Ultrasound diagnosis of acute appendicitis: impact on cost and outcome in pediatric patients

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 ultrasound (US) diagnosis in children with clinical suspected acute appendicitis. Grade compression US examination was applied using 7.0- to 10-MHz linear array transducers. A detailed US examination of the right lower abdomen was followed by a general survey of the whole abdomen to decrease the possibility of misdiagnosis.

Type of intervention
Diagnosis.

Economic study type
Cost-effectiveness analysis.

Study population
The patient population comprised children presenting with clinically suspected acute appendicitis. No further inclusion or exclusion criteria were reported.

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

Dates to which data relate
The effectiveness evidence and resource use were collected over a 5-year period, ending in 1998. The price year varied according to the year in which the patients incurred costs.

Source of effectiveness data
The effectiveness data were derived from a single study.

Link between effectiveness and cost data
The costing was carried out retrospectively on a sub-sample of patients. The authors noted that some individuals with poor data were excluded. Sufficient data were collected for 153 patients (91 in group A and 62 in group B).

Study sample
No sample size appears to have been determined in the planning phase of the study. In addition, no retrospective power calculations were performed. The study included 347 consecutive paediatric patients, of which 196 were enrolled in the first 34 months and 151 in the second 24 months. Two hundred of these patients subsequently underwent surgery. The first 113 patients (group A) were clinically evaluated without US examination over 34 months. The other 87 patients (group B) enrolled in the following 24 months were routinely referred for US examination after clinical evaluation.
Demographic data were reported only for the sub-sample included in the costing analysis (91 in group A and 62 in group B). Group A comprised 49 males and 42 females with a mean age of 8.4 years (Range: 3 months to 16 years). Group B comprised 29 males and 33 females with a mean age 8.2 years (Range: 3 to 17).

Study design
This was a diagnostic yield study, with two consecutive cohorts, that was conducted at a single hospital centre. All patients were followed up clinically if US or clinical judgement was not indicative of acute appendicitis. A 6-month follow-up was considered sufficient for obtaining a final diagnosis. US and clinical judgement were classified as positive or negative. Loss to follow-up for costing purposes occurred because the patients were not all followed in the outpatient department and the authors failed to contact them by telephone to document their post-discharge medical course.

Analysis of effectiveness
The study reported the postoperative true- and false-positive and true- and false-negative rates for US and clinical evaluation of suspected appendicitis. Appendicitis was confirmed through surgical findings and pathological examination of the specimens. The groups were also compared in terms of the relative risk of complications in patients with simple acute appendicitis versus those with gangrenous or perforated appendicitis. Study parameters also included the total length of hospital stay. Two authors reviewed the care and outcome of patients who underwent appendectomies in the two groups.

Effectiveness results
The authors examined 151 patients with US, of which 87 had appendicitis confirmed and 64 did not have the disease.

The US results were true-positive for appendicitis in 84 (96.6%) of 87 patients and true-negative in 63 (98.4%) of 64 patients. The false-positive and false-negative rates were 3.4% (3 out of 87) and 1.6% (1 out of 64), respectively.

Of the 113 surgically proven cases in Group A, clinical evaluation established 96 out of 113 with "definite or most likely appendicitis" and 17 out of 113 with "not likely but cannot be excluded". The latter was defined as false-negative (15%).

Of the 83 patients with a final diagnosis of another problem, 18 out of 83 were "definitely or most likely appendicitis" and 65 out of 83 were "not likely but cannot be excluded". The latter was defined as true-negative (78%).

In group A, 5 patients had gangrenous appendicitis and 9 had a ruptured appendix. The total complication rate was 15.3% (14 out of 91). In group B, 2 patients had gangrenous appendicitis and 5 had a ruptured appendix. The total complication rate was 8% (5 out of 62).

The total length of stay was 21 days in group B (3.6 days per patient) and 354 days in group A (3.9 days per patient).

The total length of hospital stay was significantly longer and the complication rate significantly higher in group A than in group B, (p<0.05).

Clinical conclusions
The authors concluded that their results show that US is useful in patients with clinically suspected acute appendicitis, decreasing the false-negative appendectomy rate from 15% to 3.4% and delayed treatment from 15.3% to 8%. US also decreases the complication rate, shortens hospital stay and avoids unnecessary appendectomies. Therefore, US-assisted diagnosis provides more opportunities for conservative treatment of patients with clinically suspected appendicitis.

Measure of benefits used in the economic analysis
No summary measure of benefits was used. In effect, the authors performed a cost-consequences analysis.
Direct costs
The study calculated the costs of medical care including appendectomy and relevant procedures from the hospital perspective (examinations, hospital bed, laboratory, medical imaging, management fee, surgical procedure, surgical anaesthesia, special materials, medications, medication service and injection technique). A review of data revealed that 10 patients in group A and 4 in group B were referred for further evaluation from other departments or hospitals. The costs in other hospitals were not included in the cost analysis. Discounting was not necessary as the costs for each patient were incurred within 6 months of admission. The hospital reimbursement rates used as prices in the study were variable during the study period and were not standardised to a single price year. The costs and the quantities were analysed separately, based on actual data from 91 patients in group A and 62 patients in group B.

Statistical analysis of costs
The costs were treated deterministically.

Indirect Costs
No indirect costs were included.

Currency
Taiwan new dollars (TND). The costs were also reported in US dollars ($) but no conversion rate was reported.

Sensitivity analysis
The authors reported costs when all prices were based on reimbursement in the year 1998.

Estimated benefits used in the economic analysis
See the 'Effectiveness Results' section.

Cost results
The average cost of hospital admission for appendectomy was TND 26,715 per patient in group A and TND 24,505 in group B.

If the reimbursement coded for 1998 (the last year of the study) was applied, the total saving per patient was TND 2,210 (about $69).

If this was applied to all 165 adult and paediatric patients undergoing appendectomy in 1998, the total cost-savings per year could be up to TND 364,650 ($11,395).

The authors estimated that, if patients who had received treatment in other hospitals had received US and hence enrolled in group A or B, the savings per patient would be TND 3,382 ($106).

Synthesis of costs and benefits
The costs and benefits were not combined.

Authors' conclusions
The routine use of appendiceal ultrasound (US) in paediatric patients who meet clinical criteria for suspected acute appendicitis might improve patient care, both by avoiding unnecessary appendectomy and by averting delays before proper medical or surgical treatment. The cost analysis demonstrated that this imaging policy improved the use of hospital resources, because savings achieved by eliminating unnecessary surgery and in-hospital observation outweighed the cost of appendiceal US.
CRD COMMENTARY - Selection of comparators
A justification was given for the comparator used. It represented current practice in the authors' setting. It was unclear why the authors did not investigate the other imaging technologies they recommended or discussed in their conclusion. You should decide whether the comparator (no imaging) represents current care in your own setting.

Validity of estimate of measure of effectiveness
The analysis was a diagnostic yield study based on two consecutive cohorts. This may have been appropriate (in a practical sense) in the authors' setting, as following the introduction of US imaging it might have been considered unethical to deprive patients of this potentially useful diagnostic device when conducting a randomised controlled trial. It is not certain whether the patient samples in the two cohorts were drawn from the same underlying population. The outcomes were analysed only for patients with complete cost data. Reasons for loss to follow-up were not explored and quality criteria were not explained. It was unclear whether the same persons performed the clinical evaluations in both groups. These facts may introduce potential biases and limit the internal validity of the study.

Validity of estimate of measure of benefit
The authors did not derive a measure of health benefit. The analysis was therefore classified as a cost-consequences study.

Validity of estimate of costs
The costs were analysed for a sub-sample of patients, depending on the availability and quality of data obtained. Reasons for loss to follow-up were not explored and quality criteria were not explained. Therefore, there was a potential for bias in the cost results presented. The authors reported that the costs of medical care were extracted, although not all relevant costs were included in the analysis. The authors used costs relevant to the admitting hospital department and omitted the cost of care given in other hospitals.

The costs and the quantities were reported separately, thus aiding the generalisability and reproducibility of the analysis. No statistical analysis of the quantities was performed, which may limit the interpretation of the study findings. The prices were taken from the authors' setting, but were variable over the study period according to the prevailing reimbursement rates when the patient received care. A statistical analysis of the prices was not performed, although the authors did present cost-savings per patient resulting from the application of a single price year to the resources consumed. The cost results were presented in Taiwanese and US dollars although the date and source of the exchange rate were not disclosed.

Other issues
The authors made appropriate and useful comparisons of their findings with those from other studies. The issue of generalisability to other settings was discussed, with emphasis on the differences between cost and reimbursement of US in the USA and in Taiwan. The authors did not present their results selectively, apart from the exclusion of some patients from the cost analysis for unspecified data quality issues. The study generalised conclusions across adult and paediatric populations, and also assumed that they would apply to patients requiring further evaluation (e.g. in other hospitals). The authors did not report any limitations of their study, and failed to acknowledge the inherent possibility of bias in the design study and the loss of much of the sample to follow-up. It is difficult to rely on the conclusions of a costing analysis specific to a single centre in Taiwan, which applied varying prices and several limiting assumptions to generalise conclusions across patient populations. As the authors themselves suggest, further well-performed cost-effectiveness analyses, preferably a cost-utility analysis based on randomised controlled trial data, are required to minimise bias in the results.

Implications of the study
Based on this study, the authors believe that the routine use of US in paediatric patients with suspected acute appendicitis is worthwhile and may lower costs, shorten the hospital stay, decrease the complication rate and avoid
unnecessary surgery. They recommended further cost-effectiveness studies to evaluate the utility of different diagnostic imaging studies in this clinical setting.

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