Drawbacks and benefits of cardiovascular risk tools

There are a variety of risk tools available to calculate a patient's absolute or relative risk of coronary heart disease. General practitioner Penny Lockwood discusses their differences, merits and limitations.

Abstract

There are now well-recognised guidelines[1] which state that when reducing someone's risk of cardiovascular disease the decision to start medication depends on the patient's absolute risk of coronary heart disease, as opposed to their relative risk, which should be determined using multiple risk factors.

More than 29 cardiovascular risk tools are available to calculate a patient's absolute risk of cardiovascular disease. Choosing which risk tool to use can be difficult. This article gives a description of the differences between cardiovascular risk tools. It also discusses some of the problems and benefits of risk tools in general and examines the differences between absolute and relative risk.

Key words: cardiovascular risk, description of risk calculators.

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'A clinician may use several different tools depending on what information he is looking for'

Penny Lockwood

Absolute versus relative risk

Absolute risk

This is the probability that someone will have an event within a specified time period, such as over the next 10 years. This means that if the absolute risk is 15% over 10 years, out of every 100 people with that lifestyle, 15 will have an event. Encouraging a patient to make lifestyle changes using absolute risk can be problematic. For example, age is a factor in an individual's absolute risk but someone aged 30 who smokes heavily and has hypertension will have a low absolute risk. Changes need to be made as early as possible, however, to prevent development of cardiovascular disease.

Relative risk

More recently developed cardiovascular risk tools calculate relative risk.[2] This is the probability that someone may have an event when compared to an average person for that age group and sex. If the relative risk for a particular person is three, then that person is three times more likely to have an event than someone else with a different lifestyle of that sex and in that age group. Some patients find this information more useful and it can help in encouraging lifestyle change.

Some of the tools rather than giving relative risk give the average risk of certain genders and age to use as a comparison – for example, Hingorani and Vallance's calculator.[3]

Categories of risk tools

The earliest risk tools to be used widely were paper-based ones, presenting stratified risk, e.g. Sheffield tables.[4] These usually take the form of charts or tables. Scoring systems have been developed where points increase according to lifestyle and can then be converted to the probability of a cardiovascular event occurring, e.g. categorical risk assessor.[5] These tools were mainly designed to decide whether or not to start a patient on statins.

More recently, several computer-based tools have been developed. These utilise the risk equations and can give a single figure for a patient's risk of cardiovascular disease. These computer-based programs fall into two categories: i) stand-alone calculators that can be loaded onto any PC with windows,[2] or ii) embedded in a clinical database, such as EMIS or GPASS.[6] Some of these tools have been developed to present relative risk in order to aid patient education – for example the risk program developed by Medcal.[2]

Data and calculations used

Equations used

The first equations developed from Framingham data were Logistical equations,[7] which excluded subjects who dropped out before the study was completed, hence potentially biasing the data. Furthermore, data cannot be extrapolated to calculate risk over vary-

ing lengths of time, since assuming a constant linear relationship between risk and time is questionable.

In 1991 an equation based on the Weibull Accelerated Failure time model[8] was developed using the Framingham population. This allowed for a non-linear relationship between risk factors and absolute risk – unlike the Cox proportional hazards model and Logistical equations – so one could vary the predicted years of absolute risk. The authors also looked at absolute risk for varying end points, e.g. risk of myocardial infarction (MI) versus risk of coronary heart disease.[9] Different risk calculation tools do use different end points in practice – some tools use cardiovascular disease and others use coronary heart disease as an end point.

When using risk calculators, therefore, it is important to know which end points are being looked at and which equation has been used to calculate the risk.

The Framingham risk equations have been criticised for not including risk factors such as family history, sedentary lifestyle and obesity.

Population base

Most of the calculations for risk estimates are designed to look at absolute risk and are based on Framingham data, but other calculators have been developed using equations from research with other populations. An example is the Dundee Risk Disk[10] – this was developed using data from the UK Heart Disease Prevention project and the Scottish Heart Study.

It is debated whether a tool from one population has the same accuracy when used with other populations. Some studies suggest the Framingham function may not be suitable for European populations.[11,12]

A 1999 study compared risk calculators developed in different populations, mainly German, British and the Framingham population.[11] Although it concluded that there is close agreement between risk functions developed in the UK and Germany, and the Framingham function, the results also showed that some patients identified as having an absolute risk greater than 3% a year by the calculator developed in Britain were not identified by Framingham. In the German population there were also a number of high-risk individuals not identified. This suggests Framingham may underestimate risk in European populations.

A retrospective study published in 2000 concluded that the Framingham model reliably predicts risk of heart disease in the UK population when the annual risk is above 1.5% per annum but the graphs show that the event rate was consistently higher than the predicted rate up to 48% and the confidence intervals were wide.[12] This meant that some people in the UK population who had a risk greater than 1.5% per year were not identified.

Diabetes

There is growing concern that the Framingham data underestimate the cardiovascular risk of diabetics due to the small numbers in the study (337). This is backed up by a study published in *Diabetic Medicine* in 1999 which suggested that the Sheffield tables also have a low sensitivity in diabetes mellitus.[13] In diabetics, triglycerides and HbA1c may be better predictors than the predictors currently used. The authors of the UKPDS study have developed a risk tool specifically designed for diabetics;[14] the UKPDS risk engine has been developed from data derived from a diabetic population and is probably the best current tool for diabetics.

Heart disease

Most tools are designed for use in patients without established cardiovascular disease but some tools, have been derived from studies, including people with ischaemic heart disease. These use stroke or death from heart disease as an end point and can be used when considering patients with diseases, such as angina. The calculator developed from the British Regional Heart Study is an example.[15] This can be useful when informing a patient with cardiovascular disease of the risk of cardiovascular death if they continue to smoke compared against the risk of a non-smoker in a similar situation.

Points to consider

Some calculators have been designed using data from very specific areas of the population – the Dundee Risk Disk and British Regional Heart Study Risk Function were derived from solely male data, for example, which cannot be extrapolated to women.

So when looking at a risk tool there are various issues to consider:

- There are three different types of statistical models for calculating risk. The Weibull accelerated time model being the most recent
- Different risk tools calculate risk for different end points
- The Framingham calculations do not include important points such as family history
- There is debate as to whether data from one population can be extrapolated to another
- Framingham probably underestimates diabetic risk and a new tool has been developed using UKPDS data
- There are some risk tools which have been developed using data from people with existing heart disease
- Certain tools are only relevant for people with certain demographics.

Risk reduction

Risk tools can be used by clinicians to indicate to patients what will happen if they stop smoking or if their hypertension is treated, and so on. But this method assumes that people's risk will go down to that of a non-smoker or normotensive. A group in Canada suggested that using relative risk reductions from studies looking at, say the effects of antihypertensives, could be used to recalculate the new risk for cardiovascular disease if treatment is started.[5] A life expectancy model has been produced which can forecast the benefits of risk factor modification in primary and secondary prevention.[16] It uses potential years of life saved as an outcome measure.

Evaluation of cardiovascular risk tools

Studies have evaluated the specificity, sensitivity and predictive values of risk tools,[13,17,18] but there are currently no extensive studies looking at which tools patients find easier to comprehend and which tools clinicians find easiest and quickest to use, although there is work underway at Dundee University exploring these issues.

One of these studies evaluated the New Zealand, Sheffield, Joint British, Joint European societies' tables and the Canadian categorical system. It looked at specificity, sensitivity, false negative rate and false positive rate using the Framingham function as a gold standard.[17] The findings show that different risk tools have varying levels of accuracy. Sensitivity could be as low as 40% for the Sheffield tables meaning that only 40% of high-risk patients would be detected. One tool may have a high negative predictive value but a low sensitivity making it difficult to decide which tool to use. The Modified Sheffield tables, for example, underestimate risk in 1–3% of patients (97–99% negative predictive values) but overestimate risk in 29–15% of patients (positive predictive value being 71%–85%). The actual predictive values also vary according to whether an absolute risk higher than 1.5% or 3% per annum is considered high risk.

The Dundee Risk Disk was evaluated during its development.[10] Risk was calculated using the disk for people in the Whitehall study; the death rate due to coronary heart disease was recorded at five and 10 years. The actual death rate was compared to the predicted risk – this showed that as risk increased the death rate increased. The tool was evaluated for ease of use, and although most clinicians found it difficult to use for the first time, a large percentage said they would use the tool in practice.

The Medcal CHD[2] risk disk has been evaluated in a single practice, which showed that after the introduction of the disk there were reductions in risk behaviour, and an improvement in blood pressure control, all of which led to a reduction in relative risk.

While deciding which tools to suggest in the SIGN guidelines, Isles *et al*. looked at the speed and ease of use of several risk tools.[19] The Joint British Society charts[1] scored most favourably in this study.

The UKPDS risk engine was evaluated during development and the calculated risk estimate was similar to the observed event rate.

Using the tools

Tools have varying amounts of data that need to be input to give a risk estimate. Some include family history and others do not. This affects the accuracy of the tool but less data means tools are quicker to use. This factor needs to be considered if tools are to be used during consultations. Tools embedded in clinical patient systems may get round this but they often assume any unknown data is low risk or zeroed; this may cause risk to be underestimated. The most common unknown variable is left ventricular hypertrophy (LVH). Statisticians would recommend producing a new equation that doesn't use unknown data and it would probably be beneficial to do this for two reasons: the number of people in the Framingham study with LVH was small (43) and most general practitioners who would initiate primary prevention do not automatically do ECGs.

> ***'A tool that is quick and easy to use may cut back on data to be included and so alter accuracy'***

Some risk tools are aimed at patient use and are available on the web. Information regarding their development and accuracy is unavailable.

The way the information is presented also has implications for usability. Some tools display bar charts, which turn red, for example, when a patient gets into the high-risk category and yellow in the low-risk category. Visually this can be useful to patients.

A CD-rom has been developed by Medcal that calculates relative and absolute risk. It is designed to be used as an education tool in conjunction with the patient. As risk variables are entered, the change in relative risk is shown on a coloured bar chart which changes colour according to relative risk. The idea is that the patient sees which variable has the greatest effect on their relative risk. It also has the software to allow the clinician to print leaflets giving lifestyle advice that is relevant to the individual patient.

Developments

The European Society of Cardiology is working on the SCORE (Systematic Coronary Risk Evaluation) project, which has developed a large European database of cardiovascular events and risk factors. This data has been used to develop cardiovascular risk scores and a risk chart that could be applied to Europe. These results are due to be published in the *European Heart Journal* in the near future. One of the problems the project has highlighted is that there is a dramatic difference in risk between different countries and that different risk factors have different effects in different countries.

Dundee University is investigating the usability of various risk tools and how the tools are used in practice to influence changes in a patient's lifestyle.

Summary

There is a large and varied range of cardiovascular risk tools designed to produce risk estimates. Certain tools may not be accurate or validated in certain populations. When calculating absolute risk it is important to ensure the tool is appropriate for the individual whose risk is being calculated in terms of demographics, cardiovascular history and population.

A single clinician may use several different tools depending on what information he is looking for. A tool

Key messages

- Different tools should be used in different situations – tools calculating absolute risk may not be helpful in encouraging young patients to make lifestyle changes but are useful in deciding whether to prescribe a particular drug; tools calculating relative risk with clear graphics can be helpful in patient education
- Risk tools may not extrapolate well into different populations
- It is important to know which end points each risk tool is calculating
- Different risk tools have varying levels of accuracy

which gives relative risk may be more beneficial when encouraging a young patient to stop smoking, while a tool giving absolute risk is useful when deciding on whether or not to prescribe antihypertensives or statins to a patient.

When assessing risk tools for use, it is important to look at which statistical model has been used to develop the calculation, which population the tool is derived from and the limitations on the types of patients the tools can be used for. It is also important to look at how or if the tool has been validated. Another important factor is how the tool is going to be used. A tool that is quick and easy to use is ideal during a 10 minute consultation but may cut back on data to be included and so alter accuracy of the tool. A tool used for patient education may be better if it contains graphs and bar charts but a single figure is all a clinician needs when looking for absolute risk.

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References

1. Wood D, Durrington P, Poulter N, McInnes G, Rees A, Wray A. Joint British recommendations on prevention of coronary heart disease in clinical practice. *Heart* 1998;**80**(suppl 2): S1-S29.
2. RISK computer program CD-Rom. Sheffield; Medcal Limited. Website: www.medcal.co.uk
3. Hingorani AD, Vallance P. A simple computer program for guiding management of cardiovascular risk factors and prescribing. *BMJ* 1999;**318**:101-05.
4. Haq IU, Jackson PR, Yeo WW, Jackson PR, Ramsay LE. Sheffield risk and treatment table for cholesterol lowering for primary prevention of coronary heart disease. *Lancet* 1995;**346**:1467-71.
5. McCormack JP, Levine M, Rangno RE. Primary prevention of heart disease and stroke: a simplified approach to estimating risk of events and making drug treatment decisions. *Can Med Assoc J* 1997;**157**:422-8.
6. Montgomery AA, Fahey T, Peters TJ, MacIntosh C, Sharp DJ. Estimation of computer based clinical decision support system and risk chart for management of hypertension in primary care: randomised control trial. *BMJ* 2000;**320**:686-90.
7. American Heart Association. *Coronary risk handbook: estimating the risk of coronary heart disease in daily practice.* Dallas Texas: AHA; 1973.
8. Anderson KM, Wilson PWF, Odell PM, Kannel WB. An updated coronary risk profile. *Circulation* 1991;**83**:356-62.
9. Anderson KM, Odell PM, Wilson PWF, Kannel WB. Cardiovascular disease risk profiles. *Am Heart J* 1991;**121**:293-8.
10. Tunstall-Pedoe H. The Dundee coronary risk-disk for management of change in risk factors. *BMJ* 1991;**303**:744-7.
11. Haq IU, Ramsay LE, Yeo WW, Jackson PR, Wallis EJ. Is the Framingham risk function valid for North European populations? A Comparison of methods for estimating absolute coronary risk in high risk men. *Heart* 1999;**81**:40-6.
12. Ramachandran S, French JM, Vanderpump MPJ, Croft P, Neary RH. Using the Framingham model to predict heart disease in the United Kingdom: retrospective study. *BMJ* 2000;**320**:676-7.
13. Bayly GR, Bartlett WA, Davies PH *et al*. Laboratory based calculation of coronary heart disease risk in a hospital diabetic clinic. *Diabet Med* 1999;**16**:697-701.
14. Stevens RJ, Kothari V, Adler AI, Stratton IM, Holman RR. The UKPDS risk engine: a model for the risk of coronary heart disease in type 2 diabetics (UKPDS 56). *Clin Sci* 2001;**101**: 671-9.
15. Shaper AG, Pocock SJ, Phillips AN, Walker M. Identifying men at high risk of heart attacks: strategy for use in general practice. *BMJ* 1996;**293**:474-9.
16. Grover SA, Paquet S, Levinton C, Coupal L, Zowall H. Estimating the benefits of modifying cardiovascular risk factors: a comparison of primary versus secondary prevention. *Arch Intern Med* 1998;**158**:655-62.
17. Jones AF, Walker J, Jewkes C *et al*. Comparative accuracy of cardiovascular risk prediction methods in primary care patients. *Heart* 2001;**85**:37-43.
18. Wallis EJ, Ramsay LE, Haq IU *et al*. Coronary cardiovascular risk estimation for primary prevention: validation of a new Sheffield table in the 1995 Scottish health survey population *BMJ* 2000;**320**:671-6.
19. Isles CG, Ritchie LD, Murchie P, Norrie J. Risk assessment in primary prevention of coronary heart disease: randomised comparison of 3 scoring methods. *BMJ* 2000;**320**:690-1.