CARDIOVASCULAR MEDICINE

Prevention of cardiovascular diseases: focus on modifiable cardiovascular risk

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Objective: To determine whether the use of a 20% absolute risk threshold for cardiovascular disease as recommended in current guidelines leads to exclusion of patients with a substantial modifiable risk ($\geq 5\%$).

Methods: Data collected within the framework of a randomised controlled trial in three primary health care centres located in deprived neighbourhoods were analysed. The 10 year absolute risk and the modifiable part of risk were calculated by using the Framingham risk equation. Among patients with a modifiable risk reduction of $\geq 5\%$ (number needed to treat ≤ 20) the characteristics and risk factors of patients with an absolute risk $\geq 20\%$ and those with an absolute risk $< 20\%$ were compared.

Results: 293 patients aged 30–70 years at risk of developing cardiovascular disease were included, of whom 66% were women and 36% were of Dutch origin. Of all patients, 33% had an absolute risk $\geq 20\%$ and 61% had a modifiable risk $\geq 5\%$. Of those at $\geq 20\%$ absolute risk, a vast majority (98%) had a modifiable risk $\geq 5\%$. Among those with an absolute risk $< 20\%$, 43% had a modifiable risk $\geq 5\%$; this group, who were relatively young and predominantly women, constituted 29% of the entire study population.

Conclusions: Targeting preventive strategies at a 10 year absolute risk $\geq 20\%$ leads to exclusion of a large group of relatively young, predominantly female patients. In total, about one quarter had an absolute risk $< 20\%$ but a modifiable risk $\geq 5\%$ and should therefore benefit from intervention.

Cardiovascular disease (CVD) is a major cause of disability and mortality in developed countries. Interventions targeted at modifiable risk factors, such as hypercholesterolaemia, hypertension, and smoking, can delay or even prevent the occurrence of CVD.^{1–3} Furthermore, multiple risk factor interventions in high risk groups are more beneficial than single risk factor interventions.⁴

The most widely used method for assessment of CVD risk is based on equations derived from the Framingham heart study, which are based on multiple risk factors.^{5–6} Whether patients are identified as being at high risk and thus should be targeted for prevention activities depends on absolute risk threshold values, which vary between different guidelines.^{7–9} These risk thresholds are based not only on the population prevalence of cardiovascular risk factors and CVD but also on the availability of health care resources.¹⁰ Similar to several Western guidelines, the Dutch guidelines for hypertension and hypercholesterolaemia recommend treatment in case of an absolute risk of CVD $\geq 20\%$.^{11–12} However, these national and international absolute risk thresholds depend largely on the non-modifiable risk factors age, sex, and diabetes mellitus. They do not take into consideration which part of the cardiovascular risk is due to modifiable risk factors to identify patients for prevention activities. We considered whether focus on this modifiable part of the absolute risk is more appropriate for identifying those at risk of developing CVD than the currently applied absolute risk thresholds. Firstly, CVD risk reduction is larger when larger reductions of the modifiable risk factors blood pressure, cholesterol, and smoking are achieved, indicating larger absolute risk reductions and a lower number needed to treat (NNT). Different trials on cholesterol lowering and antihypertensive interventions reported NNTs of about 20—that is, 20 patients need to be treated to prevent one cardiovascular event.^{13–16} This NNT corresponds to an absolute risk reduction of 5%. Secondly, the use of absolute risk thresholds in some patient groups such as women, young people, and ethnic minorities may

result in undertreatment because of a 10 year absolute risk $< 20\%$ compared with men, older people, and white or Western populations, respectively, despite large achievable absolute risk reductions.^{17–18} This problem is more likely to occur in deprived neighbourhoods because people living in these areas are at greater risk than the general population of developing CVD.¹⁹

We conducted a study in a heterogeneous patient population at high risk of developing CVD, which consisted of both men and women without a history of CVD from different ethnic groups living in deprived neighbourhoods. The objective of this study was to determine whether the use of a 20% absolute risk threshold as recommended in current guidelines leads to exclusion of patients with a substantial modifiable risk ($\geq 5\%$).

METHODS

We used data collected within the framework of a randomised controlled trial to assess the effectiveness of a structured collaboration within the general practice to reduce cardiovascular risk. Briefly, the trial population consisted of an intervention group that received intensified preventive care and a control group that received usual general practitioner care. Both groups were invited to the general practice for assessment of their cardiovascular risk profile every three months. We performed the study in three Dutch health care centres comprising five general practices situated in the deprived neighbourhoods of Rotterdam and The Hague. Area deprivation in the Netherlands is defined according to an index based on income, number of people dependant on social benefits, and level of urbanisation.²⁰ In this study the baseline data of the trial were analysed.

Abbreviations: CVD, cardiovascular disease; HDL, high density lipoprotein; NNT, number needed to treat

Patient selection and data collection

To identify all potential high risk patients, two steps were followed. Firstly, the electronic general practice medical records, containing all available medical data (including consultations, laboratory results, letters from specialists, and prescriptions) were searched. All patients aged 30–70 years with one or more registered risk factors (hypertension, diabetes mellitus, hypercholesterolaemia, history of CVD, family history of CVD, smoking, and measurements of blood pressure $\geq 160/90$ mm Hg or total cholesterol ≥ 6.2 mmol/l within the preceding two years) were selected. Secondly, patients thus selected were invited to participate. They were informed about the study during a home visit and asked to give their informed consent. A structured questionnaire was used to measure background characteristics, cardiovascular risk factors, family history of CVD, and history of CVD. In addition, patients underwent a limited physical examination consisting of blood pressure, weight, and height measurements by a trained research assistant. Blood pressure was measured during the home visit in a sitting position with a validated electronic sphygmomanometer. Two measurements were taken separated by at least a 10 minute interval. The mean of these readings was used for the analyses.

Blood samples were taken at the laboratory to measure fasting glucose, haemoglobin A1c, and the lipid profile.

Of 536 patients who signed informed consent for the trial, 430 had a completed cardiovascular risk profile. Of these, the Framingham risk formula could not be applied to 137 patients because of a CVD history and were thus excluded from analysis. Finally, data on 293 participants were available for analysis.

Determination of cardiovascular risk and modifiable risk

By using the Framingham equation, we calculated for each patient the 10 year risk of developing a CVD event.^{5–17} The formula considers the following independent variables: age (in years), sex (male/female), systolic blood pressure (in mm Hg), total cholesterol to high density lipoprotein (HDL) cholesterol ratio, smoking (yes/no), and diabetes mellitus (yes/no). Diabetes mellitus was considered to be present if it was registered in the patient's general practice records or if the patient was taking diabetes medication or had a fasting glucose concentration ≥ 7 mmol/l. We considered 10 year cardiovascular risk thresholds of 20% and 40% as recommended in several international guidelines.^{8–9–11}

The modifiable part of the absolute risk was determined in two ways (see appendix):

- A “potential” modifiable risk, which is the maximum reduction in the absolute risk by eliminating modifiable risk factors and is composed of the separate absolute risk reductions for systolic blood pressure (reduction from > 120 to 120 mm Hg), total to HDL cholesterol ratio (reduction from > 4 to 4), and smoking cessation (if patients smoke). The non-modifiable risk consists of the absolute risk for CVD based on age, sex, diabetes, and fixed values on modifiable risk factors (total to HDL cholesterol ratio 4, systolic blood pressure 120 mm Hg, and non-smoking).
- A “realistic” modifiable risk, which is the expected reduction in absolute risk according to trials on hypercholesterolaemia, hypertension, and smoking.^{21–22} The non-modifiable risk is based on age, sex, diabetes, a 20% decrease in total cholesterol and 5% increase in HDL cholesterol, a 12 mm Hg decrease in systolic blood pressure, and smoking cessation.^{21–22} The modifiable risk is composed of the separate risk reductions for systolic

Table 1 General characteristics and cardiovascular risk profile of the study population (n = 293)

Ethnicity	
Dutch	106 (36%)
Turkish	97 (33%)
Surinamese	36 (12%)
Moroccan	18 (6%)
Other	36 (12%)
Diabetes*	106 (36%)
Current smoker†	95 (32%)
Former smoker†	76 (26%)
Family history of CVD†	106 (36%)
With ≥ 2 CVD risk factors	220 (75%)
With ≥ 3 CVD risk factors	140 (48%)
Age (years)	51.8 (9.3)
Systolic BP (mm Hg)	143.0 (23.8)
Diastolic BP (mm Hg)	87.9 (12.5)
Haemoglobin A1c	6.5 (1.4%)
Fasting glucose (mmol/l)	6.6 (2.4)
Serum total cholesterol (mmol/l)	5.9 (1.0)
Serum HDL cholesterol (mmol/l)	1.4 (0.4)
Total:HDL cholesterol	4.4 (1.4)
Serum LDL cholesterol (mmol/l)	3.4 (1.0)
Triglycerides (mmol/l)	1.9 (1.3)
Body mass index (kg/m ²)	30.9 (5.6)
10 year CVD absolute risk (%)	17.2 (12.6)

Values are mean (SD) or number (%).

*Based on diabetes medication use, general practice medical record, or fasting glucose ≥ 7 mmol/l; †based on patients' self reports.

BP, blood pressure; CVD, cardiovascular disease; HDL, high density lipoprotein; LDL, low density lipoprotein.

blood pressure (if > 120 mm Hg), total to HDL cholesterol ratio (if > 4), and smoking (if patients smoke).

Data analyses

We used cross tabulations to determine the numbers and proportions of patients identified according to the absolute risk thresholds, the modifiable part of absolute risk, or both identification criteria. To assess differences in patient characteristics, we distinguished two groups: those with an absolute risk $\geq 20\%$ and a modifiable part of risk $\geq 5\%$; and those with an absolute risk $< 20\%$ but with a modifiable part of risk $\geq 5\%$. Proportion of women, non-Dutch ethnic group, current smokers, obese patients, and patients with total cholesterol to HDL cholesterol ratio > 4 , systolic blood pressure ≥ 140 mm Hg, the presence of diabetes mellitus, and a family history of CVD were compared between the groups by χ^2 tests, and mean age by independent *t* test.

Data were analysed by SPSS software, version 12.0 (SPSS Inc, Chicago, Illinois, USA).

RESULTS

Table 1 gives the general characteristics and cardiovascular risk factors of the 293 participants.

Two thirds of the patients were women (66%) and a majority had a non-Dutch background (36% were Dutch, 33% Turkish, 12% Surinamese, 6% Moroccan, and 12% others, mainly from the Antilles, Pakistan or India, and the former Yugoslavia). The study population was young (51.8 (9.3) years) but had multiple risk factors, 32% of patients were current smokers, and 36% reported having a family history of CVD. A large group of all patients (75%) had two or more cardiovascular risk factors and about half of the patients (48%) had three or more risk factors.

Table 2 shows that use of a 10 year absolute risk threshold $\geq 20\%$ identified 33% of patients. On the basis of the 5% modifiable risk threshold, 61% of patients were identified

Table 2 Numbers and proportions of patients according to absolute risk threshold and modifiable part of the absolute risk

10 year absolute risk*	Modifiable part of absolute risk				
	Potential reduction†		Realistic reduction‡		
	<5%	≥5%	<5%	≥5%	Total
<20%	111 (38%)	84 (29%)	148 (51%)	47 (16%)	195(67%)
≥20%	2 (1%)	96 (33%)	12 (4%)	86 (29%)	98 (33%)
<40%	113 (39%)	162 (55%)	159 (54%)	116 (40%)	275 (94%)
≥40%	0 (0%)	18 (6%)	1 (0%)	17 (6%)	18 (6%)
Total	113 (39%)	180 (61%)	160 (55%)	133 (45%)	293 (100%)

*Based on the Framingham risk equation (based on age, sex, diabetes mellitus, systolic blood pressure, total cholesterol to HDL cholesterol ratio, and smoking); †maximum reduction in 10 year absolute risk by eliminating modifiable risk factors (systolic blood pressure reduction from >120 to 120 mm Hg, total cholesterol to HDL cholesterol reduction from >4 to 4, and smoking cessation if the patient smokes); ‡expected reduction in 10 year absolute risk by lowering the modifiable risk factors according to results from trials (systolic blood pressure reduction by 12 mm Hg, total cholesterol reduction by 20%, HDL increase by 5%, and smoking cessation).

with a potential reduction $\geq 5\%$ and 45% with a realistic reduction $\geq 5\%$.

A large majority of the patients at 20% or greater absolute risk had a modifiable part of risk $\geq 5\%$ —that is, 98% had a potential modifiable risk $\geq 5\%$ and 88% had a realistic modifiable risk $\geq 5\%$. These proportions correspond, respectively, to 33% and 29% of all patients. Only 1–4% had an absolute risk $\geq 20\%$ and a modifiable risk $< 5\%$ (table 2).

Among those patients at $< 20\%$ absolute risk, a considerable group had a modifiable part of risk $\geq 5\%$, which could justify prevention activities: 43% with a potential modifiable part $\geq 5\%$ and 24% with a realistic modifiable part $\geq 5\%$. As a proportion of all patients, these proportions were 29% and 16%, respectively (table 2).

Use of a higher absolute risk threshold, for example, $\geq 40\%$ as recommended by some guidelines,⁹ identified a very small proportion of patients (6%). Among those patients not identified, a large group had a modifiable part of risk $\geq 5\%$ (55% of all patients had a potential modifiable part $\geq 5\%$ and 40% had a realistic modifiable part $\geq 5\%$).

In table 3 we compare the characteristics of patients with an absolute risk $< 20\%$ and a modifiable part of risk $\geq 5\%$

(group 1) with the characteristics of patients with an absolute risk $\geq 20\%$ and a modifiable part $\geq 5\%$ (group 2). The patients in group 1 were predominantly women and young. A slightly higher proportion in this group had a non-Dutch origin but this difference was not significant. Although the proportions of patients with modifiable risk factors were smaller in group 1 than in group 2, more than half of them had hypertension and hypercholesterolaemia and more than one quarter had diabetes mellitus. No differences in obesity were noted between the groups.

DISCUSSION

Our results show that using an absolute risk threshold of $\geq 20\%$ leads to the exclusion of patients with a large potential reduction in absolute risk mainly in women and young patients, among whom preventive activities are more cost effective in the long term. A more appropriate criterion for identifying high risk patients is the use of the proportion of absolute risk contributed by the major modifiable risk factors, namely systolic blood pressure, the cholesterol to HDL cholesterol ratio, and smoking. We considered a modifiable part of $\geq 5\%$ of the absolute risk to be appropriate because it discriminates between patients with and without the possibility of lowering the modifiable risk factors to target levels. This risk reduction corresponds also to the NNT to prevent one cardiovascular event by means of intervention activities.

The application of the proposed modifiable part of the absolute risk, instead of using a CVD risk threshold $\geq 20\%$, in general practices is advantageous for several reasons.

Firstly, it is more likely to identify those young patients who should be considered for treatment because of high levels of risk factors to prevent CVD in the long term. Similarly focusing on the modifiable risk will reduce over-treatment of older people at low modifiable risk.¹⁸

Secondly, the absolute risk of CVD is lower in women than in men. Applying the same absolute risk thresholds to men and to women excluded a large number of female patients from prevention activities, despite their unfavourable modifiable risk factors. Focusing on the modifiable part of the risk, rather than the absolute risk, would allow more women to be involved in prevention and treatment of CVD. Although not all risk factor intervention trials have included women, it is clear that the relative benefits on cardiovascular morbidity and mortality are similar for both sexes. The major risk factors have a substantial impact on the absolute risk in women—for example, in the US population as a whole, as many women as men die of coronary heart diseases.²³ Therefore, prevention based on cardiovascular risk factors in women should not be delayed.

Examples illustrating the differences between using the absolute risk threshold and the potential or realistic modifiable part of risk

Absolute risk $< 20\%$ and potential and realistic modifiable risk $\geq 5\%$

A middle aged (49.5 years) female patient without diabetes has a systolic blood pressure of 191.00 mm Hg and total cholesterol to HDL ratio of 4.42. The calculated absolute risk is lower than the 20% absolute risk threshold (16.54%). However, the potential modifiable risk is 11.29% and the realistic modifiable risk is 5.00%.

A young male diabetic patient (age 39 years) smokes cigarettes and has a systolic blood pressure of 120 mm Hg and total cholesterol to HDL cholesterol ratio of 7.17. The absolute risk is 13.85% and the potential modifiable risk is 7.80%; the realistic reduction is 5.98%.

Absolute risk $\geq 20\%$ and potential and realistic modifiable risk $< 5\%$

A male patient aged 67 years has a systolic blood pressure of 130 mm Hg, total cholesterol to HDL cholesterol ratio of 4.00, does not smoke, and does not have diabetes. The absolute risk is 21.5%, the potential modifiable risk is 3.15%, and the realistic modifiable risk is 3.31%.

Table 3 Characteristics of patients with a 10 year absolute risk* <20% and a modifiable risk ≥5% (group 1) and of patients with a 10 year absolute risk ≥20% and a modifiable part ≥5% (group 2)

Characteristic	Potential reduction ≥5%†			Realistic reduction ≥5%‡		
	Group 1 (n = 84)	Group 2 (n = 96)	p Value	Group 1 (n = 47)	Group 2 (n = 86)	p Value
Age (years)	49.9 (6.3)	59.1 (6.7)	<0.0001	49.9 (7.0)	58.4 (6.7)	<0.0001
Age categories (years)						
<50	44 (52%)	9 (9%)	<0.0001	25 (53%)	9 (11%)	<0.0001
≥50	40 (48%)	87 (91%)		22 (47%)	77 (90%)	
Women	52 (62%)	33 (34%)	<0.0001	25 (53%)	29 (34%)	0.023
Non-Dutch	54 (64%)	57 (59%)	0.301	25 (53%)	49 (57%)	0.405
Smoking§	37 (44%)	45 (47%)	0.409	29 (62%)	45 (52%)	0.196
Hypercholesterolaemia¶	53 (63%)	75 (78%)	0.020	39 (83%)	76 (88%)	0.269
Hypertension¶	50 (60%)	81 (84%)	<0.0001	22 (47%)	70 (81%)	<0.0001
Diabetes mellitus¶	25 (30%)	41 (43%)	0.050	13 (28%)	35 (41%)	0.095
Obesity¶	41 (51%)	50 (53%)	0.459	22 (50%)	46 (55%)	0.372
Family history of CVD§	31 (37%)	27 (28%)	0.136	15 (32%)	25 (29%)	0.440

Values are mean (SD) or number (%).

*Based on the Framingham risk equation (based on age, sex, diabetes mellitus, systolic blood pressure, total cholesterol to HDL cholesterol ratio, and smoking); †maximum reduction in 10 year absolute risk by eliminating modifiable risk factors (systolic blood pressure reduction from >120 to 120 mm Hg, total cholesterol to HDL cholesterol ratio reduction from >4 to 4, and smoking cessation if the patient smokes); ‡expected reduction in 10 year absolute risk by lowering the modifiable risk factors according to results from trials (systolic blood pressure reduction by 12 mm Hg, total cholesterol reduction by 20%, HDL increase by 5%, and smoking cessation); §based on patients' self reports; ¶hypercholesterolaemia defined as total cholesterol to HDL cholesterol ratio >4, hypertension defined as systolic blood pressure ≥140 mm Hg, and obesity defined as body mass index ≥30 kg/m².

Thirdly, people living in deprived neighbourhoods have a greater risk of developing CVD than the general population due to their unfavourable (modifiable) risk factors.¹⁹ Therefore, focusing on modifiable risk is a reasonable approach, mainly because of the heterogeneity within such a population in terms of ethnicity (that is, a large proportion of non-Dutch people) and age distribution (mainly young people from ethnic minorities and elderly Dutch). The ethnic origins of the population must be taken into consideration because the Framingham risk score is derived from a population consisting of a large majority of white patients of European origin and both underestimates and overestimates of the absolute risk in other ethnic groups have been reported.^{17, 24–26} About two thirds of our study population had a non-European origin, mainly Turkish, Surinamese, or Moroccan. We found no significant ethnic differences in the proportions of identified patients according to the applied risk thresholds, but this may be because of small numbers of the different ethnic minority groups. Compared with other international guidelines, the current Dutch guidelines provide no information about the underestimation of the CVD risk in ethnic minority groups.^{8, 9, 27} So the focus on the modifiable part of risk instead of the absolute risk in a heterogeneous population living in deprived neighbourhoods is a possible alternative.

Several limitations of the present study should be mentioned. The proposed modifiable part of the CVD risk is based on blood pressure measurements taken on one occasion, whereas national guidelines recommend that blood pressure should be considered after repeated measurements. Our measuring procedure may have overestimated the modifiable part of the risk and consequently of the CVD risk. On the other hand, we believe that misclassification is limited because the CVD risk assessment depends on many risk factors and because the risk formula initially was based on single measurements.

For determination of the modifiable risk, we considered that smokers can quit smoking and we included patients whose blood pressure was higher than 120 mm Hg and had a cholesterol to HDL ratio > 4. Although a limited number of patients may successfully quit smoking, according to a large Danish study smoking reduction has no impact on CVD risk

whereas smoking cessation clearly reduces the risk.²⁸ The above mentioned blood pressure levels are relatively low to justify intervention according to the guidelines. However, evidence has shown that each 10 mm Hg drop in systolic blood pressure decreases the risk of stroke in one third of patients and that this association is continuous down to levels of at least 115/75 mm Hg.²⁹

We considered in this study a modifiable risk ≥ 5%. Of course, pharmacological treatment can further reduce blood pressure (systolic blood pressure < 120 mm Hg) or lipids (total cholesterol to HDL ratio < 4) resulting in higher levels of the realistic or potential modifiable risk. Consequently fewer patients would be identified for intervention activities (lower NNT). Nevertheless, we think that further reduction of modifiable risk factors is not realistic and that drug related adverse effects are more likely to exceed the benefits.³⁰

A major strength of this study is stating the importance of reducing modifiable risk factors for all patients, despite a lower threshold of absolute cardiovascular risk. Whether the potential or realistic modifiable risk should be taken into account in daily practice depends on the levels of the modifiable risk factors and the patient's likelihood of complying with prevention strategies. In daily practice, clinicians should discuss with patients the modifiable risk for CVD because it is a more comprehensive approach for the prevention of CVD than just individual risk factors and it is easier to communicate with patients. Additionally clinicians should be aware that using risk charts based on absolute risk thresholds as recommended by the guidelines is inadequate for the identification of high risk patients to initiate intervention. Therefore, current guidelines regarding prevention of CVD should be adapted.

We conclude that targeting preventive strategies at patients with an absolute 10 year risk ≥ 20% would exclude a large group of relative young, predominantly female patients. This group constitutes as much as one quarter of all patients and they may benefit from preventive strategies to prevent CVD in the long term because their potential reduction in absolute risk of CVD exceeds 5%. Moreover, using the modifiable part of risk will reduce overtreatment of older patients with a raised absolute risk but low modifiable risk.

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APPENDIX

CALCULATIONS OF ABSOLUTE, MODIFIABLE, AND NON-MODIFIABLE RISKS

Absolute risk (AR)

$$\begin{aligned}\mu &= 18.8144 - (1.2146 \times \text{sex}) - (1.8443 \times (\ln(\text{age}))) \\ &+ (0.3668 \times \ln(\text{age}) \times \text{sex}) - (1.4032 \times \ln(\text{SBP})) \\ &- (0.3899 \times \text{smoking}) - (0.5390 \times \ln(\text{TC:HDL})) \\ &- 0.3036 \times \text{diabetes} - (0.1697 \times \text{sex} \times \text{diabetes}) \\ \sigma &= 0.6536 + (\mu \times (-0.2402)) \\ \epsilon &= \exp(\sigma) \\ \gamma &= (\ln(10) - \mu) / \epsilon \\ \text{AR} &= 100 \times (1 - \exp(-\exp(\gamma)))\end{aligned}$$

Potential reduction: non-modifiable risk (NMR_p)

AR (if systolic blood pressure = 120 mm Hg and smoking = 0 and TC:HDL = 4)

1. Separate risk for SBP: AR with SBP and (TC:HDL = 4 and smoking = 0) - NMR_p
2. Separate risk for cholesterol: AR with TC:HDL and SBP = 120 and smoking = 0) - NMR_p
3. Separate risk for smoking: AR with smoking = 1 and (SBP = 120 mm Hg and TC:HDL = 4) - NMR_p

Potential reduction: modifiable risk (MR_p)

1 (if SBP > 120) + 2 (if TC:HDL > 4) + 3 (if smoking = 1)

Realistic reduction: non-modifiable risk (NMR_r)

AR (if (SBP - 12 mm Hg) and (smoking = 0) and (TC - TC × 20%/HDL + HDL × 5%))

1. Separate risk for SBP: AR with SBP and ((TC - TC × 20%/HDL + HDL × 5%) and smoking = 0) - NMR_r
2. Separate risk for cholesterol: AR with TC:HDL and ((SBP - 12 mm Hg) and smoking = 0) - NMR_r
3. Separate risk for smoking: AR with smoking = 1 and ((SBP - 12 mm Hg) and (TC - TC × 20%/HDL + HDL × 5%)) - NMR_r

Realistic reduction: modifiable risk (MR_r)

1 (if SBP > 120 mm Hg) + 2 (if TC:HDL > 4) + 3 (if smoking = 1)

Abbreviations: HDL, high density lipoprotein cholesterol; SBP, systolic blood pressure; TC, total cholesterol

REFERENCES

- 1 Cheung BM, Laufer LJ, Lau CP, et al. Meta-analysis of large randomized controlled trials to evaluate the impact of statins on cardiovascular outcomes. *Br J Clin Pharmacol* 2004;**57**:640-51.
- 2 Blood Pressure Lowering Treatment Trialists' Collaboration. Effects of ACE inhibitors, calcium antagonists and other blood pressure lowering drugs: results of prospectively designed overviews of randomised trials. *Lancet* 2000;**355**:1955-64.
- 3 Critchley JA, Capewell S. Mortality risk reduction associated with smoking cessation in patients with coronary heart disease: a systematic review. *JAMA* 2003;**290**:86-97.
- 4 Ebrahim S, Smith GD. Systematic review of randomised controlled trials of multiple risk factor interventions for preventing coronary heart disease. *BMJ* 1997;**314**:1666-74.
- 5 Anderson KM, Odell PM, Wilson PW, et al. Cardiovascular disease risk profiles. *Am Heart J* 1991;**121**:293-8.
- 6 Jones AF, Walker J, Jewkes C, et al. Comparison of cardiovascular risk prediction methods in primary care patients. *Heart* 2001;**85**:37-43.
- 7 Hobbs FD. Cardiovascular disease: different strategies for primary and secondary prevention? *Heart* 2004;**90**:1217-23.
- 8 Wood D, Durrington P, McInnes GT, et al. Joint British recommendations on prevention of coronary heart disease in clinical practices. *Heart* 1998;**80**(suppl 2):S1-29.
- 9 Jackson R. Updated New Zealand cardiovascular disease risk-benefit prediction guide. *BMJ* 2000;**320**:709-10.
- 10 Haq I, Ramsay LE, Pickin DM, et al. Lipid-lowering for prevention of coronary heart disease: what policy now? [abstract]. *Clin Sci (Lond)* 1996;**91**:399-413.
- 11 Grobee DE, Tuut MK, Hoes AW. [CBO guideline "High blood pressure" (revision)]. *Ned Tijdschr Geneesk* 2001;**145**:2071-6.
- 12 Simoons M, Casparie A. [Therapy and prevention of coronary heart diseases through lowering of the serum cholesterol levels: third consensus 'cholesterol'. Consensus Working Group, CBO]. *Ned Tijdschr Geneesk* 1998;**142**:2096-101.
- 13 Hamilton-Craig I. The heart protection study: implication for clinical practice: the benefits of statin therapy do not come without financial cost. *Med J Aust* 2002;**177**:404-5.
- 14 Rembold CM. Number-needed-to treat analysis of the prevention of myocardial infarction and death by antidiabetic therapy. *J Fam Pract* 1996;**42**:577-86.
- 15 Mulrow CD, Cornell JA, Herrera CR, et al. Hypertension in the elderly: implications and generalizability of randomized trials. *JAMA* 1994;**272**:1932-8.
- 16 Quan A, Kerlikowske K, Gueyffier F, et al. Pharmacotherapy for hypertension in women of different races. *Cochrane Database Syst Rev* 2000;(3):CD002146.
- 17 Cappuccio FP, Oakeshoot P, Strazullo P, et al. Application of Framingham risk estimates to ethnic minorities in United Kingdom and implications for primary prevention of heart disease in general practice: cross sectional population based study. *BMJ* 2002;**325**:1-6.
- 18 Poulter N Global risk of cardiovascular disease. *Heart* 2003;**89**(suppl 11):ii2-5.
- 19 Diez Roux AV, Merkin SS, Arnett D, et al. Neighbourhood of residence and incidence of coronary heart disease. *N Engl J Med* 2001;**345**:99-106.
- 20 Velden van der J, Rasch P, Reijneveld SA. [Identification of disadvantaged areas: a system for resource allocation to family practitioners]. *Ned Tijdschr Geneesk* 1997;**141**:693-7.
- 21 LaRosa JC, He J, Vupputuri S. Effect of statins on risk of coronary disease: a meta-analysis of randomised controlled trials. *JAMA* 1999;**282**:2340-6.
- 22 Chalmers J. Trials on blood pressure-lowering and secondary stroke prevention. *Am J Cardiol* 2003;**91**(suppl):3G-8G.
- 23 Grundy SM, Balady GJ, Criqui MH, et al. Primary prevention of coronary heart disease: guidance from Framingham, a statement for healthcare professionals from the AHA Task Force on Risk Reduction. *Circulation* 1998;**97**:1876-87.
- 24 Grundy SM, Pasternak R, Greenland P, et al. Assessment of cardiovascular risk by use of multiple-risk-factor assessment equations: a statement for healthcare professionals from the American Heart Association and the American College of Cardiology. *Circulation* 1999;**100**:1481-92.
- 25 D'Agostino RB, Grundy S, Sullivan LM, et al. Validation of the Framingham coronary heart disease prediction scores. Results of a multiple ethnic groups investigation. *JAMA* 2001;**286**:180-7.
- 26 Liu J, Hong Y, D'Agostino RB, et al. Predictive value for the Chinese population of the Framingham CHD risk assessment tool compare with the Chinese multi-provincial cohort study. *JAMA* 2004;**291**:2591-9.
- 27 Manna DR, Bruijnzeels MA, Mookink HG, et al. Ethnic specific recommendations in clinical practice guidelines: a first exploratory comparison between guidelines from the USA, Canada, the UK, and the Netherlands. *Qual Saf Health Care* 2003;**12**:353-8.
- 28 Godtfredsen NS, Osler M, Vestø J, et al. Smoking reduction, smoking cessation, and incidence of fatal and non-fatal myocardial infarction in Denmark 1976-1998: a pooled cohort study. *J Epidemiol Community Health* 2003;**57**:412-6.
- 29 Lawes CMM, Bennett DA, Feigin VL, et al. Blood pressure and stroke: an overview of published reviews. *Stroke* 2004;**35**:776-85.
- 30 Studer M, Birieli M, Leimenstoll B, et al. Effect of different antidiabetic agents on mortality: a systematic review. *Arch Intern Med* 2005;**165**:725-30.