Small Area Demographic Factors Influencing Elective and Emergency Admissions

Dr Rod Jones (ACMA)

Statistical Advisor
Healthcare Analysis & Forecasting
Camberley GU15 1RQ
hcaf_rod@yahoo.co.uk
07890 640399

Key Points

- **Thresholds for elective and emergency admission/counting vary considerably between hospital sites even within the same Trust umbrella**
- **Unless admission rates are adjusted for these thresholds the true underlying value of the relationship with IMD & other variables cannot be characterised**
- **At specialty level emergency admissions always increase at a higher rate with IMD than elective admissions.**
- **In areas with a high proportion of 'full-time students' the rate of elective admission is significantly reduced**
- **Only a few specialties show increased levels of admission due to ethnic population.**
- **Areas of higher than average private health insurance (as indicated by the Acorn socio-economic classification) have lower admission rates.**
- **There are implications to the development of a small area formula suited to the needs of practice based commissioning**

Introduction

With the introduction of Practice Based Commissioning (PBC) there is a pressing need to develop a capitation formula which is capable of predicting the cost of delivering care for small population groups especially GP practice populations (DH 2007). The current formula uses ward level data and is unsuited to small area forecasts.

While many studies have been conducted in this field identifying factors such as age, sex, ethnicity and deprivation (Kendrick & Tomlinson 2007) no study appears to have included full-time students as one of the variables. This has direct relevance to the 'university' GP practices. While differences in admission rates between GP practices have been noted there appears a lack of studies looking at the effect of different acute sites on admission rates (Reid et al 1999,Majeed et al 2000, Kendrick & Tomlinson 2007).

The usual approach to identify a healthcare system is to use a PCT or local authority boundary or the list of a GP surgery, however, such boundaries do not reflect the usual flows of patients to the nearest acute hospital site. In this study each lower super output area (LSOA) has been assigned to sit in the catchment area of the nearest acute hospital site using travel time analysis. A LSOA contains around 1,000 to 3,000 head of population (the higher populations usually being associated with student halls of residence). LSOA nest together into electoral wards with around five LSOA per ward.

This work analyses the results from 2,130,000 heads (365,000 emergency & elective admissions) using admission data for the 2004/05 year. In this study the 12 acute hospital sites (both within and outside of Thames Valley) providing care to the residents of TV is used to define a population cluster or 'healthcare system'. Each LSOA was allocated to a cluster using travel time analysis. Each acute site at the centre of a cluster area does not provide a full range of services, however, it is illustrative to see how relative rates of admission vary between different population groups, e.g. supply induced demand.

Methods

Admissions in 5 year age bands (0 to 4, etc up to 85+) for England (2001/02 to 2004/05) was obtained from the NHS Information Authority 'Performance Investigator' data reporting tool. Age banded admissions were matched against 2003 mid-year population estimates to give a rate per 1,000 head for each age band.

Census population data for 2001 by 5 year age band was obtained for each lower super output area. A lower super output area (LSOA) is a geographic and socio-economically distinct area containing 960 to 6,500 head of population (average 1,500). LSOAs nest into wards and then into Unitary Authority and PCT boundaries. For each LSOA an expected volume of admissions was calculated using the age banded population and the age banded national average admission rates.

Specialty level data was aggregated into larger specialty groups with General and Elderly medicine combined; Oral, Maxillofacial, Orthodontics & Medical dental all combined. Paediatric surgery was combined with General Surgery, etc.

ONS data for each LSOA was obtained for the 2004 revision of the Index of Multiple Deprivation (IMD). 2001 census data at LSOA level on the percentage of persons from different ethnic origins was obtained from the neighbourhood statistics database of the ONS. The percentage ethnic population was calculated as a simple 'non-white' proportion. Spell- based data for admissions at LSOA level in 2004/05 was obtained via the Health Informatics Shared Services for Berkshire, Oxfordshire and Buckinghamshire. Admissions for residents outside of Thames Valley were excluded. The data set covers a population of around 2.13 million people and consists of 1,414 individual LSOA.

Actual admissions for each LSOA were compared to forecast national average using age adjusted rates. The difference between actual and forecast was converted into a standard deviation by dividing the difference by the square root of the expected average. For a Poisson distribution (applicable to admissions) the square root of the expected average is by definition the value of one standard deviation. For those LSOA where the expected number of admissions was less than the average the difference expressed as a standard deviation was recalculated as if that LSOA was at the average size. This step adjusts for the fact that Poisson randomness is greater as the expected average decreases. Hence it acts to reduce the higher scatter seen for the smaller LSOAs. The Poisson adjusted ratio was then used to establish a correlation. For those LSOA at greater than the average the ratio of actual to expected was calculated directly without modification.

Each LSOA was allocated to a Trust/Site catchment area using travel time analysis.

The population age distribution for each LSOA was used to calculate the expected number of admissions based on national average admission rates per age band. The difference between the actual number of admissions and the expected (national average) was assumed to be due to the effects of IMD, Ethnicity and Trust/Site thresholds for Counting/Admission. A linear relationship has been assumed.
The model had the following parameters:

Ratio of actual/national average =

(Intercept + A x IMD + B x % Ethnic + C x % Student) x Private insurance adjustment ÷ Site Threshold

The value of all 17 constants was simultaneously derived using the Solver function in Excel. This was accomplished by minimising the sum of residuals between the expected value predicted from the model and the actual value.

The model had two additional constraints to ensure that the outputs were valid. Firstly, the weighted sum of admission thresholds had to equal 1, i.e. an admission threshold of 1 means at the average for Thames Valley. This ensures that the ratio of actual/national average remains consistent for Thames Valley. The method of weighting was to use the number of LSOA in the Trust/Site catchment. Secondly, residuals were weighted according to the size of the LSOA as measured by expected volume of admissions. Hence a residual for an LSOA twice the size of the average would receive a weighting of 2. This avoids any bias which would occur from the smaller than average LSOA.

The intercept represents the proportion of national average for a LSOA having a zero IMD score and 0 % ethnic population. Hence an intercept of 0.77 for emergency admission to General Surgery implies that any LSOA at close to zero IMD will only have 77% of the age-adjusted national average volume of admissions.

The constant "A" gives the rate of increased admission due to IMD while the constant "B" gives the rate of increased admission due to % ethnic. It should be noted that for most specialties the value of "B" is zero indicating that ethnic origin has an insignificant effect on the volume of admissions.

Due to the role of Poisson randomness in the data at SOA level the analysis will become dominated by the randomness at around an average of 1 event per SOA. This is due to the fact that at an average of 1 a value of 0 can be expected to occur on 37% of occasions.

For emergency admission this affects the specialties Ophthalmology, Oncology, Oral Surgery, Rheumatology and Haematology (included in this work) and Neurosurgery, Neurology, Cardiothoracic Surgery, Pain Management (all excluded).

For the elective specialties this affects Neurosurgery, Cardiothoracic Surgery, Rheumatology & Neurology (all excluded from the analysis).

Excel Solver is a tool for multi-parametric estimation. Starting values are input into the model and Solver then uses sophisticated mathematical techniques to check if these are the best values and if not to then find the best values which will minimise the sum of residuals (or whatever condition Solver has been requested to fulfil).

Initiating Solver using a wide variety of starting values results in convergence of the model to values of the model parameters which are remarkably consistent, i.e. Solver has been able to locate the best choice of parameters which gives the true minimum sum of residuals. Solver usually takes around 75 iterations to achieve this result.

The next test of adequacy is to confirm that the model behaves like the real world. Hence if the Heatherwood site does not make emergency admissions to a particular specialty does the model arrive at a site threshold close to that of Wexham Park, i.e. the next site to which the patient would be directed? The model passes this test.

The final test is to see if the model detects anomalies in the base data. This was confirmed using data from MKGH where admissions to an A&E assessment unit (Specialty code 180) were reported against specialty 110 (Orthopaedics). This results in large numbers of patients with non-Orthopaedic characteristics 'corrupting' the characteristic profile for Trauma & Orthopaedics.

The model both detects that the admission threshold is exceedingly low and that the mix of patients is incorrect, i.e. the model gives values for the intercept and the IMD constant which are closer to General Medicine than Orthopaedics. Excluding data from MKGH then allows the model to arrive at sensible values for these constants.

Thresholds for Admission/Counting

The fact that there is large variation in healthcare structure & practice is widely known. It is reasonable to expect that different organisations and sites have different thresholds for 'admission'. These thresholds can arise due to:

- clinical decision
- different standards for counting of an emergency 'admission', i.e. some locations may count ward attendees, urgent outpatient appointments, assessment unit attendance, etc differently to others
- different ways of allocating a patient to a specialty, i.e. there is overlap between General Surgery/Urology/Gynaecology, between General Surgery and Gastroenterology, between General Medicine and Cardiology, etc)
- using emergency admission as a way of avoiding a breach of the 4 hour A&E waiting time target
- and for elective admission by counting outpatient procedures/ tests/treatments as a 'day case'

For example the same haematology care can be labelled and therefore counted as 'emergency', 'day case', 'outpatient attendance', or 'regular day admission' depending on how different hospitals choose to interpret the NHS Data Definitions – which in some cases is dictated by the limitations of PAS systems. By implication the same package of care can be charged at 4 different prices.

GP referral behaviour is known to vary considerably. This variability will be to some extent encapsulated into the area thresholds for admission, i.e. the observed threshold is the combined outcome of both primary and secondary care.

In this study a system threshold of 100% represents the TV average while a threshold of 120% implies 20% more admissions (or events counted as an 'admission') than the average after adjusting for the effects of age, IMD and ethnicity – the effect of which are covered in the following section. The acute sites are as follows: Frimley Park (Camberley), Heatherwood (Ascot), Hillingdon, Horton (Banbury), Milton Keynes, Oxford (ORH/NOC), Royal Berkshire (Reading), Stoke Mandeville (Aylesbury), Swindon, Wexham Park (Slough) & Wycombe.

Conversely it also implies that adjustment for the effect of system thresholds is vitally important to establishing the correct sensitivity to the effects of IMD and ethnicity. This is illustrated in Table 1 where the values of the coefficients in the model are given with and without correction for system thresholds.

As can be seen the value of the three coefficients can be skewed if the effect of system thresholds are ignored. This observation has implications to the national capitation formula where no adjustment has been made for system thresholds and hence implies that the funding allocations may be subject to bias. For example, a population with an IMD of 20 and with 20% ethnic population would receive a Urology budget of 85% of the national average after adjusting for the effect of thresholds but would only be given 73% of national average if the confounding effect of the thresholds were ignored. There is the potential for extreme bias since what appear to be small changes in the individual coefficients translate into large changes in the calculated output.

Table 1: Comparison of calculated model coefficients with and without adjustment for the effects of system thresholds on emergency admission.

Factor	Urology		Orthopaedic		Medical Group	
	With	Without	With	Without	With	Without
Intercept	51%	55%	99%	78%	58%	57%
IMD	0.012	0.007	0.017	0.015	0.023	0.024
Ethnicity	0.005	0.002	0.000	0.000	0.0044	0.0039

System thresholds for elective and emergency admission/counting are given in Table 2. Thresholds are for the surrounding population of a particular acute site. The effect of students and private healthcare usage do not apply to emergency admission. This was confirmed by attempting to run the model with these factors included. The model gave a null output for these factors.

There are considerable differentials in the rates of admission for the population groups serviced by the same Trust but at different sites.

Table 2: System thresholds for elective admission/counting

	Elective Admission		Emergency Admission	
Specialty	**Highest**	**Lowest**	**Highest**	**Lowest**
All Specialties	125%	87%	118%	88%
Surgical Group	134%	87%		
General Surgery	160%	88%		
Urology	152%	73%		
Surgery & Urology	152%	84%	113%	90%
T & O	133%	59%	296%	67%
ENT	144%	86%	144%	63%
Ophthalmology	122%	71%	185%	73%
Oral Surgery	241%	69%	349%	5%
Neurosurgery	469%	10%	n/a	n/a
Plastic Surgery	311%	37%	473%	46%
Cardiothoracic	363%	10%	n/a	n/a
Pain & Anaesthetics	529%	16%	n/a	n/a
Gynaecology	155%	34%	211%	46%
Medical Group	112%	91%	118%	91%
General & Elderly Medicine	209%	60%	121%	68%
Gastroenterology	176%	13%		
Cardiology	142%	36%		
Neurology	234%	7%		
Rheumatology	431%	8%	221%	5%
Haematology	239%	30%	611%	92%
Oncology	194%	50%	187%	5%
Paediatrics	166%	34%	132%	65%

The hospital site showing high Gynaecology admissions may be interpreting the generally accepted division between Gynaecology and Obstetrics at the first trimester of pregnancy in a different way to other hospitals.

High levels of Plastic Surgery admission appear to cluster around three sites with specialist departments. This raises the question – where do all the equivalent admissions go in other locations? Are some treated in A&E and discharged while others get admitted to other specialties?

Certain Trusts make far greater use of emergency assessment units than others. One site was admitting such patients to 'Trauma & Orthopaedics' while the others admit to the specialty A&E. It is unclear if some of these 'admissions' should more correctly attract an A&E attendance price.

It is obvious that there is no commonly applied definition of and/or counting for an admission. The implication of this is that PCTs are carrying differential costs based on different criteria for counting/admission. This appears to be especially true in Oncology and Haematology.

IMD

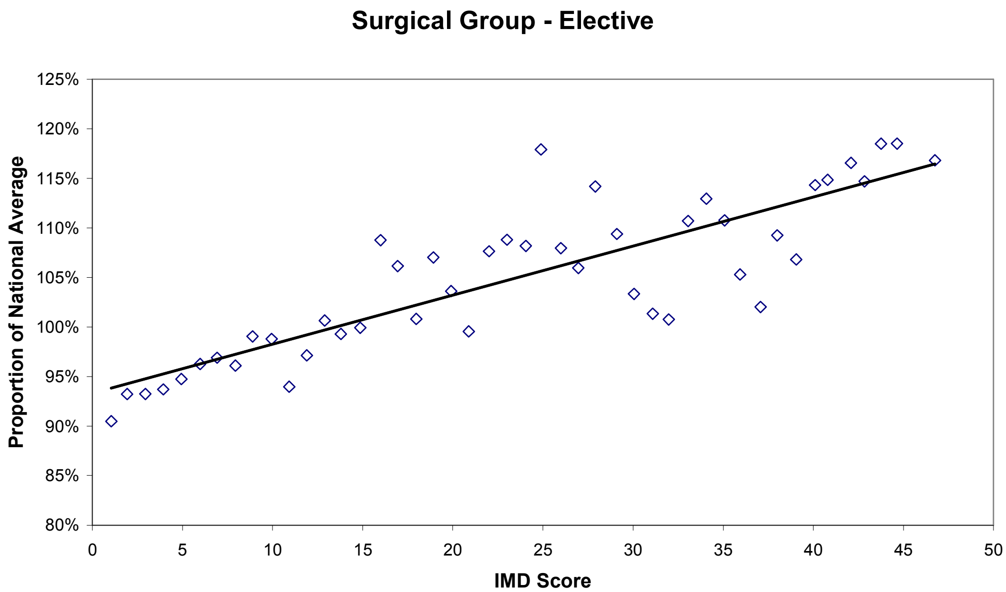
The Index of Multiple Deprivation (IMD 2004) is a measure of multiple deprivations at small area level. The IMD contains seven domains of deprivation (with associated weightings) and each domain is itself constructed from a number of indicators. It is of interest to note that IMD has a relatively good linear correlation with factors likely to affect overall health such as smoking (Hughes & Atkinson 2005).

The national average IMD is around 22 while the average for Thames Valley is around 11. The IMD for LSOAs in Thames Valley ranges from 0.6 to 53 (Eaton Manor in Milton Keynes with next highest of 50 in Oxford) while the full national range is 0.6 to 86 (a single LSOA in Liverpool).

An example of the relationship between admissions and IMD is given in Figure 1 for the surgical group of specialties. Data in Figure 1 is after adjusting for the confounding effects of site admission thresholds, proportion of students, higher rates of private healthcare usage at IMD <11 and ethnicity. Each data point is an average of a minimum of 10 LSOA.

Note that the number of LSOA per data point decreases above an IMD of 16 since only 25% of the population is above this value. The higher scatter around the trend line for IMD >16 is the direct result of the Poisson randomness associated with the use of a single year of data averaged over just 10 LSOA; however, as expected most data points lie within ± 3 standard deviations. The very high proportion relative to the national average for the data point at the average IMD of 26 is due to unusually high admissions associated with a single LSOA in the ward of Greenham in West Berkshire.

Figure 1: Increasing volume of elective admissions and IMD



The slope gives the increase in elective admissions as IMD increases while the Y-axis intercept gives the position relative to the national average (100% = national average) applied to the particular age structure of each LSOA.

Table 3 summarises the percentage increase in emergency and elective admissions for a 10 unit increase in the index of multiple deprivation (IMD). For comparison a 10 unit increase in IMD increases smoking prevalence by 5 percentage units.

The increase in emergency admission with increasing IMD creates the situation where the 14% of the population living in areas with an IMD >20 account for up to 26% of emergency admissions. These findings are consistent with the known evidence for health inequalities and the secondary effects of smoking on health (Rayleigh & Polato, 2004)

Note the differing sensitivity of emergency and elective admission to IMD. This difference partly explains why the ratio of emergency to elective admissions is so widely different in the same specialty from one PCT to another.

Only Oncology and Rheumatology show a higher rate of increase with IMD for elective over emergency admissions and ENT is the only specialty where the rate of increase is the same.

That elective intervention increases with IMD is probably linked to the most frequent procedures for each specialty. Hence poor living conditions, higher levels of manual working, etc could be expected to increase levels of admission for conditions such as adenoids & tonsils (most frequent ENT procedures), hernia repair (6^{th} most frequent General Surgical procedure), etc.

To put the link with IMD in context the most deprived area in Thames Valley (IMD = 50) would only have 5% more admissions to Haematology while Anaesthetics and

ENT would have 85% and 50% more admissions respectively than the most affluent area. Recall that 60% of the population of Thames Valley has an IMD score below 10.

Ethnic population

A few specialties show correlation with the % ethnic population. The high slope of the line of best fit for Cardiology is to be expected given the known disposition of the Asian population to heart disease. The relationship for the other specialties may have a similar basis.

For elective admission ethnicity mainly affects Cardiology and Rheumatology while for emergency admission it mainly affects Respiratory Medicine, General Medicine, Paediatrics & Cardiology.

Table 3: Coefficients for elective and emergency (after adjusting for the effect of site thresholds)

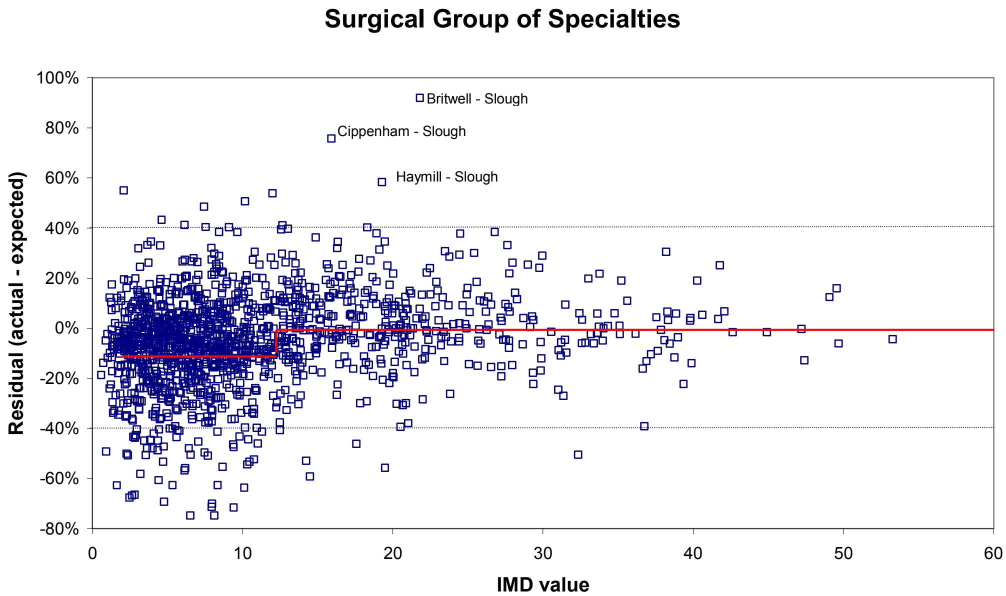
	Elective Admission			Emergency Admission		
Specialty	**Intercept**	**IMD**	**Ethnicity**	**Intercept**	**IMD**	**Ethnicity**
ENT	70%	10%	3%	52%	10%	
Gynaecology	75%	4%		29%	4%	
General Surgery	88%	4%	1%	67%	24%	
General & Elderly Medicine	30%	5%	4%	59%	23%	5%
Surgery & Urology	94%	3%	1%	64%	19%	
Ophthalmology	84%	7%	6%	83%	5%	
Rheumatology	10%	7%	11%	23%	3%	
Urology	106%	1%	2%	51%	12%	5%
Orthopaedic	91%	6%		99%	16%	
Oral Surgery	59%	3%	7%	14%	12%	
Gastroenterology	120%	5%	7%	39%	36%	
Oncology	36%	7%		40%	2%	
Plastic Surgery	112%	5%		97%	12%	
Cardiology	114%	1%	19%	50%	16%	4%
Haematology	45%	1%	5%	14%	1%	
Paediatrics	38%	1%	9%	28%	9%	3%
Anaesthetics	10%	17%	4%	n/a	n/a	
Neurology	27%	4%		n/a	n/a	
Respiratory Medicine		7%		41%	13%	9%
All	87%	4%	2%	55%	19%	
Medical Group	79%	3%	4%	60%	26%	4%

Private Healthcare & Students

Summing the residuals (i.e. the difference between actual and expected) across the surgical specialties enables the identification of those areas which have consistently higher or lower NHS usage. This will partly reflect the influence of private health usage in certain areas and high GP referral in other areas. This is given in Figure 2 here the running average is shown in red.

As can be seen the magnitude of the scatter is considerably lower at IMD >30 (the most deprived 4.3% of the population) where it is almost certain that there are very few individuals with private health insurance or the means to self pay. At the other extreme are areas with IMD < 11 where the average NHS usage for the surgical group of specialties is 10% lower - see Table Seven.

Figure 2: Residual NHS utilisation for the surgical group of specialties. A residual is the difference between the actual and the expected admission rate.



The Acorn socio-economic classification[1] suggests that an unusually 'high' level of private medical insurance would be 60% above the national average.

Investigation of those SOA with very low admissions to the NHS (i.e. a residual greater than -40% in Figure Two) shows that they are mainly clustered in Wycombe & South Buckinghamshire. Using the web tool www.upmystreet.com such areas appear to correlate with high disposable income and are typically Acorn classification Type 1 to 4 which are know to have 'high' levels of private health cover, i.e. approximate 60% above national average levels of private medical insurance leads to an average -60% residual.

This lower usage of elective NHS surgery is partly compensated for by areas of higher usage in areas with IMD values between 0 and 20. This is perhaps a reflection of the referral habits of individual GPs. In this respect the three LSOA with very high admission rates are all from Slough in the adjacent areas of Haymill & Britwell.

Using IMD less than 11 as a proxy for higher levels of private insurance does flag up some interesting anomalies, in that some specialties show higher rather than lower usage for the more affluent. This appears to affect Rheumatology, Neurology, Anaesthetics & Pain and Plastic Surgery.

Table 7: Model constants describing the effects of % Students and IMD <11 (as a proxy for high levels of private health usage) on elective-only admissions.

[1] www.caci.co.uk – put acorn into the search facility

Specialty	% Student	IMD <11
Cardiology	-1.00	94%
Oral Surgery	-0.85	89%
Surgical Group	-0.83	89%
Plastic Surgery	-0.80	103%
Gynaecology	-0.79	86%
Gastroenterology	-0.79	98%
Neurosurgery	-0.74	89%
Ophthalmology	-0.74	89%
Orthopaedics	-0.74	89%
General Surgery	-0.74	89%
All Specialties	-0.70	91%
ENT	-0.70	86%
Surgery & Urology	-0.68	89%
Paediatrics	-0.60	88%
Urology	-0.48	87%
Rheumatology	-0.43	126%
Haematology	-0.38	92%
Neurology	-0.35	105%
Medical Group	-0.27	98%
Anaeasthetics & Pain	-0.16	106%
Cardiothoracic Surgery	-0.12	79%
General & Elderly Medicine	-0.06	88%
Oncology	0.26	88%

In conclusion, while NHS utilisation in the surgical group of specialties is on average 10% lower for IMD < 11 there are particular Acorn Classification types that exhibit very low NHS usage. The referral behaviour of particular GP practices is also seen to play a role. The implication of both these statements to Practice Based Commissioning is obvious. In terms of PBC a specific adjustment is needed to correctly account for the effects of private health care usage. Other than resorting to tools such as the Acorn classification the best factor upon which to rely would appear to be the historic levels of low elective admission seen in specific LSOA.

Some 90% of LSOA have less than10% students and only 4% of LSOA have >20% students. The maximum population of students is 83% & 69% respectively for the two LSOA situated in the ward of Carfax in Oxford.

The impact of students on the overall admission rate appears to be best approximated by subtracting around 0.8 x % Students from the expected age, IMD and ethnicity adjusted rate. As can be seen in Table Seven this adjustment is specialty specific and may reflect the rather crude way that this adjustment has been applied, i.e. with no age adjustment. Further work is needed to refine the adjustment required for students.

Table Seven indicates that the high % students appear to be linked with higher rather than lower admission rates in Oncology. This association appears to be related to the different types of cancer experienced by different socio-economic groups.

Another interesting comment is that students may not have health needs reflective of the IMD for the area in which they reside during term time. Most students come from relatively affluent socio-economic parent groups and may therefore be better approximated by a single 'affluent' IMD value.

It is however clearly apparent that students do have a far lower rate of elective admission than the non-student population and that such an effect will have a major effect on PBC budgets, in particular for the University practices.

Specialty data for the correlation variables relating to emergency admission are summarised in Table Eight. Points to note are as follows:

60% of LSOA come from areas where the IMD is less than 10 (relatively high affluence) while only 4% have an IMD >30. The 4% of LSOA with an IMD >30 account for 7.3% of medical emergency admissions, i.e. targeting just 63 LSOA across the whole of Thames Valley could have the greatest effect on achieving a marginal reduction in total emergency admissions <u>if</u> appropriate strategies could be implemented.

The higher the value of the intercept the higher the levels of emergency admission within Thames Valley in relation to the national average. This mostly affects Plastic Surgery, T&O and General Surgery.

The high value in Plastic Surgery is explained by the presence of three regional centres for Plastic Surgery in Oxford, Stoke Mandeville and Wexham Park. Admissions in other parts of Thames Valley are in general lower since in the absence of a dedicated department the patients are admitted to other specialties or not admitted at all.

Admission for Oral Surgery, Haematology, Paediatrics, Gynaecology and Rheumatology is well below national average. This implies far lower thresholds for admission/counting outside of Thames Valley. For Gynaecology some hospitals may be counting events in early pregnancy as Gynaecology rather than Obstetrics or may be counting urgent 'outpatient' procedures as an emergency admission.

The situation for Oncology appears to reflect the known lower overall incidence of cancer across the area covered by the Thames Valley SHA.

A value of 0.004 for the % Ethnic constant (as for Cardiology, Paediatrics, Medicine) implies that a 100% ethnic population will have 40% more admissions.

Non-linear relationships with IMD

This report has used a linear approximation for the relationship between number of admissions and IMD. While the data clearly shows that the exact relationship is non-linear (see Figures below) it would appear that the non-linear behaviour has greatest effect for values of IMD beyond 30. Since this affects only a small proportion of the population in Thames Valley a linear approximation is adequate.

The greatest implication is to the structure of the national capitation formula where the cost across all specialties and the emergency and elective components are assumed to rise in parallel and where non-linear behaviour may not have been adequately adjusted for. At the extreme case the national formula may be over-funding areas with the highest IMD scores.

Conclusions

Even after adjusting for population characteristics likely to affect demand for healthcare the volume of admissions or what is counted as an 'admission' vary considerably. These differences appear to influence the disproportionate financial pressures experienced by PCTs. They are so significantly different that the concept of an 'average' case mix can be questioned. PCTs and Trusts will need to discuss the implications of these differences in the light of local knowledge.

Lower rates relative to the national average in around half of the specialties appear to point to more widespread counting of outpatient procedures as a 'day case' outside of Thames Valley. This has been confirmed from detailed analysis of national data at HRG level. The extreme case is Pain Management/Anaesthetics where the TV is only 40% of the national average.

PCTs should therefore scrutinise those HRGs where particular providers can count outpatient procedures (such as anti-inflammatory joint injections in Rheumatology) or regular day attendance (as in Haematology or Oncology) as a 'day case'.
The outcome of the analysis also explains why the ratio of emergency to elective admissions is so different from one PCT to another. The different sensitivity of emergency and elective admissions to IMD creates a continuum of ratios. Overlaid onto this are step adjustments to the ratio due to the additional system differences in the rates of emergency and elective admission and counting of an 'admission'.

The analysis can also shed light on which areas would benefit the most from the input of community matrons and/or admission avoidance schemes and the top 150 super output areas with the highest rates of emergency admission are identified – see Appendix Five.

The implications to Practice Based Commissioning (PBC) and the development of a small area capitation formula are discussed. The need for suitable adjustment to account for the effect of students (very low levels of elective admission) and private health usage is highlighted. The lack of a direct count of private health admissions is a serious limitation of PBC since the national formula contains no specific adjustment for this factor, i.e. it is assumed that the very limited measures of 'deprivation' used in the national formula are sufficient to adjust for the specific effect of private healthcare usage.

The outputs of this model have been used to calculate specialty benchmarks for all TV PCTs. These benchmarks allow a PCT to identify which specialties are accounting for the highest volume of 'excess to funded levels' of activity. The work has also been extended at HRG level[2] and tables are available to show which HRG have the highest volume of 'excess to funded levels' of activity.

The model assumes that the bulk of patients in a catchment area are treated at a common site. A further development of the methodology would be to analyse all admissions by actual site of admission. Unfortunately such an approach multiplies the complexity of any model and does not add to the primary aim of flagging gross differences.

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Conflict of Interest

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References

Keenan T, Rosen P, Yeates D and Goldacre M (2007) Time trends and geographical variation in cataract surgery rates in England: study of surgical workload. British Journal of Ophthalmology 91: 901-904.

Kendrick S and Tomlinson J (2007) The system of unscheduled care in Scotland: variation in the levels of emergency inpatient admission by GP practice. ISD June, www.isdscotland.org/isd/servlet/FileBuffer?namedFile=WP2_SUS_Final_29062007.pdf&pContentDispositionType=inline

Reid FD, Cook DG and Majeed A (1999) Explaining variation in hospital admission rates between general practices: cross sectional study. BMJ 319: 98-103

Majeed A, Bardsley M, Morgan D, O'Sullivan C and Bindman AB (2000) Cross sectional study of primary care groups in London: association of measures of socioeconomic and health status with hospital admission rates. BMJ, 321;1057-1060.

Hughes,A and Atkinson,H (2005) Choosing Health in the South East: Smoking. SEPHO report

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