Cost-effectiveness of diagnostic strategies for patients with chest pain
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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.

Health technology
Exercise electrocardiography, exercise echocardiography, exercise single-photon emission computed tomography (SPECT), and coronary angiography in the diagnosis of coronary artery disease. The following strategies were considered: (1) no testing and medical therapy as appropriate; (2) exercise electrocardiography with coronary angiography if test results were positive; (3) exercise echocardiography with coronary angiography if test results were positive; (4) exercise SPECT with coronary angiography if test results are positive, and (5) routine coronary angiography without previous non-invasive testing. In addition, there were two possible post-catheterisation strategies: standard: coronary artery by-pass surgery (CABG) for triple-vessel or left main coronary artery disease, percutaneous transluminal coronary angioplasty (PTCA) for single- or double-vessel coronary artery disease if the patient was eligible; otherwise, medical therapy as appropriate; and conservative: CABG for triple-vessel or left main coronary artery disease, otherwise, medical therapy as appropriate.

Type of intervention
Diagnosis.

Economic study type
Cost-utility analysis.

Study population
The study population was hypothetical cohorts of patients with three types of chest pain, typical angina, atypical angina, and non-specified chest pain. According to intensity, chest pain was classified as mild or severe. Base-case analysis considered male patients aged 50 to 59 years who had no history of myocardial infarction, and who were able to perform an exercise stress test (reference patients). Further analysis considered similar patients but from different age groups (40 to 49, and 60 to 69).

Setting
Hospital. The economic study was performed in the USA.

Dates to which data relate
Cost data were adjusted to 1996 US dollars. Effectiveness and resources used were retrieved from studies published between 1983 and 1995.

Source of effectiveness data
Effectiveness data were derived from published studies.

Modelling
A decision analytic model was constructed using SMTTREE software. Markov models were used to estimate life-time
Outcomes assessed in the review
The following outcomes were assessed from the literature: prevalence of coronary artery disease for patients with typical, atypical, and non-specific chest pain; sensitivity and specificity of diagnostic tests (exercise electrocardiography, exercise echocardiography, SPECT, and coronary angiography); probabilities of negative outcomes (death and non-fatal myocardial infarction) associated to CABG and PTCA.

Study designs and other criteria for inclusion in the review
Not stated.

Sources searched to identify primary studies
Not stated.

Criteria used to ensure the validity of primary studies
Not stated.

Methods used to judge relevance and validity, and for extracting data
Not stated.

Number of primary studies included
The authors retrieved information from 32 studies published in the period 1983-1998.

Methods of combining primary studies
Some clinical outcomes (sensitivity and specificity of exercise electrocardiography, exercise echocardiography, SPECT, and mortality risk reductions by CABG) were retrieved from a published meta-analysis. Sensitivity for multi-vessel and for severe coronary artery disease was estimated using the ratio of patients with multi-vessel (severe) disease to those with any coronary artery disease, reported in the studies included in the meta-analysis.

Investigation of differences between primary studies
Not stated.

Results of the review
The prevalence of any coronary arterial disease for base-case reference patients was 95% for typical, 71% for non-typical and 18% for non-specific angina.

Exercise electrocardiography sensitivity and specificity were 0.68 (95% CI: 0.67 - 0.69) and 0.77 (95% CI: 0.76 - 0.78).

Exercise echocardiography sensitivity and specificity were 0.85 (95% CI: 0.83 - 0.87) and 0.77 (95% CI: 0.74 - 0.80).

Exercise SPECT sensitivity and specificity were 0.87 (95% CI: 0.86 - 0.88) and 0.64 (95% CI: 0.60 - 0.68).

Associated CABG overall probability of death was 3.2% and non-fatal myocardial infarction was 7.0%.

For PTCA, mortality and non-fatal myocardial infarction rates were 0.2% and 3.5% in single vessel coronary artery disease and 0.9% and 5.2% in double vessel coronary artery disease.
Measure of benefits used in the economic analysis
Health benefits were measured in terms of quality-adjusted life expectancies (years) discounted at an annual rate of 3%. Health quality of life scores were estimated using the standard gamble method on a survey of 211 patients with chronic stable angina.

Direct costs
Costs and quantities were not reported separately. Costs were discounted at a 3% annual rate. The main costs components were: costs of exercise electrocardiography, exercise echocardiography, exercise single photon emission computed tomography, coronary angiography, percutaneous transluminal coronary angioplasty, coronary artery bypass grafting, myocardial infarction, and the annual cost of no event for patients with no angina, mild angina and severe angina. For the exercise tests Medicare-allowed charges were used as a proxy for costs. Medicare administrative data were used to obtain hospital costs. Professional costs were estimated from the Medicare fee schedule. Costs were adjusted to 1996 US dollars.

Indirect Costs
Indirect costs were not considered.

Currency
US dollars ($).

Sensitivity analysis
One-way, two-way and probabilistic (using Monte Carlo simulations) sensitivity analyses were performed. A probabilistic sensitivity analysis of cost was performed using Monte Carlo simulations.

Estimated benefits used in the economic analysis
The utility scores assigned were as follows:

non-symptomatic, 0.87 (95% CI: 0.77 - 1.0),
mild symptoms, 0.81 (95% CI: 0.68 - 1.0),
and severe symptoms 0.67 (95% CI: 0.40 - 0.98).

Discounted quality-adjusted life expectancies for base-case patients with typical angina were in the range 10.43 to 10.95 for all the alternative diagnostic strategies. Similarly discounted quality-adjusted life expectancies for base-case patients with atypical angina were in the range 11.89 to 12.21 for all possible diagnostic strategies. Finally, discounted quality-adjusted life expectancies for base-case patients with atypical angina were in the range 14.23 to 14.28 for the five different alternative diagnostic strategies.

Cost results
The estimated total costs of diagnosis using any of the alternative tests were:

patients with typical angina, $32,117 to $51,143;
patients with atypical angina, $28,666 to $44,404;
and patients with non-specific chest pain, $24,304 to $32,132.

Synthesis of costs and benefits
Cost and benefits were combined to estimate incremental cost-effectiveness ratios (cost per QALY) for all competitive strategies. Strongly dominant and weakly dominant strategies were eliminated from the analysis, and cost-effectiveness ratios were recalculated until no weakly dominant strategies remained. Cost-effectiveness ratios for reference patients (men 50 to 59 years of age with mild chest pain) with typical angina were:

- comparing no testing with the four other alternative diagnostic test, $26,200 to $28,700;
- comparing exercise electrocardiography with exercise echocardiography, exercise SPECT and angiography, $32,000 to $34,400;
- comparing exercise echocardiography with exercise SPECT, $62,800;
- comparing exercise echocardiography with angiography, $35,200; and
- comparing exercise SPECT with angiography, $32,600.

The same analysis was performed for reference patients with atypical angina, and the reported cost-effectiveness ratios for all alternative strategies were in the range $30,200 to $108,900. Sensitivity analysis revealed that reductions in coronary artery disease prevalence would have a significant effect on all cost-effectiveness ratios for the strategies considering CABG. Probabilistic sensitivity analysis using Monte Carlo simulations estimated that the 25th, 50th and 75th percentiles for exercise electrocardiography compared with no testing were $27,000, $31,500, and $36,100, per QALY saved. While the same percentiles for exercise echocardiography compared with exercise echocardiography were $37,100, $44,200 and $50,900 per QALY saved. Finally, the 25th, 50th, and 75th percentiles for CABG were $64,00, $77,700, and $90,900 per QALY saved.

Authors' conclusions
Based on the likely cost-effectiveness ratios estimated in their analysis the authors concluded that the use of non-invasive diagnostic tests in patients with chest pain was justified. The suitability of either test is determined by the level of risk associated with patients, as well as their age, sex, and type and severity of pain.

CRD COMMENTARY - Selection of comparators
Non-invasive diagnostic tests were commonly used in the authors' setting. These were compared to coronary angiography, which was not routinely performed, as well as to a "no testing" alternative. You, as a database user, should consider whether these are widely used tests in your own setting.

Validity of estimate of measure of benefit
Long-term survival was estimated using a Markov model. Inputs to the model were derived from a meta-analysis and from some single studies. However, no details about the methods of identifying, selecting and combining these studies were reported, which makes a quality assessment difficult.

Validity of estimate of costs
The estimation of the annual cost of medications, subsequent test, and out-patient follow up visits associated with patients with no angina, mild angina and severe angina, was obtained from Medicare and was based on charges rather than true costs. Therefore, cost results might not apply in other settings or countries. In addition, costs to others in society were not considered in the analysis.

Other issues
The authors performed a probabilistic sensitivity analysis for reference patients. However only a brief description of the results was reported. A more comprehensive description of the methods would have been helpful. The authors addressed the issue of the generalisability of their results to other settings. They considered this to be limited because of the existing centre-specific variabilities in the tests' performances. A discount rate of 3% was used for both costs and
benefits and this may differ from the rates used in other countries.

**Implications of the study**
As acknowledged by the authors, the results of this study should be carefully interpreted, taking into consideration centre-specific variations in diagnostic test performances and patients characteristics.

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