A comparison of three methods of setting prescribing budgets, using data derived from defined daily dose analyses of historic patterns of use

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SUMMARY

Background. *Prescribing matters (particularly budget setting and research into prescribing variation between doctors) have been handicapped by the absence of credible measures of the volume of drugs prescribed.*

Aim. *To use the defined daily dose (DDD) method to study variation in the volume and cost of drugs prescribed across the seven main British National Formulary (BNF) chapters with a view to comparing different methods of setting prescribing budgets.*

Method. *Study of one year of prescribing statistics from all 129 general practices in Lothian, covering 808 059 patients: analyses of prescribing statistics for 1995 to define volume and cost/volume of prescribing for one year for 10 groups of practices defined by the age and deprivation status of their patients, for seven BNF chapters; creation of prescribing budgets for 1996 for each individual practice based on the use of target volume and cost statistics; comparison of 1996 DDD-based budgets with those set using the conventional historical approach; and comparison of DDD-based budgets with budgets set using a capitation-based formula derived from local cost/patient information.*

Results. *The volume of drugs prescribed was affected by the age structure of the practices in BNF Chapters 1 (gastrointestinal), 2 (cardiovascular), and 6 (endocrine), and by deprivation structure for BNF Chapters 3 (respiratory) and 4 (central nervous system). Costs per DDD in the major BNF chapters were largely independent of age, deprivation structure, or fundholding status. Capitation and DDD-based budgets were similar to each other, but both differed substantially from historic budgets. One practice in seven gained or lost more than £100 000 per annum using DDD or capitation budgets compared with historic budgets. The DDD-based budget, but not the capitation-based budget, can be used to set volume-specific prescribing targets.*

Conclusions. *DDD-based and capitation-based prescribing budgets can be set using a simple explanatory model and generalizable methods. In this study, both differed substantially from historic budgets. DDD budgets could be created to accommodate new prescribing strategies and raised or lowered to reflect local intentions to alter overall prescribing volume or cost targets. We recommend that future work on setting budgets and researching prescribing variations should be based on DDD statistics.*

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Introduction

TO managers, variation between practices in the volume and cost of drugs they prescribe suggests uneven care and promises opportunities for efficiency savings. To practitioners, it suggests unfairness and an insufficiently explained phenomenon. Two management initiatives (general practice fundholding and the indicative prescribing scheme, which have now been evaluated as far as seems likely to be helpful[1–5]) have stimulated activity in the fields of analysis of variation and the definition of ways of setting capitation-based budgets. Research has confirmed that patient age is the major determinant of variation in prescribing activity.[6–8] The contribution of deprivation and of morbidity, which is long term and independent of age, is less clear, but various proposals (for example using various deprivation indices as proxies for either or both these factors) have also been researched.[9–12] One recent paper has suggested that substantial extra prescribing costs are generated in a practice with a large number of deprived patients.[13]

The Department of Health is committed to producing a capitation-based formula for setting drug (and other) budgets.[14] It appears unlikely that the models will be simple, and controversy may delay their implementation.[15] Problems in agreeing how budgets should be set include using prescription items as a measure of volume – a technique that has been shown to be inadequate at both practice and regional level.[16] Application of the World Health Organization (WHO) 'defined daily dose' (DDD) approach to measuring volumes of drugs prescribed in given categories should improve not only budget setting but also the understanding of variation in the volume and cost of prescribing generally.[17,18]

This paper uses the DDD technique first to analyse historic patterns of volume and costs of prescribing in one health board area (Lothian in Scotland) and, secondly, to construct budgets based on these analyses. Thirdly, it uses locally derived cost/patient information to derive a capitation-based formula and to construct capitation-based budgets which, in turn, are compared with both the DDD-based budgets and the area's historical budgets.

Method

The defined daily dose (DDD)

The DDD method is a formula for standardizing prescribing volume, developed by the Nordic Council on Medicines and adopted and maintained by the WHO.[17,18] It is based on the 'assumed average maintenance dose per day for a drug used on its main indication in adults'. Not all single and combined preparations have been allocated a DDD by WHO as yet and, in other cases, the Nordic standard is unrepresentative of United Kingdom (UK) prescribing practices. A pharmacist worked with the authors to allocate DDDs in these instances (information available from the

authors). The number of DDDs prescribed in any given period is calculated by multiplying the quantity of drugs prescribed by the strength of the preparations used, totalling these amounts, and dividing the total by the DDD for the relevant drug.[2]

The dataset

The complete Scottish Prescribing Dataset for all 129 Lothian practices (808 059 patients) was obtained from the Scottish Pharmacy Practice Division (PPD) for the period January–December 1995. All prescriptions in the seven major British National Formulary (BNF) chapters (1, gastrointestinal; 2, cardiovascular; 3, respiratory; 4, central nervous system; 5, infections; 6, endocrine; 10, musculoskeletal and joint diseases) were converted to DDDs. These chapters covered 80% of the area's prescribing costs. Of the remaining chapters, those covering ointments, dressings, and ear, nose, and throat (ENT) preparations were not convertible to DDDs. Those remaining covered either small or generally inapplicable sections (for example malignant disease or general anaesthesia) or areas relating to health maintenance rather than illness management (for example contraceptives and vaccines).

Calculating a drug budget based on DDDs

All practices were allocated into one of nine groups of approximately equal size based on the percentage of patients aged 65 and over and the percentage of patients for whom deprivation payments were received, reflecting current local policy on budget setting. High, medium, and low numbers of elderly patients were defined, respectively, as having 9% or more, 7–8%, or less than 7% of patients over 65 years. High-, medium-, and low-deprivation practices received deprivation payments for, respectively, 11% or more, 5–10%, or less than 5% of their patients. Note was also made of whether practices were standard fundholding practices, non-fundholders, or part of the primary care purchasing initiative (PCPI). A 10th group included the 11 practices with more than 25% of deprived patients, independent of their proportion of elderly patients. (The practices in this group have also been allocated budgets within one of the nine age/deprivation groups to which they belonged.)

The data for the seven BNF chapters were converted into DDDs and analysed using Microsoft Access. Information on practice list size was obtained from Lothian Health. A mean DDD per patient was derived for each BNF category for each of the practice groupings. These mean figures became volume targets that each practice in each of the 10 groups was assumed to be able to work to. Similarly, a cost per DDD was derived for each BNF category for each of the practice groupings. In the absence of significant cost per volume variation between practice groups, one common target cost per volume was then used for each BNF chapter.

DDD-based budgets were calculated for each practice for each BNF chapter by multiplying the volume factor appropriate to its demographic grouping by the appropriate unit cost/DDD for that BNF chapter. The aggregated budget for the seven BNF chapters redistributed 80% of Lothian historic drug costs. This figure was then uplifted to arrive back at 100% of the funds available for allocation by adding a share of the remaining 20% in proportion to the aggregated DDD budget identified for Chapters 1–6 and 10 described above.

Calculating the capitation budget

The cost and volume data for each BNF chapter used to create the DDD budget were reconfigured as a cost/patient for each BNF chapter. A series of multiple regressions was carried out to test which of the factors of percentage of patients aged over 65 years and percentage for whom deprivation payments were made predicted cost for each BNF chapter separately and for all seven chapters together after adjusting for the other. (For this purpose, the percentages of patients over 65 years and for whom deprivation payments were made were treated as single continuous variables.) After the capitation formula that best explained the influences of age and deprivation had been derived from the multiple regressions, the appropriate budget for each practice was calculated and again uplifted to cover costs not included in the seven BNF chapters for which DDDs were available.

Calculating historical prescribing budgets

The 1995–96 historical budgets used as comparators in this study were those currently applying in Lothian and were provided by the prescribing advisor to Lothian Health. These were based on actual spend in each practice in 1992–93, modified by a series of annual incentive schemes that have operated locally since then. This has made 5% of the 1992–93 budget redistributable to practices that have met a range of incentive targets relating to, for example, non-use of appetite suppressants, high use of preferred antibiotics, and percentage prescribing of generic preparations.[19]

Results

Setting the DDD budgets

Table 1 shows the number of DDDs prescribed in each BNF chapter for each demographic group, together with an overall mean figure for all nine demographic groups. It also shows aggregated figures for the three age groups, the three deprivation groups, fundholding status, and 'high deprivation' status. Age influenced volume in the cardiovascular, endocrine, and gastrointestinal chapters. CNS and respiratory prescribing increased with deprivation. Fundholding status had no general effect on volume prescribed.

Table 2 shows the average cost per DDD prescribed for the same groupings used in Table 1. With one exception, age and deprivation did not influence cost by more than 5% in any BNF chapter. It was thus decided to use the total mean unit cost per DDD for each BNF chapter as the cost multiplier. In highly deprived practices, psychotropic drug unit costs were lower than in other groups. PCPI practices generally prescribed more expensively than fundholders or non-fundholders.

The DDD-budgets calculated as above for the seven chapters analysed were uplifted to cover drugs in other BNF categories (on a proportional rather than a historic basis) and to cover cost of living increases in order to distribute the same total sum that was available for historic Lothian budgets. (Where a practice belonged to the very high deprivation group, two separate budgets were generated, one with an age group influence included and one without.)

The capitation formula

Table 3 shows the correlations between DDD per patient, cost per DDD, and cost per patient for each BNF chapter for percentage of patients over 65 years and percentage of patients who are deprived. The correlations found reflected what would have been predicted from Tables 1 and 2. Table 3 also presents the results of a multiple regression of cost/patient for each BNF chapter and for the sum of all seven chapters studied against age and deprivation (showing only significant correlations). Based on these figures, total capitation budgets were set using the formula:

Cost/patient = £41.08 + £0.845 x % over 65 years + £0.384 x % deprived.

Table 1. 1995 volume of prescribed drugs (DDDs) for seven BNF chapters for practices defined by age, deprivation, and fundholding status.

Practice category	1 GI	2 CVS	3 Respiratory	4 CNS	5 Infection	6 Endocrine	10 Musculoskeletal	Aggregate
High elderly/high deprivation	37.54	82.35	60.03	52.81	10.01	55.25	19.66	317.64
High elderly/medium deprivation	32.22	75.64	59.11	46.76	9.13	52.39	16.84	292.09
High elderly/low deprivation	38.72	83.07	56.21	42.33	10.39	54.03	18.03	302.79
Medium elderly/high deprivation	33.54	68.66	64.25	54.89	10.22	47.34	20.07	298.97
Medium eldlery/medium deprivation	34.80	69.28	52.37	47.42	9.99	51.49	18.08	300.40
Medium elderly/low deprivation	33.53	75.66	58.56	43.14	9.91	47.44	17.84	286.08
Low elderly/high deprivation	31.80	60.91	73.37	74.78	10.01	44.23	17.87	312.97
Low elderly/medium deprivation	28.69	58.91	64.22	49.07	9.18	41.53	18.07	269.66
Low elderly/low deprivation	27.75	53.93	55.17	37.32	9.18	42.85	17.56	243.74
Mean for all elderly/all deprivation	32.72	68.15	59.43	48.42	9.75	47.67	18.23	284.36
>25% deprivation	33.72	69.90	73.89	80.67	10.82	47.86	20.99	337.84
High elderly	36.52	80.76	58.27	47.01	9.91	53.97	18.24	304.28
Medium elderly	34.06	70.86	57.82	48.50	10.04	49.11	18.62	289.01
Low elderly	28.98	56.92	61.94	49.49	9.38	42.85	17.76	267.32
High deprivation	34.12	70.10	65.87	60.41	10.10	48.59	19.28	308.47
Medium deprivation	32.40	67.85	57.62	47.61	9.53	48.12	17.91	281.03
Low deprivation	32.11	67.32	56.38	40.21	9.69	46.93	17.76	270.40
Fundholders	31.23	67.47	66.39	44.90	9.55	49.54	17.80	286.87
Non-fundholders	33.05	67.69	55.10	50.53	9.78	46.15	17.68	279.97
PCPIs	33.71	70.27	62.50	47.09	9.91	49.47	20.29	293.25

GI, gastrointestinal; CVS, cardiovascular system; CNS, central nervous system.

Table 2. 1995 unit cost per DDD of prescribed drugs for seven BNF chapters for practices defined by age, deprivation and fundholding status.

Practice category	1 GI	2 CVS	3 Respiratory	4 CNS	5 Infection	6 Endocrine	10 Musculoskeletal	Aggregate
High elderly/high deprivation	0.40	0.18	0.15	0.20	0.53	0.10	0.19	0.20
High elderly/medium deprivation	0.39	0.17	0.14	0.21	0.49	0.10	0.19	0.19
High elderly/low deprivation	0.39	0.18	0.13	0.21	0.50	0.10	0.19	0.20
Medium elderly/high deprivation	0.43	0.18	0.14	0.20	0.53	0.11	0.20	0.20
Medium eldlery/medium deprivation	0.42	0.18	0.15	0.22	0.51	0.11	0.20	0.21
Medium elderly/low deprivation	0.40	0.17	0.15	0.21	0.48	0.12	0.19	0.20
Low elderly/high deprivation	0.44	0.19	0.13	0.17	0.57	0.12	0.20	0.20
Low elderly/medium deprivation	0.41	0.18	0.13	0.21	0.53	0.13	0.21	0.20
Low elderly/low deprivation	0.43	0.18	0.14	0.23	0.52	0.13	0.19	0.21
Mean for all elderly/all deprivation	0.41	0.18	0.14	0.21	0.52	0.11	0.20	0.20
>25% deprivation	0.45	0.18	0.14	0.17	0.54	0.12	0.18	0.20
High elderly	0.39	0.17	0.14	0.21	0.51	0.10	0.18	0.20
Medium elderly	0.41	0.17	0.15	0.21	0.51	0.11	0.19	0.20
Low elderly	0.43	0.18	0.13	0.20	0.54	0.12	0.19	0.20
High deprivation	0.42	0.18	0.14	0.19	0.54	0.11	0.19	0.20
Medium deprivation	0.41	0.17	0.14	0.22	0.51	0.11	0.19	0.20
Low deprivation	0.41	0.17	0.14	0.22	0.50	0.12	0.18	0.20
Fundholders	0.39	0.18	0.12	0.21	0.49	0.11	0.19	0.19
Non-fundholders	0.41	0.18	0.14	0.20	0.52	0.12	0.20	0.21
PCPIs	0.44	0.19	0.15	0.22	0.57	0.11	0.20	0.22

GI, gastrointestinal; CVS, cardiovascular system; CNS, central nervous system.

Multiple regression of total cost on the two factors gave $r^2 = 0.18$, indicating that only a small proportion of the variation in cost per patient between practices was explained by age or deprivation.

Winners and losers

Table 4 shows the DDD, capitation, and historic budgets for the largest group of practices (medium elderly/medium deprivation). Seven practices win and 10 lose when DDD budgets are compared with historic budgets. Seven practices win and nine lose with capitation budgets as against historic budgets. DDD and capitation budgets are all within 6% of each other, five being within 1% of each other. In this demographic group, DDD budgets were

Table 3. Correlations between prescribing and other factors at practice level, together with the results of multiple regression of cost per patient for each BNF chapter, and for the sum of all seven costs, on per cent aged over 65 and per cent receiving deprivation payments. Only independently significant coefficients are shown.

		Per cent >65 years	Per cent deprivation
Volume per patient			
BNF 1	Gastrointestinal system	+0.54[c]	+0.06
BNF 2	Cardiovascular system	+0.73[c]	+0.05
BNF 3	Respiratory system	-0.07	+0.16
BNF 4	Central nervous system	+0.04	+0.61[c]
BNF 5	Infections	+0.13	+0.09
BNF 6	Endocrine system	+0.46[c]	+0.01
BNF 10	Musculoskeletal and joint diseases	+0.22[a]	+0.12
Cost per DDD			
BNF 1	Gastrointestinal system	-0.11	+0.27[b]
BNF 2	Cardiovascular system	-0.12	+0.18[a]
BNF 3	Respiratory system	+0.03	-0.01
BNF 4	Central nervous system	-0.19[a]	-0.38[c]
BNF 5	Infections	-0.06	+0.17
BNF 6	Endocrine system	-0.37[c]	-0.07
BNF 10	Musculoskeletal and joint diseases	+0.06	+0.06
Cost per patient			
BNF 1	Gastrointestinal system	+0.34[c]	+0.20[a]
BNF 2	Cardiovascular system	+0.61[c]	+0.11
BNF 3	Respiratory system	-0.01	+0.34[c]
BNF 4	Central nervous system	+0.01	+0.43[c]
BNF 5	Infections	+0.05	+0.23[b]
BNF 6	Endocrine system	-0.01	-0.04
BNF 10	Musculoskeletal and joint diseases	+0.20[a]	+0.11

[a]P<0.05, [b]P<0.01, [c]P<0.001.

Multiple regression			Coefficient for	
		Constant	Per cent >65 years	Per cent deprivation
BNF 1	Gastrointestinal system	8.39	0.283	0.093
BNF 2	Cardiovascular system	4.93	0.466	
BNF 3	Respiratory system	7.46		0.082
BNF 4	Central nervous system	8.82		0.122
BNF 5	Infections	4.79		0.031
BNF 6	Endocrine system	5.29		
BNF 10	Musculoskeletal and joint diseases	2.69	0.051	
Sum		41.08	0.845	0.384

lower than capitation budgets for 13 of the 17 practices.

Overall, approximately equal numbers of the 122 practices compared gain and lose when DDD and capitation budgets are compared with historic budgets. Nine practices lose by over £100 000 and seven practices win by over £100 000 when DDD budgets are compared with historic budgets; 14 practices win and five practices lose by over £100 000 when capitation budgets are compared with historic budgets. Only two DDD and capitation budgets differ by £100 000, with 77 differing by less than 5% and 19 by less than 1%.

Discussion

We first reported work analysing prescribing trends using DDDs in 1993.[2] At that time, we noted (as part of our evaluation of the Scottish shadow fundholding project) significant inequities in the allocation of historic budgets for prescribing (up to £25 per patient in a sample of six practices) and recommended that a DDD-based mechanism for identifying both volume and cost per volume targets should be developed to help set budgets.

Ideally, budgets should reflect needs. However, a recent paper[20] has analysed the difficulty in determining funding models for the NHS generally and concluded that budget setting requires a mix of value judgement and evidence. The work to create and cost DDDs for the majority of prescriptions in one health authority area allowing for age and deprivation (summarized in Tables 1 and 2) that this paper describes is a prerequisite to further work in the field of understanding prescribing variation and setting budgets. Although different age and deprivation weightings might have been used, and different figures for volume and cost might be found in other parts of the UK, the approach described in this paper seems generalizable to other parts of the country.

In deriving volume and cost means for major demographic categories, we worked with one year's prescribing data for 129 practices covering over 800 000 patients. Two practices that included substantial student health service responsibilities were excluded from this process, as was one practice that ran a separate asthma clinic and whose prescribing of inhaled drugs wholly distorted the distribution. A total of 122 practices were able to have their historical budgets compared with their DDD or capitation budgets; this excluded the seven practices in which major partnership alterations had taken place during the study period.

The capitation-based budget formula was derived from the same information, except that continuous age and deprivation variables were used in the capitation formula as against categorical variables for DDD budgets. However, budgets set in these

Table 4. DDD, capitation, and historic budgets for 1996, for 18 practices in the medium-elderly/medium-deprivation category, showing differences between budgets.

	Budgets			DDD versus historic			Capitation versus historic			DDD versus capitation		
Fundholding status	DDD	Capitation	Historic	£	Percent	Winner/ loser	£	Percent	Winner/ loser	£	Percent	Winner/ loser
Fundholder	696 451	719 445	677 219	19 232	2.84	W	42 226	5.87	W	-22 994	-3.30%	L
Fundholder	814 381	811 375	813 865	516	0.06	W	-2 490	-0.31	L	3 006	0.37	W
Fundholder	1 278 343	1 299 906	1 328 245	-49 902	-3.76	L	-28 339	-2.18	L	-21 564	-1.69	L
Non-fundholder	627 731	627 496	418 954	208 777	49.83	W	208 542	33.23	W	235	0.04	W
Non-fundholder	210 158	217 193	175 849	34 309	19.51	W	41 344	19.04	W	-7 035	-3.35	L
Non-fundholder	332 476	339 122	309 211	23 265	7.52	W	29 911	8.82	W	-6 647	-2.00	L
Non-fundholder	426 663	451 517	440 668	-14 005	-3.18	L	10 849	2.40	W	-24 854	-5.83	L
Non-fundholder	244 949	251 337	254 650	-9 701	-3.81	L	-3 313	-1.32	L	-6 388	-2.61	L
Non-fundholder	429 562	430 841	482 849	-53 287	-11.04	L	-52 008	-12.07	L	-1 279	-0.30	L
Non-fundholder	529 234	557 426	671 027	-141 793	-21.13	L	-113 601	-20.38	L	-28 192	-5.33	L
Non-fundholder	561 126	Removed	802 200	-241 074	-30.05	L						
PCPI	659 231	672 927	584 807	74 424	12.73	W	88 120	13.10	W	-13 696	-2.08	L
PCPI	540 596	560 578	489 827	50 769	10.36	W	70 751	12.62	W	-19 982	-3.70	L
PCPI	300 819	299 870	362 083	-61 264	-16.92	L	-62 213	-20.75	L	948	0.32	W
PCPI	625 694	623 875	764 547	-138 853	-18.16	L	-140 672	-22.55	L	1819	0.29	W
PCPI	996 643	1 038 491	1 258 604	-261 961	-20.81	L	-220 113	-21.20	L	-41 848	-4.20	L
PCPI	369 226	378 925	472 306	-103 080	-21.82	L	-93 381	-24.64	L	-9 699	-2.63	L
PCPI	329 890	335 951	Missing							-6 061	-1.84	L

different ways were very similar. Both produced significantly different results from those reached using the historical budgets.

Utility of DDD-based budgets

The DDD budget, but not the capitation budget, can be reconstructed to reflect any lower or higher volume or cost/volume target felt appropriate to pursue local or national prescribing policy in any BNF chapter or subchapter. Similarly, it is easier to top slice an element of an area budget designed to cover a specific predicted increase in demand using a DDD-based budget than a capitation-based budget. Two contrasting examples are given below.

Lipid-lowering drugs. Overall, 10% of Lothian practices prescribed three or more DDDs per patient per year for lipid-lowering drugs, at 53p per DDD. If all 808 059 patients in Lothian were similarly covered, £1.29m would be needed as against the £742 000 currently being spent. This new target could be met by top-slicing the further £548 000 necessary to achieve equal prescribing throughout Lothian (0.95% of the present area budget).

All prescribing. The quartile of lowest volume prescribing practices in Lothian prescribed an average of 215 DDDs per patient per year as against 384 DDDs per patient per year in the quartile of highest volume prescribing practices. If target volumes for all practices were set at the levels used by the practices in the lowest quartile, the savings that would follow in the principal BNF chapters would be:

Gastrointestinal	£3.2m out of £10.7m	(30%)
Cardiovascular	£3.5m out of £9.8m	(36%)
Respiratory	£2.8m out of £6.6m	(42%)
CNS	£3.0m out of £8.1m	(37%)
Infection	£1.0m out of £4.0m	(25%)
Endocrine	£1.5m out of £4.2m	(36%)
Musculoskeletal	£1.0m out of £2.9m	(34%)

In total, these sums would represent £15.9m out of a budget of £46.3m (34%).

Implications for further work

The two budget-setting models we have developed and presented in this paper are based on the DDD approach to analysing prescribing trends. Even including age and deprivation, only 18% of the variation in cost per patient between practices can be explained.

Most analyses of prescribing volume and costs focus exclusively on biomedical issues, paying little or no attention to the values, beliefs, and expectations of patients and doctors, or to the context in which consultations take place. Value systems and context (particularly prevailing systems of incentives and consultation length) influence both what kind of diagnoses are made and whether non-drug approaches to treatment will be proposed or used.[21] It is unlikely that significant new understanding of the determinants of prescribing variation can be expected until the analytical model caters adequately for the behavioural as well as the biomedical issues that influence clinical decision-making.[22]

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