Acute appendicitis in young children: cost-effectiveness of US versus CT in diagnosis - a Markov decision analytic model  

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 compared the cost-effectiveness of ultrasonography, computed tomography, and ultrasonography followed by computed tomography, for the diagnosis of paediatric acute appendicitis. The authors concluded that computed tomography, and ultrasonography followed by computed tomography, were cost-effective, but the risk of cancer induced by radiation from a single abdominal computed tomography was not negligible and should be considered in the decision-making process. There were some uncertainties regarding the methods and the data, but the authors’ conclusions appear to be appropriate.

Type of economic evaluation  
Cost-utility analysis

Study objective  
The objective was to compare the cost-effectiveness of ultrasonography, computed tomography, and ultrasonography followed by computed tomography, for the diagnosis of paediatric acute appendicitis.

Interventions  
Imaging strategies, using ultrasonography, computed tomography, or ultrasonography followed by computed tomography, were compared in hypothetical cohorts of five-year-old patients with suspected appendicitis. The patients in each cohort were assumed to receive only one strategy, at presentation, without any subsequent imaging.

Location/setting  
Canada/secondary care.

Methods  
Analytical approach:  
The authors constructed a decision-analytic Markov state-transition model, to determine the clinical and economic impacts of the alternative diagnostic strategies, using published evidence. A lifetime horizon (from diagnosis at five years to death or the age of 100 years) was adopted. The authors stated that the perspective was that of the third-party payer.

Effectiveness data:  
The clinical data were from published literature, that included studies of clinical and epidemiological relevance to the setting, such as the Surveillance, Epidemiology and End Results (SEER) database, the Biological Effects of Ionizing Radiation (BEIR) VII report of the National Academy of Sciences, and a meta-analysis of the diagnostic performance of ultrasonography and computed tomography (Doria, et al. 2006, see ‘Other Publications of Related Interest’ below for bibliographic details). The key clinical parameters were the incidence of radiation-induced cancer, the diagnostic performance of computed tomography and ultrasonography, and the prevalence and complication rates associated with appendicitis.

Monetary benefit and utility valuations:  
The utility values were derived from a study of seriously ill patients, including those with acute appendicitis, and another study of healthy individuals and those living with cancer. The estimates were measured using the Health Utilities Index.
Measure of benefit:
The benefit measure was the number of quality-adjusted life-years (QALYs).

Cost data:
The analysis included the direct medical costs of imaging, including interpretation, treatment for perforated and unperforated appendicitis, and the treatment from diagnosis to death for radiation-induced malignancy. These costs were derived from published sources. Apart from the health care costs of gastric cancer, which were from a study based in England, the cost estimates were mostly from studies based in the USA. The price year was 2006 and all costs were in US dollars ($). An annual discount rate of 3% was applied to the long-term costs.

Analysis of uncertainty:
A univariate and two-way sensitivity analyses were performed by varying the key model parameters over wide ranges.

Results
The average cost of ultrasonography was estimated to be $8,942, compared with $9,237 for computed tomography, and $9,323 for ultrasonography followed by computed tomography. The effectiveness of ultrasonography was 3,879 QALYs for women and 3,638 QALYs for men. Compared with ultrasonography, the incremental QALYs for computed tomography were 0.5 in both women and men, and for ultrasonography followed by computed tomography they were 1.1 for both women and men.

In women, the incremental cost per QALY of ultrasonography followed by computed tomography was $7,852 compared with computed tomography, and $17,108 compared with ultrasonography. The incremental cost-effectiveness of computed tomography compared with ultrasonography was $26,260 per additional QALY.

In men, the incremental cost per QALY of ultrasonography followed by computed tomography was $8,684 compared with computed tomography, and $18,096 compared with ultrasonography. The incremental cost-effectiveness of computed tomography compared with ultrasonography was $26,624 per additional QALY.

The order of the effectiveness of the strategies was sensitive to the incidence of appendicitis in patients referred for imaging.

Authors' conclusions
The authors concluded that computed tomography, and ultrasonography followed by computed tomography, were cost-effective, but the risk of cancer induced by radiation from a single abdominal computed tomography was not negligible and should be considered in the decision-making process.

CRD commentary
Interventions:
The interventions were appropriate comparators as they represented the possible clinical options available in the authors' setting.

Effectiveness/benefits:
The clinical data were appropriate to the study setting and the sources were well described. The key clinical parameters were given in a table with references. It is not clear if a systematic review was conducted. The approach used to estimate the utility data for the QALY calculations was reported. QALYs were the most appropriate measure given the potential impact of the disease on both quality of life and survival. Future QALYs were not discounted, which was not consistent with the discounting of costs.

Costs:
The cost perspective was clearly defined, and it appears that all the relevant costs were included. A full breakdown of the cost items was not given, which will hinder the replication of the results in other settings. Several cost estimates were based on studies in other countries, which makes their relevance uncertain, but these estimates were varied in the sensitivity analyses. Other important details, such as the price year and the use of discounting, were provided.
Analysis and results:
The authors performed an incremental cost-effectiveness analysis for each pair-wise comparison among the three strategies. This approach does not clearly identify the cost-effectiveness of each intervention compared with the next more-effective intervention. In this base case, the incremental cost-effectiveness ratio of ultrasonography and computed tomography over ultrasonography is the most important. An incremental analysis was appropriate for determining the cost-effectiveness of the competing strategies. The uncertainty was assessed using one- and two-way sensitivity analyses, but a probabilistic sensitivity analysis would have more comprehensively assessed the overall impact of parameter uncertainty on the results. The base-case and sensitivity results were well reported and the authors highlighted the strengths and limitations of their approach.

Concluding remarks:
There were some uncertainties regarding the methods and the data, but the authors’ conclusions appear to be appropriate.

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