A simulation model of clinical and economic outcomes of cardiac CT triage of patients with acute chest pain in the emergency department

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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 coronary computed tomography (CT) angiography in the emergency department triage of low-risk patients with acute chest pain, non-significant electrocardiogram changes, and negative initial cardiac markers. The authors concluded that triage with early coronary CT angiography produced better diagnostic performance, and could improve survival and be cheaper than usual care, with either SPECT or stress echocardiography. The analysis was well presented, but had some methodological limitations that might affect the validity of the authors’ conclusions.

Type of economic evaluation
Cost-effectiveness analysis

Study objective
This study examined the cost-effectiveness of coronary computed tomography (CT) angiography, compared with usual care, in the triage in the emergency department of low-risk patients, with acute chest pain, non-significant electrocardiogram (ECG) changes, and negative initial cardiac markers.

Interventions
With usual care, the patients’ serial cardiac markers were re-evaluated six to eight hours after admission to the emergency department. Patients with positive results were referred for invasive coronary angiography, while those with negative results were either discharged or given single photon emission CT (SPECT) or stress echocardiography. With CT angiography, patients were imaged immediately and, depending on the resulting stenosis, they were discharged (none), given usual care with repeat cardiac markers and SPECT or stress echocardiography (mild or indeterminate), or referred directly to invasive coronary angiography (severe).

Location/setting
USA/hospital emergency department.

Methods
Analytical approach:
The analysis used a published micro-simulation model, with a 30-day time horizon and a cohort of 55-year-old men and women, with acute chest pain. The authors stated that the analysis was carried out from the perspective of the third-party payer.

Effectiveness data:
The clinical data appear to have been from a selection of relevant studies. Most of the epidemiology data on mortality after a cardiac event were from large cohorts of US patients. The test accuracy for CT angiography, a key model input, was from a diagnostic study, while the accuracies of SPECT and stress echocardiography were from a meta-analysis. Each model parameter appears to have been from one study with no need for pooling data. Some assumptions were made.

Monetary benefit and utility valuations:
Not considered.
Measure of benefit:
The number of patients referred to invasive angiography and the number of deaths were the key outcomes of the model.

Cost data:
The economic analysis included the costs of coronary CT angiography, SPECT, stress echocardiography, invasive coronary angiography, coronary artery bypass grafting, percutaneous coronary intervention, delay (close monitoring of patients for six to eight hours before repeat cardiac marker testing), and the emergency department visit. These costs were based on Medicare reimbursement rates, using the Current Procedural Terminology codes for each item. The quantities of resources depended on the diagnostic pathway. All costs were in US dollars ($).

Analysis of uncertainty:
One-way sensitivity analyses were carried out on the percentage of patients who were immediately discharged upon mild CT angiography findings, the prevalence of coronary artery disease, the accuracy of coronary CT angiography, the mortality due to undiagnosed acute coronary syndrome (ACS), the use of SPECT or stress echocardiography, and the costs of coronary CT angiography. The ranges of values were from published literature. A first-order Monte Carlo simulation was carried out.

Results
Due to its greater accuracy, coronary CT angiography reduced the number of missed ACS cases and the number of referrals for invasive coronary angiography. After 30 days, the number of deaths was six with usual care and four with coronary CT angiography.

With SPECT: The number of patients referred to invasive angiography was 255 for CT angiography compared with 406 for usual care. The total costs per patient were $5,397 with usual care and $5,114 with coronary CT angiography.

With stress echocardiography: The number of patients referred to invasive angiography was 252 for CT angiography compared with 370 for usual care. The total costs per patient were $4,858 with usual care and $5,066 with coronary CT angiography.

The sensitivity analysis showed that the coronary artery disease prevalence was an influential input for the model, but CT angiography remained more effective and less costly.

Authors' conclusions
The authors concluded that a triage process incorporating early coronary CT angiography produced better diagnostic performance, could improve survival, and could be cheaper than usual care with either SPECT or stress echocardiography, in the emergency department. It remained cheaper than usual care with SPECT when including the 30-day treatment costs.

CRD commentary
Interventions:
The selection of the comparators was appropriate and a clear description of the two diagnostic pathways was provided.

Effectiveness/benefits:
The epidemiological data were from large cohort studies that should have reflected the US population. The authors stated that the study that supplied the CT angiography accuracy might have underestimated its real sensitivity and specificity and these data should be considered to be conservative. The accuracies of the other tests were appropriately from a meta-analysis. Sensitivity analysis was conducted on the most uncertain data. The authors reported various outcome measures to examine the clinical impact of the two diagnostic strategies. The use of 30-day mortality as the main benefit measure appears to have been appropriate to the study objective.

Costs:
The categories of costs reflected the perspective of the third-party payer as stated by the authors. The use of Medicare as the main source of costs was typical of studies conducted in the USA, but it might not have provided precise estimates of the real costs. The total cost of each procedure was reported, with the pathway for each test and treatment
option. Some changes in the cost variables were made in the sensitivity analysis, but the costs were generally treated deterministically. The price year was not explicitly reported.

Analysis and results:
The results were clearly reported. A synthesis of the costs and benefits was not performed, as a cost-consequences analysis appears to have been carried out. The uncertainty was only partly investigated, using a deterministic and univariate approach; the results were extensively reported. The analysis used a short time horizon (30 days), which appears to have been relevant for these patients. The authors stated that a longer time horizon would have required several assumptions. The analysis was of a population at low or medium risk of ACS and it might not be transferable to patients with a very low risk of ACS. The authors acknowledged some limitations of their analysis, such as the exclusion of incidental findings and radiation exposure. This appears to be an important limitation, as CT angiography had higher radiation exposure than the other options, with potential consequences for the patients’ quality of life.

Concluding remarks:
The analysis was well presented, but had some methodological limitations that might affect the validity of the authors’ conclusions.

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