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Factors influencing demand for hospital beds in English Primary Care Organisations

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Key Words: *Hospital bed demand, deprivation, death in hospital, health and social care, Torbay Care Trust, London bed demand, bed days per death, primary care organisations, rural, city, deprivation, GPs per head, acute bed demand, integrated care, need weighted funding formula*

Subsequent research identified net migration out of London at retirement age as the cause of the very high bed days per death for most London PCO's. http://www.hcaf.biz/2013/Population_Density.pdf London also has a very low ratio of deaths per GP.

Key Points

• Demand for inpatient beds (as bed days per death) ranges from 85 to 240 (median 117) in English Primary Care Organisations.
• Bed days per death are influenced by the respective proportions of city and rural populations, the proportion of deaths occurring outside of a hospital, deprivation and full-time equivalent GPs per head of population.
• Rural communities use around 28% fewer bed days per death than city populations.
• An increase in the proportion of people dying elsewhere than in a hospital by 10 percentage points could lead to a reduction in hospital bed demand of around 15 bed days per death.
• A 10 unit increase in the PCO-wide index of multiple deprivation (IMD) leads to an extra 4 bed days per death
• For a city population with an IMD of 40 units bed demand could range from 140 to 115 bed day per death where 22% to 45% of deaths occur outside of hospital respectively.
• Some 19 (out of 153) English PCOs covering city populations (mainly in London) have more than 30% higher than the expected number of bed days per death with Haringey requiring 100% more bed days per death than expected.
• At only 75 bed days per death (33% lower than expected) the Torbay Care Trust is a national example of integrated health and social care and successful implementation of a range of acute and community-based initiatives.
• There is no correlation between bed days per death and the acute and community element of the need weighted resource allocation for each PCO suggesting that the mismatch between the two may be leading to subtle and unrecognised cost pressures.

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Abstract

This paper demonstrates that the ratio of bed days per death reflects the contribution from factors which are known to increase demand for hospital admission and bed utilisation. Data covering English Primary Care Organisations was extracted from a variety of open access sources and the relationships affecting higher bed days per death were explored. Hospital bed days per death in PCO's across England increase with deprivation, low ratio of GPs per head or urban location and decease as death outside of hospital increases or for rural populations. The validity of this ratio is illustrated at the Torbay Health Trust which has 33% fewer bed days per death than expected, arising from many years of investment in a range of integrated acute, primary and social care improvement initiatives. The capitation formula used to fund primary care organisations in England shows no correlation with bed days per death and may be inadvertently creating financial pressures. Measures of rurality and deprivation are specific to those available in England. Deaths are from all causes. Health care policy needs to foster greater integration in health care. Bed days per death is introduced as a new performance measure which can be used to track the success or otherwise, of a variety of admission avoidance and other schemes for care in the community and to support international comparisons of bed utilisation.

Introduction

The research literature over the past decade is very clear that the bulk of a persons lifetime consumption of health care costs (including use of a hospital bed) increases with nearness to death. Usage of hospital beds especially occurs in the last year of life and this is irrespective of the age at death (McGrail et al 2000, Mayhew 2001, Busse et al 2002, Seshamani & Gray 2003, Round et al 2004, Dixon et al 2004, Karamanidis et al 2007, Pot et al 2009, Bardsley et al 2010, Layte 2011, Wong et al 2011). In line with this fact, it has recently been suggested that death per se rather than demography may be the missing element in methods predicting future hospital bed demand (Jones 2010). A review of the trends in bed day per death in Australia and England over the past 15 years concluded that hospital bed usage per death was remarkably constant despite huge changes in the number of elderly people, medical technology, length of stay and health care policy during those years (Jones 2011a).

Further investigation regarding the number of bed days per death across health authorities in England showed that all, other than London, had around 122 bed days per death with the latter having a massive 167 bed days per death and this corresponds with the known excessive use of acute beds in London (NHS London 2010). It was noted that the number of bed days per death in Australia was similar to that seen in London (Jones 2011b).

Following a decade of initiatives to integrate health and social care and to improve acute efficiency New Zealand has one of the lowest levels of expenditure on health care and numbers of acute beds per head of population (Malcolm 2007) and ranks highest for the level of integrated care of the seven countries in a Commonwealth Fund survey (Davis et al 2010). In addition, the comparative data between Australia and England showed the onset of a trend to higher bed days per death in Australia from around 2001/02 onward and that for England displays the onset of a trend to lower bed days per death from around 2005/06 onward (Jones 2011a), i.e. the ratio of bed days per death is alterable and this appears to confirm the fact that higher bed days per death appears to arise from a lack of integration between primary, secondary and social care (Davies et al 2009, Ham et al 2011). It is of interest to note that, relative to other countries, the level of integration is probably lower in Australia (Davies et al 2009).

Other studies have suggested that it is a small proportion of patients which consume a disproportionate proportion of bed days (Brailsford et al 2004, Karakusevic 2010). These observations suggest that the organisation of health and social care has a huge influence on hospital bed demand. For example, a healthy housing programme (Jackson et al 2011) or increased GP visits to nursing homes (Evans 2010) can act to reduce acute hospitalisation as can a wide range of other primary care initiatives (Health Services management Centre 2006, 2009). Once in hospital removing bottlenecks to discharge, reducing hospital acquired infection and implementing treatment protocols can all reduce inpatient length of stay (Dulworth & Pyenson 2004, Rae et al 2007, Kaplan et al 2009).

This study will seek to investigate the contribution from what may be considered to be the most important factors behind bed usage to demonstrate that bed days per death offers a reliable measure of the overall performance of a wide mix of admission avoidance and other schemes. In this respect, the lower consumption of health care resources and hospital beds in rural populations is a well recognised phenomena (Harris et al 2008,Sauerzopf et al 2009) as is the contribution of deprivation to increased utilisation of acute services (Downing et al 2007, Jones 2006a,b). A lower number of GPs per head of population is likewise known to increase emergency admission and hospital standardised mortality rate (Jarman et al 1999). Lastly, the aim of a wide variety of health and social care initiatives is to prevent acute admission and death outside of hospital should serve as a proxy for the totality of these efforts. The contribution of the above factors to the variation in bed days per death observed between English PCOs will now be investigated.

Data Sources

Total bed days (acute, maternity, community and mental health) for the PCO responsible population during the four financial years 2006/07 to 2009/10 were obtained from the Hospital Episode Statistics (HES) website (http://www.hesonline.nhs.uk/Ease/servlet/ContentServer?siteID=1937&categoryID=213). Elective day case admissions were assigned a nominal one day stay and this was added to the total of overnight bed days. Total deaths and place of death data for the four calendar years 2006 to 2009 for the PCO resident population were obtained from the UK Office of National Statistics (ONS). The mid-2009 PCO resident populations for each PCO were obtained from the ONS website (http://www.statistics.gov.uk/statbase/Product.asp?vlnk=15106) while the mid-2009 PCO responsible populations were obtained from the NHS Information Centre website (http://www.ic.nhs.uk/statistics-and-data-collections/population-and-geography/gp-registered-populations). The PCO acute and community needs weighting factor was obtained from the HCHS Table in the '2012 Exposition Book A' from the Department of Health (England) website (http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_124949). The 'Urban-rural classification of PCOs' was obtained from the Association of Public Health Observatories (APHO) website (http://www.apho.org.uk/resource/item.aspx?RID=53312) and the 2010 index of multiple deprivation (IMD) score was obtained from the Communities and Local Government website (http://www.communities.gov.uk/publications/corporate/statistics/indices2010).

The number of full time equivalent (FTE) GPs per 1000 head of registered population was obtained from the 'General Practice Staff 2010 Detailed Results Table' on the NHS Information Centre website (http://www.ic.nhs.uk/statistics-and-data-collections/workforce/nhs-staff-numbers/nhs-staff-2000--2010-general-practice). The 2008/09 GP consultation rates for males and females in different age bands were obtained from the 'Trends in consultation rates in general practice 1995-96 to 2008-09 Tables' on

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the NHS Information Centre website (http://www.ic.nhs.uk/statistics-and-data-collections/primary-care/general-practice/trends-in-consultation-rates-in-general-practice--1995-2009).

Methods

Total bed days per death over the four year period (2006-2009) were adjusted for the ratio of PCO responsible to PCO resident populations. The ratio of full time equivalent (FTE) GPs per 1000 head was adjusted for gender/age weighted consultation rates using the Mid 2009 PCO responsible populations. The PCO population with the lowest adjusted population was given an adjustment factor of 1.0 (Heart of Birmingham Teaching PCO) while that with the most resource consuming population (Dorset PCO) received an adjustment factor of 1.2, i.e. GPs per head of population was reduced by 1.2 to give GPs per weighted head of population. The median adjustment factor was 1.095 and some 20 PCO (13%) were within ± 0.005 of this value.

Coefficients in the formula used to predict bed days per death were derived by simultaneous optimisation to minimise the sum of absolute value of the residuals (actual – predicted) using the 'Solver' function within Microsoft Excel. On this occasion, deprivation was measured using the Index of Multiple Deprivation (IMD) [see http://www.communities.gov.uk/communities/research/indicesdeprivation/deprivation10/] and was the average IMD value for the PCO resident population. An initial run of the optimisation routine led to the identification of a cluster of 20 PCOs (mainly from London) with >20% deviation from the expected value predicted by the model. These were then excluded from the final run to avoid undue influence on the model parameters in a method which seeks to minimise the sum of the residuals.

Results

Demand for inpatient beds (as bed days per death) ranges from 85 to 240 (median 117) in English Primary Care Organisations. Given the wide variation in the size of English PCOs from 840 deaths per annum in Kensington & Chelsea up to 11,410 in Hampshire and the fact that around half have fewer than 1,000 deaths per annum, an average over four years has been used to minimise small number variation. To test the hypothesis that bed days per death is a useful indicator, a formula was developed to predict bed usage per death across English PCOs. A variety of models were tested and the best model appeared to be the following:

Predicted bed days per death =

94.7 (the intercept)

+ 0.24 x (IMD-6.2)

+ 72 x (proportion urban population)

+ 55 x (proportion rural population)

- 151 x (proportion of deaths outside hospital)

Whilst the urban-rural classification of small area districts has 8 classes applicable to English populations it was found that a simple urban/rural split gave the best results and as can be seen in the above formula a rural population, on average, consumes around 28% fewer bed days per death than an urban one. An increase in the proportion of people dying outside of hospital by 0.1 (or 10 percentage points) reduces bed demand by around 15 bed days per death and the most deprived PCO will have around 9 more bed days per death than the least deprived PCO (average IMD ranges from around 7 to 43 units). The model

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predicts around 82 bed days per death as the minimum for a highly affluent rural population with around 45% of deaths outside of hospital which is the current maximum proportion for deaths outside of hospital in England. For a city population with an IMD of 40 units bed demand could range from 142 to 107 bed day per death where 22% to 45% of deaths occur outside of hospital respectively.

Figure 1: Effect of GPs per 100,000 head of population on PCO bed days per death

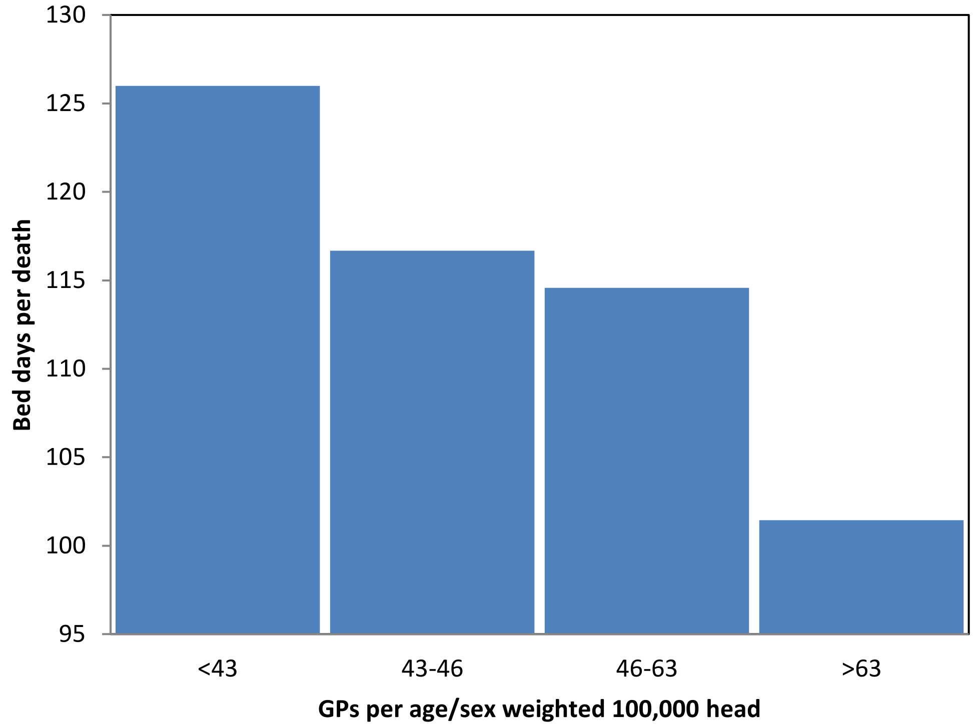

Table1: PCOs with unexpected bed days per death

PCO	Actual	Predicted	% Difference
Cambridgeshire	113	94	20%
Manchester	157	130	21%
Heart of Birmingham	163	130	22%
Waltham Forest	173	141	25%
Lewisham	164	127	26%
Kingston	156	126	27%
Torbay Care Trust	**75**	**112**	**-33%**
Wandsworth	158	118	34%
Brent	178	129	37%
Newham	187	124	51%
Southwark	196	117	68%
Hammersmith & Fulham	190	113	69%
Lambeth	190	111	71%
Kensington & Chelsea	197	107	84%
Islington	207	111	86%
Camden	202	108	88%
Tower Hamlets	224	117	91%
City & Hackney	234	119	96%
Westminster	219	110	99%
Haringey	240	119	101%

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Attempts to incorporate the ratio of GPs per head of population into the above model assuming a linear relationship between GPs per head and bed days per death were unsuccessful. However based on the known relationship of low values of this ratio to higher emergency admission (Jarman et al 1999) the possibility of a non-linear association was explored (see Fig. 1). As can be seen the ratio of GPs per age-weighted head does indeed have a highly non-linear influence on the number of bed days per death. There is a broad plateau between 4.6 and 5.8 GPs per 10,000 weighted head but below around 4.5 GPs per 10,000 head the bed days per death rises sharply (Bexley, Nottinghamshire, Redbridge, Wolverhampton, etc) and somewhere above 5.9 to 6.1 GPs per 10,000 head the bed days per death reduces sharply (Devon, Herefordshire, etc).

The actual and predicted values of bed days per death for English PCOs are shown in Figure 2 where the abnormally high bed demand seen in most London PCOs is clearly evident (see Table 1). If we assume a cost of somewhere around £200 per bed day (Jones 2008a) this equates to an excess cost of around £24,000 per death in Haringey or around £29,000,000 of excess bed day related acute costs for the 1,200 deaths per annum in this PCO.

To investigate whether this additional cost is reflected in the resource allocation formula the bed days per death for each PCO was plotted against the respective need weighting factor. As can be seen in Figure 3 there is no correlation between the two respective measures of 'need' or expressed demand, i.e. for whatever reason this additional cost is totally unfunded.

Figure 2: PCO bed usage per death

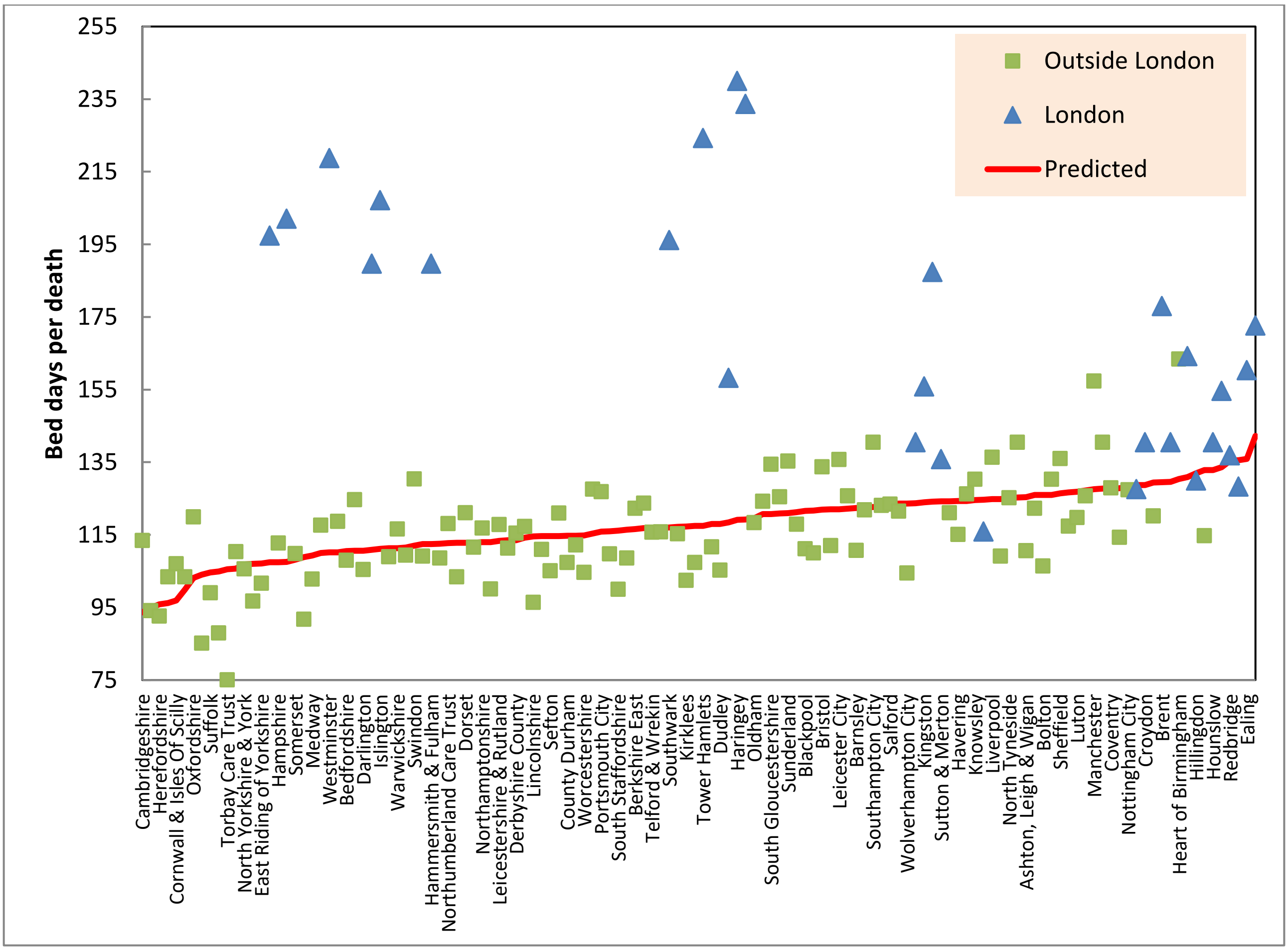

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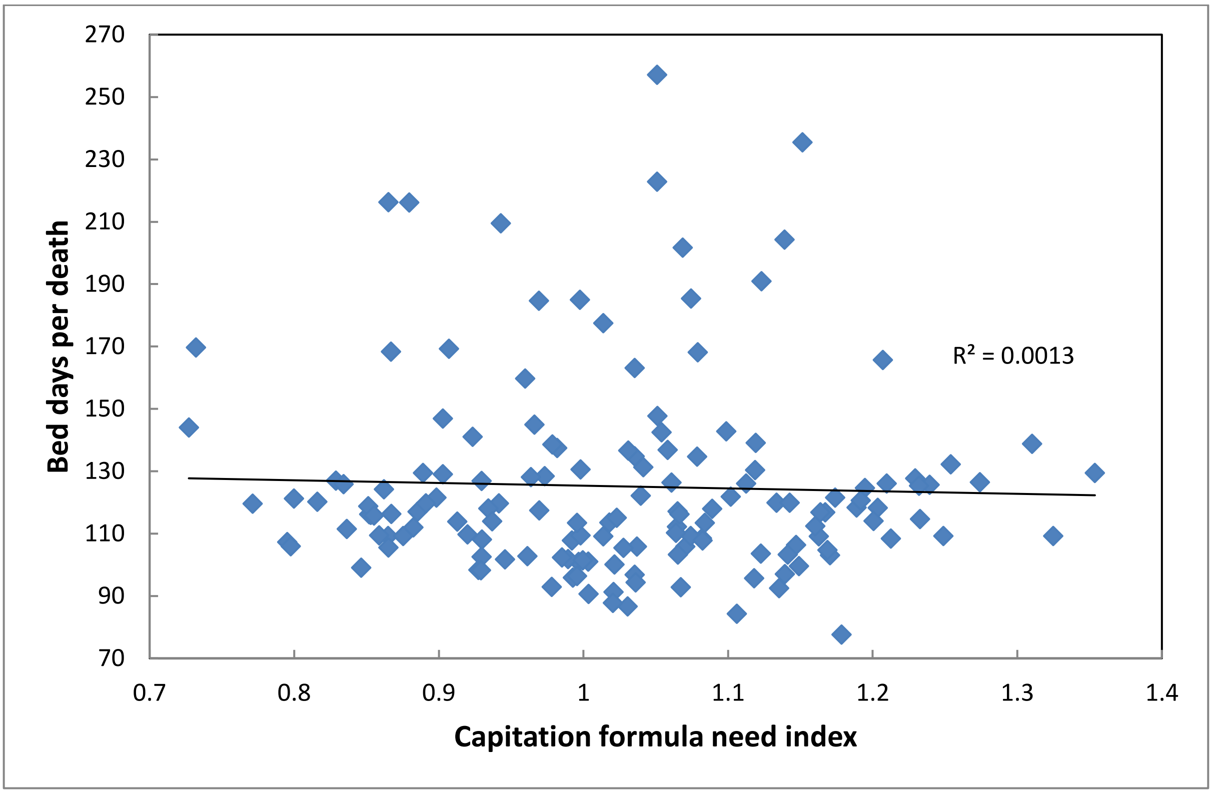
Figure 3: PCO capitation formula needs weighting



Discussion

According to Crampton et al (2004) a good indicator measuring primary care organisation performance should include the following features: linked to health outcomes, defined, sensitive to change, reflect a variety of dimensions of care, feasible to collect and report and minimise perverse incentives.

The emphasis on minimising the spiralling cost of healthcare has led to a whole range of interventions claiming to avoid admissions and reduce hospital bed usage. A recent review of eight interventions targeted at older people suggested there was little evidence to show that admissions were reduced and that some may actually be even increasing them. Complex record-linkage against paired populations was required to determine the findings (Steventon et al 2011). Hence a relatively simple and easy to implement method is required to enable rapid identification of successful schemes or organisations.

Apart from the already extensive literature base which suggests that both elective and non-elective acute bed usage is highest in the last year of life this study is seeking to verify that bed days per death is responding to known population factors (Fig 1 and 2) which would increase or decrease bed demand and hence to suggest that this does indeed provide the basis for a reliable measure which can be used to track progress over long time periods.

In this respect it is of interest to note that what are perceived to be successful schemes for admission avoidance, the virtual ward scheme in Wandsworth and the integrated care co-ordination service in Brent (Ham et al 2010) both occur in PCOs which still manage to appear around mid way in Table 1. On this occasion, the before and after values are lacking and London may be a far more challenging environment than elsewhere (see below).

The sigmoidal relationship between bed days per death and GPs per head of population seen in Fig. 1 implies that it is only at the very extremes that this ratio has a large effect on bed days per deaths. The earlier work of Jarman et al (1999) which assumed a linear relationship between GPs per head (not age/sex standardised for consultation rates as in this study) was only able to demonstrate a slope of 0.67 GPs per 100,000 head in the relationship with standardise hospital mortality rate and this is a likely outcome from attempting to fit a linear relationship to a sigmoidal data set. However the basic conclusions are the same, namely, anything less than around 4.5 GPs per 10,000 weighted head is highly detrimental to the care of patients in a community context.

The use of proportion of people dying outside of hospital as a proxy for a wide range of community-based schemes is acknowledged to be a broad measure. However, sometimes it is the simplest of factors which can influence hospital usage and the very low proportion of deaths in hospital in the state of Oregon (USA) was linked partly to the far higher proportion of nursing home residents with 'do-not-resuscitate' orders or having a living will (Tolle et al 1999). A study in Peterborough (England) showed that a 10% increase in GP visits to nursing homes led to a 20 percentage point increase in death outside of hospital (Evans 2010). In its own right, death outside of hospital will lead to a reduction in bed days per death. For example, if the average stay leading to an in-hospital death is around 10 days, then a 10 percentage point reduction in in-hospital deaths for a location with 1,000 deaths per annum will reduce bed usage by 1,000 bed days or 1 bed day per death. The suggested figure of 1.5 derived from the model therefore appears to be realistic and suggests that a move to fewer in-hospital deaths is only achieved by a wider range of initiatives than simply stopping admissions for those about to die.

At this point some discussion regarding the scatter around the trend line in Fig 2 is required along with a consideration of the general higher bed usage in London. The scatter around the trend line arises partly from the fact that a relatively simple model has been applied simply to demonstrate that bed days per death is behaving in a manner which is consistent with factors known to influence bed demand. A more comprehensive model with a larger number of factors will act to reduce the scatter. An additional contribution to the scatter will come from the fact that PCO-wide averages are merely a high level way to screen the contribution from the various factors.

For example, the index of multiple deprivation (IMD) only strictly applies at small area level and the relationships with IMD are specific to various conditions and are generally non-linear (Jones 2006a,b). Hence the approach employed here is simply to demonstrate the general fact that higher deprivation leads to generally higher bed usage. Likewise the index of rurality may partly reflect the fact that rural locations are further away from most acute sites (Harris et al 2008), however, the authors own research suggests that the relationship between distance and hospital utilisation is complex and depends on location, i.e. at equal distance the slope of the relationship is higher in some areas than others (Jones 2006 a,b). This work simply suggests that rural as opposed to city does have a strong effect of bed usage which may be partly due to factors other than socio-demography such as air quality (Sauerzopf et al 2009, Wong et al 2002). In some locations the acute hospital is a joint acute/community hospital while in other areas the community hospital is run by a social enterprise and the resulting bed days will be missing. In England, data on admissions and bed usage for private hospitals and hospices are not collected and this will add additional scatter in some locations and finally differences in acute length of stay efficiency will play an important role. Given the above, a certain amount of scatter is therefore acceptable but fails to explain the highly divergent results in particular instances.

In this respect it is not possible to explain the very high bed days per death which appear to apply in most of London. The recognised role of racial and ethnic factors in health status may well play a far more important role in London as has been demonstrated in the USA (Liao et al 2011). Such racial and ethnic factors will also influence alcohol and tobacco usage and one Australian study suggested that alcohol abuse increased the total bed days per death by 50% (Finch 2001). A US study found differences in total cost per death (which will include acute bed utilisation) which depended on the nature of the illness (van Houtuen et al 2008). The increasingly recognised role of pollution in increased levels of emergency admissions for respiratory and cardiac events may also play a greater role in London than elsewhere (Sauerzopf et al 2009, Wong et al 2002). Lastly there is that difficult to quantify role that integration between primary, secondary and social care plays upon the default usage of acute beds (Davies et al 2009, Ham et al 2011) and which appears to be the missing element in London.

As opposed to London, the unique position of the Torbay Care Trust which has only 75 bed days per death (33% fewer than expected) requires detailed explanation. The Torbay Care Trust is coterminous with the Torbay Unitary Authority and is located in Devon, SW England. It is the PCO for a population of around 140,000 head (1,700 deaths per annum) across Torquay, Paignton & Brixham and has a high age/sex weighted index for GP consultations (1.18 versus a maximum of 1.20) due to an older population. The health care improvement initiatives commenced in 1991 when the local hospital became a whole district acute and community service which worked closely with the emerging primary care organisations. In 2004/05 it was one of the first PCO's to become an integrated health and adult social care organisation and it is at this point that dramatic reductions in the rates of hospital admission were achieved through team working and information sharing focussed around the patient. Hence both the acute hospital and the Torbay Care Trust have played their part in reducing length of stay and preventing admissions respectively. Both organisations now share one the lowest length of stay in England along with one of the lowest emergency admission rates (Lavender 2006, Karakusevic 2010, Wade 2010, Thistlethwaite P 2011).

Regarding the benefits of integration, it is also of interest to note that the Isle of Wight PCO with 84 bed days per death (second lowest in England) is an integrated primary and secondary care organisation. It would appear that the data presented in this study provides a clear consensus regarding the benefits of primary, secondary and social care integration.

In all publicly funded health care systems the issue of fair funding to different localities is of central importance, hence, the concluding issue is the lack of an apparent relationship between the acute and community portion of the weighted capitation formula used to allocate money to English PCOs and the number of bed days per death. The formula itself is not without its detractors in that it is supposed to fund 'need' which is often very different to expressed demand and is a conceptually difficult issue to quantify within the limitations of available socio-economic data (Morris et al 2010) and the approaches employed to analyse such data (Galbraith 2008, Asthana & Gibson 2009).

Another difficulty is the assumed simple relationship between 'need' and admissions which is implied by the use of a fee-for-service tariff for hospital services in England called payment by results (PbR). The tariff itself contains multiple inconsistencies (Jones 2008a-e, 2009a-c) and presents perverse incentives to hinder integration (Karakusevic 2010). However, in theory, Fig 3 should contain a line of best fit with a positive slope, i.e. higher need is directly linked to higher demand (as bed days per death), since such a relationship has been shown to apply in the above investigations. Nowhere in the formula is death per se used as a measure of need. Standardised mortality rates are indeed in the formula (Morris et al 2010) but they are by no means a direct measure of deaths per annum. We must only conclude that despite its seeming enormous complexity and sophistication the formula used to fund English PCOs may be missing one of the most direct and powerful determinants of cost and need.

In conclusion, bed days per death appear to offer a reliable and easy to collect method for tracking the contribution of a variety of admission avoidance and general efficiency initiatives. The starting point in each location will include a number of contributing factors such as the proportion of the population living in a rural area, deprivation, GP's per head of population, possible environmental effects (pollution, etc) and the more difficult to measure contribution from the level of integration between primary, secondary and social care. At only 75 bed days per death (33% lower than expected) the Torbay Care Trust is a national example of integrated health and social care and successful implementation of a range of acute and community based initiatives. The key point is that we now have a performance indicator capable of assessing whether we are moving in the correct direction or are unintentionally wasting money or even making things worse.

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