Explaining the Variation in Prescribing in Wales at Local Health Group Level

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Abstract

Objective- To explain variation in prescribing throughout Wales using socioeconomic, demographic, GP characteristics and morbidity factors.

Design- 34 demographic, socioeconomic, GP and morbidity factors were entered into a multiple regression model to determine to what extent such factors could explain variation in prescribing.

Setting- The 22 Local Health Groups (LHGs)[1] in Wales for 2002.

Results- For cost per 1000 patients, five factors significantly contributed to a multiple regression model. These included two health status factors: the percentage of the population reporting a long term limiting illness and the percentage of the population in a nursing home; two demographic factors: the percentage of the population over 85 and the percentage change in the registered population over a one-year period; and one GP factor: the number of GPs practicing in a Local Health Group. This model explained 89% of the variation in the cost per 1000 patients between Local Health Groups.

Conclusions- The results show a high level of explanation of the variation in prescribing at Local Health Group level. The fact that 89% of the variation has been explained primarily by demographic and health status factors does suggest that areas with a high variation in their prescribing level and cost are simply responding to increased demand.

[1] Wales's Local Health Groups are the equivalent of Primary Care Trusts in England

Introduction

There are many factors which may affect both the cost and the volume of prescribing. Factors which may cause disparities in prescribing in a particular geographic area include demographic factors, e.g. the percentage of the elderly and very elderly in the population, socioeconomic factors, such as unemployment rates and the level of education, health status factors, for example, the percentage of the population reporting long term limiting illness, standardised mortality ratios (SMRs), the level of mental illness and the prevalence of major diseases. GP factors are also likely to be a cause of variation in the cost and volume of prescribing. For example, the number of GPs, the list size of the practice and the age and gender of the GP may all contribute to prescribing variation.

There are large disparities in prescribing throughout Wales. In 2000/2001, the number of prescription items per head of the population on a GP list within Wales differed markedly, ranging from 11.9 prescription items dispensed per person in Cardiff Local Health Group to 18.2 prescription items dispensed per person on a GP list in Methyr Tydfill. There are also large disparities in the net ingredient cost per person on a GP list, ranging from £117 in Cardiff Local Health Group to £156 in Denbighshire Local Health Group. The variation in the cost per 1000 patients also followed a similar pattern, with Cardiff LHG being the lowest cost prescriber and Denbighshire LHG being the highest cost prescriber.

The NHS in Wales spent £434 million on drugs in 1999/2000, 17% of the total NHS budget for Wales. Approximately 80% of people in Wales visit their doctor at least once a year, with, on average, 75% of those visits resulting in at least one prescription. To put Wales in context with prescribing levels elsewhere in the UK, the number of prescriptions received by resident of Wales is, on average, 30% higher than for residents of England, with the cost of primary care in Wales some 20% greater than in England (National Assembly for Wales, 2001). Variations exist at national, regional and practice level. For example, cost per 1000 patients at LHG level in Wales ranges from £131,272 in Cardiff to £177,321 in Denbighshire

There is a vast and ever expanding volume of literature on the issue of prescribing and variation in prescribing, the following is a brief summary of the literature in this area. The report of the Task and Finish Group for Prescribing in Wales (National Assembly for Wales, 2001) was designed to advise on the improvement of all aspects of prescribing in Wales. The report considers the options available to the National Assembly for Wales to improve prescribing of medicines, the provision of pharmaceutical services and the supply of products. It states that one of the primary factors explaining why Wales, in general, has higher prescribing costs than other parts of the UK is that general practitioners in Wales have a propensity to prescribe higher priced products, for example, prescribing branded drugs rather than their generic equivalents. The report offers various explanations for differences in prescribing rates throughout the UK and Wales, stating that the disparities in prescribing are largely due to the volume of prescriptions being issued. One explanation offered for this is the increase in the proportion of the elderly and very elderly in the population. The report does, however, offer a simpler explanation: the increase in the number of medical conditions that can now be effectively treated in the community, as opposed to secondary care such as heart disease and mental illness.

The main factors that influence the cost and volume of prescribing are the number of prescriptions issued, the growth in the cost of expensive drugs, and the volume of generic prescribing (Task and Finish report 2001). Demand for health care also differs according to socioeconomic and demographic factors. Avery et al. (2000) identified why some general practices have low growth in prescribing costs relative to others by examining 162 general practices. Of those identified, 54 had low growth in prescribing costs, 54 had average increases and 54 had large increases in costs. The study established that costs for new and expensive drugs are particularly important in the growth of general practice prescribing costs. The primary factors that were found to influence low growth in prescribing costs were reducing the numbers of prescription items, reducing the cost per item, maintaining low growth in expensive drugs, and increasing rates of generic prescribing. Avery et al. (2000) raise important questions and concerns about whether, when general practices strive to make savings, they do so at the expense of their patients. By being conservative in their uptake of new groups of drugs, GPs risk denying their

patients access to potentially important medication. A similar point is made by Majeed et al. (1997) who analyse what PACT (Prescribing Analysis and CosT) data can tell us about prescribing in general practice. The article states that prescribing indicators should be used to improve the quality and effectiveness of prescribing and not simply to reduce costs. It is important to achieve a balance between effective prescribing and cost control. Majeed et al. (1997) state that prescribing indicators can create perverse incentives, and it would be fairly straight forward for practices to improve their performance as measured by many of the indicators without improving their clinical management of patients. Possible explanations for variations in prescribing are noted above, however other suggested reasons for the variation in prescribing are differences and changes in socioeconomic and demographic factors. Socioeconomic and demographic differences occur between and within regions. For example, whilst there may be differences and variation in prescribing between large areas, these variations also occur at the small area level. Morton-Jones & Pringle (1993) conducted a study using demographic, morbidity and practice factors to explain variations in prescribing costs across England. Their study concludes that prescribing variations are primarily a reflection of increased demand. They suggest that variations in prescribing can be largely explained by demographic and morbidity factors. Morton-Jones & Pringle (1993) suggest that reasons for the variations in prescribing costs across England can be largely explained by differences in socioeconomic factors, patients' attitudes and demography across the country.

Carr-Hill et al. (1996) analyse the socioeconomic determinants of rates of consultation in general practice in order to identify the factors that affect consultation rates. Higher rates of consultation were found in patients who were classified as permanently sick, unemployed and those living in rented accommodation. The results of this study found that in the age group 16-64 mean consultation rates were as follows: males in rented accommodation had annual consultation rates of 3.48, whereas males in owner occupied accommodation had rates of 2.63. In the same age group the mean consultation rate for the continuously employed was 2.49, in comparison to a mean consultation rate of 3.17 for the continuously unemployed. The results of this study suggest that socioeconomic

factors can act as powerful predictors of consultation patterns, stating that there is a well established association between deprivation measured in terms of census variables and various indices of rates of use of general medical services. Carr-Hill et al. (1996) also discovered that a change in employment status had a powerful affect on consultation rates. It was found that those who had lost employment during the study year were the most frequent consulters. The chief findings of this paper are that variations in GP workload can be better explained by the characteristics of individuals rather than the small area in which they live.

NcNiece & Majeed (1999) also explore the socioeconomic differences in general practice consultation rates, however this study is limited to patients over the age of 65. The study was conducted in 60 general practices across England and Wales to determine how annual contact rates and home visiting rates differ according to differences in socioeconomic status, the primary conclusions being that elderly people show socioeconomic differences in consultation rates, with annual contact rates about 50% higher in elderly patients than in other age groups. NcNiece & Majeed's results also show that social class has a role to play in consultation rates, with persons from social class V consulting much more frequently than persons from social class I (where I is considered higher on the social class scale than V).

In general, good prescribing should maximize effectiveness, minimize risk, minimize cost, and respect patient choice (Barber, 1995). However, measuring the quality of prescribing is difficult. Selecting over or under prescribing as a marker is dangerous because neither are necessarily good indicators of appropriate prescribing. The key point to outline here is that high prescribing is not necessarily bad prescribing. Avery et al. (2000) suggests that hospital initiated drugs and high cost drugs may be part of the reason for high prescribing costs. However, it must be noted that the use of expensive drugs, where appropriate, may reduce levels of hospital admission, and therefore have an overall positive effect on the health care bill.

Socioeconomic, demographic, health status and GP factors can all lead to differing levels of health care demand within an area, which, in turn, affects both the volume and the cost of prescribing. Whilst fluctuations in the volume and cost of prescribing are to be expected, it is the unexplained variation in prescribing which is a cause for particular concern to those responsible for allocation of NHS resources for prescribing. The following sections of this paper reports on a multiple regression model which goes some way towards explaining the variation in prescribing costs at the Local Health Group level in Wales in terms of the relationship between socioeconomic, demographic, GP and health status factors.

Methods

34 factors that might influence prescribing costs were identified through the prescribing literature and through discussions with prescribing advisors at Denbighshire Local Health Group. The data for each of these factors was obtained for all twenty-two Local Health Groups in Wales.

The primary measure of prescribing costs used was cost per 1000 patients for each Local Health Group. Cost per 1000 patients was chosen over and above the alternatives of cost per 1000 prescribing units and items per 1000 patients on the following grounds. Cost per 1000 prescribing units (PUs) was discounted from our model on the basis that this measure is already adjusted for age. The "prescribing unit" system scores people over 65 as requiring 3 times more costly prescribing than the rest of the population. There has been widespread debate on the issue of prescribing units, primarily because they appear to underestimate the effects of ageing on prescribing levels and because they ignore gender (Morton-Jones & Pringle, 1993). Items per 1000 patients was also discounted from our model because the length of a prescription is not standard. An "item" could mean one week's supply or six months supply, making comparisons between Local Health Groups using items per 1000 patients as a reliable measure an impossibility. An additional reason for selecting cost per 1000 patients as the primary measure was that it is

unweighted, making it compatible for use with the 34 socioeconomic, demographic and GP variables which are also unweighted.

The 34 variables were examined separately for correlation with cost per 1000 patients. As the factors appeared to be normally distributed, a Pearson Product Moment correlation was employed to test the strength and direction of the linear relationship between the variables. Pearson Product Moment coefficients were obtained for all 34 variables. Pearson coefficients take values from –1 to +1. The plus or minus sign simply indicates whether there is a positive correlation (as one variable increases so too does the other) or a negative correlation (as one variable increases, the other decreases). The size of the value, ignoring the sign, provides an indication of the strength of the relationship. A perfect correlation (-1 or +1) indicates that the value of one variable can be determined exactly by knowing the value on the other variable.

Multiple regression analysis of the data was performed using cost per 1000 patients as the dependent variable. The forward selection method of multiple regression was used, whereby all 34 independent variables were initially entered into the model simultaneously, allowing the statistics program (SPSS) to select the variables to be entered into the second stage of the model. This method entails the addition or removal of variables from the model in order to obtain the best level of prediction/explanation of prescribing variation.

Of the 34 variables tested (shown in Table 1), nine variables were found to be highly correlated with the dependent variable. These were total population, unemployment rate, cost per 1000 prescribing units of drugs less suitable for prescribing, cost per 1000 patients of drugs less suitable for prescribing, number of GPs, number of practices, limiting long term illness, female GPs, and the percentage of the population in a nursing home.

The only socioeconomic variable from the list that was found to correlate highly with cost per 1000 patients was the unemployment rate, which supports previous findings by

Carr-Hill et al. (1996), who related unemployment to higher consultation rates, which implies higher prescribing rates and costs in areas with higher than average unemployment rates. Change in employment status has also been found to affect rates of consultation in primary care (Carr-Hill et al., 1996). For this reason we also analysed the change in the employment status of the population within all 22 Local Health Groups. This variable was positively correlated (although not highly significant) with cost per 1000 patients, reiterating the finding that a change in employment status does affect primary care prescribing.

The numbers of elderly and very elderly are also known to have higher rates of prescribing. This is the motivation behind the development of the prescribing unit system which scores people aged over 65 as requiring three times more costly prescribing than people aged under 65. For this reason, the percentage of the population aged over 65 and aged over 85 in each Local Health Group area was calculated and included in our list of explanatory variables. Both age groups were found to be positively correlated with cost per 1000 patients, indicating that the higher the percentage of elderly people in the population, the higher the cost per 1000 patients. The number of people who were registered with a general practitioner was also analysed. The rate of change in the registered population (number of people registered with a GP) was calculated over a one-year period. This was thought to be an important factor because if an area has a high influx of people, then costs would undoubtedly rise. A calculation was also made of the difference in the registered population and the population as measured by the 1991 census (projected to 2000). Registered patient lists, generally speaking, tend to be higher than resident populations. This is due to factors such as patients leaving an area and failing to reregister with a new practice, therefore remaining on the old practice list (Morton-Jones & Pringle 1993). Morton-Jones & Pringle (1993) found that the effect of this variable was to artificially reduce the cost per patient in those areas with high list inflation.

In all, three GP factors were found to be highly correlated with cost per 1000 patients. These factors were the number of GPs in an area, the number of practices in an area and the percentage of female GPs. All three factors were found to be negatively correlated

with cost per 1000 patients, meaning that a high number of practices, a high number of GPs and a high percentage of female GPs lead to a lower cost per 1000 patients. One explanation for this could be that areas with fewer GPs are under more pressure, and therefore are not as cost effective in their prescribing.

The health status factors analysed included the percentage of the population with a long term limiting illness, the standardised mortality ratios of an area, the percentage of the population self-reporting some form of mental ill health and the percentage of the population in a nursing home. Of these factors only two proved to be highly correlated with cost per 1000 patients: firstly, the percentage of the population reporting a long term limiting illness and secondly, the percentage of the population in nursing homes. These two factors were found to be positively correlated with cost per 1000 patients. This result was to be expected. An increase in the number of people who report that they are suffering some form of long-term illness would be expected to increase the level and cost of prescribing in an area. The number of people in a nursing home proved to be the most significant correlation of all 34 variables. This indicates that an area with a large proportion of people in nursing homes would have a higher than average cost per 1000 patients.

Results and comment

Using cost per 1000 patients as the dependent variable, five factors significantly contributed to the multiple regression model (shown in Table 2). Three of the five factors used in the final multiple regression model showed the greatest individual correlation with cost per 1000 patients. The model consists of two health status factors: the percentage of the population reporting a long term limiting illness and the percentage of the population in a nursing home; two demographic factors: the percentage of the population over the age of 85 and the percentage change in the registered population over a one-year period; and one GP factor: the number of practicing GPs in a Local Health Group area. This final multiple regression model explained 89% of the variation in prescribing in Wales at Local Health Group level. Our model, in comparison to the published literature in this area of prescribing, performs well. The average percentage explained by other models hovers around the 50% mark, although Morton-Jones &

Pringle (1993) explained 81% of the variation in net ingredient cost at family health service level in England using similar variables.

Readers will note that, whilst our final regression model excludes some factors which are correlated with the dependent variable cost per 1000 patients, e.g. unemployment rates, other factors which are not significantly correlated with the dependent variable (e.g. population aged over 85) have been included in the model. This is because the variables used in this model are the "best fit" variables which, when combined together in the model, explain the highest degree of variation in prescribing in Wales. This is not to say that we do not believe there is an association between factors such as unemployment and prescribing rates, but simply that, using the multiple regression model, a combination involving other factors is able to explain a higher percentage of the variation in prescribing than an alternative model including this variable.

The output from the multiple regression model was analysed to ensure that the general assumptions for the use of multiple regression were met. A problem was discovered with multicollinearity, which occurs where the independent variables are highly correlated. This was primarily due to an over-fitting of the data. With a small sample size (n=22) the inclusion of any more than two variables produced problems with multicollinearity. The problem was addressed by transforming the data into Z variables, a process which standardises the data. A standardised score calculates how many standard deviation units a case is above or below the mean score. The standardised scores were calculated and saved as new variables. All of the variables, with the exception of the dependent variable, were standardised. We then re-ran the multiple regression model using the standardised scores. The model result, as expected, did not change, however, the problems with multicollinearity were addressed.

Sensitivity Analysis

In order to strengthen the validity of our results, a sensitivity analysis was performed using net ingredient cost as the dependent variable rather that cost per 1000 patients. A similar result was obtained in terms of the amount of variation explained by the multiple

regression model. Using the same five predictor variables and net ingredient cost as the dependent variable, the multiple regression model explained 88% of the variation in prescribing cost at Local Health Group level. This sub-analysis using net ingredient cost enables a more direct comparison with Morton-Jones & Pringle's regression model result explaining 81% of variation, as net ingredient cost was their primary dependent variable.

Concluding Discussion

The results of this study show a high level of explanation of prescribing variation at Local Health Group level. The fact that 89% of the variation in prescribing at this level in Wales has been explained does suggest that areas with high prescribing are responding to increased demand caused largely by the health status and demographic characteristics of their populations. Our forward selection method has enabled us to specify, out of a total of 34 variables, which five variables account for 89% of variation in prescribing at the LHG level in Wales, a higher percentage than in any other study identified in the literature. With the prominence in our results of factors relating to elderly populations (percentage of population in a nursing home and proportion of the population aged over 85 jointly accounted for 40.7% of variation in the model) we may conclude that an ageing population such as that of the UK, may play a large role in increasing demand upon primary care prescribing budgets both now and in the future.

Although our model accounted for 89% of variation in prescribing at LHG level in Wales, there are other factors which we identified as possible explanatory variables that we were not able to include in our model due to difficulty in obtaining appropriate data. Addition of these factors into a future model may provide answers regarding the 11% of variation which we were unable to account for. These variables include the number of exemption and pre-payment certificates issued, the influence of secondary care prescribing and the impact of pharmaceutical marketing activities and drug company representatives on primary care prescribing and represent potential areas for future research into factors contributing to variation in the costs and volume of prescribing.

Table 1: Results of Pearson's Product Moment test for correlation between cost per 1000 patients and 34 other factors across 22 Local Health Groups

	Pearson's r-value	p-value	Significant correlation
Population aged <5	0.066	0.772	
Population aged >65	0.392	0.071	
Population aged >85	0.267	0.229	
Total population	-0.521	0.013	*
Unemployment rate	0.506	0.016	*
Unemployed per 1000	0.406	0.061	
Change in unemployment	0.371	0.089	
Total cost of black triangle drugs prescribed	-0.289	0.192	
Total number of black triangle items prescribed	0.237	0.289	
Black triangle average cost	-0.253	0.256	
Black triangle cost per 1000 PUs	0.188	0.401	
Black triangle cost per 1000 patients	0.217	0.331	
Drugs less suitable for prescribing total cost	-0.142	0.529	
Drugs less suitable for prescribing average cost	0.248	0.266	
Drugs less suitable for prescribing cost per 1000 PUs	0.538	0.01	**
Drugs less suitable for prescribing cost per 1000 patients	0.575	0.005	**
Number of GPs	-0.594	0.004	**
Number of GP practices	-0.474	0.026	*
Number of patients per GP	0.21	0.347	
Proportion of population reporting limiting long term illness	0.561	0.007	**
Pensioners living alone	0.297	0.179	
Income <£10,000	0.359	0.101	
Average list size	0.211	0.317	
GPs aged >55	0.019	0.934	
Percentage of GPs who are female	-0.554	0.007	**
GP single handed	0.198	0.377	
GP dispensing	0.094	0.678	
Proportion of children receiving free school meals	0.215	0.336	
Standardised mortality ratio	0.376	0.084	
SF36	-0.248	0.265	
GCSE	0.158	0.483	
Nursing Homes	0.618	0.002	**
List inflation 2000-2001	0.131	0.562	
Mental illness	0.257	0.248	

*Statistically significant correlation at p#0.05

**Highly statistically significant correlation at p#0.01

Table 2: Regression coefficients, significances, and percentage contributions of factors used in cost per 1000 patients multiple regression model

Regression Detail	% of population in nursing homes	% of population reporting limiting long term illness	Number of GPs	Population aged >85	GP list inflation-2000-2001
Regression Coefficient	0.940	0.501	-0.255	-0.464	0.188
t-value	7.638	6.143	-3.004	-3.711	2.244
Significance	0.000	0.000	0.008	0.002	0.039
% of variation explained	35.0	36.7	8.6	5.7	2.7
Cumulative % of variation explained	35.0	71.7	80.3	86.0	88.7

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