Variation in the pharmaceutical costs of New Zealand general practices: a national database linkage study

Andrew M. Tomlin¹, Todd D. Gillies¹, Murray W. Tilyard¹,², Susan M. Dovey²

¹BPACNZ, Dunedin 9016, New Zealand
²Department of General Practice and Rural Health, Dunedin School of Medicine, Dunedin 9013, New Zealand
Address correspondence to Susan M. Dovey, E-mail: susan.dovey@otago.ac.nz

ABSTRACT

Background Variation in prescription costs between general practices and within practices over time is poorly understood.

Methods From New Zealand’s national health data collections, we extracted dispensed medicines data for 1045 general practices in 2011 and 917 practices continuously existing 2008–11. Using indirect standardization to account for patient demographics and morbidity, a standardized prescribing cost ratio (SPR: the ratio of actual : expected prescription costs) was calculated for each practice in each year. Case studies of three outlier clinics explored reasons for their status.

Results SPRs ranged from 0.53 to 2.28 (median = 0.98). Of 469 practices with higher than expected costs (SPR > 1.0) in 2011, 204 (43.5%) had a single medicine or therapeutic drug class accounting for 15% of total costs. Case studies contrasted practices with overall pharmaceutical expenditure influenced strongly by a few patients needing high-cost medicines, more patients using medicines in one high-cost therapeutic drug class (antiretrovirals), and high medicine use across all therapeutic drug classes.

Conclusions Routine data collections can measure inter-practice variation in prescription costs, adjusted for differences in the demography and morbidity profile of each practice’s patients. Small groups of patients using high-cost medicines influence general practices’ expenditure on pharmaceuticals.

Keywords data collection, general practice, health expenditures, New Zealand

Introduction

Variation in healthcare treatments between general practices may be a marker for inequality and reduced care quality in at least some practices, yet the patient-centred value of general practice¹ suggests that variation may also be an appropriate consequence of delivering the right care to the right patient at the right time. In developed countries, primary care is where most health care is provided to most people most of the time,² and in New Zealand ~80% of publicly funded pharmaceutical expenditure is generated outside hospitals.³ Internationally, health system costs of prescription medicines are increasing.⁴–⁶ This is often attributed to aging populations, increasing prevalence of long-term conditions and efforts to satisfy patient demands.⁷–⁹ Better understanding of variation between general practices in the medicines use of their patients may provide insights into ways to reduce variation between practices and increase care quality as well as predict and control medicines-related expenditure.

Quality prescribing is not necessarily low-cost prescribing: appropriate prescription of medicines may help patients avoid other more expensive treatments, including hospital care.¹⁰ No association has been found between prescribing costs and achievement of Quality and Outcome measures in the UK, suggesting that lower prescribing rates may not compromise healthcare quality.¹¹ However, in discrete areas of care such

Andrew M. Tomlin, Research Consultant
Todd D. Gillies, Senior Data Analyst
Murray W. Tilyard, Professor, Chief Executive
Susan M. Dovey, Professor
as cholesterol management, there is some evidence of a relationship between prescribing costs and care quality. Most prescribers consider both total cost and cost to patients when prescribing, secondary only to clinical factors, but their knowledge of medicine prices is poor. Previous studies have found that as well as variation in patients’ needs, doctor factors such as age, previous experience, time constraints and reliance on drug company information may lead to different prescribing choices.

We aimed in this study to investigate variation, and reasons for variation, in medicine costs across all general practices in New Zealand. With a view to transparency and to enable replication, we used routinely collected data to test whether useful predictive models of pharmaceutical expenditure could be made with existing accessible data sources. As well as measuring variation between general practices and within practices over time, we explore outlier practices generating higher and lower medicines costs to better understand whether changing the medicines expenditure of outlier general practices is likely to be practically possible or desirable.

**Methods**

**Data sources**

We analysed data from two national data collections administered by the New Zealand Ministry of Health: the Pharmaceutical Collection, containing records of all publicly subsidized medicines dispensed in community pharmacies, and the Primary Health Organisation (PHO) Enrolment Collection containing records of patients registered in New Zealand general practices. Patient registration affects practices capitation funding so although registration is voluntary, most New Zealanders (4.19 million (95.3%) of an estimated total population of 4.39 million) are part of a PHO and registered in a general practice. Every patient has a unique National Health Index (NHI) code recorded in the national healthcare data sets. This code, in an encrypted form, was used to link practice register and medicines data.

**Data elements**

Patient demographic data from practice registers included date of birth, sex, ethnic group (European, Maori, Pacific People, Asian and Other) and residence deprivation quintile derived from the NZDep2006 census-based index of deprivation. Dispensing data included the NHI code, date of dispensing, generic name of chemical dispensed, formulation, quantity prescribed, dosage information and the cost of the dispensed drug, exclusive of taxes.

Medicines were categorized according to the New Zealand Pharmaceutical Schedule, within therapeutic groups of the 12 major therapeutic drug groups (alimentary tract and metabolism, blood and blood-forming organs, cardiovascular system, dermatologicals, genito-urinary system, hormone preparations, infections, musculo-skeletal system, nervous system, oncology agents and immunosuppressants, respiratory system and allergies and sensory organs). These groups provided proxy indicators of patient morbidity. We excluded medicines not included in the 12 major therapeutic groups, including extemporaneously compounded preparations, galenicals and special foods, as total expenditure on these products was small (2.3% of total costs) and they are prescribed for a wide range of patient conditions.

We collated dispensing data for the 2011 calendar year for patients registered to 1045 of 1074 general practices on the PHO enrolment registers. The 29 excluded practices (1.0% of all registered patients) were atypical, because they had <200 registered patients (12 practices), an almost exclusively male population (1 practice), a nursing home focus (3 practices), or were university health centres with mainly young registered patients (13 practices). To examine changes in prescribing costs within practices over time, we analysed dispensing data for each calendar year from 2008 to 2011 for the 917 practices (85.4% of practices existing in 2011), providing healthcare continuously throughout the 4-year period. The 128 practices excluded from this analysis had closed or changed their name during this time.

**Statistical analysis**

To assess variation in costs, we first calculated the mean cost and number of dispensed medicines per patient by age group, sex, ethnic group and deprivation quintile and in each of the 12 therapeutic drug groups. We also calculated the proportion of patients in each practice within each of these groups.

To compare practices’ prescribing costs, we employed indirect standardization with the total New Zealand registered patient population as the standard population. Actual costs were derived from medicine type, formulation strength and quantity dispensed. Practice prescribing costs were calculated by summing costs for every dispensing attributed to each practice and then adjusted to account for differences in the age, sex, ethnicity, social deprivation and morbidity profile (using the medicines therapeutic group proxy) of practices’ registered patient populations. The result was a standardized prescribing ratio (SPR) for each practice of the actual cost of dispensed medicines to the expected cost based on cost rates.
in the standard population. A ratio of 1.0 indicated that the total expenditure for a practice was equal to the national average practice based on differential prescribing costs within patient demographic and drug therapeutic groups. We calculated SPRs for 1045 practices in 2011 and, to examine variation in practice prescribing costs practices over time, 917 practices in each year from 2008 to 2011.

Funnel plots of practice ratios and expected expenditure identified outlier practices, using control limits set at 2 and 3 SD from the mean expenditure of all practices, to adjust for bias due to small practice size and expenditure. We then used case studies to explore reasons for medicine costs in exemplar high and low outlier practices.

Results
A total of 4 145 415 patients were registered at 1045 practices in 2011 and were included in this study (94.5% of the New Zealand population). In 2011, 61 625 737 prescription items were dispensed to 3 055 125 patients (73.7%) at a total cost of $815 958 478.

Variation in prescribing rates and practice populations by age, sex, ethnicity, deprivation and therapeutic group
There were considerable differences in prescribing costs per patient across age, ethnicity, deprivation and therapeutic groups, but not by sex (Table 1). The mean cost per patient was $429 for patients aged >55 and $120 for patients aged <55. The average cost for patients of European ethnicity was 40% higher than for patients in the other major ethnic groups, and patient costs in the three highest deprivation quintiles were 10% higher than for patients in the least deprived areas. Only 1.2% of patients used oncology agents or immunosuppressants, yet this therapeutic group accounted for 14.3% of total pharmaceuticals expenditure. Although overall costs were similar for males and females, there were large differences in costs and use of medicines within therapeutic groups. For example, 17.3% of females and 1.5% of males used genito-urinary medicines, but mean cost per patient for these items was $27 for females and $64 for males.

There was substantial variation among practices in the demographic profiles of their patients. The proportion of registered patients aged >65 ranged from 5 to 25%. In 10% of practices, >35% of patients were Māori and 93 practices had >50% of their patients living in areas categorized as being the most deprived. Variation between practices in the medicines used within therapeutic groups was also notable with the proportion of patients treated for infections and nervous system disorders ranging from <20 to >60%. Medicines in these two therapeutic groups were also the most used by New Zealanders. Figure 1 shows practice variation in proportion of patients using these and medicines in other therapeutic groups in 2011.

Practice variation in expected prescribing costs
The funnel plot in Fig. 2 shows the distribution of SPRs for 1045 practices in relation to total pharmaceutical expenditure expected by the demographic and morbidity profile of each practice. Fifteen practices were definite outliers (SPR outside the 3 SD control limit), and another 33 practices were possible outliers (SPR outside the 2 SD control limit). Of the 1045 practices, 469 (44.9%) had higher costs than expected. As the expected expenditure of each practice was related to both its patient list size and the demography and morbidity of its patients, the range of SPRs in smaller practices was greater than in larger practices. In small practices, a few patients with high costs influenced total practice expenditure more than in larger practices with greater total expenditure.

Table 2 lists high-cost medicines and therapeutic groups and their contribution to the higher than expected costs of practices with an SPR > 1.0 in 2011. Practices with either a single medicine or medicine class accounting for >15% of total practice prescribing costs are also shown. A single medicine accounted for >15% of total practice expenditure at 74 practices despite the median practice cost for these drugs being 0%. Prominent among these medicines were chemotherapeutic agents and immunosuppressants.

Variation in expected prescribing costs within practices 2008–11
The number of patients registered at the 917 general practices providing services throughout 2008–11 increased from 3 530 327 in 2008 to 3 725 850 in 2011 (89.9% of patients at all study practices in 2011). Over this time, pharmaceutical expenditure for these patients increased from $652 368 287 to $729 947 319 (89.4% of total prescribing costs at all study practices in 2011).

Figure 3 shows the distribution of SPRs for individual practices over the 4-year period. For ease of presentation, data are illustrated for 118 practices within four DHB districts. Higher cost practices tended to have higher costs in all years, with lower cost practices remaining low cost relative to other practices. Some practices displayed considerable variation in costs with time. For example, the SPR of one practice fell from 1.45 in 2008 to 0.98 in 2009 due mainly to a single patient decreasing imiglucerase use. Figure 3 also indicates
that some DHBs have relatively more practices with high prescription costs.

**Case study practices**

At Practice A (SPR = 1.31), a single patient was treated with one medicine that accounted for 20.4% of the practice’s total prescribing costs. To examine the influence of this single drug

| Table 1 Pharmaceutical use and expenditure by age, sex, ethnicity, deprivation and drug therapeutic group in 2011 |
|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| Registered | Rx items (n) | Rx cost ($) | Practice variation |
| Patients, n (%) | NZ total '000 000 | Per patient | NZ total '000 000 | Per patient | Median % of patients (1st to 9th decile) |
| Age | | | | | |
| 0–4 | 302 023 (7.3) | 2.072 | 6.86 | 9.255 | 30.64 | 6.8 (4.3–9.8) |
| 5–14 | 582 616 (14.1) | 2.001 | 3.44 | 20.325 | 34.89 | 13.5 (8.9–18.5) |
| 15–24 | 550 154 (13.3) | 2.616 | 4.76 | 37.370 | 67.93 | 12.9 (9.7–17.2) |
| 25–34 | 499 576 (12.1) | 3.535 | 7.08 | 55.720 | 111.53 | 10.9 (7.8–16.6) |
| 35–44 | 589 025 (14.2) | 5.912 | 10.04 | 103.199 | 175.20 | 13.6 (11.1–17.0) |
| 45–54 | 593 552 (14.3) | 8.379 | 14.12 | 148.676 | 250.48 | 14.4 (11.7–16.9) |
| 55–64 | 472 424 (11.4) | 10.064 | 21.30 | 169.412 | 358.60 | 11.8 (7.7–15.8) |
| 65–74 | 307 584 (7.4) | 10.705 | 34.80 | 149.213 | 485.11 | 7.7 (3.9–11.8) |
| 75–84 | 180 378 (4.4) | 10.756 | 59.63 | 93.805 | 420.05 | 4.4 (1.6–7.9) |
| 85 and over | 68 083 (1.6) | 5.585 | 82.03 | 28.983 | 425.70 | 1.5 (0.3–3.5) |
| Sex | | | | | | |
| Female | 2 147 493 (51.8) | 35.363 | 16.47 | 429.452 | 199.98 | 51.0 (46.5–56.7) |
| Male | 1 997 922 (48.2) | 26.263 | 13.14 | 386.506 | 193.45 | 49.9 (43.3–53.5) |
| Ethnicity | | | | | | |
| Asian | 349 439 (8.4) | 3.137 | 8.98 | 43.748 | 125.19 | 3.1 (0.7–19.7) |
| European | 2 791 041 (67.3) | 46.160 | 16.54 | 622.080 | 222.88 | 78.1 (18.2–90.8) |
| Maori | 571 439 (13.8) | 7.477 | 13.09 | 90.387 | 158.17 | 8.4 (2.5–35.6) |
| Pacific | 296 573 (7.2) | 3.564 | 12.02 | 39.113 | 131.88 | 1.6 (0.4–15.4) |
| Other | 10 727 (2.6) | 0.928 | 8.61 | 15.937 | 147.94 | 1.3 (0.3–5.7) |
| Deprivation quintile | | | | | | |
| 1 | 834 639 (19.9) | 9.327 | 11.17 | 151.638 | 181.68 | 16.4 (2.0–37.0) |
| 2 | 774 403 (18.5) | 10.038 | 12.96 | 146.977 | 189.79 | 18.0 (5.4–29.0) |
| 3 | 748 162 (17.9) | 11.152 | 14.89 | 151.578 | 202.45 | 18.0 (7.6–25.7) |
| 4 | 748 623 (17.9) | 12.769 | 17.06 | 157.157 | 209.93 | 18.2 (5.8–28.0) |
| 5 | 757 487 (18.1) | 13.567 | 17.91 | 151.235 | 199.65 | 12.1 (1.3–46.6) |
| Therapeutic group | | | | | | |
| Alimentary tract and metabolism | 1 070 809 (25.8) | 9.27 | 8.65 | 90.19 | 84.23 | 25.7 (20.0–33.4) |
| Blood and blood-forming organs | 764 398 (18.4) | 7.21 | 9.44 | 96.53 | 126.29 | 18.6 (13.0–25.5) |
| Cardiovascular | 732 162 (17.7) | 10.34 | 14.12 | 77.67 | 106.09 | 18.2 (12.0–25.6) |
| Dermatologicals | 1 023 346 (24.7) | 2.74 | 2.68 | 18.82 | 18.39 | 24.4 (19.1–29.8) |
| Genito-urinary | 401 789 (9.7) | 1.02 | 2.53 | 11.85 | 29.50 | 9.5 (6.4–12.1) |
| Hormone preparations | 487 378 (11.8) | 1.89 | 3.89 | 21.08 | 43.25 | 11.3 (8.1–16.0) |
| Infections | 1 795 097 (43.3) | 4.24 | 2.36 | 53.61 | 29.87 | 43.0 (34.3–51.7) |
| Musculo-skeletal | 969 126 (23.4) | 2.91 | 3.00 | 71.36 | 73.63 | 23.0 (18.5–27.6) |
| Nervous system | 1 746 912 (42.1) | 15.79 | 9.04 | 167.04 | 95.62 | 41.8 (33.8–49.1) |
| Oncology agents and immunosuppressants | 49 011 (1.2) | 0.44 | 9.01 | 116.98 | 2386.75 | 1.2 (0.7–1.7) |
| Respiratory system and allergies | 971 816 (23.4) | 4.69 | 4.83 | 80.36 | 82.70 | 22.6 (17.6–28.8) |
| Sensory organs | 423 875 (10.2) | 1.09 | 2.57 | 10.46 | 24.67 | 10.1 (7.5–12.8) |
on the SPR, we repeated the standardization of prescribing costs excluding it. Following this, Practice A’s adjusted SPR was 1.05, but four more patients accounted for 20.5% of total prescription costs: one taking another medicine (11.8% of total cost) and three patients using a third drug (8.7%). The patients taking the two most costly drugs accounted for 33.2% of the practice’s total prescription costs.

At Practice B (SPR = 2.28), 91 patients were treated with antiretrovirals costing $13,287 per patient. The median number of patients using antiretrovirals at all 1045 practices was 0. Antiretrovirals contributed 45% of Practice B’s total medicines expenditure.

Practice C (SPR = 1.44) was one of 265 practices with an SPR > 1.0 but no single medicine or medicines class accounted for >15% of its total prescribing costs. Its cost per patient was higher than the national average in 9 out of 12 major therapeutic groups. Overall, its cost per patient was 69.9% higher than the national average.

Practice D (SPR = 0.53) had the lowest SPR of all practices. Prescribing costs per patient were 50.8% lower than the national average and the number of medicines per patient 20.9% lower. Costs were lower than expected in 11 of the 12 therapeutic groups. The total number of medicines dispensed was 14.9% lower than expected.

At Practice E, the total number of medicines dispensed was 7.1% higher than expected (SPR = 0.56), but prescription costs were 60.4% of expected. Prescription costs per patient ($21.24) were 71.9% lower than the national average ($75.55) and costs per item were 56.0% lower.

Practices with lower than expected costs were characterized by low prescription costs per patient across most therapeutic groups and usually a low prescription rate per patient.

![Figure 1](image1.png)  
**Fig. 1** Practice variation in proportion of patients by therapeutic group in 2011. Box, inter-quartile range. 95% of practices lie within the whiskers. ATM, alimentary tract and metabolism; BLD, blood and blood-forming organs; CVD, cardiovascular system; DRM, dermatologicals; GNU, genito-urinary system; HRM, hormone preparations; INF, infections; MSK, musculo-skeletal system; NRV, nervous system; OAI, oncology agents and immunosuppressants; RSP, respiratory system and allergies; SNS, sensory organs.

![Figure 2](image2.png)  
**Fig. 2** Standardized prescribing ratios for 1045 New Zealand general practices by expected cost of prescribing 2011. Dots, practices. Dashed curves: 2 SD, solid curves: 3 SD, bold dots are ‘definite’ (>3 SD) or ‘possible’ outliers (2–3 SD).
Discussion

Main finding of this study

Our findings indicate that there is substantial variation in pharmaceutical expenditure per patient between New Zealand general practices. This is true for both actual and standardized expenditure resulting from the adjustment of costs to account for practices’ differences in patient demographics and morbidity. Our results also indicate that practices’ prescribing costs may vary considerably over time, an important consideration when deciding which practices may benefit from interventions to alter prescribing.
What is already known

Among the factors associated with varying medicines use in general practice, patients’ age has most frequently been factored into analyses of variation, but age alone does not account for enough variation to set robust budgets for medicines expenditure. Models including age and sex account for around 25% of variation, additional demographic factors up to 51% and models that include morbidity account for more variability (up to 80%). The use of medicines within therapeutic groups provides an indicator of patient morbidity and treatment needs within a practice and has been included in previous models of prescribing activity in general practice. Variation in practices’ mortality rates, but not prescribing costs, has been investigated by standardizing practices to account for their patients’ morbidity. Doctor characteristics and morbidity profiles in regional databases have been used to explore drivers of variation in general practice prescribing, and a network of computerized general practice prescribing has shown longitudinal changes in prescribing behaviour.

What this study adds

We could find no previous investigations of variation in medicines costs per practice involving national data sets. This study builds on previous research showing the importance of including patient morbidity in models of practice variation, adding to previous models by including patients’ ethnicity and deprivation indicator, both associated with health care inequalities in New Zealand. We used all these variables, comprehensively recorded in New Zealand’s national health care data sets, to identify the standardized distribution of New Zealand general practices’ pharmaceuticals expenditure.

We showed that analysis of routine national data collections provides a starting point for identifying practices with potentially modifiable prescribing costs through interventions such as academic detailing. This extends previous work by exploring the practical implications of identifying outlier general practices. We confirmed that high-cost outlier practices are not necessarily generating modifiable pharmaceutical expenditure. Practices with more morbid patients, especially in chronic conditions, are more likely to have higher prescription costs. High costs per capita in smaller practices were often due to individual patients using very high cost but necessary medicines. Unusually large numbers of patients requiring expensive treatments also contribute to higher costs than expected. Practices with consistently higher than expected costs across most patient demographic and therapeutic drug groups may be more likely candidates for interventions aimed at reducing pharmaceutical expenditure.

Limitations of this study

Our analysis included all pharmaceuticals dispensed to all patients registered to each practice as recorded in the national Pharmaceutical Collection. It is a limitation of this study that many of these medicines may not have been prescribed by doctors at practices registering patients. Some practices,
particularly those in popular holiday areas, provide care for many casual patients whose prescription costs are attributed to practices they are enrolled in rather than the prescribing practices. Therefore, this analysis does not precisely quantify the total prescription costs generated by each practice.

We were able to analyze variation in prescription costs from 2008 to 2011 for only 917 of the 1045 practices. This limitation reflects the changing nature of general practices as businesses that may close, merge, transfer patients or move location. We included merged practices that had kept the same name throughout the study period. In many cases, mergers would have resulted in changes in the demographic profile of such practices, influencing the relative prescription ratios across the 4-year period.

Conclusions
This study indicates that there is considerable variation in prescription costs per patient among New Zealand general practices after adjusting for their patients’ demographic and morbidity profiles. The methodology identified outlier practices with higher expenditure than expected that may be targeted in interventions to reduce prescribing costs.

While indirect standardization should not be used in creating practice league tables as bias is introduced when patient denominators differ substantially, it may be used to indicate how far practices are from the expected cost of prescribing.\textsuperscript{43} In our analysis, the expected cost was determined by the national average prescribing cost rates observed within patient demographic and major therapeutic drug groups. Each practice was thus compared with the reference population representing all registered general practice patients in New Zealand.

General practices may have higher than expected prescription costs, even after adjusting for demographic and morbidity factors, for a variety of reasons. Patients with special needs may require expensive pharmaceutical treatment, medicines with little or no therapeutic benefit may be inappropriately prescribed, or general practitioners may view their role squarely in terms of service provision, with prescribing as part of that service. Low-cost prescribers, by contrast, are more comfortable with a wider view of their role in society that may require limiting patients’ pharmaceuticals use.\textsuperscript{44} Also it is possible that lower cost practices may be providing poorer quality care, particularly in the identification and management of patients with chronic conditions. Interventions aimed at controlling prescribing costs need to be informed by the reasons that practices have outlier costs as well as by robust evidence of the expenditures they generate.

Acknowledgements
We thank PHARMAC for providing permission to use the Pharmaceutical Collection.

Funding
This research was conducted as a component of the usual employment of the authors by Bpacz\textsuperscript{nz} and the University of Otago. Bpacz\textsuperscript{nz} is a registered charity operating under contracts with PHARMAC and District Health Boards Shared Services (DHBSS). Bpacz\textsuperscript{nz} is co-owned by the University of Otago, ProCare Health Limited, South Link Health, General Practice New Zealand and Pegasus Health.

References


41 Orzella L, Chini F, Rossi PG et al. Physician and patient characteristics associated with prescriptions and costs of drugs in the Lazio region of Italy. Health Policy 2010;95(2–3):236–44.

