Traditional SCORE-based health check fails to identify individuals who develop acute myocardial infarction

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ABSTRACT

INTRODUCTION: Atherosclerotic cardiovascular disease (CVD), including acute myocardial infarction (AMI), is caused by well-known risk factors. They constitute important therapeutic targets, but their predictive value is disputed. We evaluated the effectiveness of the risk scoring system (SCORE) and thresholds for pharmacotherapy recommended in the European guidelines on CVD prevention.

MATERIAL AND METHODS: The medical records of 605 consecutive patients hospitalized for a first AMI were reviewed. Patients with pre-existing CVD, diabetes, or incomplete information on risk factors were excluded. Those not treated with statin before AMI were risk stratified based on risk factors. A SCORE ≥ 5% or ≥ 10% was considered to qualify for preventive medication in young adults (age ≤ 60 years) or elderly (age > 60 years), respectively.

RESULTS: Before AMI, 40 (9%) used statin. Among non-statin users, only five of the 109 young adults had a SCORE ≥ 5%, and 23 of the 284 elderly had a SCORE ≥ 10%. Among women, only three elderly qualified for treatment. More than four times more patients would have qualified for treatment with the high-risk country chart used in 2011. The incremental value of the novel high-density lipoprotein adjusted SCORE charts was limited.

CONCLUSION: Few patients admitted with a first AMI used statin. Among non-statin users, SCORE and the recommended thresholds for pharmacotherapy identified no women and less than one out of ten men who untreated were destined for an AMI before 61 years of age. The preventive potential of a traditional risk factor-based health check is limited.

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Atherothrombotic cardiovascular disease (CVD), including acute myocardial infarction (AMI), is an important cause of premature death, chronic disability, and escalating healthcare costs. The only way to limit this unfortunate development is to prevent this disease from developing in the first place – i.e., primary prevention.

Atherothrombotic CVD is caused by well-known risk factors of which many are modifiable, such as elevated plasma cholesterol and blood pressure, smoking, physical inactivity and diabetes. It is generally believed that these risk factors can be used to find those at high risk of developing the disease, which is why many medical organizations and societies, including the National Health Service (NHS) in England [1], the Danish Heart Foundation (DHF) [2] and the Copenhagen Consensus Centre (CCC) [3], recommend systematic health checks to all aged 40-74 years (NHS) or 30-49 years (DHF and CCC) to identify those who need personalized prevention.

The purpose of this study was to evaluate the effectiveness of such a high-risk strategy. We simply asked the question: How many of those admitted to hospital with a first atherosclerotic event (AMI) would have met the guideline-recommended criteria for effective prevention, including risk-reducing medication, if they had completed a traditional health check the day before the event?

MATERIAL AND METHODS

We reviewed the medical records of all patients admitted with an AMI during 2011 to three hospitals in Denmark (Aarhus University Hospital and the Regional Hospitals in Randers and Herning). Among the 605 patients presenting with a first AMI, we excluded those with pre-existing CVD (n = 48), diabetes (n = 92), or incomplete information on risk factors (n = 32). In the remaining 433 patients, we extracted information on traditional risk factors (age, sex, smoking status, cholesterol, and systolic blood pressure (SBP)) and use of risk-reducing medication. Those who had not smoked within the past two years were categorized as non-smokers. Plasma lipid values were accepted if obtained within 24 hours after admission. The blood pressure used for risk estimation was obtained prior to admission (if hospitalized previous year) or after recovery from AMI (before hospital discharge or at first visit to the rehabilitation clinic). Hypertension was defined as SBP >140 mmHg and/or use of antihypertensive agents at admission.

The risk of developing CVD was estimated from the guideline-recommended SCORE (Systematic COronary Risk Evaluation) risk charts based on knowledge about a person's age, sex, smoking status, total cholesterol and SBP [4]. To evaluate the impact of changing the risk status of a European country, we estimated the CVD risk

ORIGINAL ARTICLE

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TABLE 1

Study population: non-statin users hospitalized with a first myocardial infarction.

	All			Male			Female		
	≤ 60 years	> 60 years	total	≤ 60 years	> 60 years	total	≤ 60 years	> 60 years	total
n (%)	109	284	393	74	169	243 (62)	35	115	150 (38)
Age, yrs	–	–	68.6 (± 14.1)	–	–	67.2 (13.8)	–	–	70.8 (14.3)
Total cholesterol conc.[a], mmol/l	–	–	5.2 (± 1.1)	–	–	5.1 (± 1.0)	–	–	5.4 (± 1.2)
LDL-cholesterol conc.[a], mmol/l	–	–	3.2 (± 0.9)	–	–	3.1 (± 9.0)	–	–	3.2 (± 1.0)
HDL-cholesterol conc.[a], mmol/l	–	–	1.3 (± 0.4)	–	–	1.2 (± 0.4)	–	–	1.5 (± 0.5)
Triglyceride conc.[a], mmol/l	–	–	1.5 (± 0.9)	–	–	1.5 (± 1.0)	–	–	1.4 (± 0.8)
Current smoker, %	–	–	40.3	–	–	40.6	–	–	39.7
Hypertension, %	–	–	48.4	–	–	46.3	–	–	51.7
Systolic blood pressure[a], mmHg	–	–	137.6 (± 19.8)			137.2 (± 19.0)	–		138.3 (± 21.4)
Low-risk country charts									
Standard SCORE ≥ 5%, n (%)	5 (5)	120 (42)	–	5 (7)	99 (59)	–	0 (0)	21 (18)	–
Standard SCORE ≥ 10%, n (%)	0 (0)	23 (8)	–	0 (0)	21 (12)	–	0 (0)	2 (2)	–
HDL-adjusted SCORE ≥ 5%, n (%)	5 (5)	130 (46)	–	5 (7)	106 (63)	–	0 (0)	24 (21)	–
HDL-adjusted SCORE ≥ 10%, n (%)	0 (0)	24 (8)	–	0 (0)	22 (13)	–	0 (0)	2 (2)	–
High-risk country charts			–			–		–	
Standard SCORE ≥ 5%, n (%)	30 (28)	223 (79)	–	29 (39)	157 (93)	–	1 (3)	66 (57)	–
Standard SCORE ≥ 10%, n (%)	4 (4)	86 (30)	–	4 (5)	76 (45)	–	0 (0)	10 (9)	–
HDL-adjusted SCORE ≥ 5%, n (%)	31 (28)	237 (83)	–	31 (42)	165 (98)	–	0 (0)	72 (63)	–
HDL-adjusted SCORE ≥ 10%, n (%)	5 (5)	99 (35)	–	5 (7)	76 (45)	–	0 (0)	22 (19)	–

HDL = high-density lipoprotein; LDL = low-density lipoprotein; SCORE = Systematic COronary Risk Evaluation.
a) Mean (± standard deviation).

using both the high-risk and the low-risk SCORE charts provided in the guidelines [4, 5, 6]. We also evaluated the performance of the newly developed high-density lipoprotein (HDL)-adjusted risk charts. Statistical analysis was performed with Fisher's exact test and Student's t-test. Continuous variables are presented as mean (± standard deviation).

Trial registration: not relevant.

RESULTS

Among the 433 AMI patients who remained after excluding those with pre-existing CVD, diabetes and incomplete risk factor information, 40 patients (9%) used statins before the acute event. Among young adults (age ≤ 60 years, n = 115), only six (5%) used statin. The 393 non-statin users with a first AMI constitute the study population (**Table 1**).

Plasma cholesterol

Mean values are shown in Table 1. Plasma total cholesterol was < 5 mmol/l in 41% of the patients, low-density lipoprotein (LDL) cholesterol was < 3 mmol/l and HDL cholesterol was > 1 mmol/l in 39% and 72% of the patients, respectively. Two patients, a man aged 47 and a woman aged 61, had total cholesterol > 8 mmol/l.

In 181 patients, the general practitioner had measured total cholesterol within the previous two years. The mean value was 5.48 mmol/l before hospitalization, compared with 5.18 mmol/l after hospitalization (i.e., 5% lower the first day of AMI).

Blood pressure

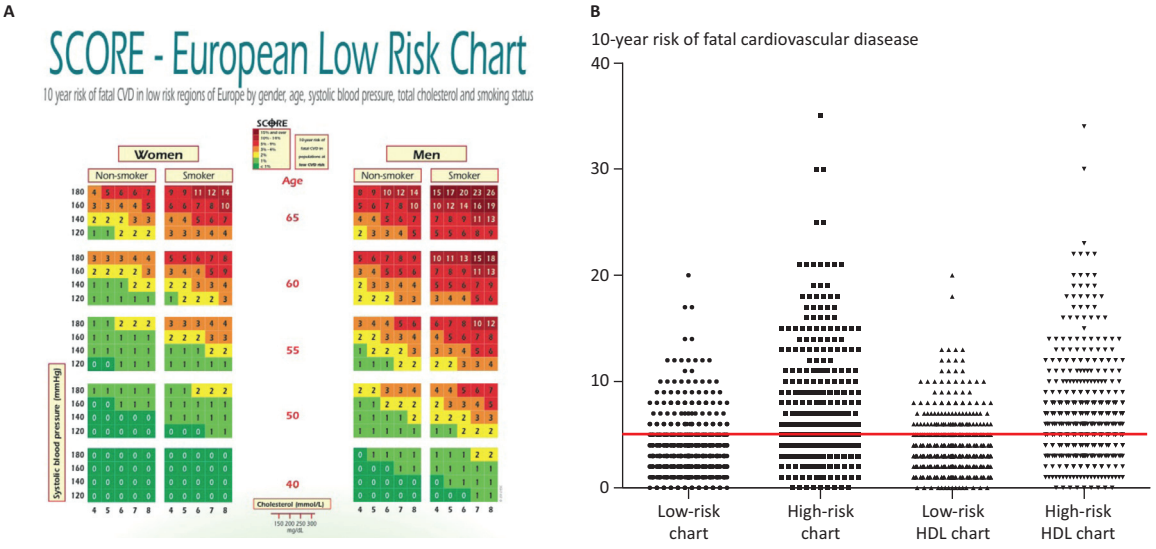
Mean SBP was 138 mmHg (Table 1) and did not differ between those in whom it was obtained before (139 mmHg; n = 103) or after (137 mmHg; n = 290) the acute event (p = 0.31). It was also similar in the 60 patients in whom it was measured both before AMI and before hospital discharge (138 versus 134 mmHg; p = 0.22). The same applied to the 39 patients in whom it was measured both before AMI and at rehabilitation (141 versus 142 mmHg, p = 0.78).

Risk assessment

The SCORE risks are shown in Table 1. Using standard SCORE charts, significantly more patients passed the 5% high-risk threshold with the high-risk country chart compared with the low-risk country chart (64% versus 32%, p < 0.0001) (**Figure 1**). A similar result was obtained with the HDL-adjusted risk charts (68% versus 34%, p < 0.0001).

Figure 2 shows the same data for young adults and the elderly separately. With the SCORE charts created for use in low-risk European countries (Denmark 2012), less than 5% of young adults hospitalized for a first AMI qualified for drug treatment before the event, compared

FIGURE 1



SCORE risk in study population. **A.** SCORE chart for use in low-risk European countries. **B.** Plots showing the ten-year risk of fatal atherosclerotic cardiovascular disease determined from standard or high-density lipoprotein-adjusted SCORE charts developed for use in low-risk and high-risk European countries. Red line indicates the high-risk threshold (SCORE 5%).

with 28% ($p < 0.0001$) with the SCORE chart created for use in high-risk European countries (Denmark 2011). Similar results were obtained with the HDL-adjusted risk charts.

Figure 3 shows how many passed the guideline-recommended age-dependent threshold (SCORE 5% in adults ≤ 60, SCORE 10% in those > 60) above which drug treatment should be considered. Very few passed this threshold (less than 5% in adults ≤ 60 years of age, 8% in those older than 60). Thus, more than nine out of ten would not have qualified for preventive medication if they had completed a traditional health check before the event. Similar results were obtained with the HDL-adjusted risk charts (overall, 7% versus 7%, $p = 1.0$).

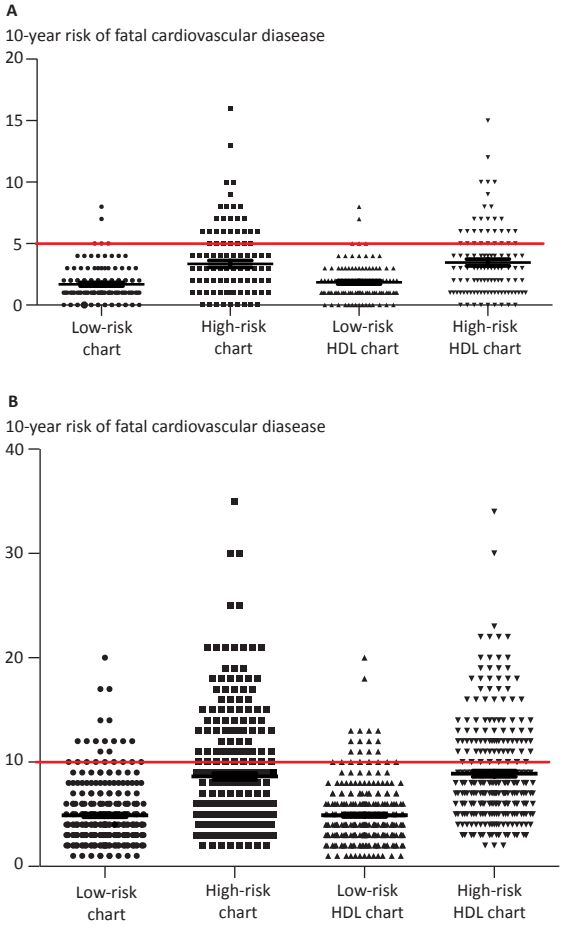
Among women, no younger and only three older than 60 years (two with SCORE ≥ 10% and one with total cholesterol > 8 mmol/l) passed the guideline-recommended thresholds above which drug treatment should be considered (Table 1).

Sensitivity analysis

To assess the robustness of our results, we reassessed the risk after increasing both total cholesterol with 5% and SBP with 5 mmHg for each patient. A total of eight young adults (all men; versus five before) and 27 elderly (versus 23 before) passed the guideline-recommended thresholds for pharmacotherapy (overall 9% versus 7% before) using the low-risk SCORE chart.

The major determinants of risk (age, sex and smoking status) do not change with hospitalization, but using age at admission tends to overestimate risk systematically.

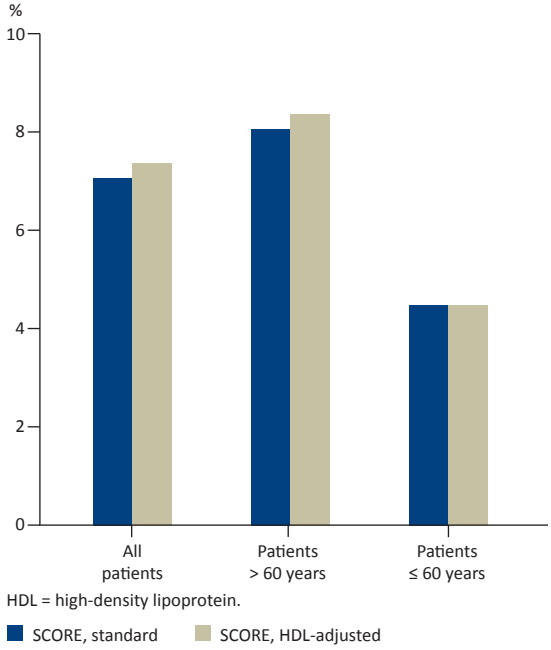
FIGURE 2



SCORE risk in young adults (≤ 60 years of age) (**A**) and the elderly (> 60 years of age) (**B**). These risk data are similar to those in Figure 1, but presented separately for young adults (n = 109) and the elderly (n = 284). In 2011, Denmark was defined as a high-risk country, in 2012 as a low-risk country. *Red lines* indicate the guideline-recommended age-dependent thresholds above which drug treatment should be considered.

FIGURE 3

Qualification for pharmacological prevention. Percentage of all patients, young adults (age ≤ 60) and elderly (age > 60) who passed the guideline-recommended age-dependent threshold (SCORE 5% in young adults, SCORE 10% in elderly) above which pharmacological intervention should be considered in a European low-risk country, such as Denmark.



DISCUSSION

Our findings indicate that very few patients hospitalized with a first AMI would have qualified for guideline-recommended risk-reducing medication if they had completed a traditional health check the day before the event. In patients ≤ 60 years of age (n = 115), only six (5%) used statins and less than 5% of non-statin users passed the high-risk threshold defined by SCORE [4]. This poor performance of SCORE is partly explained by the recent reclassification of Denmark from a high-risk to a low-risk country. The consequence of this is that many of those who previously qualified for intensive preventive treatment no longer do so. Thus, the recommended use of statin in the primary prevention of CVD has been dramatically restricted in Denmark with the new guidelines introduced in 2012 [4].

Age-adjusted thresholds for pharmacological prevention

The new guidelines define a SCORE ≥ 5% and < 10% as "high risk", and a SCORE ≥ 10% as "very high risk" [4]. Because the effect of individualized non-pharmacological lifestyle intervention is questionable [7, 8], the action thresholds for treatment with risk-reducing medications are important. They are, however, floating and less clearly defined in the following way: "In general, those with a risk of CVD death of ≥ 5% qualify for intensive advice, and may benefit from drug treatment. At risk levels > 10%, drug treatment is more frequently required. In persons older than 60, these thresholds should be interpreted more leniently, because their age-specific risk is normally around these levels, even when other cardiovascular risk factor levels are ''normal'' [4]. Thus, if SCORE is < 5%, drug is rarely indicated in adults below 60 unless in the presence of CVD, diabetes, chronic kidney disease, severe hypertension or familial dyslipidemia. Above 60, the no-action threshold approaches 10% [4]. With the 2012 version of the guidelines, very few young adults (< 5%) who untreated are destined for an AMI before 60 years of age will be offered effective pharmacological prevention (Table 1). The same is true for those above 60 (8%), if the threshold for intensive prevention is elevated from 5% to 10% in the elderly.

Recalibration of SCORE: unforeseen consequences?

SCORE was developed from mortality data with the purpose of creating a uniform European CVD risk scoring system that could be recalibrated for use in all European countries [9]. A not discussed and probably unintended and unforeseen consequence is that with declining mortality, the SCORE risk charts are recalibrated as if the need for primary prevention is no longer so important (lower priority), regardless of morbidity and costs associated with CVD. Owing to improved survival, many patients are now living longer with a chronic, potentially disabling and costly CVD [10, 11]. This paradoxical effect of using the mortality-based SCORE risk charts in the primary prevention of CVD is illustrated by our data. With the high-risk country chart recommended for use in 2011, the 5% action threshold identified 28% of those young adults who developed a first AMI, declining to less that 5% with the low-risk country chart now in use [4]. Consequently, fewer of those who really need it will now qualify for effective pharmacological prevention, because the disease is no longer so deadly, but "just" potentially disabling and costly. This unfortunate development, which Denmark shares with many other European countries [4], coincides with the markedly improved availability of inexpensive, cost-saving, effective and safe risk-reducing generic drugs [12, 13] – a development opposite that seen in countries using risk scoring not based on mortality alone [14, 15]. It is time to reconsider the wisdom in using mortality as the gold standard for the intensity of the preventive care offered by many European countries.

High-density lipoprotein-adjusted SCORE charts

In the updated 2012 version of the European guidelines on CVD prevention, the role of HDL cholesterol in risk

estimation was systematically re-examined [4]. It was concluded that HDL cholesterol can contribute substantially to risk estimation if entered as an independent variable [4]. Our data indicate that the ability of SCORE to secure effective pharmacological prevention to those at risk of a near-term AMI is not improved substantially by the new HDL-adjusted risk charts, with the possible exception of elderly women in high-risk countries (Table 1).

Beyond SCORE

Among non-statin users with a first AMI, total and LDL cholesterol levels were similar to or below those of the general population (total cholesterol: 5.2 versus 5.5 mmol/l; LDL cholesterol: 3.2 versus 3.3 mmol/l) [16]. This may appear surprising, but similar observations have been reported before [17] and they illustrate the limited predictive power of a major risk factor (cholesterol) that, nevertheless, constitutes an important therapeutic target in preventive medicine.

Nearly half (46%) of the study population had their cholesterol checked by their general practitioner within two years before admission. This documents the central position of general practitioners in the primary prevention of CVD. However, the high potential for more effective prevention is not met by focusing only on the traditional risk factors with their limited predictive power [18]. In the present study, the great majority of those destined for a near-term AMI did not pass the risk factor-based threshold for effective pharmacotherapy. Most of those hospitalized with a first AMI belonged to the intermediate risk category (SCORE ≥ 1 and < 5%) in which risk stratification can be substantially improved by assessment of subclinical (asymptomatic) atherosclerosis, such as quantification of coronary calcium by computed tomography (CT) and carotid disease by ultrasound [19]. In asymptomatic adults at moderate/intermediate risk, these non-invasive risk assessment procedures received a Class IIa recommendation in both the American [20] and the European guidelines on CVD prevention [4]. These tests for subclinical atherosclerosis can correctly reclassify a substantial number of adults in the therapeutic grey area called “intermediate risk” to lower or higher risk categories, for which indications for treatment are better defined [19].

Limitations

Firstly, plasma cholesterol is known to fall during hospitalization for AMI. However, we accepted cholesterol levels measured early after admission (within the first 24 hours), which are widely accepted to represent true baseline values [21], supported by our data demonstrating that cholesterol values measured at admission were only 5% lower than those measured previously by a general practitioner. Secondly, although the blood pressure may change during and after an AMI, our data indicate that such potential changes usually were limited in our patients. Furthermore, the sensitivity analysis demonstrates that minor changes in cholesterol and blood pressure cannot in any way affect the validity of our conclusions. Thirdly, although known to occur, underreporting of smoking cannot explain the failure of SCORE to identify those at high risk, because we used the recommended approach (self-reporting) and, furthermore, categorized all who had smoked within the past two years as smokers. Fourthly, the SCORE risk charts will underestimate the risk in adults approaching 70 years of age and older. However, we used these risk charts as recommended in the guidelines, and our purpose was to evaluate the performance of the guidelines. Finally, the use of statin was so infrequent (n = 40, 9%) that potential bias caused by statin use can be ignored. Assuming a 30% risk reduction with short-term use of statin [15], without statin we would expect only 17 more first AMI cases (40/0.7 = 57), which indicates that the current use of statin in Denmark prevents very few first AMIs (~ 4%)

CONCLUSION

Our observations seriously question the preventive effect of a traditional risk factor-based health check as recommended by many medical societies and organizations. A probably more effective approach would be to promote the clinical implementation of the Class IIa recommended use of non-invasive assessment of coronary calcium by CT and/or carotid disease by ultrasound.

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