Clinical outcomes and cost-effectiveness of coronary computed tomography angiography in the evaluation of patients with chest pain


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 coronary computed tomography angiography (CCTA), compared with conventional diagnostic procedures, for patients with stable chest pain and suspected coronary artery disease. CCTA with or without subsequent stress electrocardiogram was marginally associated with the greatest quality-adjusted survival, at a reasonable cost, but there was little difference in health and cost outcomes across all the strategies. The methods were robust and the authors’ conclusions appear to be valid.

Type of economic evaluation
Cost-utility analysis

Study objective
This study examined the cost-effectiveness of coronary computed tomography angiography (CCTA), compared with conventional diagnostic procedures, for patients aged 45 to 65 years with stable chest pain and suspected coronary artery disease (CAD), which was defined as a 50% or greater stenosis in the left main coronary artery or a 70% or greater stenosis in any other coronary artery.

Interventions
The analysis considered eight strategies, which were CCTA followed by stress electrocardiogram (ECG); stress ECG followed by CCTA; CCTA alone; stress ECG alone; stress echocardiography; stress single-photon emission computed tomography (SPECT); cardiac catheterisation; and no diagnostic test.

Stress testing was performed using exercise rather than drugs. Each diagnostic test was followed by treatment based on positive or negative results, and this included medicines, percutaneous coronary intervention, or coronary artery bypass graft (CAGB) surgery.

Location/setting
USA/primary care and hospital.

Methods
Analytical approach:
The analysis was based on a Monte Carlo micro-simulation model, with a lifetime horizon. The authors did not explicitly state the perspective adopted.

Effectiveness data:
The clinical data were from a selection of relevant studies. The accuracy of diagnostic tests (sensitivity and specificity) was the key input to the model and was from meta-analyses of published studies. Other important data, such as the adverse events or incidental findings with CCTA were from meta-analyses, clinical trials, and studies that pooled results from published reports. Some data were from official registries, such as the National Cancer Institute. Some assumptions were required.

Monetary benefit and utility valuations:
The utility values were from published studies that assessed the decrements in quality of life, due to severe angina.
Measure of benefit:
Quality-adjusted life-years (QALYs) were the summary benefit measure and they were discounted at an annual rate of 3%.

Cost data:
The economic analysis included the costs of the tests, medicines, and treatment of events directly related to CAD, including medication, diagnostic investigations, surgery, hospital stay, and annual costs for non-fatal myocardial infarction. These costs were mainly from Medicare reimbursement rates, as well as from published studies. They were in US dollars ($) and were discounted at an annual rate of 3%. The price year was 2005.

Analysis of uncertainty:
The analysis consisted of 1,000,000 first-order Monte Carlo simulations. One-way sensitivity analyses were carried out on the key inputs to the model.

Results
The expected QALYs were similar for the various strategies for both men and women. The QALYs for men were: 13.632 with CCTA then ECG; 13.552 with ECG then CCTA; 13.631 with CCTA; 13.566 with ECG; 13.586 with echocardiography; 13.62 with SPECT; 13.605 with cardiac catheterisation; and 13.33 with no test. The results for women ranged from 16.5 to 16.605.

The projected total costs in men were: $35,500 with CCTA then ECG; $33,870 with ECG then CCTA; $35,720 with CCTA; $33,970 with ECG; $34,510 with echocardiography; $35,670 with SPECT; $37,340 with cardiac catheterisation; and $27,580 with no test. The costs were about half these amounts for women. The higher costs with CCTA were due to the increasing rate of CAD detection and the detection and follow-up of incidental findings (pulmonary nodules).

The incremental analysis showed that the most efficient strategies were ECG then CCTA and CCTA then ECG in women, while in men, the most efficient strategy was CCTA then ECG. The incremental cost per QALY gained with CCTA then ECG was $26,200 in men and $35,000 in women.

The sensitivity analysis showed that the lower the pre-test risk of CAD, the higher the incremental cost per QALY. In the worst-case scenario for CCTA efficacy, the results did not change substantially. The exclusion of follow-up for incidental findings did not affect the QALYs, but did reduce the costs for CCTA strategies.

Authors' conclusions
The authors concluded that CCTA with or without stress ECG was marginally associated with the greatest quality-adjusted survival, at a reasonable cost, but there was little difference in cost and health outcomes across all of the strategies.

CRD commentary
Interventions:
The selection of the comparators was appropriate as a wide range of diagnostic strategies was considered. Patient management, in the key diagnostic branches of the model, was described. The authors stated that other pathways were possible.

Effectiveness/benefits:
No systematic review was reported to identify the relevant sources of data. In general, meta-analyses and clinical trials were appropriate sources as their methods should ensure the validity of the clinical inputs. Meta-analyses were used for the key model parameters, namely the accuracy of the diagnostic tests. The authors stated that survival and the adverse event rates were from a trial that included a population with higher risks than the one considered in this study, and this might be a limitation of the analysis, but these values were tested in the sensitivity analyses. QALYs were an appropriate benefit measure because the disease has a substantial impact on both morbidity and mortality in CAD patients. The estimates of health-related quality of life were from the literature, but the instruments used to elicit the preferences and who supplied these preferences were not reported.
Costs:
The perspective was not explicitly stated, but the categories of costs and their sources suggest the adoption of a third-party payer perspective. The unit costs were presented for some items, but category totals were reported for most of them. This approach is typical when payer costs are considered, but it reduces the transparency of the analysis. The price year and discounting were clearly stated. Alternative cost estimates were investigated in the sensitivity analyses.

Analysis and results:
The analysis used a valid incremental approach that allowed the identification of the most cost-effective strategy. The expected costs and benefits were clearly reported for both women and men, but the incremental cost-utility ratios were only presented in graphs. The uncertainty was investigated well, using both a deterministic and a probabilistic approach, and the results were clearly reported. The authors stated that the exclusion of incidental findings other than lung nodules might have reduced the real costs, but also the potential benefits of CCTA. They also stated that the high uncertainty and similarity in the costs and outcomes of the various strategies showed the need for future large and well-conducted randomised controlled trials comparing these options.

Concluding remarks:
The methods were robust and the authors' conclusions appear to be valid.

Funding
Funding received from NEMA.

Bibliographic details

PubMedID
20082932

DOI
10.1016/j.jacc.2009.10.012

Original Paper URL
http://content.onlinejacc.org/cgi/content/short/54/25/2409

Indexing Status
Subject indexing assigned by NLM

MeSH
Cardiac Catheterization /economics; Chest Pain /epidemiology; Computer Simulation; Coronary Angiography /economics; Coronary Artery Disease /diagnosis /economics; Coronary Stenosis /diagnosis /economics; Cost-Benefit Analysis; Electrocardiography /economics; Exercise Test /economics; Female; Health Care Costs; Humans; Longevity; Male; Middle Aged; Monte Carlo Method; Quality of Life; Quality-Adjusted Life Years; Sex Factors; Tomography, Emission-Computed, Single-Photon /economics; Tomography, X-Ray Computed /economics

AccessionNumber
22010000075

Date bibliographic record published
04/08/2010

Date abstract record published
16/03/2011