Time-Trend Analysis on the Framingham Risk Score and Prevalence of Cardiovascular Risk Factors in Patients Undergoing Percutaneous Coronary Intervention Without Prior History of Coronary Vascular Disease Over the Last 17 Years: A Study From the Mayo Clinic PCI Registry

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ABSTRACT

Background: There is a paucity of data on the temporal trends of cardiovascular risk factors in patients undergoing percutaneous coronary intervention (PCI). We investigated the secular trends of risk profiles of patients undergoing PCI without prior history of cardiovascular disease (CVD).

Hypothesis: CVD risk factors are changed over time.

Methods: This time-trend analysis from 1994 to 2010 was performed within the Mayo Clinic PCI Registry. Outcome measures were prevalence of CVD risk factors, including the Framingham risk score (FRS), at the time of admission for PCI.

Results: During this period, 12,055 patients without a history of CVD (mean age, 65.0 ± 12.4 years, 67% male) underwent PCI at the Mayo Clinic. Age distribution slightly shifted toward older age (P for trend <0.05), but sex did not change over time. Despite a higher prevalence of hypertension, hypercholesterolemia, and diabetes mellitus over time, actual blood pressure and lipid profiles improved (P for trend <0.001). Over time, FRS and 10-year CVD risk improved significantly (7.3 ± 3.2 to 6.5 ± 3.3 , P for trend <0.001 ; and 11.0 to 9.0 , P for trend <0.001 , respectively). Body mass index, not included in the FRS, increased significantly (29.0 ± 5.2 to 30.1 ± 6.2 kg/m², P for trend <0.001), whereas smoking prevalence did not change.

Conclusions: The current study demonstrates that although traditional FRS and its associated predicted 10-year cardiovascular risk declined over time, the prevalence of risk factors increased in patients undergoing PCI. The study suggests the need for a new risk-factor assessment in this patient population.

Introduction

Despite high prevalence of cardiovascular disease (CVD) and its risk factors, mortality has declined in the overall population during the past 30 years.^{1,2} However, CVD still accounts for nearly 700,000 deaths per year in the United States.³ Multiple cardiovascular risk factors (cvRF) have been demonstrated to be associated with incident CVD, and approximately 75% to 90% of CVD incidence could be attributed to conventional cvRF.⁴ Highly prevalent cvRF are of great public-health significance, as their modification might result in significantly reduced risk of CVD.

Therefore, recognizing temporal trends in the major cvRF, as well as changes in the use of evidence-based medications, is of importance not only for the prevention of CVD, but also for looking into avenues for further improvement. However, there is a paucity of data on such temporal trends,⁵ particularly in the primary-prevention setting in patients referred for percutaneous coronary intervention (PCI). The Framingham Risk Score (FRS) is the most commonly used tool for stratifying risk of CVD. However, the FRS may have limitations in certain populations, particularly in patients undergoing PCI. Moreover, the magnitude and direction of changes in cvRF and their association with the FRS in these patients is unknown. With that background, the current study was designed to examine the 17-year trends in CVD

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risk factors and the FRS in patients undergoing PCI without prior CVD history.

Methods

Patients, Workups, and Grouping

We analyzed data collected from all PCI patients included in the Mayo Clinic PCI Registry in Rochester, Minnesota, from January 1, 1994, to December 31, 2010. Patients undergoing PCI are prospectively followed in a registry that includes demographic, clinical, angiographic, and procedural data. The supervisor for data integrity randomly audits 10% of all records. Relevant clinical information is abstracted from medical records.

There were 26,172 PCI hospitalizations of 20,711 unique patients during this period. For the present study, in patients who underwent multiple PCIs within a single hospitalization, only the first PCI of that hospitalization was included. Five hundred thirty patients who refused authorization of their records for research were excluded. We also excluded 8,153 PCI patients who experienced cardiovascular events. Finally, we selected 12,055 PCI patients with no prior cardiovascular events (PCI, coronary artery bypass surgery, or myocardial infarction) as our study subjects. The Mayo Clinic Institutional Review Board approved this study.

Data retrieved from the PCI Registry included general demographic information (hospital identification, date, age, sex, and family history of heart disease) and cvRF profiles (smoking status, presence of diabetes mellitus [DM], hypertension, hypercholesterolemia, body mass index [BMI]).⁶ Medication use included aspirin (ASA), β -blockers, angiotensin-converting enzyme inhibitors (ACEIs), and lipid-lowering drugs at baseline (within 3 days prior to PCI) and on discharge. Hypercholesterolemia was defined as history of total cholesterol (TC) >240 mg/dL. Presence of hypertension was defined as a documented history of hypertension that has been treated with medication. Cholesterol and blood pressure (BP) values were retrieved from electronic medical records. Blood pressure values within 1 year prior to PCI were acceptable; if multiple measures were found, the measure occurring on the date closest to the PCI was recorded. Cholesterol values within 2 years prior to, or for 2 months after, PCI were acceptable; in the event of multiple measurements, the maximum value (minimum for high-density lipoprotein cholesterol [HDL-C]) closest to the PCI was recorded. These data were used to calculate estimated risk of CVD using the FRS sheet.⁷ Risk factors were treated as absent in the presence of missing data for calculating the FRS.

Statistical Analysis

Continuous variables are presented as mean (standard deviation) or as median (interquartile range, Q1, Q3). Discrete data are presented as frequencies and percentages. We classified the patients into 3 groups based on the date of PCI for the statistical analysis of trends. The first group included patients who underwent PCI from 1994 to 1999, the second group included PCI from 2000 to 2005, and the third group included PCI from 2006 to 2010. Analysis of variance with a linear contrast analysis was used to assess the

trend of continuous variables, and the Cochran-Armitage trend test was used for comparison of proportions both overall and within sex subgroups. Statistical analysis was performed with SAS version 9.2 (SAS Institute Inc., Cary, NC). All hypothesis tests were 2-tailed with a significance level of 0.05.

Results

Between 1994 and 2010, a total of 12,055 patients (mean age, 65.0 ± 12.4 years; 67% male) without a prior history of CVD underwent PCI at the Mayo Clinic in Rochester, Minnesota. Clinical characteristics and trends of the FRS and its components are presented in Table 1 and Table 2.

Trends in Cardiovascular Risk Factors

Over time there was a slight but significant increase in age but no change in sex distribution. Despite the significantly higher prevalence of hypertension, hypercholesterolemia, and DM, patients in the contemporary era have a significantly lower FRS and associated 10-year CVD risk compared with 17 years ago (7.3 ± 3.2 vs 6.5 ± 3.3 , P for trend <0.001). Average BMI, not included in the FRS, increased considerably in the entire patient group (29.0 ± 5.2 to 30.1 ± 6.2 kg/m², P for trend <0.001). The trend of increasing BMI also was seen in both men and women over time (29.0 ± 4.8 to 30.3 ± 5.7 kg/m², P for trend <0.001 ; and 29.1 ± 6.0 to 29.7 ± 7.0 kg/m², P for trend = 0.017, respectively).

The prevalence of current smoking did not differ between time points. Sex-specific results did not differ, except for the prevalence of DM and the serum HDL-C. In females, in contrast to men, no increase in DM and no change in HDL-C were found over time. The most pronounced overall changes were observed with BP. Systolic BP was on average 15.7 mm Hg higher on admission in 1994 than in the contemporary era (137.5 mm Hg in 1994–1999 vs 121.8 mm Hg in 2006–2010, P for trend <0.001). There was also a significant and relevant decline in TC and low-density lipoprotein cholesterol (LDL-C) over time (P for trend <0.001 ; Tables 1 and 2, Figures 1 and 2).

Trends in Cardiovascular Medications

The use of all pharmaceutical therapies at baseline and on discharge significantly increased over time in both men and women (all P for trend <0.001). Over this period, the use of ASA, β -blockers, ACEIs, and lipid-lowering drugs at the time of admission increased by 17.0, 9.0, 23.0, and 37.0 percentage points, respectively, from 1994–1999 to 2006–2010 (all P for trend <0.001). Similarly, the use of ASA, β -blockers, ACEIs, and lipid-lowering drugs on discharge increased by 4.0, 17.0, 32.0, and 50.0 percentage points, respectively, from 1994–1999 to 2006–2010 (all P for trend <0.001). The use of lipid-lowering drugs, particularly, showed an increase: At baseline, they increased by 37.0%, from 18.0% in 1994–1999 to 55.0% in 2006–2010; and on discharge, they increased by 50.0%, from 40.0% in 1994–1999 to 90.0% in 2006–2010 (all P for trend <0.001). This trend also was seen in both men

Table 1. Trend of FRS and Its Component by Sex and Era

Characteristic ^a	Overall, N = 12,055	Group			Relative Change, Difference, %	P Value for Trend ^b
		1994–1999, n = 4,014	2000–2005, n = 4,591	2006–2010, n = 3,450		
Overall						
FRS	7.0 (3.3)	7.3 (3.2)	7.1 (3.3)	6.5 (3.3)	−0.8	<0.001
10-year CVD risk, %	11.0 (7.0, 15.0)	11.0 (8.0, 17.0)	11.0 (7.0, 18.0)	9.0 (7.0, 14.0)	−2.0	<0.001
Age, y	65.0 (12.4)	64.4 (11.9)	65.4 (12.5)	65.2 (12.7)	0.8	0.004
Male sex	8, 125 (67.0)	2, 726 (68.0)	3, 078 (67.0)	2, 321 (67.0)	−1.0	0.540
SBP, mm Hg	128.5 (22.2)	137.5 (22.2)	130.8 (22.5)	121.8 (19.7)	−15.7	<0.001
DBP, mm Hg	71.2 (13.6)	76.2 (12.9)	71.6 (13.7)	68.6 (13.2)	−7.6	<0.001
Hypertension	7, 502 (65.0)	2, 173 (56.0)	2, 933 (68.0)	2, 396 (73.0)	17.0	<0.001
LDL-C, mg/dL	112.3 (38.3)	124.4 (37.4)	110.0 (37.4)	104.5 (37.5)	−19.9	<0.001
TC, mg/dL	185.9 (46.0)	198.7 (43.0)	183.8 (43.0)	177.3 (49.6)	−21.4	<0.001
HDL-C, mg/dL	44.4 (13.1)	43.3 (12.4)	44.8 (12.9)	44.7 (13.9)	1.4	<0.001
DM	2, 391 (20.0)	706 (18.0)	953 (21.0)	732 (21.0)	3.0	<0.001
Current smoker	2, 675 (22.0)	829 (23.0)	967 (21.0)	779 (23.0)	0.0	0.490
Ever smoker	7, 319 (61.0)	2, 498 (62.0)	2, 761 (60.0)	2, 060 (60.0)	−2.0	0.023
Men						
FRS	6.2 (2.6)	6.3 (2.6)	6.3 (2.7)	5.9 (2.5)	−0.4	<0.001
10-year CVD risk, %	11.0 (7.0, 18.0)	11 (9.0, 18.0)	11. (7.0, 18.0)	11.0 (7.0, 14.0)	0.0	<0.001
Age, y	65.3 (11.8)	62.6 (11.6)	63.3 (12.0)	63.2 (12.1)	0.6	0.047
SBP, mm Hg	128.1 (21.4)	136.0 (21.1)	130.4 (21.8)	121.8 (19.2)	−14.2	<0.001
DBP, mm Hg	72.7 (13.2)	77.2 (12.7)	72.7 (13.5)	70.6 (12.7)	−6.6	<0.001
Hypertension	4, 705 (61.0)	1, 347 (51.0)	1, 827 (64.0)	1, 531 (70.0)	19.0	<0.001
LDL-C, mg/dL	111.8 (37.2)	122.5 (35.4)	110.1 (36.8)	104.2 (37.0)	−18.3	0.003
TC, mg/dL	182.9 (45.3)	193.9 (40.4)	181.2 (42.0)	174.9 (51.3)	−19.0	<0.001
HDL-C, mg/dL	41.9 (11.6)	41.0 (10.8)	42.4 (11.5)	42.1 (12.5)	0.9	<0.001
DM	1, 481 (18.0)	414 (15.0)	596 (19.0)	471 (20.0)	5.0	<0.001
Current smoker	1, 940 (24.0)	669 (25.0)	703 (23.0)	568 (24.0)	−1.0	0.890
Ever smoker	5, 486 (68.0)	1, 896 (70.0)	2, 069 (67.0)	1, 522 (66.0)	−4.0	0.003
Women						
FRS	8.6 (3.9)	9.4 (3.4)	8.7 (4.0)	7.7 (4.1)	−1.7	<0.001
10-year CVD risk, %	8.0 (6.0, 13.0)	9.0 (8.0, 15.0)	8.0 (6.0, 13.0)	8.0 (5.0, 11.0)	−1.0	<0.001
Age, y	69.1 (12.3)	68.4 (11.5)	69.5 (12.4)	69.4 (13.0)	1.0	0.038
SBP, mm Hg	129.4 (23.8)	140.8 (24.3)	131.6 (23.9)	122.0 (20.9)	−18.8	<0.001
DBP, mm Hg	68.1 (14.0)	73.9 (13.2)	69.3 (13.9)	64.4 (13.3)	−9.5	<0.001
Hypertension	2, 797 (74.0)	826 (65.0)	1, 106 (77.0)	865 (81.0)	16.0	<0.001
LDL-C, mg/dL	113.4 (40.5)	128.9 (41.5)	109.9 (38.8)	105.3 (38.6)	−23.6	<0.001

Table 1. Continued

Characteristic ^a	Overall, N = 12,055	Group			Relative Change, Difference, %	P Value for Trend ^b
		1994–1999, n = 4,014	2000–2005, n = 4,591	2006–2010, n = 3,450		
TC, mg/dL	192.6 (46.7)	210.3 (46.8)	189.3 (44.6)	182.4 (45.2)	−27.9	<0.001
HDL-C, mg/dL	49.2 (14.5)	48.9 (14.1)	50.0 (14.3)	50.2 (15.2)	1.3	0.063
DM	910 (23.0)	292 (23.0)	357 (24.0)	261 (23.0)	0.0	0.800
Current smoker	735 (19.0)	260 (20.0)	264 (17.0)	211 (19.0)	−1.0	0.310
Ever smoker	1,833 (47.0)	603 (47.0)	692 (46.0)	538 (48.0)	1.0	0.710

Abbreviations: CVD, cardiovascular disease; DBP, diastolic blood pressure; DM, diabetes mellitus; FRS, Framingham risk score; HDL-C, high-density lipoprotein cholesterol; IQR, interquartile range; LDL-C, low-density lipoprotein cholesterol; Q, quartile; SBP, systolic blood pressure; TC, total cholesterol. ^aValues are presented as no. of patients (%), or median (IQR Q1, Q3). ^bLinear regression analysis was used to assess the trend of continuous variables, and the Cochran-Armitage trend test was used for comparison of proportions.

Table 2. Trend of Other CHD Risk Factors by Sex and Era

Characteristic ^a	Overall, N = 12,055	Group			Relative Change, Difference, %	P Value for Trend ^b
		1994–1999, n = 4,014	2000–2005, n = 4,591	2006–2010, n = 3,450		
Overall						
BMI, kg/m ²	29.6 (5.7)	29.0 (5.2)	29.6 (5.8)	30.1 (6.2)	1.1	<0.001
History of hypercholesterolemia	7,162 (67.0)	1,871 (54.0)	2,992 (75.0)	2,299 (73.0)	19.0	<0.001
Men						
BMI, kg/m ²	29.6 (5.3)	29.0 (4.8)	29.7 (5.3)	30.3 (5.7)	0.9	<0.001
History of hypercholesterolemia	4,657 (65.0)	1,162 (49.0)	1,960 (74.0)	1,535 (73.0)	24.0	
Women						
BMI, kg/m ²	29.4 (6.5)	29.1 (6.0)	29.4 (6.6)	29.7 (7.0)	0.6	0.017
History of hypercholesterolemia ^c	2,505 (72.0)	709 (64.0)	1,032 (78.0)	764 (74.0)	10.0	<0.001
Abbreviations: BMI, body mass index; CHD, coronary heart disease; TC, total cholesterol.						
^a Values are presented as no. of patients (%). ^b Linear regression analysis was used to assess the trend of continuous variables, and the Cochran-Armitage trend test was used for comparison of proportions. ^c Hypercholesterolemia was defined as TC ≥240 mg/dL.						

and women over time. Overall, there was a significant and relevant change in the use of cardiovascular drugs over time, already in the primary-prevention setting and irrespective of gender (Table 3).

Discussion

In this large single-center registry study, which also includes the contemporary era, we report temporal trends in cvRF over the past 17 years in patients undergoing PCI without prior CVD. The current study demonstrated that although the calculated cardiovascular risk as assessed by the FRS (10-year CVD risk) declined, the prevalence of traditional cvRF, including BMI, increased over time. With the shift in demographics and the high prevalence of risk factors not included in the FRS, the current study suggests that a novel risk-factor profile assessment may be needed for risk stratification of patients undergoing PCI.

Trends in Cardiovascular Risk Factors and Framingham Risk Score

There is an apparent discrepancy between the prevalence and the quantification of the risk factors contributing to the FRS. This may be explained in part by the decrease in actual BP and lower cholesterol levels, both integral parts of the FRS. Indeed, it is likely that in the last several years the integration of primary prevention strategies and lifestyle modifications has improved considerably.^{6,8} Thus, the observed decrease in FRS in our study might reflect improved risk management, which is also reflected by the increase in the use of cardiovascular medications prior to admission, statins in particular. On the other side, ever-stricter definitions of arterial hypertension and dyslipidemia⁶ might have increased the prevalence of these risk factors over time. Additionally, the definition of the presence of hypertension used in the current study (a documented history of hypertension or taking antihypertensives) may account for the high prevalence. It may also represent an increase in awareness of disease due

Figure 1. Trend of the Framingham Risk Score (top) and 10-year CVD risk (bottom) in patients undergoing PCI from 1994 to 2010 without prior history of coronary artery disease. Abbreviations: CVD, cardiovascular disease; PCI, percutaneous coronary intervention.

to change in policies or diagnostic methods. In this way, increased risk-factor awareness could result in decreased FRS as risk factors are detected and treated earlier. However, other epidemiological studies in various settings also showed similar results on the higher prevalence of both risk factors.^{5,9–12}

In our study, 2 findings were particularly remarkable: the decline in the BP level and the decline in LDL-C level (and

the increase in HDL-C level), despite the higher prevalence of hypertension and dyslipidemia, respectively. Both might reflect adherence to lifestyle modifications and guidelines for treatment already at the primary-prevention level. Blood pressure declined particularly at 2 critical points in 1997 and 2003, which may coincide with guidelines released in 1997 and updated in 2003.^{8,9,13} Nevertheless, the decline in BP and LDL-C levels also could be attributed to the development

Figure 2. Trends for the components of the Framingham Risk Score among patients undergoing PCI from 1994 to 2010 without prior history of coronary artery disease. (A) Mean age, SBP, and DBP. (B) Lipid profile including TC, LDL-C, and HDL-C. (C) Presence of hypertension history, DM prevalence, and rate of current smoking. Abbreviations: DBP, diastolic blood pressure; DM, diabetes mellitus; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; PCI, percutaneous coronary intervention; SBP, systolic blood pressure; TC, total cholesterol.

of optimal medical treatments for the management of these risk factors.

Unfortunately, our study confirms a significant trend toward increase in overweight and obesity, and the associated higher prevalence of DM.^{5,11,14,15} There has been a marked increase in overweight and obesity in

the United States over the past 25 years,^{1,2} with the prevalence of obesity among adults age 20 to 74 years rising from 13% to 31%.¹⁴ The prevalence of DM has increased concomitantly.¹¹ Thus, it is conceivable that a new, alternative risk-factor profile assessment should take this trend into account.

Figure 2. Continued.

Furthermore, in the last decade there has been growing evidence of the effect of smoking and smoking cessation on cardiovascular health.^{16,17} Despite the efforts to ban smoking from almost any public spaces¹⁸ and the awareness of the importance of smoking cessation, the prevalence of current smokers referred to a PCI did not change over time. Our finding may only at first glance contrast with epidemiological and clinical studies demonstrating lower smoking rates.^{1,5,11,14,19} However, the current study does not represent the prevalence of smoking in the general population, but rather in patients referred for coronary intervention, underscoring the significant contribution of smoking to coronary artery disease.

The FRS does not take into account whether a patient has been diagnosed with hypertension or dyslipidemia, but rather the current BP and lipid values. Whether adequately treated persons with a diagnosis of hypertension have the same prognosis as healthy persons with the same BP is uncertain. Furthermore, although there might be a greater awareness of the importance of prevention and more adequate interventions are performed nowadays compared with 17 years ago, a high burden of CVD with its morbidity

and mortality still remains. Therefore, it may be speculated that alternative ways to better identify patients at risk may be needed. The current study may suggest that future risk assessment should incorporate more markers of disease, such as physiologic measures like endothelial function and carotid intima-media thickness,^{20,21} both surrogates for atherosclerotic disease,²² and also markers of body weight, either BMI or central adiposity. This approach might increase the likelihood of better identifying patients at risk in the future; however, studies in this respect are needed.

Trends in Cardiovascular Medications

Another interesting aspect of our study is the use of cardiovascular medications over time. As expected, the use of statins and ASA significantly increased over time.²³ However, β -blocker use declined after 2005, as well as the use of ACEIs in women. These results may be due to the discouraged use of β -blockers in hypertension^{24,25} and the replacement of ACEIs by angiotensin receptor blockers.^{26,27} Except for the use of ACEIs, the prevalence of drug types used at baseline in 1994–1999 was similar as observed by other authors.²³

Table 3. Trend of Pharmaceutical Therapies by Sex and Era

Characteristic ^a	Overall, N = 12,055	Group			Relative Change, %	P Value for Trend ^b
		1994–1999, n = 4,014	2000–2005, n = 4,591	2006–2010, n = 3,450		
Overall						
ASA at baseline ^c	10, 245 (86.0)	3, 122 (78.0)	3, 868 (86.0)	3, 255 (95.0)	17.0	<0.001
β-Blocker at baseline	8, 898 (68.0)	2, 451 (61.0)	3, 226 (71.0)	2, 421 (70.0)	9.0	<0.001
ACEI at baseline	3, 293 (27.0)	538 (15.0)	1, 405 (31.0)	1, 305 (38.0)	23.0	<0.001
Lipid-lowering drug at baseline	4, 420 (37.0)	710 (18.0)	1, 817 (41.0)	1, 893 (55.0)	37.0	<0.001
ASA on discharge	11, 353 (95.0)	3, 724 (94.0)	4, 312 (95.0)	3, 317 (98.0)	4.0	<0.001
β-Blocker on discharge	9, 219 (78.0)	2, 692 (68.0)	3, 648 (81.0)	2, 878 (85.0)	17.0	<0.001
ACEI on discharge	5, 380 (45.0)	996 (25.0)	2, 444 (54.0)	1, 940 (57.0)	32.0	<0.001
Lipid-lowering drug on discharge	8, 296 (70.0)	1, 595 (40.0)	3, 637 (81.0)	3, 064 (90.0)	50.0	<0.001
Males						
ASA at baseline	6, 916 (86.0)	2, 110 (78.0)	2, 065 (86.0)	2, 201 (95.0)	17.0	<0.001
β-Blocker at baseline	5, 382 (67.0)	1, 629 (60.0)	2, 139 (70.0)	1, 614 (70.0)	10.0	<0.001
ACEI at baseline	2, 099 (26.0)	381 (14.0)	874 (29.0)	844 (36.0)	10.0	<0.001
Lipid-lowering drug at baseline	2, 927 (36.0)	454 (17.0)	1, 210 (40.0)	1, 263 (54.0)	37.0	<0.001
ASA on discharge	7, 712 (96.0)	2, 555 (95.0)	2, 918 (96.0)	2, 239 (98.0)	3.0	<0.001
β-Blocker on discharge	6, 201 (77.0)	1, 820 (67.0)	2, 445 (80.0)	1, 936 (85.0)	18.0	<0.001
ACEI on discharge	3, 536 (44.0)	655 (24.0)	1, 596 (52.0)	1, 317 (58.0)	34.0	<0.001
Lipid-lowering drug on discharge	5, 619 (70.0)	1, 072 (40.0)	2, 477 (82.0)	2, 070 (90.0)	50.0	<0.001
Females						
ASA at baseline	3, 329 (86.0)	1, 012 (79.0)	1, 263 (85.0)	1, 054 (94.0)	15.0	<0.001
β-Blocker at baseline	2, 716 (70.0)	822 (64.0)	1, 087 (73.0)	807 (72.0)	8.0	<0.001
ACEI at baseline	1, 194 (31.0)	202 (16.0)	531 (36.0)	461 (41.0)	25.0	<0.001
Lipid-lowering drug at baseline	1, 493 (39.0)	256 (20.0)	607 (41.0)	630 (56.0)	36.0	<0.001
ASA on discharge	3, 614 (94.0)	1, 169 (92.0)	1, 394 (94.0)	1, 078 (97.0)	5.0	<0.001
β-Blocker on discharge	3, 018 (78.0)	873 (69.0)	1, 203 (81.0)	942 (85.0)	16.0	<0.001
ACEI on discharge	1, 812 (47.0)	341 (27.0)	848 (57.0)	623 (56.0)	29.0	<0.001
Lipid-lowering drug on discharge	2, 677 (69.0)	523 (41.0)	1, 160 (78.0)	994 (89.0)	48.0	<0.001
Abbreviations: ACEI, angiotensin-converting enzyme inhibitor; ASA, aspirin; PCI, percutaneous coronary intervention.						
^a Values are presented as no. of patients (%). ^b The Cochran-Armitage trend test was used for comparison of proportions. ^c Baseline means that the medication was used at some point within 3 days prior to PCI.						

Study Strengths and Limitations

This study demonstrates in a very large registry of patients without prior CVD that despite a reduction in cardiovascular risk as assessed by the FRS and 10-year CVD risk, the overall incidence of cvRF has remained high over the last 17 years. The decrease in FRS was driven mainly by better cholesterol and BP values over time. The current study suggests a need for a novel risk-factor assessment that takes into account the changes in risk factors over time. Whether these changes

are relevant for future risk-stratification models has to be assessed in additional studies performed under different clinical settings.

Several limitations of our study should be taken into account. This study is a retrospective analysis from a single institution, which might limit its broad application and generalization, but it represents a very extensive population analysis of temporal trends of cvRF in PCI patients over time. The study may be limited by the lack of clinical

characteristics and outcomes, atypical risk factors, genetic factors, and related environmental factors, such as diet. Furthermore, the study was limited to hospitalized PCI patients and may be influenced by selection bias, because the patients referred to tertiary centers may be a selected group, perhaps with more severe cases of coronary heart disease.

Conclusion

Because the FRS assesses risk in the general population, patients who have undergone PCI will exhibit an inherently higher risk score than the general population. Changing thresholds for PCI also may affect the observation. Therefore, our findings should be extended and further examined in different populations and geographic settings.

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