Cost-effectiveness of whole-body CT screening
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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
The study examined one-time whole-body computed tomographic (CT) screening of the heart, chest, abdomen, and pelvis in asymptomatic individuals for the early detection of eight specific organ systems. More specifically, ovarian, pancreatic, lung, liver, kidney and colon cancer, abdominal aortic aneurysm and coronary artery disease.

Type of intervention
Screening.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised a hypothetical cohort of self-referred asymptomatic individuals.

Setting
The setting was secondary care. The economic study was carried out in the USA.

Dates to which data relate
The effectiveness data were obtained from studies published between 1979 and 2003. The economic data were obtained from studies published between 1993 and 2002. The price year was 2001.

Source of effectiveness data
The effectiveness evidence was derived from a synthesis of completed studies and some assumptions.

Modelling
A Monte Carlo decision model was constructed to predict the clinical and economic outcomes associated with one-time whole-body CT screening, compared with routine care, in a hypothetical cohort of 500,000 asymptomatic men aged 50 years. The time horizon of the model was the patient's lifetime. Test results (true- or false-positive or negative cases) were modelled. For whole-body CT screening, the model first assigned each individual a disease or no-disease status for each of the eight conditions under study (ovarian, pancreatic, lung, liver, kidney and colon cancer, abdominal aortic aneurysm and coronary artery disease) on the basis of age and gender. Then, patients could move to true- or false-positive or negative cases on the basis of disease-specific sensitivities and specificities of CT. For routine care, the model assigned patient disease status on the basis of age- and gender-specific disease prevalence in the general population.

Outcomes assessed in the review
The outcomes estimated from the literature were disease prevalence, the accuracy of CT, and the effect of whole-body
CT screening on life expectancy.

**Study designs and other criteria for inclusion in the review**
It was not stated whether a systematic review of the literature was undertaken to identify all relevant studies providing
clinical data for the decision model. Mortality for reasons other than the diseases considered in the analysis was
estimated from life tables, while data from a cancer registry were used for other estimates. The designs of other studies
providing evidence were not reported.

**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**
Thirteen primary studies provided the clinical inputs used in the decision model.

**Methods of combining primary studies**
Not stated.

**Investigation of differences between primary studies**
Not stated.

**Results of the review**
The sensitivity and specificity of un-enhanced CT were, respectively:

92% and 89% for ovarian cancer;
83% and 83% for lung cancer;
83% and 93% for pancreatic cancer;
94% and 85% for kidney cancer;
63% and 63% for liver cancer;
100% and 100% for abdominal aortic aneurysm; and
92% and 51% for coronary artery disease.

The stage distributions for local, regional and distant cancer were as follows.
Ovary: 68%, 27% and 5% with CT screening; 40%, 49% and 11% with routine care.
Colon: 64%, 25% and 11% with CT screening; 39%, 39% and 21% with routine care.

Lung: 45%, 27% and 28% with CT screening; 17%, 27% and 56% with routine care.

Pancreas: 40%, 31% and 30% with CT screening; 9%, 32% and 59% with routine care.

Kidney: 69%, 18% and 12% with CT screening; 51%, 24% and 25% with routine care.

Liver: 58%, 26% and 17% with CT screening; 32%, 35% and 33% with routine care.

Data on disease prevalence and life expectancy were not reported.

Among patients with coronary artery disease detected by whole-body CT screening, it was assumed that 20% would initiate statin therapy and this would cause a 30% reduction in the rate of myocardial infarction.

Patients undergoing biopsy were subject to a mortality risk of 0.001.

Methods used to derive estimates of effectiveness

The authors made assumptions to derive some clinical estimates.

Estimates of effectiveness and key assumptions

It was assumed that the presence or absence of each disease was independent of the presence or absence of the other diseases.

The key assumption of the analysis was that cancers that were correctly identified at whole-body CT screening were detected at earlier stages than if they had been detected incidentally and/or on the basis of the development of symptoms.

For patients with whole-body CT screening, a life expectancy gain because of the elimination of rupture risk was assumed.

The sensitivity and specificity of un-enhanced CT for colon cancer were both 50%.

Measure of benefits used in the economic analysis

The summary benefit measure was life expectancy. This was expressed as the number of life-years (LYs) obtained from the decision model. No discount rate was applied.

Direct costs

No discounting was applied since it was unclear when lifetime costs were incurred. The unit costs were not presented separately from the quantities of resources used for all items. The economic evaluation considered the costs of whole-body CT screening, care for cancer and other diseases, and follow-up testing for patients with false-positive scans. The cost/resource boundary of the study appears to have been that of the third-party payer, although it was not explicitly stated. The cost of a whole-body CT examination was estimated from prices advertised on the Internet. Other costs and resource use data were derived from the literature. Medicare reimbursements to hospital and physicians were used. All the costs were inflated to 2001 values using the Medical Care Consumer Price Index.

Statistical analysis of costs

The costs were treated deterministically.

Indirect Costs
The indirect costs were not included in the economic evaluation.

**Currency**
US dollars ($).

**Sensitivity analysis**
Univariate sensitivity analyses were carried out to examine the robustness of the cost-effectiveness results to variations in model inputs. The inputs varied included disease prevalence, the proportion of life expectancy gain attributable to time-lead bias, the sensitivity and specificity of whole-body CT, the costs of follow-up for false-positive screening results, the costs of whole-body CT and disease management, the rate at which biopsies were performed and the complication rate. All the sensitivity analyses were carried out in both men and women aged 45, 50 and 55 years. The ranges of values used were generally derived from the literature.

**Estimated benefits used in the economic analysis**
In a hypothetical 55-year-old individual, the estimated LYS were 26.3289 with whole-body CT screening and 26.3123 with routine care. The lifetime difference was 0.0166 years or 6 days in favour of CT screening.

**Cost results**
In a hypothetical 55-year-old individual, the estimated lifetime costs were $5,332 with whole-body CT screening and $2,820 with routine care. The difference in costs was $2.513.

The screening test accounted for 16.9% of the total costs, biopsy complications accounted for 0.1%, work-up for false-positive results accounted for 32.3%, management for true-positive results accounted for 50.2%, and management for false-negative test results accounted for 0.5%.

**Synthesis of costs and benefits**
An incremental cost-effectiveness ratio (ICER; i.e. the cost per LY gained) was calculated to combine the costs and LYS of the alternative screening strategies.

The incremental cost per LY gained with whole-body CT screening over routine care was $151,000. The corresponding figure in a 50-year-old woman was $170,000.

The sensitivity analysis showed that the ICER was sensitive to disease prevalence, the effect of screening on stage of diagnosis, the specificity of whole-body CT, the cost of follow-up for false-positive findings, and the cost of a whole-body CT scan. However, the ICER remained high, usually above $100,000 per LY gained. Even in the most favourable scenario the ICER was $54,000 (55-year-old men with follow-up costs reduced by 50%).

Whole-body CT screening was less cost-effective for women because of lower prevalence of the diseases.

**Authors’ conclusions**
In a population of asymptomatic individuals, one-time whole-body computed tomographic (CT) screening was not cost-effective in comparison with routine care, mainly because of the low prevalence of disease in the population undergoing screening.

**CRD COMMENTARY - Selection of comparators**
The selection of the comparator (routine care) was appropriate as it reflected the standard approach. Limited information on routine care was provided and routine care may vary depending on the setting. You should decide whether they are valid comparators in your own setting.
Validity of estimate of measure of effectiveness
The effectiveness evidence was derived from published evidence as well as assumptions. It was not stated whether a systematic review of the literature was undertaken to identify relevant studies. No details on the designs and other characteristics of the primary studies were provided. The validity of the studies was not discussed. The authors made most of the assumptions, stating that some assumptions were biased in favour of CT screening in order to evaluate a CT screening favourable scenario. Owing to the uncertainty in the estimates used in the model, key inputs were varied in the sensitivity analysis. This enhanced the robustness of the effectiveness evidence.

Validity of estimate of measure of benefit
The use of LYs as a summary benefit measure was appropriate since survival was the most relevant dimension of health. The authors stated that an assessment of quality of life would have been interesting, but it was not possible because of the lack of robust data. Discounting would have been relevant but was not performed. LYs are comparable with the benefits of other health care interventions.

Validity of estimate of costs
Although the authors stated that a quasi-societal perspective was adopted in the analysis, the perspective appears to have been that of the third-party payer since only direct medical costs were taken into consideration. Most of the costs were presented as macro-categories and a detailed breakdown of single items was not provided. No information on resource consumption was provided, which limits the possibility of replicating the study in other settings. The source of the data was reported. The costs were treated deterministically, but key cost estimates were varied in the sensitivity analysis. The price year was reported, which aids reflation exercises in other settings. Alternative scenarios for economic data were considered. However, no discount rate was applied to future costs, given the lack of information on when these costs were incurred. This would appear to be a limitation of the study because it is likely that some important cost categories might occur in the future and the use of a discount rate can substantially change the cost-effectiveness results.

Other issues
The authors did not compare their findings with those from published studies. The issue of the generalisability of the study results to other settings was not explicitly addressed, although sensitivity analyses were carried out. These make the results of the analysis more transferable to other settings. The results of the analysis were clearly presented. The authors noted some limitations of the analysis, such as the extensive use of assumptions to develop a tractable model. Further, the authors stated that it was not possible to model all diseases that could be detected with whole-body CT screening. The effect of race, income and education on the cost-effectiveness of screening was not investigated.

Implications of the study
The study results did not support the use of one-time whole-body CT screening, owing to the low prevalence of disease. The authors stated that future studies should investigate the impact of race, income and education on the costs and benefits of screening.

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Other publications of related interest


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