community. This suggests that the deprivation of a community increases the rate of potentially avoidable admissions with unspecified chest pain. This corresponds to findings in a wider study of potentially avoidable admissions which found that deprivation accounted for 72% of the variation in their admission rates.[5] The effect is not as powerful in our study suggesting that other factors impact on chest pain admission rates.

The total number of beds per 1000 of the trust population reflects the provision of secondary healthcare to the catchment population. The association with admission rate is difficult to interpret and may be complex. It may reflect appropriate provision of care in response to need (more beds being provided in trusts with higher admission rates) or may suggest supply induced demand (admission rates increasing when more beds are provided). However, bed occupancy rates did not predict admission rate suggesting that supply induced demand does not explain the association between bed provision and admission rate.

We expected RACPC provision to have a negative impact on admission rates with unspecified chest pain, assuming that it offered an alternative to hospital admission for low risk patients. However the

association was positive. This may indicate a common factor, such as population prevalence of coronary heart disease, that drives both admission rates and need for RACPC provision, or it could indicate that RACPC provision increases admissions by attracting patients from primary to secondary care. Caution should be taken with the interpretation as the data is only for one annual quarter, however it suggests that further research is warranted.

The survey data showed some development of chest pain management since 2006,[10] with increased use of guidelines and changes in biomarker use. Including survey data in the multivariate analysis showed no evidence that chest pain management explained variation in admission rate. This may be because (a) chest pain management interventions are instituted in trusts in response to high admission rates, (b) interventions are ineffective or (c) our study was not powered to detect small differences in admission rates. Analysis showed an association between longer ED waiting times and increased admission rates, but this finding should be treated with caution as it was not identified in the analysis of all 142 trusts.

Our findings reflect those of previous studies that have shown that deprivation and provision of beds are both associated with admission rates.[5,6] Other studies have evaluated the role of technologies and services in reducing chest pain admissions and have produced mixed results. Impacts have tended to be more favourable in the United States (US) than the UK, perhaps due to higher baseline admission rates in the US. For example, chest pain units appeared to reduce admissions in the US [11-13] but failed to reduce admissions in the UK [8]. Promising findings in uncontrolled evaluations of some technologies have been followed by more modest impact in randomised trials. For example, point of care biomarker testing appears to reduce turnaround times for results,[14] but this translates into only modest and inconsistent effects on hospital admissions.[15,16] Sensitive troponin assays and CT coronary angiography are the latest technologies with the potential to reduce chest pain admissions. We found no evidence that use of either is associated with reduced admission rates but specific evaluation of these technologies (ideally a randomised trial) is required.

The study used routine administrative data from a large number of English trusts and achieved a survey response rate of over 70%, providing a reasonably representative sample. There are, however, a number of limitations that need to be taken into account. The power of the study to detect potentially important associations is limited by the number of trusts with usable data, so failure to show an association should not be interpreted as demonstrating that no association exists. It should be noted that the study has less power to detect associations with the dichotomous survey variables, particularly those where responses fell mainly into one category (e.g. use of guidelines, availability of a specific chest pain unit or point of care troponin), than the continuous routine data variables. The survey relied upon a clinician reporting the availability and use of services and technologies rather than direct measurement. There was a disparity between the years of admissions data obtained, with routine data being collected from 2008-2011 while survey data were collected in 2012-2013. It may be that the effect of some variables, particularly newer technologies, will not be apparent due to this. For example, the publication of NICE chest pain guidance in 2010 [17] may have standardised management and reduced variation, but this would not be reflected in the admission data analysed here. The data for RACPC attendances were only from one quarter, which may not have been representative. Finally, we cannot assume that all admissions with unspecified chest pain are avoidable, only that expert consensus suggests that this diagnostic category is likely to be rich in avoidable admissions.

Conclusion

Hospitals with higher admission rates for unspecified chest pain have greater bed provision, more RACPC attendances and serve populations with a higher percentage of households in poverty. These findings may be explained by services responding to demand in populations with greater need. We found no evidence that ED chest pain management influenced admissions with unspecified chest pain.

Contributorship

SG designed the study with help from AOC and RM. TB undertook the survey of emergency departments. RM provided the avoidable admission rates. AOC provided data from the Emergency Admissions Study. TB undertook the analysis with advice from RM and SG. TB wrote the first draft of the article and all authors contributed to the final article. SG acts as guarantor.

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Conflicts of interest

None to declare

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What this paper adds

What is already known on this subject

- Unspecified chest pain is a common reason for potentially avoidable emergency hospital admission
- Admission rates with unspecified chest pain vary between hospitals and may be influenced by chest pain management in the emergency department

What this study adds

- Hospitals with higher admission rates for unspecified chest pain have greater bed provision, more rapid access chest pain clinic attendances and serve more deprived populations
- Emergency department chest pain management does not appear to influence admission rates with unspecified chest pain

Appendix: Survey of Management of Chest Pain Patients in Emergency Departments in the UK

1. Do you have guidelines for chest pain management in your department?

   Yes **[ ]** No **[ ]**

2. On a typical weekday, how many hours of the day is a consultant present in the ED?

   _____ **/24 hours**

3. Can patients with chest pain typically be managed on an ED-based chest pain unit or clinical decision unit that allows decision-making beyond the 4-hour target without requiring formal hospital admission?

   Yes **[ ]** No **[ ]**

4. Do you have a specific chest pain unit?

   Yes **[ ]** No **[ ]**

5. Do you have a service which you can make use of to avoid 'social admissions', that is, patients who are medically fit but require support for social issues?

   Yes **[ ]** No **[ ]**

6. If yes, how many hours a day is it available on a typical weekday?

   _____ **/24 hours**

7. Do you use point-of-care troponin in the ED?

   Yes **[ ]** No **[ ]**

8. What biochemical criteria do you use to rule out MI:

   a) Negative troponin measured 10-12 hours after symptom onset (NICE guidance) **[ ]**
   b) Negative high sensitivity troponin measured at arrival and 3 hours later (ESC guidance) **[ ]**
   c) Other criteria (please specify)

   _____

   _____

   _____

9. Do you use a formalised risk score system, such as TIMI or GRACE, in the assessment of chest pain patients?

   Yes **[ ]** No **[ ]**

10. Do you have routine access to CT coronary angiography from your department?

    Yes **[ ]** No **[ ]**

11. If yes, is this access typically:

    a) the same day **[ ]**

    b) next working day **[ ]**

    c) within a week **[ ]**

    d) longer than a week **[ ]**

12. Do you have routine access to exercise stress testing in your department?

    Yes **[ ]** No **[ ]**

13. If yes, is this access typically:

    a) the same day **[ ]**

    b) next working day **[ ]**

    c) within a week **[ ]**

    d) longer than a week **[ ]**

14. Are all chest pain patients reviewed by a senior member of staff, ST4 or above, before discharge or admission?

    Yes **[ ]** No **[ ]**

15. Do you have specialist chest pain nurses?

    Yes **[ ]** No **[ ]**

16. Please state below if you are aware of any other factors that might influence the admission rate of patients with chest pain in your department:

_____

_____

_____

Would you like feedback on your hospitals admission rate? Yes **[ ]**