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DO DIFFERENCES IN PRACTICE PRESCRIBING COSTS REFLECT RELATIVE NEEDS?

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ABSTRACT

Weighted capitation formulae are increasingly being used to inform prescribing budget setting. Under such formulae, resource allocations are based on the age and gender characteristics of registered populations and an index of relative needs based on population morbidity and socio-economic circumstances. These weights are estimated using current patterns of prescribing across the population and practices. The sustained assumption is that differences in levels of prescribing reflect relative needs. In the absence of comprehensive, epidemiological measures of need, we propose two ways of assessing the validity of this assumption. The first proposes that prescribing should exhibit a similar relationship to predictors of morbidity as do direct measures of morbidity. The second proposes that, unless the relationship between prescribing and the estimated needs index is equal in all areas, we should be explicit about which areas we choose to include in the analysis. We present analyses of prescribing data in Scotland where we find evidence that patterns of prescribing across practices do not satisfy these conditions. [164 words]

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INTRODUCTION

Weighted capitation formulae are increasingly being used to allocate budgets to health care plans (Rice and Smith, 1999). Proposed formulae for prescribing in Scotland, England and Northern Ireland have recently been published (Scottish Executive, 1999; Rice et al, 2000; Rice, 1999). These formulae have a common structure. The share of total expenditure allocated to each group of practices is based on its population share, adjusted to reflect differences in (a) age and gender composition and (b) morbidity and socioeconomic circumstances. The adjustments for age and gender are based on average prescribing costs of each group. The adjustments for morbidity and socioeconomic characteristics are based on the regression methods proposed by Carr-Hill et al (1994).

This paper explores the way in which these adjustments reflect prescribing resource needs. Because the purpose of weighted capitation formulae is to derive equitable *shares* of resources, these adjustments reflect differences in *relative* rather than *absolute* need. Furthermore, as the formulae are based on the current patterns of prescribing across population groups, they do not explicitly seek to reflect "capacity to benefit". These adjustments aim to provide an allocation of resources to each group of practices so that each individual could, *in principle*, receive the average level of resources for their population group. The new objective for resource allocation in England changes this agenda for England to "reducing avoidable inequalities in health". This paper considers how an existing formula may perpetuate current inequalities in prescribing allocations.

The regression methods used to derive the adjustment for morbidity and socioeconomic characteristics attempt to control for the possible effects of supply on the use of health care. The sustained assumption is that "on average the system gets it right" (van Doorslaer et al, 1999), so that the differences in prescribing across the population and practices reflect differences in relative need. However, there have been concerns for a long time that this may not be the case:

> *'the availability of good medical care tends to vary inversely with the needs for it in the population served'. (Tudor Hart, 1971)*

Carr-Hill et al acknowledged this limitation of their methods and called for further research:

> *'This entire study was predicated on the assumption that utilisation of NHS resources is a good predictor of health care need. For many reasons, this assumption may be suspect. Some groups may be systematically excluded, others may 'capture' more NHS resources than their clinical need justifies. There is a clear need for research to establish whether utilisation is a legitimate predictor of need.' (Carr-Hill et al, 1994, p.138)*

A subsequent review of the literature on equity in health care concluded that there was little good-quality evidence on which to assess the validity of this assumption (Goddard and Smith, 1998).

We propose that there are conceptually three ways of assessing the validity of the assumption that 'on average the system gets it right'.

The first way of to assess the validity of the assumption would be to develop a resource allocation model based on epidemiological measures of ill-health and "best-practice" health care packages, with the aim of maximising benefit from limited resources. However, this approach would be "data hungry" and as Rice and Smith noted

> *'The selection of needs factors to be considered in a health care capitation has often been highly complex and controversial process…research evidence on appropriate needs factors is sparse, dated and ambiguous in its implications.' (Rice and Smith,1999, p8)*

The second method is based on the assertion that patterns of prescribing use should exhibit similar patterns with predictors of morbidity as do direct measures of morbidity. By this, we do not mean that the gradient of prescribing use across predictors of morbidity should be the same as the gradient of direct measures of morbidity across these variables. The debate between Le Grand and others addressed this issue (Le Grand, 1978, 1991, O'Donnell and Propper, 1991, Wagstaff et al, 1991). Le Grand's (1978) approach to measuring equity in health care proposed that equity was achieved when each population group's share of health care was equal to its share of morbidity. O'Donnell and Propper' (1991) and Wagstaff et al's (1991) work demonstrated that the results were sensitive to this judgement and that current patterns of health care use were *not* proportional to differences in levels of morbidity. The judgement about what distribution of health care use is equitable for each level of morbidity is therefore an important but contentious matter.

Our proposed method for analysing the pattern of prescribing use is based on the first and second derivatives across a suitable predictor of morbidity. In our empirical work we use a composite index of deprivation (Carstairs and Morris, 1991) but any good predictor of morbidity would be possible. We propose that the use of prescribing resources should increase with deprivation since direct measures of morbidity (e.g. permanent sickness rates, premature mortality) increase with deprivation. Furthermore, we propose that the *rate* of increase of prescribing resource use should not fall if the *rate* of increase in morbidity across deprivation does not fall. Therefore, the first and second derivatives of prescribing resource use and morbidity over deprivation should have the same sign.

Our third method considers whether the relationship between prescribing resource use and predictors of morbidity are constant across all areas (in Scotland these are geographically defined Health Boards). We propose that the relationship between prescribing use and predictors of morbidity should be same in all areas if we are to unconditionally include all areas in the analysis. If there are variations between areas in the slope of prescribing use across predictors of morbidity then this heterogeneity may provide information on the extent to which differences in prescribing patterns reflect relative needs. If we find significant heterogeneity, we must assume that this is random if we are to include all areas in the analysis. If the heterogeneity is not random, then we have to make a judgement about which areas have prescribing patterns which reflect relative needs. Such choices should be as evidence-based and explicit as possible.

The focus on areas or Health Board differences in prescribing resource use is particularly appropriate because one of the most important determinants of practice level prescribing use are the sizes of the budgets allocated by local planners. In Scotland, prescribing budgets are set at a Health Board level by a process of annual review using a variety of techniques. These techniques range from simply uplifting historical expenditure to using a formulaic approach and adjusting for the age and sex structure of the practice and for prescribing need (usually using a modified version of a national prescribing allocation formula). Currently, over 60% of the Scottish population live in Health Boards where budgets are based purely on historical expenditure (Lock, 2000). Given that such a high proportion of prescribing budgets and thus prescribing use is historically determined it is important to consider whether historical resource use on average reflects need. In certain subgroups of the population it might not. It is also important to consider whether in certain Health Boards the relationship between resource use and

need may be different because local planners have the ability to set local budgets and exercise this power to a greater or lesser extent.

In the first section of the paper we describe the data used in the construction of a prescribing formula in Scotland. In the second section we explore the relationship between the use of prescribing resources in deprived subgroups of the population compared to the relationship between three epidemiological measures of ill-health. In the third section we explore heterogeneity in the relationship between the use of prescribing resources and an aggregate indicator of prescribing needs. In the final section of the paper we calculate a summary measure of the progressivity with which prescribing resources are delivered to needy populations in each region.

DATA

We examined these issues using data which are being used to allocate prescribing resources to 15 Health Boards in Scotland as part of the Arbuthnott Review (Scottish Executive, 1999). These Health Boards vary considerably in terms of population size and population socio-economic profiles. For example, Greater Glasgow is the largest and most deprived Health Board with 18% of the Scottish population and 52% of its population in the lowest deprivation quintile (Carstairs and Morris, 1991).

The Arbuthnott review generated a prescribing model dataset for 1032 GP practices subdivided into six care programmes. The care programmes were defined by BNF chapters: gastro-intestinal disease (BNF chapter 1), circulatory disease (BNF chapter 2), mental illness (BNF chapter 4), infections (BNF chapter 5), musculoskeletal disease (BNF chapter 10) and a residual (BNF chapters 3, 6 and all others).

For each practice and care programme an age and gender standardised index of prescribing use was available (*U*). Prescribing use was measured using data from an administrative database of all prescriptions for the year 1996/7. Prescriptions were costed using generic equivalent prices. An index of prescribing need was also available by care programme (*N*). This needs index was calculated using weighted least squares regression to estimate the relationship between the use of prescribing and various morbidity, socio-economic and supply variables. More detailed information about the methods used to calculate the needs index, the variables and the results of the modelling are provided in the *Fair Shares For All* reports (Scottish Executive, 1999). The dataset contained the list size of each practice and a Health Board identifier.

Three epidemiological measures of ill-health were calculated for each GP practice. These were the standardised mortality rate in under 65 year olds (SMR64), the standardised illness ratio (SIR) and the standardised permanent sickness rate (SPR). The former measure was calculated from Register General Death Records and the latter two from the 1991 Census.

METHODS

Relationship between Prescribing Costs and Deprivation

To examine whether there is a shortfall in the use of prescribing resources by the relatively deprived we examined the relationship between deprivation and utilisation data (*U*) and compared this to the relationship between deprivation and epidemiological measures (*E*). Deprivation was measured using the Carstairs index (*CAR*), which is a composite score of four census variables, male unemployment, social class, car ownership and overcrowding. The scores range from –4.97 (most affluent) to 9.98 (most deprived) in Scotland (Carstairs and Morris, 1991).

We expected the relationship between both epidemiological and resources use data and the Carstairs index to be approximately linear. This is because the Carstairs index is constructed using proportion variables, for example, if male unemployment is an individual risk factor for ill-health a x% increase in unemployment would be expected to result in a αx% increase in ill-health. Our hypothesis are therefore that morbidity and resource use would increase across the deprivation index and have positive first and non-negative second derivatives.

Spline regression was used to analyse whether the relationship between (a) prescribing costs and (b) indicators of ill-health and the Carstairs index. Six threshold values or knots (t_j) were specified at points along the deprivation spectrum representing percentiles of the Scottish population ranked by the Carstairs index.

The knots were specified using six dummy variables (K_{ihj}):

$$K_{ihj} = 1 \text{ if } CAR_{ih} \geq t_j \text{ or } 0 \text{ otherwise}$$

where t_1 = takes the value of the Carstairs Index at the 20^{th} percentile, $t_2 = 40^{th}$ percentile, $t_3 = 60^{th}$ percentile, $t_4 = 80^{th}$ percentile, $t_5 = 90^{th}$ percentile and $t_6 = 95^{th}$ percentile.

Least square estimates were obtained by multiple regression, using the following specification:

$$U_{ih} = f_0 + f_1 CAR_{ih} + \sum_{j=1}^{J-1} l_j K_{ihj} X_{ihj} + e_{ih} \quad [1]$$

$$E_{ih} = f_0 + f_1 CAR_{ih} + \sum_{j=1}^{J-1} l_j K_{ihj} X_{ihj} + e_{ih} \quad [2]$$

in which U_{ih} are the age and gender standardised estimated costs of prescribing in GP practice i in board h, E_{ih} are the age and gender standardised measures of ill-health and e_{ih} are independently distributed error terms with zero mean.

where

$$X_{ihj} = CAR_{ih} - t_j \quad [3]$$

We used a forward stepwise procedure to determine the statistical significance of the individual dummy variables at a 5% level of confidence. The RESET test was used to test the specification of the model and Huber-White standard errors were used to control for heteroskedasticity.

Health Board Specific Relationship between Prescribing Costs and Need

It is assumed that the relationship between prescribing and the estimated needs index should be equal in all areas, however, the relationship may vary significantly between Health Boards. We introduced Health Board specific intercept and slope terms for the needs index to test whether the relationship between prescribing use and the needs index was equal across Health Boards.

$$U_{ih} = a + b\ N_{ih} + e_{ih} \quad [4]$$

$$U_{ih} = a + \sum_{h=1}^{H-1} d_h D_{ih} + s N_{ih} + \sum_{h=1}^{H-1} D_{ih} b_h N_{ih} + e_{ih} \quad [5]$$

A vector of fourteen dummy variables representing Health Board of management was included (where D_{ih} = 1 if the practice is managed by Health Board h: D_{ih} = 0 otherwise). The most

populated Board (Greater Glasgow) was the reference group. We tested the joint significance of the b_h and d_h terms using a subset F-test.

We then measured the extent to which Health Boards allocated prescribing resources to the most needy populations using a measure of progressivity of the distribution of resources relative to need. Progressivity was measured using a Kakwani index (Kakwani, 1977). The index measures the extent to which the use of resources rises in relation to need across practices within each Health Board. An index of progressivity for each Health Board (V_h) was constructed such that:

$$V_h = C^U{}_h - G^N{}_h \qquad [6]$$

where $G^N{}_h$ are Health Board specific Gini coefficients for need and $C^U{}_h$ are concentration coefficients of resource use over need (Figure 1).

The index of progressivity (V_h) is positive when resource use tends to rise less than proportionately with need and negative when resource use rises more than proportionately with need. Because need is measured using the national average slope parameters, some boards will have positive values for V_h and others will have negative values for V_h. Therefore, boards with negative V_h values are more progressive than the national average and boards with positive V_h values are less progressive than the national average.

RESULTS

Relationship between Prescribing Costs and Deprivation

The three of the epidemiological indicators of ill-health were generally positively related to the Carstairs index across the entire deprivation spectrum as expected (Table 1). In particular there was no evidence of any statistical decrease in the relationship at high levels of deprivation. On the other hand, the *rate* of increase in the use of prescribing resources in five out of the six care programmes declined at high levels of deprivation. In the gastro-intestinal and mental illness care programmes the rate of increase in the use of prescribing resources declined in the 40% most deprived GP practices, likewise in the 10% most deprived practices in the musculoskeletal model. In the circulatory disease and infection care programmes the relationship between the use of prescribing resources and deprivation was negative at high levels of deprivation.

Insert Table 1 here

Figure 2 illustrates the fitted values from equations [4] and [5] for the circulatory disease care programme and the standardised permanent sickness rate. The use of circulatory disease prescribing resources declines at high levels of deprivation whilst the epidemiological measure of ill-health increases (note that the Scottish population is not evenly distributed across the Carstairs index as only a very small percentage of the population live in practices with high scores). Given our expectation that the use of prescribing resources should increase continuously across the deprivation spectrum a pattern exhibited by the epidemiological indicators of ill-health we consider this to indicate an unmet need for prescribing resources in deprived populations.

Insert Figure 2 here

Health Board Specific Relationship between Prescribing Costs and Need

Table 2 illustrates that the Health Board specific slope and intercept terms were jointly significant in all six of the care programmes. This provides evidence that the relationship between the use of prescribing resources and the needs index is not constant in all areas.

Table 3 illustrates the Kakwani progressivity scores for each Health Board in Scotland by care programme. The results indicate that Borders and Lanarkshire appear to allocate prescribing resources least progressively of the mainland Health Boards as illustrated by the positive and above average V_h scores in five out of the six care programmes. Lothian, Forth Valley and Tayside appear to allocate prescribing resources most progressively across the six care programmes. This indicates that in Borders and Lanarkshire a smaller proportion of prescribing resources is given to needy GP practices than in Tayside.

Insert Table 2 here

The differences in the targeting of prescribing resources to needy populations within each Health Board could reflect a number of factors, for example, differences in the budget setting process or differences in the level of funding. We attempted to explain the differences in the progressivity indices using various indicators of the funding of the Health Board but no significant relationships were found.

DISCUSSION

In this paper we have tested the validity of two of the assumptions underpinning the utilisation-based approach to constructing weighted capitation formulae. Using data from a formula used to allocate prescribing resources in Scotland we have shown that the differences in prescribing costs do not always represent relative need and that the relationship between prescribing costs and need is not always homogeneous across Scotland.

We have presented empirical results indicating that the rate of increase in the use of prescribing resources is lower or even negative in some of the most deprived GP practices in Scotland. We have contrasted this pattern of resource use with three epidemiological measures of morbidity none of which exhibit a similar pattern. This comparison was restricted to comparing the first and second derivatives against a single index of deprivation. Nevertheless it is interesting to note that the rate of increase across the deprivation index was considerably greater in the epidemiological measures compared to the use of prescribing resources.

We interpret this result as an indication that the use of prescribing resources is lower than expected in deprived communities. An utilisation-based prescribing formula may perpetuate this problem of unmet need by not recognising that deprived communities receive less than a fair share of prescribing resources. Under these conditions an utilisation-based formula would not allocate sufficient resources to deprived communities. If prescribing data from deprived GP practices are not representative of relative need then there is a strong case for excluding this data from the estimation of a prescribing weighted capitation formula.

We acknowledge that in this analysis we did not control for supply side effects. It is possible that those living in deprived GP practice areas under use prescribing resources due to supply constraints such a relative shortage of GPs etc. However, in previous analysis an adjustment for supply factors made little or no difference to the results. This is not to say that the under utilisation of prescribing resources is not due to supply side factors, just that these remain unmeasured using traditional supply-side adjustments such as controlling for GP numbers. There may be other ‘unmeasurable effects’ causing this shortfall.

We also illustrated that that the pattern of resource use and need was not the same in all Health Boards in Scotland. This implies that a GP practice in one Health Board might receive a greater

share of resources than an identical practice in another (after controlling for various population characteristics). Under these conditions we have to make a judgement about the relative merits of each Health Board's allocation of prescribing resources i.e. in which Board does relative use best reflect relative need? There is no reason to arbitrarily accept that the average association between population characteristics and prescribing resource use is 'right'. The association between population characteristics and prescribing resource may be 'more right' in Board's that exhibit a more progressive allocation of prescribing resources. Data from the least progressive Health Boards could be excluded when estimating a prescribing formula if we consider that differences in practice prescribing costs in these areas are not representative of relative need.

A number of Health Boards in Scotland are moving towards using the national formula for setting local GP practice budgets. Therefore, one test of the plausibility of using a national formula would be to consider the reaction of decision makers in more progressive Health Boards. If such a formula were to be implemented within a progressive Board it would reallocate funding from deprived practices to practices in more affluent areas. It is unlikely that that such a shift in resources would be deemed acceptable, especially considering current government policy initiatives to reduce inequalities in health.

We have illustrated that two key assumptions underpinning an utilisation-based prescribing formula in Scotland are not always valid. We have suggested that the problems highlighted could be remedied by making adjustments to the dataset used to estimate the formula. Further work is needed to consider the validity of these adjustments, the representativeness of the prescribing cost data and to explain why prescribing costs fall relative to need in deprived practices in Scotland.

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Figure 1. Kakwani Index of Progressivity

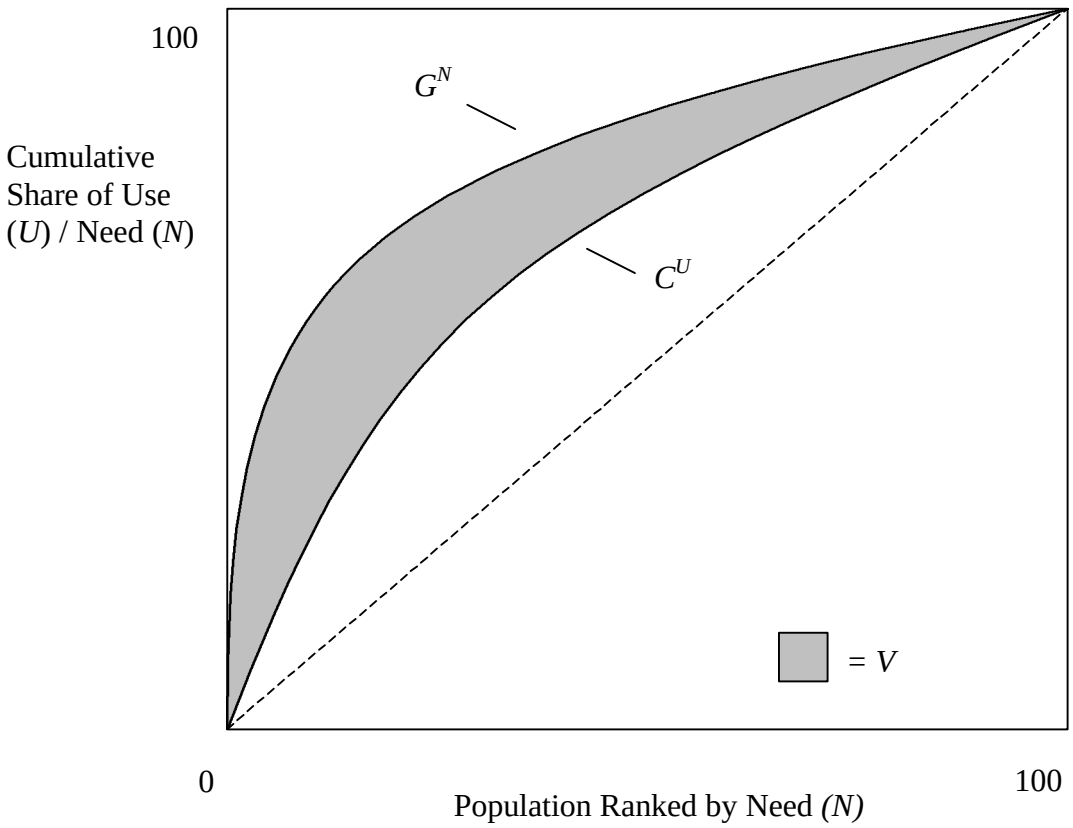

Figure 2. Standardised Permanent Sickness Ratio and Circulatory Disease Prescribing by the Carstairs Index

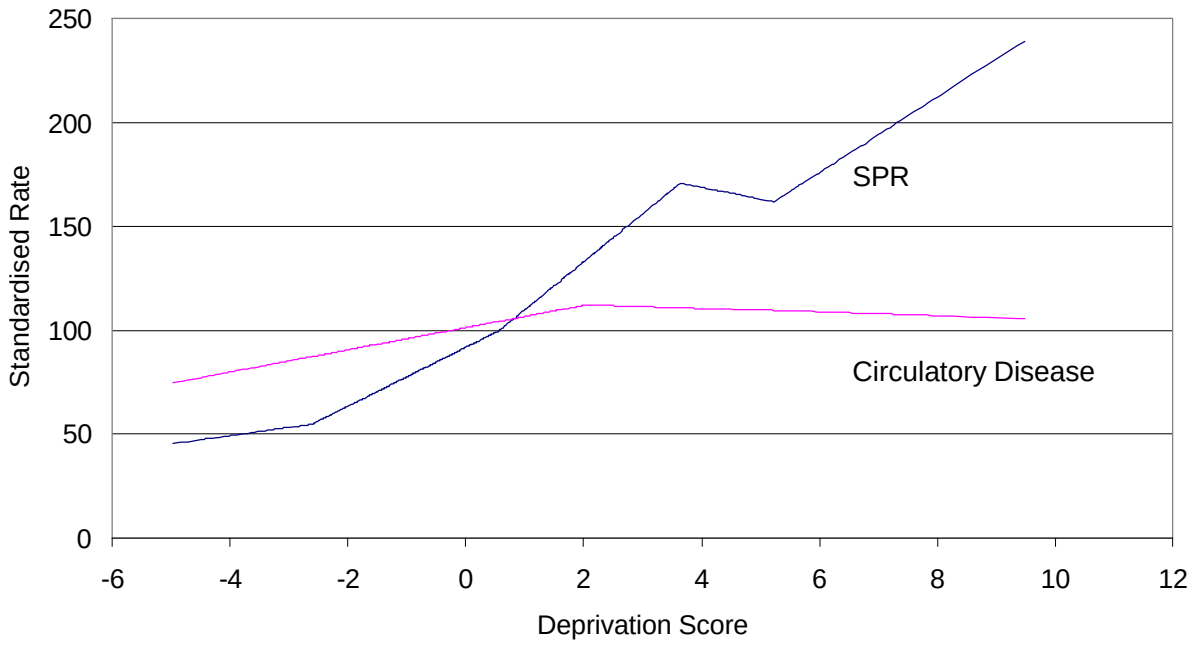

Table 1. Results of Spline Regression by Care Programme

	Diagnostics		Coefficient (t-ratio)							
	R^2	RESET	f_0	f_1	l_1	l_2	l_3	l_4	l_5	l_6
Resource Use *(U_i)*										
Circulatory	0.150	0.440	0.745	0.053				***-0.062***		
			(37.4)	(12.1)				***(-6.00)***		
Gastro-intestinal	0.198	0.329	0.676	0.069			***-0.046***			
			(28.3)	(11.4)			***(-4.39)***			
Infection	0.008	0.395	0.950	0.011					***-0.044***	
			(40.1)	(2.39)					***(-3.01)***	
Musco-skeletal	0.294	0.792	0.609	0.078					***-0.061***	
			(27.8)	(16.8)					***(-3.21)***	
Mental Illness	0.123	0.278	0.664	0.074			***-0.060***			
			(20.4)	(9.17)			***(-4.59)***			
Residual	0.162	0.246	0.853	0.028						
			(69.5)	(12.6)						
Epidemiology (E_i)										
SMR0_64	0.853	0.000	52.9	8.76			3.06			
			(47.7)	(30.7)			(5.31)			
SPR	0.723	0.238	43.4	5.59	16.9	-12.7	14.04		-30.2	24.5
			(8.68)	(2.89)	(3.65)	(-2.18)	(3.38)		(-6.88)	(6.30)
SIR	0.824	0.284	59.2	6.06	4.54				-10.0	9.89
			(41.0)	(10.6)	(6.08)				(-8.10)	(6.30)

Coefficients highlighted in bold and italics illustrate the point at which we assume there is a shortfall in the use of services.

Table 2. Joint Significance of Health Board slope and intercept terms for the Needs Index

Care Programme	R-squared		F-test: H_0: $b_h = 0$, $d_h = 0$
	Equation [4]	Equation [5]	(P-value)
Circulatory	12.8	36.9	13.6 (0.000)
Gastro-intestinal	24.7	41.9	10.6 (0.000)
Infection	3.3	13.1	5.3 (0.000)
Mental Illness	11.2	26.7	7.4 (0.000)
Musculo-skeletal	36.9	45.9	6.0 (0.000)
Residual	18.9	28.1	4.6 (0.000)

Table 3. Measures of Progressivity by Health Board and Care Programme

Health Board	Progressivity Score (*V*)					
	Circulatory	Gastro-intestinal	Infection	Mental Illness	Musculo-skeletal	Residual
Ayrshire and Arran	0.017	0.000	0.008	-0.015	-0.002	0.004
Borders	0.024	0.051	0.044	-0.029	0.015	0.029
Argyll and Clyde	0.049	0.026	0.027	-0.001	0.001	0.003
Fife	0.019	0.038	-0.001	0.028	0.017	0.018
Greater Glasgow	0.038	-0.004	0.000	0.019	-0.002	0.001
Highland	0.025	0.009	0.030	-0.039	0.048	0.005
Lanarkshire	-0.003	0.024	0.034	0.025	0.022	0.024
Grampian	0.050	0.023	-0.018	0.005	0.021	0.010
Orkney	0.061	0.009	0.085	0.049	0.065	0.045
Lothian	-0.008	-0.011	-0.005	0.008	-0.025	0.017
Tayside	-0.009	-0.025	-0.041	-0.053	0.009	-0.012
Forth Valley	-0.004	-0.014	0.003	-0.014	-0.014	0.003
Western Isles	-0.002	0.051	0.032	-0.136	0.098	0.041
Dumfries and Galloway	0.028	0.011	-0.020	-0.006	0.012	-0.010
Shetland	0.038	0.012	0.060	0.067	0.069	0.015