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REVIEW ARTICLE

Global Cardiovascular Risk Assessment: Strengths and Limitations

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Abstract Global cardiovascular (CV) risk assessment tries to answer the questions: who will benefit from intervention? And when should non-pharmacologic and pharmacologic treatment be started? Used for the assessment of CV risk in the presence of one main CV risk factor, the presence of previous CV disease, diabetes, chronic kidney disease, coronary heart disease and severely elevated single risk factors, are situations with a high or very high risk. For the majority of subjects without any of the above, a calculation of risk can help to decide the best management. The methodology of assessing global CV risk has both strength and limitations. Several computational methods have been developed to assess global CV risk but no risk estimation can consider all the potential risk factors. The most used score chart is the Framingham CardioVascular Risk Score, although in Europe the Systematic Coronary risk evaluation is widespread. The strengths of the global CV risk scores depend on the methodology applied at the time of construction: (a) appropriate statistical methods (representative sample, sufficient power, clear definition of the outcomes); (b) inclusion of appropriate risk factors (age, sex, conventional risk factors, and inclusion of others that can be relevant). Once developed, the function requires internal and external validity as well as calibration. There are several limitations, which have been solved with different approaches. In the case of hypertension, one element is introduced in the score charts, the presence of hypertension-induced organ damage offering a refinement of the approach to the global CV risk.

Keywords Global cardiovascular risk · Hypertension · Framingham score · SCORE

1 Introduction

Global cardiovascular (CV) risk assessment tries to answer the questions: who will benefit from intervention? And when should non-pharmacologic and pharmacologic treatment be started? In this context, individuals at the highest levels of risk are those that gain most from risk factor management, if life expectancy is long enough to actually achieve the benefit. Although these individuals are those that gain most, the majority of deaths in a community come from those at lower levels of risk, simply because they are more numerous compared to high risk individuals, who develop fewer events in absolute terms. Used for the assessment of CV risk in the presence of one main CV risk factor, the presence of previous CV disease, diabetes, chronic kidney disease, coronary heart disease and severely elevated single risk factors, are situations with a high or very high risk. For the majority of subjects without any of the above, a calculation of risk can help to decide the best management. The methodology of assessing global CV risk has both strengths and limitations that limit their use.

2 Methods to Assess Global Cardiovascular Risk

Several computational methods have been developed to assess global CV risk but no risk estimation can consider all the potential risk factors [1]. The most used score

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chart is the Framingham CardioVascular Risk Score [2], although in Europe the systematic coronary risk evaluation [3] is widespread. Table 1 summarizes the most used score chart. These two, Framingham and SCORE and the others used, ASSIGN–SCORE [4], PROCAM [5], CUORE [6], QRISKI 1–2 [7, 8] and the pooled cohort studies equation [9], have been calculated from different populations with different age ranges, ethnic and socio-economic characteristics; some express the results as CV risk at 10 or 20 years and others in risk of mortality. Other differences include the age range and the presence or not of diabetics. To solve the problem of different populations some of the chart has been recalculated for specific countries with different levels of risk and the SCORE provides different charts for European countries with low, moderate and high risk. To avoid the problems of lack of diabetes or the limited age range, multiplication for correction factors are used, SCORE multiplies by four the risk of mortality to calculate the risk for CV disease.

3 Strengths and Limitations

The strengths of the global CV risk scores depend on the methodology applied at the time of construction [1]: (a) appropriate statistical methods (representative sample, sufficient power, clear definition of the outcomes); (b) inclusion of appropriate risk factors (age, sex, conventional risk factors, and inclusion of others that can be relevant). Once developed, the function requires internal and external validity as well as calibration. There are several limitations to the different charts, although these do not invalidate the utility of their use, but should however be considered when the decisions are based on the global CV risk.

3.1 Time Period Used for the Calculation

The majority of the charts were generated using baseline data from before 2000, with the exception of the QRISK2 which used data up to 2008. These old data introduce the bias of overestimating risk, since the secular trends of CV risk have diminished in the last decades.

Table 1 Current cardiovascular disease risk estimation systems

	Mortality 10 years	Morbidity and mortality 10 years	Lifetime
Framingham [2]		+	
SCORE [3]	+		
ASSIGN–SCORE [4]		+	
QRISKI 1–2 [7, 8]		+	+
PROCAM [5]		+	
CUORE [6]		+	
Pooled cohort studies equation [9]		+	+

3.2 Calculations of Risk

Practically all charts used the 10 year risk for coronary heart disease or total CV events, with the exception of the SCORE, which estimated 10-year risk of CV mortality. This limitation to mortality data causes one to use assumptions such as, for example, that the total CV disease is calculated from mortality multiplied by three for men and by four for women. In the case of older subjects a factor of three is used.

3.3 Age

Age is a relevant issue at the time to calculate the risk in both extremes of age. Young people will have very low estimated CV death risk. Decisions to treat based on global CV risk deals with the problem of a low absolute risk in young people even with multiple risk factors since risk is assessed for the following 10–20 years in the majority of the risk charts or scores. To solve this, other approaches such as the relative risk charts [10], the lifetime risk [7, 8] or the pooled cohort studies equation [9] are more suitable for young adults.

Likewise, older men will have estimated CV death risks exceeding 5–10 %, even when CV risk factors are low. In this case, SCORE multiplies mortality by three.

3.4 Women

Women usually have lower CV risk than men, and therefore for estimation of risk two things must be taken into account. First is that recommendation to estimate risk is delayed until fifty years of age in contrast with forty years, which is the starting point of estimating risk in men. Second, their risk is deferred by about 10 years rather than avoided.

3.5 Modifiers of Risk

Besides the main CV risk factors that are included in the charts, several modifiers of risk should be taken into account. The ESH Guidelines on CV prevention [10] use the SCORE charts but introduce some modifiers increasing the risk. These are: sedentary subjects, central obesity, socially deprived individuals and ethnic minorities, impaired fasting glucose or glucose intolerance, increased levels of triglycerides, fibrinogen, apolipoprotein B, lipoprotein (a) and high sensitivity C-reactive protein and family history of premature CVD.

4 The Case of Hypertension

In hypertension, quantification of global CV risk is now generally accepted and integrated in the ESH-ESC guidelines from 2003 [11]. This combines three components: BP levels, coexistence of other CV risk factors and presence of clinical or subclinical organ damage (Fig. 1). The group with previous CV events, diabetes, renal disease or severe elevated single factor is only a small fraction of the hypertensives that represent high or very high CV risk. The remaining requires the use of models to estimate CV risk. Risk assessment of hypertension included specific elements derived from the presence of early target organ damage (TOD). The inclusion of TOD introduces a new dimension that seems to improve the prognostic value of the classic components of risk charts [12].

ESH-ESC system also has several limitations besides those present in general in the global CV risk charts. First, is how the organ damage is evaluated, for example at the time to assess the presence or not of left ventricular hypertrophy. This is quite different if the method is ECG or echocardiography, which has superior sensibility to detect the hypertrophy. Likewise, whether to assess only heart or kidney or to include vascular assessment with carotid-intima thickness or pulse wave velocity. Second, is the lack of quantification of risk derived from the presence of TOD. Third, any threshold of risk is arbitrary and to trigger certain interventions is problematic since risk is a continuum. Fourth, it only considers office BP instead of the widely used out-of-office BP, which has a better relationship with the presence of TOD and CV risk. Finally, one question is still unsolved: the fact that the BP included in the chart was under antihypertensive treatment. Some time ago, D'Agostino [13] published the equivalence of risk score of stroke using Framingham data between subjects with and without antihypertensive treatment. For example, the risk of stroke in untreated men with BP of 166–175 mmHg was similar to BP values of 143–150 mmHg in treated subjects.

Despite all of these the ESH-ESC Guidelines recommended that in asymptomatic subjects with hypertension, but free of CV disease, chronic kidney disease and diabetes, total CV risk stratification using the SCORE model as a minimal requirement (evidence class I, level B). As there is evidence that TOD predicts CV death independently of SCORE, a search for TOD should be considered, particularly in individuals at moderate risk (evidence class IIa, level B). Finally, it is recommended that decisions on treatment strategies depend on the initial level of total CV risk (evidence class I, level B).

2013 ESH/ESC Hypertension Guidelines

Stratification of total CV risk in hypertension

Other risk factors, asymptomatic organ damage or disease	Blood Pressure (mmHg)			
	High normal SBP 130–139 or DBP 85–89	Grade 1 HT SBP 140–159 or DBP 90–99	Grade 2 HT SBP 160–179 or DBP 100–109	Grade 3 HT SBP ≥180 or DBP ≥110
No other RF		Low risk	Moderate risk	High risk
1–2 RF	Low risk	Moderate risk	Moderate to high risk	High risk
≥3 RF	Low to Moderate risk	Moderate to high risk	High Risk	High risk
OD, CKD stage 3 or diabetes	Moderate to high risk	High risk	High risk	High to very high risk
Symptomatic CVD, CKD stage ≥4 or diabetes with OD/RFs	Very high risk	Very high risk	Very high risk	Very high risk

Fig. 1 Stratification of total CV risk in hypertension. *CV* cardiovascular, *CVD* cardiovascular disease, *CKD* chronic kidney disease, *DBP* diastolic blood pressure, *HT* hypertension, *OD* organ damage, *RF* risk factor, *SBP* systolic blood pressure. Figure reproduced with permission from European Society of Hypertension

5 Conclusions

Overall, more research is required to quantify the clinical benefits and cost effectiveness of such an approach. However, a greater problem is the underutilization of CVD prevention in clinical practice. New computer based assistance as well apps can help to easily implement it. Then, rather than competing over which is the best method, it is better to encourage their use.

Compliance with Ethical Standards

This article does not contain any studies with human participants or animals performed by any of the authors. The author declares that he has no conflict of interest. The paper did not receive any funding.

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