CT coronary angiography in patients suspected of having coronary artery disease: decision making from various perspectives in the face of uncertainty

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Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

CRD summary
This study examined the cost-effectiveness of computed tomography (CT) coronary angiography, performed before conventional coronary angiography, in patients with suspected coronary artery disease. The optimal diagnostic strategy depended on the diagnostic accuracy of CT coronary angiography and the prior probability of coronary artery disease, with CT coronary angiography likely to be cost-effective below an average prior probability of 40%. The methods were valid and, despite some limited reporting of data sources, the authors’ conclusions appear to be robust.

Type of economic evaluation
Cost-utility analysis

Study objective
This study examined the cost-effectiveness of using computed tomography (CT) coronary angiography as a triage test, performed before conventional coronary angiography, in patients with chest pain who were suspected of having coronary artery disease.

Interventions
The new strategy was 64-section CT coronary angiography as an initial imaging test, followed by conventional coronary angiography if CT coronary angiography results were positive. The comparator was conventional coronary angiography only.

Location/setting
Netherlands/out-patient.

Methods
Analytical approach:
The analysis was based on a decision analytic model for the short-term period followed by a Markov model with a lifetime horizon. The authors stated that the analysis was conducted from the perspectives of the patient, physician, hospital, health care system and society. Three perspectives that followed international guidelines for cost-effectiveness were used: in the UK, health care perspective; in the USA, societal perspective (without friction costs); and in the Netherlands, societal perspective (with friction costs).

Effectiveness data:
The clinical data were identified through a literature review. Limited details of inclusion criteria and types of studies found were provided. Diagnostic accuracy of CT coronary angiography was the main clinical input of the model and was obtained from two recent meta-analyses. Other data on mortality risk were taken from the Framingham Heart Study. An alternative analysis was conducted using data from a cohort of 233 patients with suspected coronary artery disease treated at the authors’ institution. Some assumptions were also necessary. Men and women were studied separately, given the different level of risk for cardiac events.

Monetary benefit and utility valuations:
Quality of life was modelled on the probability of successful relief from angina by means of treatment. Utility values were derived from published studies, including one study on patients with multi-vessel coronary artery disease.
Measure of benefit:
Quality-adjusted life-years (QALYs) were used as the summary benefit measure. Life-years were also reported. The annual discount rate was 3.5% using UK guidelines, 3% using US guidelines, and 1.5% using Dutch guidelines.

Cost data:
The economic analysis included the costs of diagnostic tests, treatment (percutaneous coronary intervention, coronary artery bypass graft, medication), events during follow-up, travel, patient time, productivity losses and re-interventions. Resource use data appear to have been derived from the literature, or were based on authors’ assumptions. Both friction costs method was used to assess productivity costs using the Dutch guidelines. Most unit costs were derived from the Dutch manual, the Central Bureau of Statistics, and the National Health Care Authority. Costs were in Euros (EUR) and the price year was 2007. The discount rate was 3.5% using UK guidelines, 3% using US guidelines, and 4% using Dutch guidelines.

Analysis of uncertainty:
One-way and two-way sensitivity analyses were carried out on model inputs. Alternative estimates were derived from the literature. A probabilistic analysis was also undertaken using a Monte Carlo simulation of 100,000 samples, and predetermined probability distributions. The expected value of perfect information was assessed to identify the parameters that were the greatest sources of uncertainty. Finally, a scenario analysis was carried out using input data from the cohort study of 233 stable patients suspected of having coronary artery disease that was carried out at the authors’ institution.

Results
From the patient/physician perspective, CT coronary angiography maximised QALYs at a prior probability of coronary artery disease of less than 17% in men and less than 11% in women.

From the hospital/health care perspective, CT coronary angiography lowered all costs at a prior probability of less than 87 to 92%.

From a societal perspective, when using a threshold of EUR 80,000 per QALY, CT coronary angiography was cost-effective when the prior probability was lower than 44% in men and 37% in women.

For UK guidelines, men with a prior probability of coronary artery disease of 79%, the expected cost was EUR 31,506 and QALYs were 11.578 with CT coronary angiography; with conventional coronary angiography the expected cost was EUR 32,095 and QALYs were 11.615; the incremental cost per QALY gained for conventional coronary angiography over CT coronary angiography was EUR 15,915 (incremental cost per QALY for women was EUR 19,913, with a prior probability of coronary artery disease of 65%).

The corresponding values when using US guidelines for men were EUR 34,154 for expected cost and 12.180 QALYs with CT coronary angiography; with conventional coronary angiography expected cost of EUR 34,797 and 12.219 QALYs; the incremental cost per QALY gained for conventional coronary angiography over CT coronary angiography was EUR 16,509 (EUR 20,360 for women).

The corresponding values when using Dutch guidelines were EUR 386,640 for expected costs and 14.36 QALYs with CT coronary angiography; with conventional coronary angiography expected cost of EUR 386,822 and 14.406 QALYS; the incremental cost per QALY gained for conventional over CT coronary angiography of EUR 4,095 (EUR 10,383 for women).

Thus, conventional angiography was cost-effective using all these guidelines at the average risk of prior probability of coronary artery disease found in the literature.

Higher figures were found in the cohort study, but conventional angiography was still cost-effective. The deterministic analysis highlighted the impact of CT coronary angiography sensitivity on the base case findings. The probability of CT coronary angiography being cost-effective at a threshold of EUR 80,000 per QALY was 2% in men and 13% in women. Value of information analysis showed an expected value of perfect information for further research of EUR 3 per man and EUR 46 per woman. The most uncertain variables for women were the prior probability of coronary artery
disease, radiation risk and test characteristics.

**Authors' conclusions**
The authors concluded that the optimal diagnostic strategy depended on the diagnostic accuracy of CT coronary angiography and the prior probability of coronary artery disease, with CT coronary angiography likely to be cost-effective below an average prior probability of 40%. Above this threshold, conventional coronary angiography remained the preferred strategy.

**CRD commentary**

**Interventions:**
The rationale for the selection of the comparators was clear; the new diagnostic strategy (CT coronary angiography) was compared with the conventional and invasive coronary angiography approach.

**Effectiveness/benefits:**
A review of the literature was a valid means to identify relevant data sources, but the methods and conduct of the review were not fully presented. Also, the authors provided limited information on data sources and did not mention the quality of the data. However, it was stated that the best available evidence in the literature was used, and that the accuracy of CT coronary angiography (which was one of the key parameters) was based on meta-analyses that should have ensured high internal validity. In addition, an alternative scenario with data obtained from a cohort of patients at the authors’ institution was used. The utility values used to derive QALYs were extensively reported, but the methodological aspects of utility sources were not provided. QALYs were an appropriate benefit measure for this specific patient population given the impact of the disease on both quality of life and survival.

**Costs:**
The economic analysis appeared to have been valid and was consistent with the various viewpoints considered in the study, although limited information on unit costs and quantities of resources used was given. Clear information on the derivation of costs was provided. The price year and the use of discounting were clearly reported. Costs were varied both in the deterministic and probabilistic sensitivity analysis using standard distributions. In general, the economic side of the study was well presented.

**Analysis and results:**
An appropriate incremental approach was used to synthesise the costs and benefits of the two diagnostic approaches. The study results were clearly presented. The issue of uncertainty was satisfactorily investigated using various approaches, the findings of which were discussed. The models were only partially described, with supplementary information available from an online appendix (see 'URL for Additional Data' below for the link). The authors acknowledged some limitations of their analysis, such as the use of some data that may have partially biased some results.

**Concluding remarks:**
The study appeared to have been based on valid methodology and, despite some limited reporting of data sources, the authors' conclusions appear robust.

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