Is general practice identification of prior cardiovascular disease at the time of CVD risk assessment accurate and does it matter?

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ABSTRACT

AIMS: To determine the accuracy of general practice recording of prior cardiovascular disease (CVD) at the time of CVD risk assessment and whether recording impacts on CVD management.

METHODS: Prior CVD status entered at the time of a first CVD risk assessment from 2002–2015 was compared to prior ischaemic CVD hospitalisations from national datasets using anonymous linkage with an encrypted National Health Index identifier. Clinical factors associated with inaccurate recording of prior events were identified using multivariable logistic regression. The impact of recording accuracy was assessed by the dispensing of CVD preventive medications in the six months after first CVD risk assessment.

RESULTS: Among 454,369 people aged 35–74 years who had CVD risk assessments, 30,924 (6.8%) had previously been admitted with ischaemic CVD. Of these people, only 61% were recorded as having prior CVD during risk assessment, with better recording for coronary and stroke events than for peripheral vascular procedures. Inaccurate primary care recording was more likely for younger people (<55 years), women, Māori, Pacific, Indian and Asian ethnic groups whereas smokers and people with diabetes were more likely to have prior CVD correctly identified. Over more than a decade, the odds of inaccurate recording during risk assessment increased [OR 1.09 (95% CIs 1.08–1.10)]. If prior CVD was entered at the time of risk assessment then dispensing of blood pressure-lowering, lipid-lowering, antiplatelet/anticoagulant medications, separately or together, was higher (86%, 85%, 83% and 69%, respectively) than if not recorded (70%, 60%, 60% and 43%).

CONCLUSIONS: Overall, 39% of people with prior CVD hospitalisations were not recorded as having prior CVD when their CVD risk was first assessed in general practice. This was associated with inequities in evidence-based risk management. System-based measures are required for robust data sharing at the time of clinical decision making.

New Zealand cardiovascular disease (CVD) risk management guidelines[1] recommend that people with prior ischaemic CVD should be managed intensively with diet, lifestyle and triple medication therapy as tolerated. Triple therapy (ie, a combination of blood pressure-lowering, lipid-lowering and antiplatelet/anticoagulant medications) could reduce the risk of recurrent events by at least 50% over five years.[1,2] National analyses indicate that maintenance of triple therapy for patients with prior CVD in New Zealand is suboptimal at around 59% and varies from 54% to 66% across district health boards (DHBs).[3] Patients aged less than 50 years were about 20% less likely than older patients, and women were 10% less likely than men, to be maintained on triple therapy.[3] This evidence-practice gap and variation by age

and sex has been recognised as a potential contributor to ambulatory sensitive hospitalisations, and is being monitored as an indicator for healthcare quality.

At the point of hospital discharge from cardiology services, 80–86% of patients who have presented with an acute coronary syndrome are prescribed triple therapy,[4] but a variety of system, information technology (IT), provider and patient factors may affect medication initiation, dispensing and maintenance.

While New Zealand primary care is highly computerised, accurate and timely identification of these high-risk patients may be hindered by a number of issues. For example, electronic data transfer at hospital discharge may be suboptimal (eg, wrong general practice [GP], wrong address or patient has no GP), discharge summaries may not be saved in GP records, CVD events may not be coded or classified in electronic health records (EHR) and triple therapy on discharge may not be reconciled with patients' long-term medication lists. However, even if a CVD event was known and recorded in one general practice, a patient may move to another region without their EHR (especially prior to GP2GP software), thus interrupting continuity of care. Furthermore, patients may not realise that they need to continue these medications long-term, particularly after coronary procedures (eg, stenting).

Since 2002, PREDICT software, integrated into practice patient management systems, has enabled primary care practitioners to conduct CVD risk assessments of patients with and without prior CVD and to access individualised risk management advice. The software has been implemented in approximately 35–40% of New Zealand primary care practices mainly in the Auckland and Northland regions. These practices serve around 1.6 million people and represent around 35% of the New Zealand resident population.[5]

PREDICT records structured CVD history and risk factor data from routine consultations via an online form. If available, data fields are automatically filled in with relevant clinical data from the EHR. This can be checked with the patient and missing fields completed by the practitioner. A copy of each patient's CVD risk profile is stored both in the EHR and on a secure off-site server held by a private IT company (Enigma) on behalf of primary care providers. Over 98%[7] of New Zealanders have a National Health Index number (NHI) allowing identification and linkage of multiple health contacts such as primary health organisation (PHO) enrolment, pharmaceutical dispensing, hospitalisations and deaths.[8] With provider permission, patient risk factor profiles are anonymised by encrypting the NHI and then transferred to the University of Auckland. These anonymous profiles are then annually linked to national health databases via similarly encrypted NHIs.

In terms of representativeness of the PREDICT cohort to the general population, the socio-demographic distribution of the cohort is strongly influenced by New Zealand CVD guidelines recommendations for screening. National primary care performance indicators have progressively resulted in increased recruitment. By 2014, the cohort included between 79% and 88% of eligible patients.[6]

We compared patients' prior CVD status entered by primary care practitioners at the time of first CVD risk assessments to prior ischaemic CVD hospitalisations from national hospitalisation datasets, to determine the accuracy of recording, whether it is changing over time, and whether this recording impacts on CVD management.

Methods

CVD risk profiles relating to patients' first (baseline) CVD assessment from 1 August 2002 to 12 October 2015 were stratified by clinical history of CVD. Data fields for a history of prior CVD included angina, myocardial infarction (MI), percutaneous coronary intervention (PCI), coronary artery bypass graft (CABG), ischaemic stroke, transient ischaemic attack (TIA) and peripheral vascular disease (PVD). Data relating to prior CVD are mandatory fields and without completion a CVD risk assessment cannot be submitted.

The study population were all people aged 35–74 years, which is the age group New Zealand guidelines recommend should have CVD risk assessments. Ethnicity was defined using a prioritisation process based on a

national protocol[9] in the following order; Māori, Pacific, Indian, Asian, New Zealand European and Other combined ethnicities (including Middle Eastern, Latin American, African, not specified, other). Socio-economic status was assessed using the New Zealand Deprivation Index (NZDep), a measure assigned to patients according to the deprivation score of their area of residence. NZDep is based on nine variables from the national Census reflecting eight dimensions of relative deprivation of census tracts.[10] For these analyses, NZDep was divided into quintiles from 1 (least deprived) to 5 (most deprived).

A person's smoking status was defined as either a smoker (including recently quit in the last 12 months) or non-smoker and diabetes status was classified as none or type 1, type 2 or type unknown entered at the time of CVD risk assessment.

The Charlson comorbidity index is a weighted scoring system that assesses the degree of previously hospitalised comorbidity burden. It is based on 12 conditions that predict one-year survival[11] and has been adapted for use with hospital discharge data using a well-validated ICD-10 coding algorithm.[12] Comorbidities were identified from hospitalisations up to five years prior to the first CVD risk assessment.

The National Minimum Dataset was used to identify patients who had prior CVD-related public hospital admission before their baseline CVD risk assessment to determine clinical history. Over 95% of CVD hospitalisations are to the New Zealand's state-funded public health service.[13] The capture of history of a hospitalised event used data starting at 1 January 1988 and was truncated at 12 July 2015 to allow three months for discharge summaries to arrive at the primary care practice or for a patient to visit their GP post-discharge, especially if triggered by a need for repeat prescriptions. (Appendix 1 has the full list of the International Classification of Diseases, version 10 (ICD-10) codes used to define an ischaemic CVD-related hospitalisation). While all our definitions use ICD-10 codes, any hospital diagnoses recorded in the ICD-9 format was forward-mapped using the New Zealand Ministry of Health ICD-9 to ICD-10 forward mapping convention.[14] Hospitalisation for haemorrhagic stroke and heart failure were not included as these diagnoses were not included as prior ischaemic CVD in the CVD risk assessment template.

The pharmaceutical collection (PHARMS) is a national database of subsidised pharmaceutical dispensing. Reliable identification of dispensing episodes by NHI number has increased over the last decade from 64% in 2004, to 92% in 2006 and over 96% from 2009 onwards.[15] PHARMS was used to identify patients who were dispensed blood pressure-lowering, lipid-lowering and antiplatelet/anticoagulant medications at least once in the six months after the baseline CVD risk assessment from 2006 until 2015. All classes of these medications were considered. While aspirin is available in New Zealand without a prescription, the objective was to detect any differences in dispensing by concordance of recording not the absolute proportion per se.

Outcomes

The primary outcome was concordance between prior CVD hospitalisations and recording of prior CVD at the baseline CVD risk assessment. Concordance by year of first CVD risk assessment (entry into the PREDICT template) was also assessed. To gauge the impact of recording accuracy in primary care on CVD risk management, we assessed the dispensing of cardiovascular medications at least once in the six months after the first CVD risk assessment.

Statistical analysis

We initially generated a 2x2 table plotting the concordance of prior CVD recorded in PREDICT and in national hospitalisation data. Using patients with prior CVD hospitalisations as the denominator, descriptive analyses were undertaken by socio-demographic and clinical characteristics and concordance by year of first CVD risk assessment for all and by hospitalisation diagnosis (ie, MI, PCI or CABG, stroke or TIA, and peripheral vascular procedures). Multivariable logistic regression was undertaken to determine the odds ratio (with 95% confidence intervals [CI]) of the associations with discordance (ie, prior CVD hospitalisation not being recorded in PREDICT). Dispensing of CVD preventive medications in the six months after CVD risk assessment was compared in patients with concordant/discordant recording of prior CVD. This was undertaken from 2006 given the completeness of dispensing records.[15]

Table 1: Concordance of prior CVD recording in PREDICT primary care risk assessment template and in national hospitalisation database.

	Prior CVD recorded in national hospitalisation database		
	No	Yes	Totals
Prior CVD recorded in PREDICT risk assessment template			
No	413,453	12,160 (39%) discordance	425,613
Yes	9,989	18,765 (61%) concordance	28,754
Totals	423,442	30,925	454,367

Statistical significance was assessed using the 2-sample test of proportions. All analyses were performed using R v3.0.2.

Ethics approval

The PREDICT study was approved by the Northern Region Ethics Committee Y in 2003 (AKY/03/12/314) with subsequent annual approval by the National Multi Region Ethics Committee since 2007 (MEC07/19/EXP).

Results

There were 454,367 people aged 35–74 years who had baseline PREDICT CVD risk assessments between August 2002 and October 2015. Of these, 30,925 had a prior CVD hospitalisation recorded in the national hospitalisation database. The concordance of being reported in both the primary care risk assessment template and the hospitalisation database was 61% (18,765/30,925). Therefore 12,160 people with a prior ischaemic CVD hospitalisation were not recorded as such at the time of their first risk assessment (Table 1, Figure 1).

There were also 9,989 patients recorded as having prior CVD in the risk assessment template who were not recorded as having a prior CVD-related admission in the national hospitalisation database. These people had one or more CVD diagnoses entered and were recorded as having angina (32%), MI (13%), PCI/CABG (19%), stroke or TIA (29%) and PVD (15%). Some of these events will have been managed only in primary care (eg, angina, TIA, claudication, or 'silent' MI detected later by electrocardiogram), whereas other events/procedures will have occurred/been managed overseas or in private hospitals.

Table 2 describes the characteristics of people with a prior CVD hospitalisation (30,925) at the time of first CVD risk assessment in general practice according to

Figure 1: Venn diagram of patients with a prior public hospitalisation of ischaemic CVD (30,925 [12,160 + 18,765]), patients with CVD entered only on the PREDICT template in general practice (9,989) and the concordance in both general practice and hospital records (18,765).

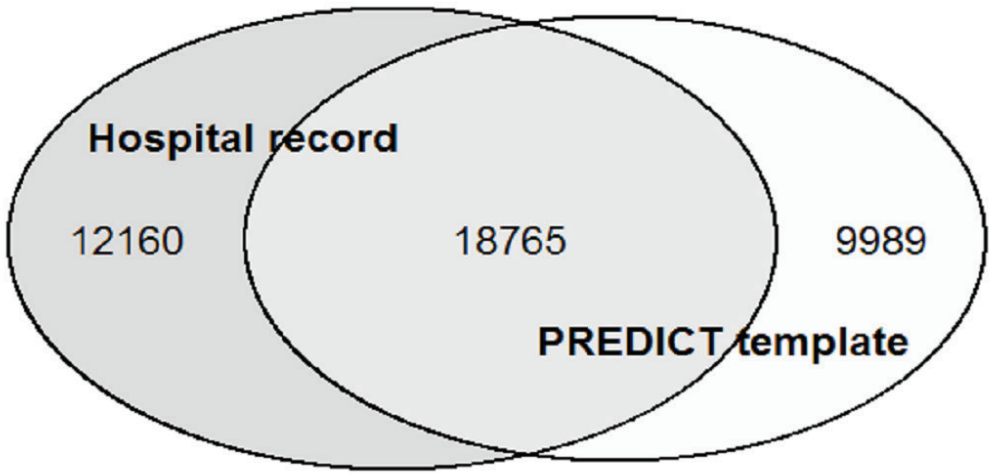

Table 2: Baseline characteristics of those with prior hospitalisation with CVD according to PREDICT and hospital records and multivariable logistic regression of the associations with discordance (n=30,925).

	Concordance (hospital and PREDICT)	Discordance (hospital only)	Odds ratio (95% CI) of a prior CVD hospitalisation not being recorded in PREDICT (discordance)*	p value
n	18,765	12,160		
Female, %	5,852 (31)	5,165 (43)	1.67 (1.59, 1.76)	<0.001
Age group, %				
35–44 years	583 (3)	575 (5)	1.36 (1.20, 1.55)	<0.001
45–54 years	3,076 (16)	2,430 (20)	1.14 (1.06, 1.22)	<0.001
55–64 years	6,576 (35)	4,495 (37)	1	
65–74 years	8,530 (45)	4,660 (38)	0.81 (0.76, 0.85)	<0.001
Ethnic group, %				
Māori	2,977 (16)	2,193 (18)	1.21 (1.12, 1.30)	<0.001
Pacific	1,788 (10)	1,654 (14)	1.62 (1.49, 1.76)	<0.001
Indian	1,257 (7)	1,018 (8)	1.43 (1.30, 1.58)	<0.001
Asian	731 (4)	543 (5)	1.21 (1.07, 1.36)	0.002
European	11,793 (63)	6,596 (54)	1	
Other**	219 (1)	156 (1)	1.22 (0.98, 1.51)	0.073
Deprivation Index, quintile				
1 (least)	2,708 (14)	1,730 (14)	1	
2	2,637 (14)	1,598 (13)	0.96 (0.87, 1.04)	0.312
3	3,610 (19)	2,154 (18)	0.90 (0.83, 0.98)	0.019
4	4,049 (22)	2,440 (20)	0.89 (0.82, 0.97)	0.006
5 (most)	5,733 (31)	4,220 (35)	1.02 (0.94, 1.10)	0.665
Diabetes, %	6,833 (36)	4,230 (35)	0.99 (0.85, 0.95)	<0.001
Current smoker, %	2,975 (16)	1,877 (15)	0.90 (0.84, 0.96)	0.001
Charlson Index				
0	13,369 (71)	8,716 (72)	1	
1–2	3,856 (21)	2,431 (20)	0.95 (0.89, 1.01)	0.089
≥3	1,540 (8)	1,013 (8)	1.01 (0.92, 1.10)	0.914
Year of CVD risk assessment, per year			1.09 (1.08, 1.10)	<0.001

*Intercept for multivariable logistic regression model 0.32 (0.29, 0.36).

**Other combined ethnicities included Middle Eastern, Latin American, African, other, not specified.

primary and secondary care records and the factors associated with discordance using a multivariable logistic regression model. The adjusted odds ratios for discordance were higher for people aged less than 55 years, for women, for all ethnic groups (Māori, Pacific, Asian, Indian, Others) compared to European but lower for smokers and those with diabetes. Having one or more comorbidities was not significantly associated with discordance and there was no clear pattern with socio-economic status (NZDep quintile). However, over more than a decade of CVD risk assessments, the odds per year of inaccurate recording increased (OR 1.09 [95% CIs 1.08–1.10]).

Figure 2: Concordance for all CVD and CVD subgroups between hospitalisation records and first CVD risk assessment conducted in general practice.

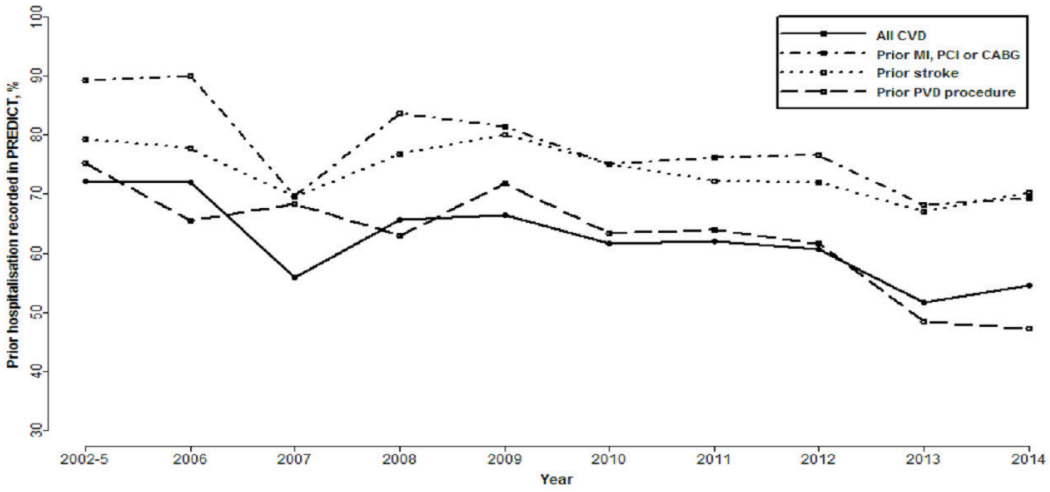

Figure 2 shows the level of concordance for all CVD and CVD subgroups between the national hospitalisation records and the CVD risk assessment template (first CVD risk assessment). Due to small numbers of CVD risk assessments in 2002–2005, these years have been aggregated together. As 2015 was only a partial year, concordance has not been shown. Prior ischaemic heart disease events (MI, PCI or CABG) were most likely to be recorded at the time of CVD risk assessment, prior peripheral vascular procedures the least likely. Overall, the concordance of recording declined over time; from 72% before 2006 to 52% in 2013 and 55% in 2014.

We investigated the dispensing of CVD medications in the six months after the first CVD risk assessment. This was undertaken from 2006 as dispensing records were 92% complete after this date[15] and therefore includes 28,995 (94%) of the CVD cohort of interest. Table 3 shows that if prior CVD was recorded in both the hospitalisation database and the CVD risk assessment template (ie, concordant) then dispensing of blood pressure lowering medications was 86%, lipid lowering 85%, antiplatelet/anticoagulant medications 83% and triple therapy 69%. However, if people with prior CVD-related hospitalisations were not recorded in the CVD risk assessment template, it was 70%, 60%, 60% and 43% respectively.

Table 3: Dispensing—up to six months after first CVD risk assessment (from 2006).

	Concordant (hospital and PREDICT)	Discordant (hospital only)	p-values
n	17,371	11,624	<0.001
Aspirin/anticoagulant	14,353 (83%)	6,966 (60%)	<0.001
Lipid lowering	14,744 (85%)	6,990 (60%)	<0.001
BP lowering	14,861 (86%)	8,128 (70%)	<0.001
Triple therapy	12,024 (69%)	5,044 (43%)	<0.001

Discussion

We found that 39% of people with prior publicly-funded CVD hospitalisations were not recorded as such (ie, had discordant recording) at the time of their first CVD risk assessment in general practice. This discordance worsened over time and was associated with markedly lower dispensing of evidence-based medications. People aged less than 55 years, women and those of non-European ethnicities were more likely to have discordant recording whereas smokers and people with diabetes were more likely to have their prior CVD hospitalisations accurately recorded in the primary care risk assessment.

The findings suggest a classic 'swiss cheese' system failure[16] where information is lost through one or more process steps; when preparing and sending hospital discharge letters (via secure portal, fax or paper-based); transmitting discharge summaries to the right GPs at the right general practices; filing in general practice EHRs after receipt; coding events in the EHR; using codes compatible with the integrated risk assessment template; and accurately entering CVD history at the time of CVD risk assessments in primary care. The decreasing accuracy in recording over time may be due to several factors. CVD hospitalised events that might have occurred in the previous 14 years may have been more subject to patient recall bias or loss of information from the system. In addition it might have been influenced by a recommendation in a 2013 guideline update[17] supporting virtual CVD risk assessments. While this helped primary health organisations (PHOs) meet national performance targets it meant that patients were not present at the time CVD risk assessment to check the fields and update clinical history data. Also some of these assessments may have been done by people not familiar with the patient, who relied only on medical record queries.

One enabler of more accurate identification is the facility for patients to access their EHR via portals. If practices allow patients to view their medical history, they could potentially report gaps and inaccuracies in CVD classification. Currently 47% of New Zealand practices have implemented portals and about 10% of the population over 18 years have been registered, so this will take time to develop.[18]

Patients may also move or change GPs. Approximately half the population change addresses every five years between censuses.[19] While many will remain with their original GP, about 10% per year will change their general practice, but this varies by age group (unpublished report W Cheuk Chan CMDHB 2017). New practices are not always forwarded the patient's EHR. While electronic transfer is much improved with GP2GP file transfer, one of the ongoing problems is the loss of previous recalls/follow-up reminders (personal communication J Kriechbaum 2017). While we could find no published New Zealand data, Read coding of long-term conditions is also likely to vary between providers. A systematic review investigating the quality of morbidity coding in general practice in the UK found the completeness of heart disease registers was 'poor' compared to a combination of information (eg, hospital discharge information, hospital letters, medications and procedures stored electronically)[20] One study reported that heart disease registers captured approximately 72% of patients with validated coronary heart disease based on related information (paper notes and computer records)[21] while a further study noted that only 43% of patients who had left hospital following a heart attack were coded in four practices.[22] Our findings for ischaemic heart disease are higher than this; around 80% over the past decade from at least 200 practices using PREDICT.

Information chaos in healthcare is thought to be comprised of information overload, information underload, information scatter, information conflict and erroneous information and has implications for clinical performance and patient safety.[23] Each of the steps in the process highlighted above (at the transfer of care to, within, and between general practices) are recurrent error traps. All hospital discharge summaries in the Auckland region (where the majority of patients in this cohort resided at the time of risk assessment) are now in electronic form. At least 90% are written before discharge with a small proportion written after the patient has left the hospital. Most are electronically transmitted via a secure portal to general practices. If the discharge summary

does arrive at the right practice, it is usually in PDF format, so while it can be saved, it cannot be directly imported into the EHR and so does not immediately provide an opportunity for appropriate coding, recalls or medication review. The very high burden of documentation, coding, setting up recalls and medication reconciliation falls directly on individual providers who are working in very time constrained environments.

Our findings provide some explanation for the national findings of suboptimal triple therapy for people who have had a prior ischaemic CVD hospitalisation;[3] that patients aged less than 50 years were about 20% less likely than older patients, and women were 10% less likely than men to be maintained on triple therapy.[3]

One limitation is the accuracy of hospital admission coding which we have used to benchmark primary care recording against. While some of the hospital CVD records will be incorrect, recent analyses have found that over 90% of people with an ICD coded acute coronary syndrome hospitalisation did have coronary heart disease on review of the hospital clinical notes (A Kerr, 2017 unpublished study).

Yarnall et al found that one of the major reasons for large evidence-practice gaps in primary care was an *absolute lack of time.*[24] In 2009, they estimated that a primary care physician with 2,500 patients needed 22 hours a day to deliver the recommended care (preventive services, long-term conditions plus acute care). If we translate that to the Ministry of Health estimates of an average of one full-time equivalent (FTE) per 1,650 enrolled patients, it equates to New Zealand GPs working 15-hour days to meet recommended care. Furthermore, with an ageing population, rising burden of long-term conditions, and new diagnostic and treatment options being recommended, we can expect the primary care workload to increase.

Some of the important potential benefits of electronic patient records are to facilitate timely access to relevant data, simplify data entry and help document processes of care, rather than add to information chaos and burden primary care providers with unnecessary documentation and coding. Clinical time is much better used being present for patients. It has been suggested that EHRs could easily aggregate and accept structured clinical data from external sources.[25] In addition, clinicians need EHRs that can facilitate the coordination and tracking of care across different settings using standard data models, coding systems and vocabularies such as SNOMED-CT or ICD codes.[25] One potential solution might be automated coding of hospitalisations into primary care records. Such system-based measures are required for robust data sharing and accurate detection at the time of clinical decision making.

Conclusion

Overall, 39% of people with prior CVD hospitalisations did not have this information recorded when they completed a CVD risk assessment in primary care. This inaccurate recording of prior CVD was associated with lower levels of evidence-based CVD preventive drug treatment. This study highlights the need for 'whole of system' clinical information to be available to better support primary care. It is timely that the Ministry of Health is investigating the implementation of a unified national electronic health record.

Appendix 1: International Classification of Diseases, version 10 Australian modification (ICD-10-AM) codes used to define an ischaemic CVD-related hospitalisation.

Category	ICD-10-AM codes[a]
Cardiac arrest	I46[b]
IHD	Angina pectoris: I20,[b] Acute MI: I21[b] Subsequent MI: I22,[b] Complications of acute MI: I23,[b] Other IHD: I24[b] (except I241 – Dressler's syndrome), Chronic IHD: I25[b]
Coronary procedures‡	Angioplasty/stent(s): 3530400-3530401, 3530500-3530501, 3530906-3530909, 3531000-3531005, Bypass: 3849700-3849707, 3850000-3850004, 3850300-3850304, 9020100-9020103, Other: 3845619, 3850500, 3850700, 3850800, 3850900, 3863700, Presence of coronary procedure: Z951, Z955, Z958, Z959
Ischaemic stroke	Cerebral infarction: I63,[b] Stroke, not specified as haemorrhage or infarction (as these are usually ischaemic): I64 (no subcategories), Sequelae of cerebral infarction: I693, Sequelae of stroke, not specified as haemorrhage or infarction: I694
Haemorrhagic stroke	Subarachnoid haemorrhage: I60,[b] Intracerebral haemorrhage: I61,[b] Sequelae of subarachnoid haemorrhage: I690, Sequelae of intracerebral haemorrhage: I691
Other CeVD	TIA: G45[b] (except G454 – transient global amnesia), G46[b] Occlusion and stenosis of precerebral arteries, not resulting in cerebral infarction: I65,[b] Occlusion and stenosis of cerebral arteries, not resulting in cerebral infarction: I66,[b] Dissection of cerebral arteries, nonruptured: I670, Cerebral atherosclerosis: I672, Sequelae of other and unspecified CeVD: I698
PVD	Atherosclerosis with symptoms: I702,[b] Atherosclerosis (other): I700, I701, I7020, I708, I709, Aortic aneurysm and dissection: I71,[b] PVD, unspecified: I739, Arterial embolism and thrombosis: I74,[b] DM with peripheral circulatory complications DM with other circulatory complications: E105,[b] E115,[b] E145[b]
PVD procedures‡	The following procedures: aneurysm excisions, repairs and replacements, bypasses, endarterectomies and patch grafts, resections and re-anastomoses Involving the following arteries: carotid: 327000-3271011, 3270300, 3310000, 3350000 aorta: 3270800-3270803, 3311200, 3311500, 3311800, 3312100, 3315100, 3315400, 3315700, 3316000, 3350900, 3351200, 3351500 femoral: 3271200-3271201, 3271500-3271503, 3271800-3271801, 3273900, 3274200, 3274500, 3274800, 3275100-3275103, 3275400-3275402, 3275700-3275701, 3351501, 3352100, 3354200 mesenteric : 3273000-3273001, 3273300-3273301, 3273600, 3353001, 3353300, 3353600 other: 3276300-3276303, 3276305-3276314, 3276316-3276319, 3305000, 3305500, 3307500, 3308000, 3312400, 3312700, 3313000, 3316300, 3317800, 3318100, 3350600-3350601, 3351800, 3352400, 3352700, 3353000, 3353900, 3354800-3354803, 3355100, 3355400, 3530306-3530307, 3531200-3531201,3531500-3531501, , 9022900, 902300

Hospital records from 1 January 1988 to 31 December 2015.

CVD=cardiovascular disease, CeVD=cerebrovascular disease, CHF=congestive heart failure, DM=diabetes mellitus, ICD-10-AM= International Statistical Classification of Diseases and Related Health Problems, Australian Modification, IHD=ischaemic heart disease, MI=myocardial infarction, PVD=peripheral vascular disease, TIA=transient (cerebral) ischaemic attack.

[a]These are the codes used by the Vascular Informatics Using Epidemiology and the Web (VIEW) team, Department of Epidemiology and Biostatistics, University of Auckland (at March 2016) to identify people with ischaemic CVD from hospital records. Only ICD-10-AM codes were used because diagnoses and procedures were mapped by the Ministry of Health to ICD-10-AM 2nd edition (where mappings existed), as well as the original submitted ICD-9-CM-A /ICD-10-AM version.

[b]Includes any subcategories that come after the last number, unless specified as excluded.

Competing interests:
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