REVIEW

Comorbidity complicates cardiovascular treatment: is diabetes the exception?

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ABSTRACT

Background: Many patients with cardiovascular disease do not attain the targets for health-related lifestyle and preventive treatment recommended in practice guidelines. The aim of this study was to assess the impact of diabetes (DM) and chronic obstructive pulmonary disease (COPD) on the quality of cardiovascular risk management in patients with established cardiovascular diseases (CVD).

Methods and Results: Patients with established CVD were randomly selected in primary care practices using recorded diagnoses. Structured case forms were used to review data on 20 performance indicators concerning CVD from medical records. Descriptive and multilevel regression analyses were conducted.

In 45 primary care practices with 106 physicians in the Netherlands, 1614 medical records of patients with CVD (37.9% women) were reviewed. A total of 1076 (66.7%) patients had recorded CVD only (reference group); 7.8% had CVD and COPD; 22.4% had CVD and DM; 3.1% patients had CVD, COPD and DM. Compared with the reference group, patients with CVD and DM yielded higher scores on 17 of 20 indicators; patients with CVD, DM and COPD on 14 indicators; and patients with CVD and COPD on three indicators. Of the patients with CVD and DM, fewer patients had LDL-cholesterol levels over 2.5 mmol/l (OR=0.36; 95% CI 0.26-0.50), more had antiplatelet drugs prescribed (OR=1.72; 95% CI 1.17-2.54), and more had systolic blood pressure measurement (OR=4.12; 95% CI 2.80-6.06).

Conclusions: This study showed that DM but not COPD was associated with more comprehensive cardiovascular risk management. This finding adds to cumulating evidence that presence of DM is associated with better preventive treatment of cardiovascular risk.

KEYWORDS

Cardiovascular diseases, comorbidity, disease management, primary health care, quality of care

INTRODUCTION

Cardiovascular disease (CVD) remains an important cause of death and disability in the world. In the United States, 33.6% of all deaths are caused by CVD.[1] Similar numbers were found in the Netherlands where one in three individuals dies of CVD (Netherlands Heart Foundation).[2] Many activities have been developed to prevent CVD in public health and in primary care.[3,4] Despite these activities and a range of practice guidelines,[5,6] many individuals receive suboptimal cardiovascular risk management. Many cardiovascular disease patients do not attain the lifestyle, risk factor and therapeutic targets that are recommended.[6,7] One reason may be the presence of comorbidity in CVD patients, which can complicate treatment.[8-10] The prevalence of comorbidity in patients with cardiovascular risk is high, especially in patients over the age of 65 years.[11] Practice guidelines tend to ignore comorbidity, although adherence to a guideline for one disease may have a negative effect in treatment of a co-existing disease.[10] Nevertheless, studies on guideline adherence concerning patients with comorbidity have remained inconclusive and whether higher guideline adherence results in better health outcomes in patients with comorbidity is as yet unclear. On the one hand, many multi-morbid patients receive multiple drugs which may compromise adherence and safety of treatment.[12] Research has also suggested that these patients have a poorer functional status or quality of life, a higher

mortality risk and greater use of health services.[13] On the other hand, some studies have in fact shown a positive association between the number of medical conditions and guideline adherence.[14-17] For instance, a Dutch survey demonstrated that patients with chronic heart failure and diabetes mellitus (DM) received treatment that was more consistent with guideline recommendations than patients with chronic heart failure but no DM.[18] Furthermore, type of comorbid conditions may also be of influence on guideline adherence.[9,19]

The aim of this study was to assess the impact of DM and chronic obstructive pulmonary disease (COPD) on measures of cardiovascular risk management in patients with established CVD. Given the commonalities in the preventive treatment of the three conditions, which is illustrated by overlapping quality indicators, we expected comorbidity to be associated with higher scores on these measures.

MATERIALS AND METHODS

Design

This study was based on the baseline measurement in a cluster randomised trial no. NCT00791362, which was executed from September 2008 until February 2011. The trial aimed to determine the effectiveness and efficiency of a national accreditation and improvement program (NHG-Praktijkaccreditering) for primary care practice, focusing on patients with established CVD. The national accreditation and improvement program was a new strategy for quality improvement in Dutch primary care. It consists of a set of implementation interventions including: audit and feedback, outreach visits by trained facilitators and planning improvements according to the quality management principles. The Arnhem-Nijmegen ethics committee waived approval for this trial. Data were collected by audit of electronic medical records of primary care patients in the Netherlands.

Study population

We recruited patients with established CVD, namely angina pectoris, acute myocardial infarction, transient ischaemic attack (TIA), ischaemic stroke, peripheral arterial disease, aortic aneurysm and other chronic ischaemic heart diseases. Selection of patients with these conditions was based on corresponding diagnostic codes (ICPC K74, K75, K89, K90.3, K92.1, K99.1 and K76). Patients were classified as having DM or COPD if the corresponding diagnostic codes (T90 for DM, R95 for COPD) were recorded in their medical record. Patients were recruited from 45 primary care practices involving 106 family physicians in the Netherlands who agreed to participate in the study. All primary care practices which voluntarily enrolled in the Dutch national accreditation program (NHG-Praktijkaccreditering) from December 2008 until March 2010 were invited by letter to participate in the study. All primary care practices used electronic medical records, which is common in the Netherlands, and International Classification of Primary Care codes (ICPC codes), a worldwide system to label conditions in primary care.[20]

Measurements

In each practice 40 patients with established CVD were randomly sampled from the practice register. Data collection, related to the last 12 months, was based on quality indicators for established CVD[21] (developed by the Dutch College of Family Physicians), which included: systolic blood pressure in mmHg measured in the practice, LDL cholesterol in mmol/l, prescription of statin and antiplatelet drugs, smoking status, stop smoking advice, body mass index in kg/m^2, waist circumference ever measured, fasting glucose measurement measured in the past five years, influenza vaccination, registration of alcohol intake and control and advice on exercise and diet. This set of 20 indicators was complemented by information on age, sex and the presence of comorbidity (COPD and DM). Paper-based abstraction forms were used to collect data. Data were manually abstracted out of electronic medical records from January 2009 until May 2010. The starting point in this study was indicators related to established CVD[21] but when considering indicators for all three chronic illnesses,[21-23] seven indicators were commonly shared. These indicators were: exercise control, influenza vaccination, measurement of BMI, BMI <25 kg/m^2, smoking status, patient is a smoker and stop smoking advice. Eight indicators concerned both established CVD and DM. These indicators were: systolic blood pressure measurement, systolic blood pressure <140 mmHg, LDL-cholesterol measurement, LDL cholesterol <2.5 mmol/l, advice on physical activity, diet control, counselling about diet and registration of alcohol intake. Five indicators related to established CVD only (measurement of waist circumference, prescription of antiplatelet drugs, fasting glucose measurement, patients with LDL cholesterol ≥2.5 mmol/l with statin prescription and comprehensive risk assessment).

Statistical analysis

Data were analysed using the SPSS 16.0 software package (Chicago, Illinois, USA). Outcome measures were all indicators as described above. All indicators (all dichotomous outcomes) were included in a two-level logistic regression, taking into account the hierarchical structure of our study (patients nested within practices). Multilevel analysis was performed in the SAS 9.2 package with procedure PROC GLIMMIX. We performed a logistic

model (with a binomial distribution and a logit link function) with a random intercept and all other variables (group, age and sex) fixed. Only patient variables were included in the model. In the multilevel regression analysis four groups were taken into account. The first group, the reference group, consisted of patients with CVD only, the second group were patients with CVD and COPD, the third group were patients with CVD and DM, the fourth group were patients with CVD, DM and COPD.

RESULTS

Of the 336 practices invited to participate in this study, 45 entered the study, representing 106 family physicians. In 45 practices a random sample of 1614 patients with established CVD and possibly DM and/or COPD as comorbidity was recruited.

Table 1 presents characteristics of the study population. More men (62.1%) were included in the sample. The mean age was 69.5 years (SD 11.8). A total of 1076 (66.7%) patients had CVD only; 126 (7.8%) had CVD and COPD; 362 (22.4%) had CVD and DM; and 50 (3.1%) patients had CVD, COPD and DM. *Table 2* describes the cardiovascular diseases. The most common cardiovascular history was angina pectoris (37.4% of patients) followed by myocardial infarction (30%). Of patients with multiple cardiovascular disorders (n=247) 37.2% had coronary heart disease only (K74, K75, K76), 31.6% had coronary heart disease and peripheral arterial disease or aortic aneurysm (K92.1, K99.1) and 22.3% had coronary heart disease and TIA or ischaemic stroke (K89, K90.3). *Table 3* shows that in audited records, recording was best for blood pressure measurement (75.9%), influenza vaccination (76.3%) and prescription of antiplatelet drugs (84.8%) and worst for risk assessment (4.8%). Goals for outcome measurement BMI (<25 kg/m^2) were achieved in 16.9% of patients whose BMI was measured. Systolic blood pressure was <140 mmHg in 60.2% of patients with a record of BP, and LDL-cholesterol levels were below 2.5 mmol/l in 46.8% of patients with a record of LDL cholesterol.

Indicator scores

Indicators shared across conditions

Of the seven indicators that are relevant for each of the conditions, three to five yielded higher scores in patients with DM and/or COPD in addition to CVD (*table 4*). Smoking status was better registered for all patients with comorbidity compared with patients with CVD only. In the group of patients with CVD and COPD and in patients with CVD, DM and COPD more smokers were present (odds ratio (OR)=4.13; 95% confidence interval (CI) 2.26-7.54; OR=2.61; 95% CI 1.23-5.54). Patients with CVD and DM and patients with CVD, DM and COPD had more recordings of BMI (OR=7.09; 95% CI 5.24-9.60; OR=7.97; 95% CI 4.16-15.30) and control of exercise (OR=6.26; 95% CI 4.69-8.35; OR=5.72; 95% CI 3.06-10.68). More patients with CVD and DM and patients with CVD and COPD received influenza vaccinations (OR=1.84; 95% CI 1.30-2.59; OR=1.99; 95% CI 1.15-3.44) than patients with CVD only. No differences between groups were identified regarding the process measurement 'stop smoking advice'.

Table 1. *Characteristics of the study population (n=1614)*

	CVD (%)	CVD+COPD (%)	CVD+DM (%)	CVD+DM+COPD (%)	Total scores (%)
Men	665 (61.8)	90 (71.4)	212 (58.6)	36 (72)	1003 (62.1)
Women	411 (38.2)	36 (28.6)	150 (41.4)	14 (28)	611 (37.9)
Total	1076 (66.7)	126 (7.8)	362 (22.4)	50 (3.1)	1614
Mean age in years (SD)	68.7 (12.2)	71.3 (9.6)	70.9 (10.9)	70.1 (11.4)	69.5 (11.8)

Table 2. *Type of cardiovascular disease*

	ICPC	CVD (%)	CVD+COPD (%)	CVD+DM (%)	CVD+DM+COPD (%)	Total scores (%)
AP	K74	401 (37.5)	51 (40.8)	123 (34.5)	23 (46)	598 (37.4)
MI	K75	324 (30.3)	44 (35.2)	98 (27.5)	15 (30)	481 (30)
Other chronic IHD	K76	108 (10.1)	8 (6.4)	47 (13.2)	6 (12)	169 (10.6)
TIA	K89	175 (16.4)	17 (13.6)	48 (13.4)	2 (4)	242 (15.1)
Ischaemic stroke	K90.3	77 (7.2)	4 (3.2)	23 (6.4)	3 (6)	107 (6.7)
PAD, intermittent claudication	K92.1	104 (9.7)	17 (13.6)	68 (19)	9 (18)	198 (12.4)
Aortic aneurysm	K99.1	56 (5.2)	13 (10.4)	10 (2.8)	3 (6)	82 (5.1)

AP = angina pectoris; IHD = ischaemic heart disease; MI = myocardial infarction; PAD = peripheral arterial disease; TIA = transient ischaemic attack.

Table 3. *Record of indicators for cardiovascular risk management in electronic medical records*

Type of indicator	Indicators commonly shared across CVD/COPD/DM	CVD (%)	CVD+COPD (%)	CVD+DM (%)	CVD+DM+ COPD (%)	Total (%)
Process	Smoking status	359 (33.4)	62 (49.2)	212 (58.6)	35 (70)	668 (41.5)
Outcome	Patient is a smoker	110 (30.6)	36 (58.1)	43 (20.2)	18 (51.4)	207 (41.6)
Process	Stop smoking advice	60 (54.5)	22 (61.1)	26 (60.5)	12 (66.7)	119 (54.8)
Process	BMI measured	191 (17.8)	29 (23)	189 (52.2)	29 (58)	438 (27.2)
Outcome	BMI <25 kg/m^2	38 (19.9)	6 (20.7)	26 (13.8)	4 (13.8)	74 (16.9)
Process	Influenza vaccination	784 (72.9)	106 (84.1)	301 (83.1)	39 (78)	1230 (76.3)
Process	Exercise control	209 (19.4)	25 (19.8)	191 (52.8)	25 (50)	450 (27.9)
	Indicators shared across CVD/DM					
Process	Systolic blood pressure measured	755 (70.2)	90 (71.4)	329 (90.9)	48 (96)	1222 (75.9)
Outcome	Systolic blood pressure <140 mmHg	464 (61.5)	50 (55.6)	196 (59.6)	26 (54.2)	736 (60.2)
Process	LDL cholesterol measured	446 (41.4)	54 (42.9)	267 (73.8)	38 (76)	805 (50)
Outcome	LDL cholesterol <2.5 mmol/l	170 (38.1)	20 (37.0)	166 (62.2)	21 (55.3)	377 (46.8)
Process	Advice physical activity	150 (13.9)	19 (15.1)	142 (39.2)	16 (32)	327 (20.3)
Process	Diet control	137 (12.7)	17 (13.5)	216 (59.7)	28 (56)	398 (24.7)
Process	Counselling about diet	158 (14.7)	14 (11.1)	197 (54.4)	26 (52)	395 (24.5)
Process	Registration of alcohol intake	245 (22.8)	31 (24.6)	183 (50.6)	27 (54)	486 (30.2)
	Indicators CVD only					
Process	Patients with LDL cholesterol ≥2.5 mmol/l with statin prescription	170 (61.6)	23 (67.6)	73 (72.3)	7 (41.2)	273 (63.8)
Process	Waist circumference measured	103 (9.6)	12 (9.5)	87 (24)	16 (32)	218 (13.7)
Process	Prescription antiplatelet drugs	896 (83.6)	101 (80.2)	325 (89.8)	44 (88)	1366 (84.8)
Process	Fasting glucose measured	644 (59.9)	76 (60.3)	328 (90.6)	46 (92)	1094 (68)
Process	Comprehensive risk assessment*	27 (2.5)	2 (1.6)	41 (11.3)	7 (14)	77 (4.8)

***positive score when there is a record of: blood pressure, BMI, waist circumference, fasting glucose measurement, LDL-cholesterol measurement, smoking behaviour, alcohol intake, advice and control of diet and physical exercise in the past 12 months.**

More patients with CVD and DM had a BMI over 25 kg/m^2 (OR=2.05; 95% CI 1.15-3.65). On the practice level, intra-class coefficient (ICC) scores ranged from 0.038 for 'patient is a smoker' to 0.261 for 'BMI measured'.

Indicators shared across CVD and DM

Of eight indicators shared across CVD and DM all but one (systolic blood pressure <140 mmHg) yielded higher scores in patients with DM (with or without COPD). In patients with CVD and COPD, indicator scores were the same as in patients with CVD only. Patients with CVD and DM and patients with CVD, DM and COPD were more likely to have blood pressure measurement (OR=4.12; 95% CI 2.80-6.06; OR=10.56; 95% CI 2.53-44.09), LDL-cholesterol measurement (OR=4.03; 95% CI 3.08-5.28; OR=4.82; 95% CI 2.47-9.39), advice (OR=8.26; 95% CI 6.20-11.00; OR=7.32; 95% CI 3.96-13.56) and control (OR=12.04; 95% CI 8.94-16.21; OR=10.92; 95% CI 5.86-20.35) on diet, advice about physical activity (OR=4.38; 95% CI, 3.29-5.84; OR=3.21; 95% CI 1.68-6.14) and registration of alcohol intake (OR=4.18; 95% CI 3.17-5.51; OR=5.32; 95% CI 2.85-9.93) compared with patients with CVD only. No differences were found between groups regarding systolic blood pressure ≤140 mmHg. Patients with CVD and DM and patients with CVD, DM and COPD were less likely to have a LDL-cholesterol level ≥2.5 mmol/l (OR=0.36; 95% CI 0.26-0.50; OR=0.49; 95% CI 0.25-0.96). On the practice level, ICC scores ranged from 0.021 for 'systolic blood pressure <140 mmHg' to 0.159 for 'registration of alcohol intake'.

Indicators for CVD only

Of five indicators that are only relevant for CVD, three to five yielded higher scores in patients with DM (with or without COPD). No such differences were found in patients with CVD and COPD. Patients with CVD and DM and patients with CVD, DM and COPD were more likely to have a record of waist circumference (OR=4.83; 95% CI 3.33-7.02; OR=6.07; 95% CI 2.93-12.56), fasting glucose measurement (OR=7.40; 95% CI 4.99-10.98; OR=9.41; 95% CI 3.30-26.84) and a comprehensive risk assessment (OR=6.99; 95% CI 3.98-12.27; OR=7.15; 95% CI 2.56-20.02) than patients with CVD only. Antiplatelet drugs were more often prescribed to patients with CVD and DM (OR=1.72; 95% CI 1.17-2.54) than to patients with CVD only. Patients with CVD and DM with

Table 4. *Impact of recorded diseases on scores for CVD indicators (odds ratios with 95% confidence intervals and CVD only as reference group)*

Indicators commonly shared across CVD/COPD/DM	Smoking status	Patient is a smoker	Stop smoking advice	BMI measured	BMI ≥25 kg/m²	Influenza vaccination	Exercise control
Fixed effect							
CVD & COPD	2.58* (1.73-3.85)	4.13* (2.26-7.54)	1.48 (0.65-3.39)	1.46 (0.90-2.37)	1.18 (0.44-3.20)	1.99* (1.15-3.44)	1.35 (0.83-2.21)
CVD & DM	3.64* (2.78-4.75)	0.67 (0.44-1.03)	1.09 (0.52-2.28)	7.09* (5.24-9.60)	2.05* (1.15-3.65)	1.84* (1.30-2.59)	6.26* (4.69-8.35)
CVD & DM & COPD	6.31* (3.29-12.10)	2.61* (1.23-5.54)	2.18 (0.71-6.69)	7.97* (4.16-15.30)	1.87 (0.59-5.95)	1.50 (0.70-3.20)	5.72* (3.06-10.68)
CVD (reference group)							
Age[1]	0.97* (0.96-0.98)	0.95* (0.93-0.96)	0.99 (0.97-1.02)	1.01 (0.99-1.02)	0.94* (0.91-0.96)	1.05* (1.04-1.06)	1.00 (0.99-1.01)
Sex[2]	1.15 (0.92-1.44)	0.97 (0.66-1.42)	0.75 (0.41-1.38)	1.31 (0.99-1.72)	1.13 (0.66-1.95)	1.01 (0.77-1.32)	1.05 (0.81-1.35)
Random effect	Variance component (SE)						
Level-two variance (practice)	0.47 (0.13)	0.13 (0.11)	0.45 (0.31)	1.16 (0.31)	0	0.84 (0.24)	0.74 (0.20)
ICC	0.125	0.038	0.120	0.261	0	0.203	0.184

Indicators shared across CVD/DM	Systolic blood pressure measured	Systolic blood pressure <140 mmHg	LDL cholesterol measured	LDL cholesterol ≥2.5 mmol/l	Advice physical activity	Diet control	Counselling about diet	Registration of alcohol intake
Fixed effect								
CVD & COPD	0.97 (0.63-1.47)	1.22 (0.78-1.92)	1.10 (0.76-1.62)	1.06 (0.58-1.92)	1.22 (0.72-2.09)	1.27 (0.72-2.21)	0.81 (0.45-1.47)	1.35 (0.86-2.13)
CVD & DM	4.12* (2.80-6.06)	1.02 (0.77-1.34)	4.03* (3.08-5.28)	0.36* (0.26-0.50)	4.38* (3.29-5.84)	12.04* (8.94-16.21)	8.26* (6.20-11.00)	4.18* (3.17-5.51)
CVD & DM & COPD	10.56* (2.53-44.09)	1.36 (0.74-2.49)	4.82* (2.47-9.39)	0.49* (0.25-0.96)	3.21* (1.68-6.14)	10.92* (5.86-20.35)	7.32* (3.96-13.56)	5.32* (2.85-9.93)
CVD (reference group)								
Age[1]	1.02* (1.01-1.03)	1.03* (1.02-1.04)	0.99 (0.98-1.00)	1.00 (0.99-1.01)	0.99* (0.97-1.00)	0.99* (0.98-1.00)	0.98* (0.97-0.99)	0.99 (0.98-1.00)
Sex[2]	0.92 (0.72-1.18)	0.83 (0.65-1.06)	0.93 (0.75-1.15)	0.80 (0.59-1.08)	1.02 (0.78-1.34)	1.01 (0.77-1.33)	1.11 (0.85-1.45)	1.49* (1.16-1.90)
Random effect	Variance component (SE)							
Level-two variance (practice)	0.16 (0.07)	0.07 (0.05)	0.09 (0.05)	0.09 (0.07)	0.35 (0.12)	0.39 (0.13)	0.31 (0.11)	0.62 (0.17)
ICC	0.046	0.021	0.027	0.027	0.096	0.106	0.086	0.159

Indicators CVD only	Patients with LDL ≥2.5 mmol/l with statin prescription	Waist circumference measured	Prescription anti-platelet drugs	Fasting glucose measured	Comprehensive risk assessment
Fixed effect					
CVD & COPD	1.54 (0.70-3.43)	1.14 (0.57-2.26)	0.68 (0.42-1.11)	1.12 (0.75-1.66)	0.77 (0.17-3.44)
CVD & DM	2.13* (1.24-3.67)	4.83* (3.33-7.02)	1.72* (1.17-2.54)	7.40* (4.99-10.98)	6.99* (3.98-12.27)
CVD & DM & COPD	0.50 (0.18-1.43)	6.07* (2.93-12.56)	1.37 (0.56-3.34)	9.41* (3.30-26.84)	7.15* (2.56-20.02)
CVD (reference group)					
Age[1]	0.96* (0.94-0.98)	0.98* (0.96-0.99)	1.03* (1.01-1.04)	1.00 (0.99-1.01)	0.98 (0.96-1.00)
Sex[2]	1.44 (0.94-2.21)	1.39 (0.99-1.96)	1.99* (1.49-2.64)	1.04 (0.82-1.31)	1.31 (0.76-2.27)
Random effect	Variance component (SE)				
Level-two variance (practice)	0.20 (0.16)	1.67 (0.47)	0.19 (0.09)	0.37 (0.12)	1.95 (0.62)
ICC	0.057	0.337	0.055	0.101	0.372

***p<0.05; [1]age increasing in one-year steps; [2]reference group is men.**

LDL-cholesterol levels above 2.5 mmol/l were more likely to receive a statin (OR=2.13; 95% CI 1.24-3.67).
Increasing patient age was positively correlated with prescribing antiplatelet drugs (OR=1.03; 95% CI 1.01-1.04) and receiving influenza vaccination (OR=1.05; 95% CI 1.04-1.06). Recording of blood pressure measurement was positively correlated with increasing age as well (OR=1.02; 95% CI 1.01-1.03); however, with increasing age blood pressure targets were less often achieved.
Increasing age was negatively correlated with a record of smoking behaviour (OR=0.97; 95% CI 0.96-0.98), advice on physical activity (OR=0.99; 95% CI 0.97-1.00), dietary advice (OR=0.98; 95% CI 0.97-0.99) and control (OR=0.99; 95% CI 0.98-1.00), record of waist circumference (OR=0.98; 95% CI 0.96-0.99) and statin prescription for patients with an LDL-cholesterol level ≥2.5 mmol/l (OR=0.96; 95% CI 0.94-0.98). With increasing age, more patients had a BMI below 25 kg/m^2 (OR=0.94; 95% CI 0.91-0.96) and of the patients whose smoking behaviour was registered, less patients smoked (OR=0.95; 95% CI 0.93-0.96). On the practice level, ICC scores ranged from 0.055 for 'prescription of antiplatelet drugs' to 0.372 for 'comprehensive risk assessment'. Female gender was positively correlated with prescription of antiplatelet drugs (OR=1.99; 95% CI 1.49-2.64) and the registration of alcohol intake (OR=1.49; 95% CI 1.16-1.90). No differences regarding gender were found for the remaining indicators.

DISCUSSION

In line with our expectations, we found evidence that comorbidity was associated with more comprehensive cardiovascular risk management. However, this only applied to DM and not to COPD. This trend applied to indicators that were shared across the conditions, but remarkably also to indicators that were only related to CVD. This study adds to the cumulating research evidence that the presence of DM is associated with better preventive treatment for other diseases.[17,18,24] Our findings should be interpreted in the context of the sample of primary care practices, which may be the early majority with respect to quality improvement as they had voluntarily joined an accreditation program.
A plausible explanation for our findings seems to be that disease management programs for diabetes care have been well established on a nationwide basis in Dutch primary care in recent years. Evidence found that these programs have positive effects on the quality of care.[25] We suggest that similar programs might explain similar findings from studies in other countries.[17,24] In the Netherlands, disease management programs are governed by so-called 'care groups'. This is an organisation of 50 to 100 primary care practices which is responsible for the coordination and provision of contracted care in a particular region. Since 2010 all care groups in the Netherlands have a bundled payment contract for the diabetes care program; so 100% national coverage has been achieved.[26] So far, few care groups have focused on COPD or CVD in the Netherlands. The impact of disease management is based on a number of mechanisms. One component of care in disease management programs is that clinical activities and clinical parameters are registered in electronic medical records, which use this information to provide computer generated reminders. This implies that more such activities can be found in a chart audit.
DM and CVD are concordant conditions while they represent parts of the same pathophysiological risk profile and are more likely to be the focus of the same disease management plan. Discordant conditions, in contrast, are not directly related in management or pathogenesis.[27] COPD and CVD are less concordant conditions than DM and CVD.[19,28] Our findings illustrate that the management of DM and CVD has more in common than the management of COPD and CVD. This could even apply to the indicators concerning CVD only. For instance, better prescription of antiplatelet drugs might be explained by the fact that the recommendation for antiplatelet drugs for diabetes patients with established CVD is mentioned in the diabetes guideline. This is not recommended for diabetes patients without established CVD.[29,30]
A third determinant of our findings is that CVD patients visiting the practice because of their structured DM care are being considered not just DM related but more broadly as cardiometabolic risk, which can be seen as an integral primary care approach. For instance, waist circumference and risk for developing DM are related.[29] Although not an indicator for DM in the Dutch national accreditation program (NHG-Praktijkaccreditering), in many DM care groups in the Netherlands waist circumference is measured routinely. The same applies to fasting glucose measurement, which is not defined as a quality indicator for DM, but is used to diagnose DM and to monitor glucose levels in patients with DM.[29] When considering comprehensive risk assessment, all items are recommended preventive care in diabetes patients.
While most performance indicators yielded higher scores in patients with comorbidity, no differences were found between patient groups for 'systolic blood pressure ≤140 mmHg', which is a proxy health outcome. More smokers were represented in the group of patients with CVD and COPD and patients with CVD, DM and COPD. While smoking is the most important cause of COPD, most COPD patients smoke or have a history of smoking.[31] The decreasing numbers of patients who smoke with increasing age could be the consequence of the fatal effects of smoking.

For the proxy outcome indicator 'LDL cholesterol <2.5 mmol/l' targets were more often attained in patients with CVD and DM and patients with CVD, DM and COPD than in patients with CVD only. Previous research shows that many patients with CVD do not attain therapeutic targets set in guidelines for CVD.[6,32,33] Higher target attainment for LDL-cholesterol levels in patients with CVD and DM may be related to better prescription of statins in this group of patients, which may be related to the sample of primary care practices included in this study.
Overall, the results of this study showed room for improvement in preventive care in patients with established CVD, even in this sample of primary care practices. This is in line with results from other studies.[6,7,34] Improvements can be made especially on lifestyle counselling in patients with established CVD with or without COPD, while results on these items are disappointing. Primary care has an important role to play in effective health promotion and disease prevention.[35]

This study had some limitations. Primary care practices participating in this study were enrolled in a national implementation and accreditation program. It seems likely that they were better organised and staffed than average. Primary care practices with a clear preference for a specific improvement plan could not participate in the study while participating practices were randomised to a group which started with an improvement plan on cardiovascular risk management or to a group that did not. This also accounted for practices that participated in ongoing improvement programs due to regional developments in disease management, which makes the assessment of the true participation rate of practices in this study unattainable. The sampling of patients in this study was based on ICPC codes allocated to patients by family physicians. However, some cardiovascular diseases, for example TIA, are more difficult to diagnose, while diagnosis is made based on the anamnesis.[36] This does not seem to be a large problem as 12% of the patients had only TIA as cardiovascular diagnosis. In this study we only assessed COPD and DM as comorbidities of influence on preventive cardiovascular care while these are common in patients with established CVD.[37,38] Furthermore we only considered patient characteristics in this study while practice characteristics could also be of influence on the outcomes. Further research should consider the influence of other concordant and discordant comorbidities and practice characteristics on cardiovascular risk management.
At the time of the study, disease management programs for DM were well established in primary care practices, unlike disease management programs for CVD and COPD. The results of this study illustrate the influence of these programs on the quality of care. Currently ongoing initiatives aim to implement disease management programs for CVD and COPD in primary care. It would be relevant to repeat this study when disease management programs for CVD and COPD are well established. As many components of preventive care for patients with CVD and DM are shared, it may be efficient to integrate these components in a comprehensive care program. This would reduce the burden for both caregivers and patients and open up time for other important clinical tasks.

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