The cost-effectiveness of CT colonography in screening for colorectal neoplasia

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 several screening strategies for colorectal cancer (CRC):
- two- and three-dimensional computerised tomography colonography (2D and 3D CTC) performed every 5 or 10 years;
- an annual faecal occult blood test (FOBT);
- sigmoidoscopy every 5 years;
- optical colonoscopy (OC) every 10 years; and
- a combination of FOBT annually and sigmoidoscopy every 5 years.

A strategy of no screening was also considered. Screening was assumed to begin at age 50 years and continue to age 80.

Type of intervention
Screening.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised a hypothetical cohort of 50-year-old individuals.

Setting
The setting was a hospital. The economic study was carried out in the USA.

Dates to which data relate
The clinical data were derived from studies published between 1961 and 2005. No dates for resource use were explicitly reported. The price year was 2003.

Source of effectiveness data
The clinical and economic inputs of the model were:
- adenoma prevalence and incidence,
- disease progression (low-risk polyp, high-risk polyp, and local, regional and disseminated cancer),
- 5-year CRC mortality,
accuracy (sensitivity and specificity) of the screening tests, and
the rates of perforation and mortality associated with OC.

Modelling
A published Markov model was updated in order to model the evolution of cancer from adenoma growth through
malignant transformation in a hypothetical cohort of 50-year-olds. Standard health states that represent CRC
progression were included and described. The model had a lifetime (age 100) time horizon and annual cycles. The
structure of the model was represented graphically.

Sources searched to identify primary studies
Clinical estimates for natural history of disease were derived from colonoscopic screening studies and autopsy studies,
as well as surveillance, epidemiology and end-results (SEER) registry data. Mortality data were obtained from National
Center for Health Statistics publications. The accuracy of CTC came from a meta-analysis, while the sensitivity and
specificity of other screening tests were derived using data from observational studies.

Methods used to judge relevance and validity, and for extracting data
The majority of the clinical data were derived from the published decision model. The primary updates to the model
were based on the use of standardised assumptions established by the Institute of Medicine workshop on the economics
of CRC screening. In addition, an updated review of the literature was undertaken to derive ranges of estimates for the
sensitivity analysis. Some details of this review were reported.

Measure of benefits used in the economic analysis
The summary benefit measure used was expected survival. This was estimated using the decision model. Life-years
(LYs) were discounted at an annual rate of 3%. Other model outputs, such as lifetime cancer risk and lifetime cancer
mortality, were also reported.

Direct costs
The analysis of the costs was carried out from the viewpoint of the third-party payer. It included the costs associated
with CTC, FOBT, flexible sigmoidoscopy (with or without biopsy and pathology), OC, polypectomy including
pathology, cancer care (localised, regional or disseminated disease) and the treatment of colon perforation. The unit
costs and the resource quantities were not presented separately for all items. The source of the resource use data was not
explicitly stated, although the data might have been based on US screening guidelines. The costs of screening tests and
interventions were taken from the 2003 Medicare reimbursement schedule. Since CTC was not an approved
reimbursable technology at the time of the study, it was costed as an abdominal and pelvic computed tomography scan,
with both Medicare physician fees and facility expenses also included. The other costs were derived from the literature.
Discounting was relevant, as long-term costs were evaluated, and an annual rate of 3% was applied. The costs were
inflated to 2003 prices using the Consumer Price Index.

Statistical analysis of costs
The costs appear to have been treated deterministically.

Indirect Costs
Lost productivity costs were considered in a sensitivity analysis. Details of this category of costs were not provided.

Currency
US dollars ($).
Sensitivity analysis
In order to evaluate the robustness of the cost-effectiveness results, all model inputs were tested in a one-way sensitivity analysis using published ranges of values. The most influential inputs were further tested in a two-way sensitivity analysis. A multivariate sensitivity analysis was also carried out, using 10,000 Monte Carlo simulations and assuming specific statistical distributions for all inputs.

Estimated benefits used in the economic analysis
The expected LYs per patient were:

17.1215 with no screening;
17.1738 with 2D CTC every 5 years and 17.1536 with 2D CTC every 10 years;
17.1766 with 3D CTC every 5 years and 17.1655 with 3D CTC every 10 years;
17.1504 with annual FOBT;
17.1528 with sigmoidoscopy every 5 years;
17.1746 with OC every 10 years; and
17.1719 with FOBT annually and sigmoidoscopy every 5 years.

No screening was associated with a lifetime cancer risk of 5.6% and a mortality due to CRC of 2.1%.

The use of 2D CTC conducted every 10 years reduced the cancer risk to 2.7% and cancer mortality to 0.9%. When conducted at 5-year intervals it reduced the cancer risk to 1.6% and cancer mortality to 0.5%.

The use of 3D CTC every 10 years reduced the cancer risk to 2.3% and mortality to 0.8%. When conducted at 5-year intervals it reduced the cancer risk to 1.3% and mortality to 0.4%.

Cost results
The expected lifetime costs per patient were:

$1,240 with no screening;
$1,990 with 2D CTC every 5 years and $1,800 with 2D CTC every 10 years;
$1,980 with 3D CTC every 5 years and $1,600 with 3D CTC every 10 years;
$1,400 with annual FOBT;
$1,990 with sigmoidoscopy every 5 years;
$1,670 with OC every 10 years; and
$2,140 with FOBT annually and sigmoidoscopy every 5 years.

Synthesis of costs and benefits
Incremental cost-effectiveness ratios (ICERs; i.e. the incremental cost per LY gained) were calculated to combine the costs and benefits of the alternative strategies.

In comparison with no screening, the ICERS were:
$14,290 with 2D CTC every 5 years and $17,280 with 2D CTC every 10 years;
$13,460 with 3D CTC every 5 years and $8,150 with 3D CTC every 10 years;
$5,360 with annual FOBT;
$23,830 with sigmoidoscopy every 5 years;
$8,090 with OC every 10 years; and
$18,000 with FOBT annually and sigmoidoscopy every 5 years.

Thus, all screening strategies could be considered cost-effective in comparison with no screening at baseline estimates.

CTC options were then compared with other screening strategies. In comparison with the other existing strategies, 3D CTC every 5 years was dominant over sigmoidoscopy-based strategies (more effective and less expensive), while the ICER was $22,400 compared with annual FOBT and $156,000 compared with OC. The use of 3D CTC every 10 years was dominant over sigmoidoscopy every 5 years, and the ICER over annual FOBT was $13,480. FOBT plus sigmoidoscopy and OC were more effective than 3D CTC every 5 years. The ICER of FOBT combined with sigmoidoscopy over 3D CTC every 10 years was $84,160, and OC was weakly dominant over 3D CTC.

The results of the sensitivity analysis showed that, in the comparison with no screening, the cost-effectiveness of the screening strategies remained robust to plausible variations in the model inputs. In the comparison between different tests, the variable with the greatest impact was adherence with follow-up tests. For example, if adherence with follow-up OC increased from the base estimate of 75% to 95%, then OC remained more effective but the ICER was $107,530 compared with 3D CTC every 10 years (it was dominant in the base-case).

The cost-effectiveness of 3D CTC every 10 years was highly sensitive to cost variables. In particular, the two-way sensitivity analysis indicated that the relative cost of CTC to OC was the key factor in establishing the incremental cost-effectiveness of screening with CTC. The incremental cost-effectiveness of 3D CTC every 5 years was highly sensitive to a number of parameters, mainly its cost and sensitivity to detect polyps. For example, if the sensitivity of 3D CTC for 1-cm adenomas was below 83% (as with 2D imaging), then OC every 10 years would be a dominant strategy over CTC every 5 years. Alternatively, if the sensitivity was as high as 99%, the cost-effectiveness of 3D CTC every 5 years would be about $75,220 per LY saved.

The Monte Carlo simulation showed that OC dominated CTC every 5 years in 17.0% of simulations, while CTC dominated in 10.9% of simulations. The ICER of 3D CTC every 5 years was below the threshold of $100,000 in about 38% of simulations in comparison with OC.

Authors’ conclusions
Computerised tomography colonography (CTC) was an effective screening strategy for colorectal cancer (CRC), but optical colonoscopy (OC) was more cost-effective from the perspective of the third-party payer. However, high uncertainty was found around the cost-effectiveness ratios and slight variations in key parameters had a strong impact on the relative value for money of the screening strategies.

CRD COMMENTARY - Selection of comparators
The rationale for the choice of the comparators was clear in that existing screening strategies were compared with the novel approach as well as with an option of no screening. Several strategies or combinations of screening options with different frequencies were considered. You should decide whether they are valid comparators in your own setting.

Validity of estimate of measure of effectiveness
The authors combined data from an existing model with data from a review of the literature. Some details of a systematic search for data were reported. Some characteristics concerning the design of the primary studies were
Validity of estimate of measure of benefit
The use of LYs as the summary benefit measure was appropriate as expected survival represents a widely used output of screening tests. Further, LYs can be compared with the benefits of other health care interventions. The impact of quality of life was not investigated. Discounting was performed, as recommended by US guidelines.

Validity of estimate of costs
The cost categories included were consistent with the authors-stated perspective. The use of an alternative perspective was tested in the sensitivity analysis, although the estimation of productivity costs was difficult. Little information on resource consumption was provided, which limits the possibility of replicating the analysis in other settings. The sources of the costs were reported for several items. However, some costs were derived from published studies and no details of their calculation were given. Statistical analyses of the costs were performed in the sensitivity analysis. The price year was reported, which will facilitate reflation exercises in other time periods.

Other issues
The authors did not make extensive comparisons of their findings with those from other studies, pointing out only that a recent study reported similar findings for CTC every 10 years. The issue of the generalisability of the study results to other settings was not explicitly addressed, although the extensive use of sensitivity analyses enhances the external validity of the analysis. The authors noted some limitations of their analysis which were mainly related to the use of secondary data from different sources.

Implications of the study
The study results suggest that the use of CTC as a primary screening test for CRC should be implemented cautiously, especially in settings with lower diagnostic accuracy (i.e. non-academic centres).

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Khandker RK, Dulski JD, Kilpatrick JB, et al. A decision model and cost-effectiveness analysis of colorectal cancer


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