Cost-effectiveness of cardiac resynchronization therapy in patients with symptomatic heart failure

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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 use of cardiac resynchronisation therapy for patients with reduced ventricular function and prolonged QRS. Biventricular pacemakers resynchronise the ventricular contraction to improve ejection fraction and relaxation of the left ventricle.

Type of intervention
Treatment.

Economic study type
Cost-utility analysis.

Study population
The target population comprised patients with reduced ventricular function and prolonged QRS. The base-case analysis considered patients with New York Heart Association (NYHA) Class III heart failure.

Setting
The setting was secondary care. The economic study was conducted by the University of Alberta Evidence-based Practice Centre, Canada.

Dates to which data relate
The effectiveness data were derived from a review of papers published between 2001 and 2004. The cost data were derived from 2003 manufacturers' price lists, 2003 Procedural Terminology Codes and a published study in 2003. The price year was 2003.

Source of effectiveness data
The effectiveness evidence was derived from a systematic review of the literature.

Modelling
A state transition Markov model was developed to compare the costs and outcomes of congestive heart failure treated with cardiac resynchronisation therapy versus medical therapy. A cycle length of 1 month was used. The time horizon was the lifetime. The future costs and effects were discounted at a rate of 3%.

Outcomes assessed in the review
The clinical and epidemiological data derived from the literature and included as inputs in the model were the probabilities of:
cardiovascular death, 
arrhythmic death, 
death from heart failure, 
hospitalisation for heart failure, and 
adverse effects associated with either therapy.

**Study designs and other criteria for inclusion in the review**
A systematic review was apparently conducted, although the methods were reported in another study (McAlister et al. 2004, see 'Other Publications of Related Interest' below for bibliographic details).

**Sources searched to identify primary studies**
Not reported.

**Criteria used to ensure the validity of primary studies**
Not reported.

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

**Number of primary studies included**
Nine studies were included in the analysis of efficacy.

**Methods of combining primary studies**

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

**Results of the review**
For patients assigned to medical therapy, the mean annual mortality rate was 24.7% (95% confidence interval, CI: 20.7 - 29.2) during a mean follow-up of 26.2 weeks.

The mean annual rate of heart failure hospitalisation was 56.0% (CI: 47.6 - 66.2) during a mean follow-up 18.5 weeks.

The mean annual rate of cardiac death was 20.3% (CI: 15.1 - 27.0) during a mean follow-up of 15.8 weeks.

For patients assigned to cardiac resynchronisation therapy, the pooled relative risk (was 0.79 (CI: 0.66 - 0.96) for death, 0.68 (CI: 0.41 - 1.12) for heart failure hospitalisation, and 0.84 (CI: 0.56 - 1.25) for cardiac death. However, the data reported for the latter (relative risk for cardiac death) differed between the table and the text.

**Measure of benefits used in the economic analysis**
Quality-adjusted life-years (QALYs) were used for the economic analysis. The general public was surveyed to derive utilities because the analysis considered resource allocation among different types of interventions. No other methods
were reported. The authors referenced an appendix which is available on the Annals of Internal Medicine website (www.annals.org).

Direct costs
The cost/quantity boundary adopted was that of the health care system. Broad expenditure items included hospitalisation, procedure and laboratory tests. The costs were expressed in 2003 US dollars. The costs of insertion for a resynchronisation-capable device were based on a survey of the manufacturers' list prices. Physician costs related to cardiac resynchronisation were based on Current Procedural Terminology Codes. The costs of hospitalisation associated with congestive heart failure were based on estimates derived from a cohort study of health resource use by patients participating in a randomised trial of medical therapy for heart failure. The number of hospitalisations was determined by the model. The costs were discounted at a rate of 3% and were adjusted for inflation using the US Consumer Price Indexes.

Statistical analysis of costs
The cost data were treated stochastically.

Indirect Costs
No indirect costs were included in the study.

Currency
US dollars ($).

Sensitivity analysis
Variability in the data was investigated. The value of each variable in the decision model was replaced with its upper and lower limits while holding all other values constant. For empirical variables, these limits were 95% CI for each variable. For assumed variables, these limits were based on reasonable possible limits (+/- 50%). Threshold analyses were performed for each variable of the model. Sensitivity analyses considered lower incidences of device-related complications than those observed in the trials. A structural sensitivity analysis considered cardiac death and death due to unrelated causes simultaneously.

Parameter uncertainty was assessed by a probabilistic analysis. Empirical cost variables were assigned log-normal distributions, while probability variables were assigned beta distributions. Variables without a known distributional form were assigned a triangular distribution. Results of the Monte Carlo simulation were illustrated as a scatter plot of incremental effects in QALYs versus incremental costs. Uncertainty in the parameters was also illustrated in the form of a cost-effectiveness acceptability curve (CEAC).

Estimated benefits used in the economic analysis
In patients with heart failure, medical therapy yielded a median of 2.64 (interquartile range, IQR: 2.47 - 2.82) discounted QALYs and cardiac resynchronisation therapy yielded a median of 2.92 (IQR: 2.72 - 3.14) discounted QALYs.

Cost results
The authors reported a median discounted lifetime cost of $34,400 (IQR: 31,100 - 37,700) for patients treated with medical therapy and $64,400 (OQR: 59,900 - 70,200) for patients treated with resynchronisation therapy.

Synthesis of costs and benefits
Cardiac resynchronisation therapy was associated with a median incremental cost of $107,800 (IQR: 79,800 - 156,000)
per additional QALY. The authors said that the CEAC illustrated a probability of less than 45% that resynchronisation is cost-effective in comparison with medical treatment, given a maximum willingness to pay of $100,000 per QALY. The CEAC was given in the paper.

Authors' conclusions
The authors did not say that cardiac resynchronisation was cost-effective, but stated that it has similar incremental costs per quality-adjusted life-year (QALY) when compared with other commonly used health interventions for patients with heart failure.

CRD COMMENTARY - Selection of comparators
The rationale for the choice of the comparator was clear, as medical therapy represents what used to be standard practice in the USA.

Validity of estimate of measure of effectiveness
The authors obtained the probabilities of cardiovascular death, arrhythmic death, death from heart failure, hospitalisation from heart failure, and adverse effects associated with either therapy from a concurrent systematic review. Since the methods were not reported in this paper, it was not possible to assess the quality of the review. For this, the reader is advised to read the paper by McAlister et al. 2004. The authors stated that some inputs were assumed, but it was not described how they came to these assumptions. To compensate for this limitation, however, the authors undertook a sensitivity analysis on variability in the data and parameter uncertainty.

Validity of estimate of measure of benefit
QALYs are a valid measure of the benefit. However, a description of the method used to derive the utilities was not reported in the study.

Validity of estimate of costs
The cost analysis was performed from the perspective of the health care system. It appears that all the relevant categories of costs have been included in the analysis. The costs, the price year and discount rates were all reported, thus improving the transferability of the results to other settings.

Other issues
According to the authors, this was the first study to compare the long-term effects and costs of cardiac resynchronisation and medical therapy. Hence, a comparison of the findings of this research with those of other published studies on resynchronisation could not be performed. The authors acknowledged that input data such as the effectiveness of resynchronisation were derived from several sources and might be confounded by information that was not included in the study. Also, the results of the model were sensitive to assumptions. The findings of this research should therefore be considered with some caution until additional long-term data on cardiac resynchronisation become available.

Implications of the study
The study suggested that resynchronisation therapy should not be considered in patients with co-morbid conditions that shorten life expectancy. This finding should be re-evaluated when the long-term incidence of complications of resynchronisation is known.

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**Bibliographic details**

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**Other publications of related interest**


**Indexing Status**
Subject indexing assigned by NLM

**MeSH**
Cardiac Pacing, Artificial /economics; Computer Simulation; Cost-Benefit Analysis; Decision Support Techniques; Defibrillators, Implantable /economics; Electric Countershock /economics; Heart Failure /drug therapy /therapy; Humans; Markov Chains; Monte Carlo Method; Quality-Adjusted Life Years

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