

# The effectiveness and cost-effectiveness of computed tomography screening for coronary artery disease: systematic review

N Waugh,<sup>1\*</sup> C Black,<sup>1</sup> S Walker,<sup>2</sup> L McIntyre,<sup>3</sup>  
E Cummins<sup>4</sup> and G Hillis<sup>5</sup>

<sup>1</sup> Department of Public Health, University of Aberdeen, UK

<sup>2</sup> Radiology Department, Aberdeen Royal Infirmary, UK

<sup>3</sup> Stromness, Orkney, UK

<sup>4</sup> McMaster Development Consultants, Glasgow, UK

<sup>5</sup> Cardiology Department, Aberdeen Royal Infirmary, UK

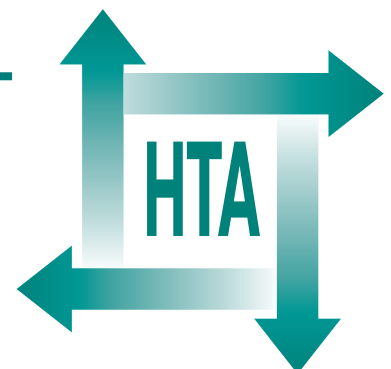
\* Corresponding author



## Executive summary

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## Executive summary

### Background

Coronary heart disease (CHD) is one of the main causes of mortality and morbidity in the UK and other Western countries. The disease can be asymptomatic until the first event, which may be a fatal myocardial infarction (heart attack). Half of all heart attacks occur in people who have had no prior warning of coronary disease, and almost half will die from the first attack.

Risk scores based on well-known factors such as age, blood pressure, smoking, cholesterol and diabetes have been used to assess risk, but are imperfect: not all high-risk people develop heart disease, and many low-risk people do. Indeed, depending on which cut-off is used to define high risk, most heart attacks occur in low-risk people, because the number of people at low risk is much greater than the number at high risk. There is therefore a need for a better way of identifying those at risk so that they can treat themselves with lifestyle measures, or receive drug therapy such as statins and antihypertensive drugs as appropriate.

Computed tomography (CT) is a form of radiological imaging that can detect calcium deposits in the coronary arteries. This calcification is a marker for CHD, and so CT imaging could be a way of detecting asymptomatic but serious CHD. CT is quick and non-invasive, but does involve a relatively large radiation dose.

### Objectives

The aim of the review was to assess the clinical and cost-effectiveness of CT screening for asymptomatic coronary artery disease (CAD). The first question was whether such screening would be worthwhile. If so, subsidiary questions included how to target screening, and which CT method should be used. Other questions included:

- Does coronary artery calcification (CAC) predict coronary events?
- Does CAC add anything to risk factor scores?
- Does measuring CAC change treatment?

### Methods

A systematic review of screening studies and economic evaluations was carried out, along with a review of the case for screening against the criteria used by the National Screening Committee (NSC) for assessing screening programmes.

#### Search strategy and inclusion criteria

Searches were carried out for a broad range of evidence using a sensitive search strategy, using the bibliographic databases MEDLINE, EMBASE, Cochrane Database of Systematic Reviews, Cochrane CENTRAL Register of Clinical Trials, NHS EED, the HTA database, Science Citation Index, BIOSIS, Web of Science Proceedings and the National Research Register. There was no language restriction.

Preliminary searches showed that there had been no randomised controlled trials (RCTs) to evaluate screening for CAD using CT, and so no limitation on type of study was applied. Systematic reviews were sought for the period 1994–2005, and assessed for quality. Primary studies were sought only for the years subsequent to the dates of searches in the recent reviews. It was decided that information from observational studies such as case series or cohort studies may provide evidence of effectiveness and costs. Ideally, studies would include an intervention to reduce risk. The bibliographies of included studies were searched, but authors were not contacted for further information. Studies were included if screening for CHD was the principal theme of the study, and if data were provided that allowed comparison of CT screening with current practice, which was taken to be risk factor scoring. The study was particularly interested in whether there were mismatches between CAC scores and risk factor scoring, for example if some people with low risk factor scores had high CAC scores, and vice versa, since this might imply that CT detection of CAC provided added value to risk scoring alone.

### Results

No RCTs were found that assessed the value of CT screening in reducing cardiac events. Seven studies

were identified that assessed the association between CAC scores on CT and cardiac outcomes in asymptomatic people and included 30,599 people. Six used electron-beam CT. The relative risk of a cardiac event was 4.4 if CAC was present, compared to there being no CAC. As CAC score increased, so did the risk of cardiac events. The correlation between CAC and cardiac risk was consistent across studies.

There was evidence that CAC scores varied among people with the same Framingham risk factor scores, and that within the same Framingham bands, people with higher CAC scores had significantly higher cardiac event rates. This applied mainly when the CAC scores exceeded 300. There was little difference in event rates among the groups with no CAC, and scores of 1–100 and 101–300. In one study, CAC score was a better predictor of cardiac events than the Framingham risk scores.

No studies were found that showed whether the addition of CAC scores to standard risk factor assessment would improve outcomes. There were reports from two observational studies that lowering of low-density lipoprotein cholesterol to about 3 mmol l<sup>-1</sup> or below with statin treatment modestly reduced CAC scores, but this was not confirmed in two RCTs. Three studies examined whether knowledge of CAC scores would affect compliance with lifestyle measures. The knowledge affected perception of risk, but did not improve smoking cessation rates. It did increase anxiety.

### Summary of cost-effectiveness

There were few economic studies of CT screening for heart disease. These provided useful data on costs of scans, other investigations and treatment, but had to rely on a number of assumptions, and were unable to provide definitive answers. One modelling study estimated that adding CT screening to risk factor scoring, and only giving statins to those with a CAC score over 100, would save money, based on a cost per CT screen of US\$400 and statin costs of US\$1000 per annum per patient. However, the arrival of generic statins has reduced the price dramatically, and these savings no longer apply.

### Conclusions

CT examination of the coronary arteries can detect calcification indicative of arterial disease in

asymptomatic people, many of whom would be at low risk when assessed by traditional risk factors. The higher the CAC score, the higher the risk. Treatment with statins can reduce that risk. However, CT screening would miss many of the most dangerous patches of arterial disease, because they are not yet calcified, and so there would be false-negative results: normal CT followed by a heart attack. There would also be false-positive results in that many calcified arteries will have normal blood flow and will not be affected by clinically apparent thrombosis: abnormal CT not followed by a heart attack.

For CT screening to be cost-effective, it has to add value over risk factor scoring, by producing sufficient extra information to change treatment and hence cardiac outcomes, at an affordable cost per quality-adjusted life-year. There was insufficient evidence to support this. Most of the NSC criteria were either not met or only partially met.

### Recommendations for future research

It remains unclear whether CT screening would provide sufficient extra information over risk factor scoring for it to be worthwhile.

- More data are needed, including from the UK, on the distributions of risk scores and CAC scores in asymptomatic people, and the level of concordance between risk factor and CAC scores.
- The risk of cardiac events per annum according to CAC score and risk factor scores should be assessed
- Information on the acceptability of CT screening, after information about the radiation dose, would be useful.
- An RCT could be conducted on adding CT screening to current risk factor-based practice.

### Publication

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# NHS R&D HTA Programme

The research findings from the NHS R&D Health Technology Assessment (HTA) Programme directly influence key decision-making bodies such as the National Institute for Health and Clinical Excellence (NICE) and the National Screening Committee (NSC) who rely on HTA outputs to help raise standards of care. HTA findings also help to improve the quality of the service in the NHS indirectly in that they form a key component of the 'National Knowledge Service' that is being developed to improve the evidence of clinical practice throughout the NHS.

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