Under-utilisation of preventive medication in patients with cardiovascular disease is greatest in younger age groups (PREDICT-CVD 15)

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ABSTRACT

INTRODUCTION: Blood pressure–lowering (BPL) and lipid-lowering (LL) medications together reduce estimated absolute five-year cardiovascular disease (CVD) risk by >40%. International studies indicate that the proportion of people with CVD receiving pharmacotherapy increases with advancing age.

AIM: To compare BPL and LL medications, by sociodemographic characteristics, for patients with known CVD in primary care settings.

METHODS: The study population included patients aged 35–74 with known CVD assessed in primary care from July 2006 to October 2009 using a web-based computerised decision support system (PREDICT) for risk assessment and management. Clinical data linked anonymously to national sociodemographic and pharmaceutical dispensing databases. Differences in dispensing BPL and LL medications in six months before first PREDICT assessment was analysed according to age, sex, ethnicity and deprivation.

RESULTS: Of 7622 people with CVD, 1625 <55 years old, 2862 were women and 4609 lived in deprived areas (NZDep quintiles 4/5). The study population included 4249 European, 1556 Maori, 1151 Pacific and 329 Indian peoples. BPL medications were dispensed to 81%, LL medications to 73%, both BPL and LL medications to 67%, and 87% received either class of medication. Compared with people aged 65–75, people aged 35–44 were 30–40% less likely and those aged 45–54 were 10–15% less likely to be dispensed BPL, LL medications or both. There were minimal differences in likelihood of dispensing according to sex, ethnicity or deprivation.

DISCUSSION: BPL and LL medications are under-utilised in patients with known CVD in New Zealand. Only two-thirds of patients in this cohort are on both. Younger patients are considerably less likely to be on recommended medications.

KEYWORDS: Cardiovascular diseases; drug therapy; secondary prevention; primary health care; demography

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Introduction

Pharmacotherapy is a cornerstone of effective secondary prevention of cardiovascular disease (CVD). Current New Zealand guidelines on CVD risk assessment and management recommend that aspirin, blood pressure–lowering (BPL) and lipid-lowering (LL) medications should be considered for all people with CVD or those with an estimated five-year CVD risk of 15% or greater.[1] BPL and LL medications together have been shown to reduce estimated absolute CVD risk over a five-year period by over 40%.[2]

Various studies suggest that, in general, younger people [3–6] and the elderly[3,4,7–11] are less likely to

receive pharmacotherapy, even after controlling for other factors such as CVD risk. Bennett et al. examined variation in prescribing practices for patients with ischaemic heart disease in Ireland using data sourced from a national database recording pharmacy claims.[3] In that study, aspirin and statin therapy increased with age until 65 years, after which the odds of pharmacotherapy declined markedly. Prescription rates for ACE inhibitors, on the other hand, continued to increase until 75 years of age. There is no consensus among published studies as to the influence of sex,[3,7,8,12–14] ethnicity,[4,7,12,13,15–20] or social class.[8,10,12,14,21–23] Only five of these studies investigated whether systematic differences in the use of medications for secondary CVD prevention exist in New Zealand,[7,15,16,18,23] and none examined all of these sociodemographic characteristics together within a large study population.

Differences in both the incidence and mortality of CVD according to age, sex, ethnic group and socioeconomic status are well recognised in New Zealand.[23–25] Sociodemographic disparities in pharmacotherapy for CVD are likely to contribute to these differences in outcomes. Therefore, we examined patterns of BPL and LL therapy for CVD by age, sex, ethnicity and deprivation for people in a large secondary prevention cohort who had been assessed in primary care.

Methods

Study population

PREDICT is a web-based clinical decision support programme that was developed to provide cardiovascular risk assessment and risk management advice for health professionals and patients.[26] Since 2002, it has been used mainly opportunistically in 15 Primary Health Organisations (PHOs) across Auckland and Northland in New Zealand. When a risk assessment is performed with PREDICT, cardiovascular risk factor data for each patient are stored anonymously, generating a large and evolving patient cohort. From August 2002 to October 2009, data from about 124 000 patients were gathered. A medication history from the primary care provider was entered in PREDICT for a subset of participants (about 34 000) for whom CVD risk management templates were also completed.

Patients were included in these analyses if they had a history of CVD recorded by the primary care provider at the time of their initial PREDICT assessment, were 35–74 years of age, and were risk assessed for the first time between 1 July 2006 and 16 October 2009. A history of CVD was defined as prior angina or myocardial infarction (MI), stroke, transient ischaemic attack (TIA), peripheral vascular disease (PVD), percutaneous coronary intervention, or coronary artery bypass graft.

Linkage to National Health Index database to augment sociodemographic data

National Health Index (NHI) numbers uniquely identify people within the New Zealand health system. The NHI database is administered by the New Zealand Ministry of Health and records a patient's date of birth, sex, ethnicity, and New Zealand Deprivation 2001 index score (NZDep01). NZDep01 is a census-based index of deprivation for small areas that uses population census data relating to eight dimensions of deprivation.[27] Anonymous linkage via encrypted NHI numbers allowed sociodemographic data from PREDICT (date of birth, ethnicity and sex) to be verified and augmented with data regarding ethnicity and NZDep01 from this national database.

Linkage to medication dispensing data

Cardiovascular medications dispensed to each patient in the cohort were identified by anonymously linking the PREDICT database to the Pharmaceutical Information Database (PHARMS), using encrypted NHI numbers. PHARMS is jointly administered by the New Zealand Ministry of Health and the Pharmaceutical Management Agency of New Zealand (PHARMAC), and collects data on government-subsidised medications dispensed by community pharmacies nationwide.[28] In 2006, 92% of PHARMS dispensing data were reliably identifiable by NHI numbers, and this increased to 96% in 2009. PHARMS data collected prior to 2006 were considered inadequate for inclusion in these analyses as less than 87% of this data could be reliably linked. (S Ross, personal communication, 2009)

Drugs of interest

All classes of BPL and LL medications were considered (listed in Appendix 1 published in the web version of this paper). Aspirin was not investigated because it is available in the community without prescription and is less likely to be recorded in the PHARMS database.

Analysis

The main outcome of interest was dispensing of BPL and LL medications at least once in the six months prior to first PREDICT assessment. A six-month period for data collection was used because, although cardiovascular medications are usually prescribed three-monthly, people sometimes fill their prescription outside this time period. Three categories of therapy were used: BPL medications alone, LL medications alone and both classes of medications together. Dispensing was analysed by age, sex, ethnic group and deprivation. Age was stratified in 10-year intervals. Ethnic groups were defined according to the New Zealand Ministry of Health's *Ethnicity Data Protocols for the Health and Disability Sector*.[29] Ethnic groups of interest were: European (Level 2 codes 10–12), Maori (Level 2 code 21), Pacific (Level 2 codes 30–37), Indian (Level 2 code 43), Chinese (Level 2 code 42), Other Asian (Level 2 codes 40, 41 and 44), and Other (Level 2 codes 51–99). Each patient within the PREDICT cohort can potentially have six ethnic groups recorded, as both the PREDICT template and the NHI database allow for three ethnicities to be entered. Agreement between ethnicity data recorded in the PREDICT and NHI databases has been found to be good (kappa coefficient of 0.82).[30] If multiple ethnicities were recorded for a patient, then the ethnic group was prioritised. Patients defined as having 'Chinese', 'Other Asian', or 'Other' ethnicities were subsequently excluded due to very small numbers. Quintiles of deprivation, according to NZDep01, were used to approximate socioeconomic status.

To assess the representativeness of the included study population, demographic data from anonymised PREDICT participants were compared with corresponding data from people across Auckland and Northland with an NHI number during the period 1 July 2006 to 30 June 2007, who had a history of CVD. For this Auckland/Northland dataset, a history of CVD was defined by dispensing of nitrates or perhexiline on at least two occasions between 1 July 2001 and 30 June 2007, or having a CVD-related hospital admission in the public or private sector between 1 January 1988 and 31 December 2007.

Data was analysed using STATA 10.0 statistical software. A binomial regression model calculated crude and adjusted relative risks (RR), with 95% confidence intervals (CI), of being dispensed BPL medications, LL medications or both for each sociodemographic characteristic examined.

Within the study population, a history of prescribed CVD medications was available for 2736 people. We calculated the proportion of prescriptions given to patients for BPL and LL medications which were subsequently dispensed. This allowed us to determine whether dispensing differences among these people were related to the decision to prescribe medications or to the likelihood of patients filling prescriptions.

Ethical approval

The cohort study and research process was approved by the Northern Region Ethics Committee Y in 2003 (AKY /03/12/314), with subsequent approval by the National Multi Region Ethics Committee in 2007 (MEC/07/19/EXP).

WHAT GAP THIS FILLS

What we already know: Blood pressure–lowering and lipid-lowering medications together have been shown to reduce estimated absolute cardiovascular risk over a five-year period by over 40%. Various international studies suggest that, in general, the proportion of people with CVD who receive pharmacotherapy increases with advancing age, although there is no consensus among published studies as to the influence of sex, ethnicity or social class.

What this study adds: Blood pressure–lowering and lipid-lowering medications continue to be under-utilised in patients with known cardiovascular disease in New Zealand: only two-thirds of patients are on both. Younger patients were considerably less likely to be on recommended medications, although clinically significant differences in dispensing by sex, deprivation or ethnicity were not found.

Table 1. Characteristics of 7622 people with a known history of CVD at first PREDICT assessment compared to characteristics of people with CVD from across Auckland/Northland

Baseline characteristic		Number (%) assessed by PREDICT with CVD*	Number (%) across Auckland/ Northland with CVD†
Age (years)	35–44	306 (4%)	1411 (7%)
	45–54	1319(17%)	3689 (18%)
	55–64	2703 (36%)	6908 (33%)
	65–74	3294 (43%)	8714 (42%)
Sex	Male	4760 (63%)	12 110 (58%)
	Female	2862 (38%)	8612 (42%)
Ethnicity	Maori	1556 (20%)	3588 (17%)
	Pacific Island	1151 (15%)	2300 (11%)
	Indian	329 (4%)	903 (4%)
	European and Other	4586 (60%)	13 931 (67%)
	European	4249 (55%)	Not available
	Chinese	143 (2%)	Not available
	Other Asian	95 (1%)	Not available
	Other	99 (1%)	Not available
Deprivation quintile	Quintile 1: NZDep 1–2	744 (10%)	2573 (12%)
	Quintile 2: NZDep 3–4	968 (13%)	2942 (14%)
	Quintile 3: NZDep 5–6	1287(17%)	3511 (17%)
	Quintile 4: NZDep 7–8	1859 (24%)	4080 (20%)
	Quintile 5: NZDep 9–10	2750 (36%)	6334 (31%)
	Missing data	14 (0.2%)	1282 (6%)
Dispensed CVD medications	Blood pressure–lowering medications alone	5868 (81%)	Not available
	Lipid-lowering medications alone	5348 (73%)	Not available
	Both classes of medication	4860 (67%)	Not available
	Either class of medication	6356 (87%)	Not available
Total number with CVD		7622	20 722

* Patients included in this study population were aged 35–74 years, with a first PREDICT assessment occurring between 1 July 2006 and 16 October 2009.

† This comparison dataset comprised people from across Auckland and Northland, with an NHI number during the period 1 July 2006 to 30 June 2007 inclusive, who had a history of CVD. A history of CVD was defined by dispensing of medications commonly used to treat angina on at least two occasions between 1 July 2001 and 30 June 2007, or having a CVD-related hospital admission in the public or private sector between 1 January 1988 and 31 December 2007.

Results

The sociodemographic characteristics of the 7622 people who met inclusion criteria are detailed in Table 1. The age distribution closely approximates the corresponding age distribution for Auckland and Northland. Among those assessed with PREDICT, men and people of Maori and Pacific ethnicities were slightly over-represented, with Indians similarly represented. The analysis was conducted on the 7285 individuals who remained after exclusion of 'Chinese' (n=143), 'Other Asian' (n=95) and 'Other' (n=99) ethnic groups. Higher percentages of people from deprived quintiles were noted among the PREDICT sample, compared to the deprivation distribution across Auckland and Northland. Among people with a history of CVD recorded in PREDICT, 62% (n=4691) had suffered a coronary event, 28% (n=2103) had been diagnosed with either a stroke or TIA, and 13% (n=963) were affected by PVD.

BPL medications were dispensed to 81% (n=5868), LL medications to 73% (n=5348), both BPL

Table 2. Likelihood, according to age, of being dispensed CVD medications in the six months prior to first PREDICT assessment among people with a known history of CVD (reference group is 65–74-year-old age group)

Medication category	Age group (years)	Numbers (%) dispensed for each age group	Sex, ethnicity and deprivation adjusted relative risks (95% CI)*
Blood pressure–lowering medications alone	35–44	161 (56%)	0.63 (0.57–0.71)
	45–54	904 (72%)	0.84 (0.81–0.87)
	55–64	2106 (81%)	0.94 (0.92–0.96)
	65–74	2697 (86%)	1
Lipid-lowering medications alone	35–44	155 (56%)	0.70 (0.63–0.78)
	45–54	855 (68%)	0.90 (0.86–0.94)
	55–64	1954 (75%)	0.99 (0.96–1.02)
	65–74	2384 (76%)	1
Both classes of medication	35–44	122 (42%)	0.58 (0.51–0.67)
	45–54	767 (61%)	0.86 (0.82–0.91)
	55–64	1759 (68%)	0.95 (0.92–0.99)
	65–74	2212 (70%)	1

* Please note that the crude relative risks have not been presented as they were not appreciably different to the adjusted relative risks.

and LL medications to 67% (n=4860), and 87% (n=6356) received either class of medication. Among people using BPL medications, 63% (n=3698) were dispensed ACE inhibitors, 63% (n=3695) received beta blockers, 36% (n=2122) received calcium channel blockers and 25% (n=1447) received thiazides. Statins were dispensed to 97% (n=5202) of people receiving LL medications.

Tables 2, 3, 4 and 5 present the numbers and proportions of people dispensed each category of medication, and adjusted RRs with 95% CI, according to age, sex, ethnicity and deprivation. Crude RRs are not presented, as they were not appreciably different to the adjusted RRs.

People aged 35–44 years were less likely to be dispensed BPL medications by 37% (RR 0.63, 95% CI 0.57–0.71), LL medications by 30% (RR 0.70, 95% CI 0.63–0.78) or both by 42% (RR 0.58, 95% CI 0.51–0.67) compared to people aged 65–74 years. For each medication category, the likelihood of dispensing increased with advancing age (Table 2).

Small differences in dispensing by sex were noted. After adjustment for age, ethnicity and deprivation, women were equally likely to be dis-

Table 3. Likelihood, according to sex, of being dispensed CVD medications in the six months prior to first PREDICT assessment among people with a known history of CVD (reference group is males)

Medication category	Sex	Numbers (%) dispensed for each sex	Age, ethnicity and deprivation adjusted relative risks (95% CI)*
Blood pressure–lowering medications alone	Female	2213 (81%)	0.99 (0.97–1.01)
	Male	3655 (81%)	1
Lipid-lowering medications alone	Female	1888 (69%)	0.91 (0.88–0.93)
	Male	3460 (76%)	1
Both classes of medication	Female	1726 (63%)	0.91 (0.88–0.94)
	Male	3134 (69%)	1

* Please note that the crude relative risks have not been presented as they were not appreciably different to the adjusted relative risks.

Table 4. Likelihood, according to ethnicity, of being dispensed CVD medications in the six months prior to first PREDICT assessment among people with a known history of CVD (reference group is European)

Medication category	Ethnicity	Numbers (%) dispensed for each ethnicity	Sex and age-adjusted relative risks (95% CI)*
Blood pressure–lowering medications alone	Maori	1246 (80%)	1.03 (1.00–1.06)
	Pacific	939 (82%)	1.05 (1.02–1.08)
	Indian	279 (85%)	1.07 (1.02–1.12)
	European	3404 (80%)	1
Lipid-lowering medications alone	Maori	1069 (69%)	0.96 (0.93–0.99)
	Pacific	864 (75%)	1.04 (0.99–1.08)
	Indian	265 (81%)	1.10 (1.04–1.16)
	European	3150 (74%)	1
Both classes of medication	Maori	992 (64%)	1.01 (0.96–1.05)
	Pacific	800 (70%)	1.08 (1.04–1.13)
	Indian	245 (75%)	1.14 (1.07–1.22)
	European	2823 (66%)	1

* Please note that the crude relative risks have not been presented as they were not appreciably different to the adjusted relative risks. In addition, as ethnicity and deprivation are correlated variables, an adjustment for deprivation was not included in Table 4. Adjustment for deprivation, however, did not affect the sex and age-adjusted relative risks.

pensed BPL therapy compared to men (RR 0.99, 95% CI 0.97–1.01). However, women were 9% less likely than men to be dispensed LL medications alone (RR 0.91, 95% CI 0.88–0.93) or dual therapy (RR 0.91, 95% CI 0.88–0.94) (Table 3).

The likelihood of being dispensed each category of medication was similar across the four ethnic groups, even after adjustment for sex and age (Table 4). RRs were not adjusted for deprivation, as ethnicity and deprivation are correlated variables.

No clinically relevant differences in dispensing according to deprivation quintiles were noted across the three medication categories (Table 5).

People with a recorded history of prescribed CVD medications (n=2736) had similar characteristics to the total study population. Prescriptions for BPL medications were subsequently dispensed by a pharmacist to 95% of patients, while prescriptions for LL medications were dispensed to 94% and prescriptions for both BPL and LL medications to 93% of this subsample. These proportions remained relatively consistent when considered according to sociodemographic characteristics and documented type of CVD, with the exception of dispensing of recorded prescriptions of BPL medications (84%, n=50) and dual therapy (84%, n=42) to people aged 35–44 years. (See Appendix 2 published in the web version of this paper.)

Discussion

In a large primary care cohort with CVD, BPL medications were dispensed to 81%, LL medications to 73%, both BPL and LL medications to 67%, and 87% received either class of medication. Younger people were the most under-treated, but minimal differences in dispensing of medicines according to sex, ethnicity and deprivation status were found. Among those patients with a prescription history available, more than 93% of prescriptions for BPL and LL medications were subsequently dispensed.

Our findings demonstrate considerable under-use of recommended medications for people with CVD, despite current evidence-based guidelines for the use of triple pharmacotherapy in such patients. Other New Zealand studies have similarly noted a substantial treatment gap. A nationwide audit of acute coronary patients hospitalised in 2007 found suboptimal prescribing of aspirin (82%), beta blockers (65%), ACE inhibitors (51%),

and statins (70%) for the 1003 patients examined.[31] Among another sample of 232 people with CVD from three New Zealand general practices, aspirin was prescribed to 74%, statins to 65% and BPL medications to 79% of participants.[15] Our findings may represent a 'best case scenario' as the study population was identified by primary care teams who were taking an active approach to CVD management by using the PREDICT decision support system. We were unable to investigate the use of aspirin. Records of dispensing were available for 67% of our study population, which probably reflects patients purchasing this medication over the counter to avoid prescription-related costs.

The lower level of dispensing in younger people with CVD is significant given their greater potential and productive years of life lost compared with older age groups. This is particularly salient for Maori, Pacific and Indian people, whose populations have a younger age structure than the total New Zealand population.[32–34] Various factors could account for this age discrepancy. Firstly, general practitioners (GPs) might still be managing CVD using a risk factor–based approach rather than according to absolute cardiovascular risk. Therefore, they may be unwilling to commence pharmacotherapy for those younger patients with CVD who do not have elevated blood pressure or lipids. Younger people may also be less likely than older patients to decide in favour of taking secondary prevention medications.[35,36] The reasons for this are likely to be multifactorial, and include financial pressures such as dependent children, and an arguably greater likelihood of poor lifestyle and health choices among younger people with CVD. Medication costs may also have been a deterrent for people aged less than 45 years until July 2007, when prescription charges incurred by PHO enrolees from this age group reduced markedly.

Various studies have noted reduced dispensing to older people, related to drug–drug interactions, drug–comorbid disease interactions, physiological intolerance and patient wishes against treatment.[3,7–11] We did not observe this finding, possibly due to the exclusion of people aged 75 years or older.

Table 5. Likelihood, according to deprivation, of being dispensed CVD medications in the six months prior to first PREDICT assessment among people with a known history of CVD (reference group is deprivation quintile 1)

Medication category	Deprivation quintile	Numbers (%) dispensed for each deprivation quintile	Sex and age adjusted relative risks (95% CI)*
Blood pressure–lowering medications alone	1	525 (77%)	1
	2	739 (81%)	1.05 (1.00–1.10)
	3	984 (81%)	1.04 (0.99–1.09)
	4	1432 (81%)	1.05 (0.99–1.09)
	5	2180 (81%)	1.06 (1.02–1.11)
Lipid-lowering medications alone	1	501 (74%)	1
	2	677 (74%)	1.01 (0.95–1.07)
	3	925 (76%)	1.02 (0.97–1.08)
	4	1282 (72%)	0.98 (0.93–1.04)
	5	1955 (73%)	(0.96–1.05)
Both classes of medication	1	443 (65%)	1
	2	614 (67%)	1.03 (0.96–1.11)
	3	823 (68%)	1.03 (0.96–1.10)
	4	1171 (66%)	1.02 (0.96–1.08)
	5	1802 (67%)	1.05 (0.99–1.12)

* Please note that the crude relative risks have not been presented as they were not appreciably different to the adjusted relative risks. In addition, as ethnicity and deprivation are correlated variables, an adjustment for ethnicity was not included in Table 4. Adjustment for ethnicity, however, did not affect the sex and age adjusted relative risks.

The differences in dispensing according to sex were relatively small, in keeping with published studies internationally.[3,7,8,12–14] Women are more likely to report statin-related myopathy[37,38] or present with non-specific aches and pains[39,40] that may be interpreted as intolerance, which may account for the slight under-dispensing of LL medications and dual therapy to women within our cohort.

We did not find systematic differences in cardiovascular medication dispensing based on ethnicity. However, primary care professionals should maintain a level of vigilance regarding pharmacotherapy for high-risk ethnic groups, given their younger age distributions, and their disproportionate burden of recurrent events.[41]

Relatively equal patterns of dispensing by deprivation were also noted, although the NZDep01 Index employed in our study is a relatively crude measure of socioeconomic status. Reduced patient co-payments for subsidised prescription medications are likely to have eased some of the cost barriers for those most deprived.

Our sample originated from one of the largest cohorts of patients prospectively assessed for risk of CVD worldwide. The demographic and drug dispensing data for the sample were generated through routine clinical practice, rather than in a simulated research environment, which aids the generalisability of the findings to the wider primary care setting. Data regarding dispensed medications were abstracted from a relatively comprehensive nationwide database of medications dispensed by community pharmacists. This minimised the potential for misclassification error based on patient self-report or incomplete health provider records of pharmacotherapy.

Our analyses have several limitations. We did not have access to records of patient intolerance to medications, which may account for some of the treatment gap observed. Prescriptions for CVD medications written by hospital or specialist health professionals are unlikely to be recorded in the PHARMS database; the higher patient co-payment associated with such scripts markedly reduces the incentive for pharmacists to claim for a subsidy. A small number of patients within our study population may have experienced their first CVD event shortly before their initial PREDICT assessment, introducing misclassification error in the event that these patients had only redeemed hospital or specialist-issued prescriptions prior to risk assessment. Similarly, it is possible that a few patients may have been first registered as having CVD (e.g. new angina) at the time of entry into PREDICT.

However, the main limitation of these analyses is the possibility of selection bias. This study population comprised about one-third of the estimated total number of people with CVD in the study area (see Table 1) and may represent a better treated patient group. To enter the study population, the participants had to visit a GP and a PREDICT assessment is unlikely to have been completed on non-regular patients. However, the sociodemographic profile of the PREDICT sample with CVD is similar to the corresponding characteristics of people from across Auckland and Northland with CVD at June 2007. Given the potential for selection bias, the main focus of these analyses was to compare dispensing patterns within the study population. The validity of these comparisons depends on the assumption that similar selection biases are likely to apply to the different subgroups within the study. We plan to conduct a follow-up analysis examining whether CVD risk assessment subsequently influenced pharmacotherapy, as well as link dispensing of CVD medications to CVD hospital discharges for the total New Zealand population. A comparison of risk factor profiles and type of CVD diagnosis by pharmacotherapy status would also be worthwhile.

In conclusion, under-utilisation of recommended medications among people with CVD remains a problem in New Zealand, particularly in younger patients. Patient likelihood of filling prescriptions does not appear to be a major contributor to sociodemographic differences in pharmacotherapy for CVD, as most prescriptions for CVD medications were dispensed.

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COMPETING INTERESTS
None declared.

APPENDIX A: Medications

Medications were classified as blood pressure–lowering medications or lipid-lowering medications if they were categorised as such in both the PHARMS database and inclusion criteria for the PREDICT risk management templates, or were deemed appropriate for inclusion by Dr Sue Wells (co-principal investigator for the PREDICT project). It is recognised that many of the medications categorised as blood pressure–lowering agents may not have been prescribed solely for this purpose, as these medications have a role in secondary prevention of CVD beyond their anti-hypertensive properties.

Blood pressure–lowering medications:

Acebutolol (beta-blocker), Acebutolol with hydrochlorthiazide (beta-blocker with thiazide diuretic), Alprenolol (beta-blocker), Amiloride (potassium-sparing diuretic), Amiloride with hydrochlorothiazide (potassium-sparing diuretic with thiazide diuretic), Amlodipine (calcium-channel blocker), Amyl nitrate (vasodilator), Atenolol (beta-blocker), Atenolol and Chlorthalidone (beta-blocker with thiazide-like diuretic), Benazepril (ACE inhibitor), Bendrofluazide (thiazide diuretic), Candesartan (angiotensin II receptor blocker), Captopril (ACE inhibitor), Captopril with hydrochlorthiazide (ACE inhibitor with thiazide diuretic), Carvedilol (beta-blocker), Celiprolol(beta-blocker), Chlorothiazide (thiazide diuretic), Chlorthalidone (thiazide-like diuretic), Cilazapril (ACE inhibitor), Cilazipril with hydrochlorthiazide (ACE inhibitor with thiazide diuretic), Clonidine (alpha-2 adrenergic agonist), Cyclopenthiazide (thiazide diuretic), Cylandelate (vasodilator), Diazoxide (vasodilator), Diltiazem hydrochloride (calcium-channel blocker), Doxazosin mesylate (alpha-blocker), Enalapril (ACE inhibitor), Enalapril with hydrochlorthiazide (ACE inhibitor with thiazide diuretic), Felodipine (calcium-channel blocker), Guanethidine sulphate (adrenergic-blocker), Hydralazine (vasodilator), Indapamide (thiazide-like diuretic), Isradipine (calcium-channel blocker), Labetalol (beta-blocker), Lisinopril(ACE inhibitor), Lisinopril with hydrochlorthiazide (ACE inhibitor with thiazide diuretic), Losartan (angiotensin II receptor blocker), Losartan with hydrochlorthiazide (angiotensin II receptor blocker with thiazide diuretic), Methyclothiazide (thiazide diuretic), Methyldopa (alpha-2 adrenergic agonist), Methyldopa with hydrochlorthiazide (alpha-2 adrenergic agonist with thiazide diuretic), Metoprolol succinate (beta-blocker), Metoprolol tartrate (beta-blocker), Minoxidil (vasodilator),Nadolol (beta-blocker), Nicotinyl alcohol tartrate (vasodilator), Nifedipine (calcium-channel blocker), Oxypentifylline (vasodilator), Oxprenolol (beta-blocker), Papaverine hydrochloride (vasodilator), Perindopril (ACE inhibitor), Phenoxybenzamine hydrochloride (alpha-blocker), Phentolamine mesylate (alpha-blocker), Pindolol (beta-blocker), Pindolol with clopamide (beta-blocker with thiazide-like diuretic), Prazosin hydrochloride (alpha-blocker), Propanolol (beta-blocker),Quinapril (ACE inhibitor), Quinapril with hydrochlorthiazide (ACE inhibitor with thiazide diuretic), Sotalol (beta-blocker), Terazosin hydrochloride (alpha-blocker), Timolol (beta-blocker), Timolol maleate (beta-blocker), Trandolapril (ACE inhibitor), Triamterene with hydrochlorothiazide (potassium-sparing diuretic with thiazide diuretic), Verapamil hydrochloride (calcium-channel blocker).

Lipid-lowering medications

Acipimox (vitamin B3 derivative), Atorvastatin (statin), Bezafibrate (fibrate), Cholestyramine with aspartame (resin with artificial sweetner), Clofibrate (fibrate), Colestipol hydrochloride (resin), Ezetimibe (cholesterol absorption inhibitor), Ezetimibe with simvastatin (cholesterol absorption inhibitor with statin), Fluvastatin (statin), Gemfibrozil (fibrate), Nicotinic Acid (vitamin B3), Pravastatin (statin), Simvastatin (statin).

APPENDIX B: Recorded prescriptions

*Numbers and proportions of recorded prescriptions which were dispensed in the six months before first PREDICT assessment among people with a known history of CVD**

Baseline characteristic		Percentage of recorded prescriptions dispensed		
		Blood pressure–lowering medications alone	Lipid-lowering medications alone	Both classes of medication
All patients with prescription data		2104 (95%)	1890 (94%)	1701 (93%)
Age (years)	35–44	50 (84%)	53 (95%)	42 (84%)
	45–54	303 (93%)	285 (93%)	252 (93%)
	55–64	724 (95%)	665 (94%)	591 (92%)
	65–74	1027 (97%)	887 (95%)	816 (95%)
Sex	Male	1294 (95%)	1216 (94%)	1095 (94%)
	Female	810 (96%)	674 (94%)	606 (93%)
Ethnicity	Maori	460 (93%)	377 (92%)	351 (91%)
	Pacific	208 (95%)	183 (95%)	169 (93%)
	Indian	107 (96%)	99 (95%)	92 (95%)
	European	1329 (96%)	1231 (95%)	1089 (94%)
Deprivation quintile	Quintile 1—NZDep 1–2	208 (99%)	194 (95%)	176 (97%)
	Quintile 2—NZDep 3–4	275 (95%)	243 (92%)	219 (92%)
	Quintile 3—NZDep 5–6	374 (94%)	356 (95%)	308 (92%)
	Quintile 4—NZDep 7–8	494 (95%)	448 (95%)	404 (94%)
	Quintile 5—NZDep 9–10	749 (95%)	644 (94%)	590 (93%)
	Missing Data	4 (100%)	5 (100%)	4 (100%)
CVD event	Angina/MI†	1437 (95%)	1303 (95%)	1198 (94%)
	Stroke or TIA‡	485 (94%)	409 (90%)	353 (90%)
	PVD§	271 (94%)	225 (94%)	207 (92%)

* 2736 patients were aged 35–74 years, with a first PREDICT assessment occurring between 1 July 2006 and 16 October 2009, and had a prescription history from their primary care provider recorded with their assessment.

† MI : Myocardial infarction

‡ TIA: Transient ischaemic attack

§ PVD: Peripheral vascular disease