Diagnosis of pulmonary embolism: a cost-effectiveness analysis


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 compared three diagnostic strategies for pulmonary embolism (PE) in pregnant women.

One strategy was compression ultrasonography, followed by anticoagulation in case of positive results (high probability ventilation-perfusion (VQ) scans) or by VQ scan or spiral computed tomography (CT) in case of negative results. Low probability VQ scans resulted in no treatment, whereas high probability VQ scans resulted in anticoagulation. Intermediate tests were followed by a second test (CT or pulmonary angiography).

Another strategy was VQ scan as a primary test followed by anticoagulation.

The third strategy was spiral CT followed by anticoagulation in case of a positive result.

Type of intervention
Diagnosis.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised a hypothetical cohort of 100 pregnant women or women in the puerperium with clinical suspicion of PE and no other medical problems. All pregnant women were assumed to be at high risk. No further inclusion or exclusion criteria were reported.

Setting
As this was a modelling study, a setting was not explicitly stated. The economic study was carried out in the USA.

Dates to which data relate
The effectiveness data were derived from studies published between 1995 and 2003. The cost data were derived from studies published between 1996 and 2003. The price year was not reported.

Source of effectiveness data
The effectiveness data were derived from a review and synthesis of completed studies. Some parameters of the model were based on authors’ assumptions.

Modelling
The authors constructed a decision tree, using decision analysis software (data 4.0 for Health Professionals; TreeAge Software Inc.), to evaluate the costs and effectiveness of each diagnostic strategy. The time horizon was unclear, but it was likely to have been until delivery. The decision tree was based on several assumptions. It was assumed that all
women received the same initial diagnostic workup, which comprised chest radiography, electrocardiography, arterial blood gas and pulse oximetry. It was also assumed that the same costs were applied to each strategy.

Outcomes assessed in the review
The following parameters were included in the model:

- the sensitivity of CT;
- the sensitivity of angiography;
- compression ultrasonography for deep vein thrombosis;
- VQ scan;
- the anticoagulation-associated and angiography-associated mortality rate; and
- the mortality rate of treated and untreated PE during pregnancy.

Study designs and other criteria for inclusion in the review
Studies on PE and PE during pregnancy that contained the terms PE, venous thromboembolism, pregnancy, cost analysis, CT, VQ scan and ultrasonography, and also referred to the medical effectiveness or contained cost data on the compared strategies, were included in the review. Study designs and further criteria for inclusion in the review were not reported.

Sources searched to identify primary studies
PubMed was searched for primary studies.

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
Overall, the authors reported 18 primary studies as sources of effectiveness evidence.

Methods of combining primary studies
Not reported.

Investigation of differences between primary studies
The authors do not appear to have investigated differences between the primary studies.

Results of the review
The sensitivity of CT was 70 to 95%.

The sensitivity of angiography was 98%.
Compression ultrasonography for deep vein thrombosis was 30 to 50% among patients with PE.

VQ scan was used for diagnosis in 30 to 40% of the patients.

The anticoagulation-associated mortality rate was 0.2%.

The angiography-associated mortality rate was 0.5%.

The mortality rate of treated PE during pregnancy was 0.7 to 8%.

The mortality rate of untreated PE during pregnancy was 15% (range: 10 - 50).

Methods used to derive estimates of effectiveness
The authors made assumptions to derive some estimates of effectiveness.

Estimates of effectiveness and key assumptions
The following baseline estimates of effectiveness were derived from authors' assumptions:

The incidence of PE among pregnant women with suspected PE was 5%.

The proportion of documented PEs with a positive compression ultrasound scan was 40%.

The proportion of VQ scans for suspected PE that are of high probability (i.e. positive test result that necessitates treatment) was 10%.

The proportion of VQ scans that are of indeterminate probability was 60%.

The proportion of VQ scans that are of low probability was 30%.

Measure of benefits used in the economic analysis
The outcome measure used in the economic analysis was the maternal lives saved. This was derived from the model.

Direct costs
The perspective of a third-party payer was adopted in the economic analysis. Under this perspective, the costs included were for ultrasonography, anticoagulation treatment, VQ scan, angiography and spiral CT. The unit costs were reported. All the costs were derived from published sources. Although these sources referred to different fiscal years, appropriate adjustments were not reported. The price year used in the current study was not reported. Discounting was not relevant as the costs were incurred during a short time.

Statistical analysis of costs
The costs were treated deterministically.

Indirect Costs
The indirect costs were not included in the analysis.

Currency
US dollars ($).
Sensitivity analysis
The type of sensitivity analysis performed was not explicitly reported. However, it seems that a one-way sensitivity analysis over a wide range of baseline parameters was conducted to investigate variability in the data and to test the robustness of the results. The parameters investigated were the probability of PE, the sensitivity of CT, VQ scans, compression ultrasonography, the cost of CT, and the mortality rate of untreated PE.

In addition, threshold analyses were conducted on the rate of low probability of VQ scans and the sensitivity of a CT scan.

Estimated benefits used in the economic analysis
The number of maternal lives saved by each diagnostic strategy was not reported.

Cost results
The total intervention costs for each diagnostic strategy were not reported.

Synthesis of costs and benefits
The spiral CT strategy resulted in a cost of $17,208 per life saved, the compression ultrasound strategy in a cost of $24,004 per life saved, and the VQ scan strategy in a cost of $35,906 per life saved.

The authors reported that, if VQ scanning or compression ultrasound scanning was used as the primary diagnostic modality, spiral CT was the most cost-effective secondary test (the results were not shown).

The threshold analysis demonstrated that VQ scans became the most cost-effective option only when more than 75% of VQ scans were low probability, which negated the need for further testing.

Authors’ conclusions
The analysis demonstrated that spiral computed tomography (CT) is the most cost-effective strategy for the diagnosis of pulmonary embolism (PE) in pregnant women.

CRD COMMENTARY - Selection of comparators
The choice of the comparators was justified. Spiral CT is the most widely used initial diagnostic method for non pregnant patients and is being used increasingly among pregnant women for the diagnosis of PE in the authors' setting. The other comparators represented potential diagnostic alternatives. You should decide if spiral CT represents a valid comparator in your own setting.

Validity of estimate of measure of effectiveness
It was not explicitly stated that a systematic review of the literature had been undertaken, although this was likely to have been the case. The methods and conduct of the review were not adequately reported. Although the authors reported the sources searched for relevant studies, they did not report the inclusion and exclusion criteria used. The study designs of the included studies were not reported, nor were any specific methods used to judge the relevance and validity of the data available. It is therefore likely that the authors used the available data selectively. The method used to combine the studies was not reported, and potential differences between the primary studies were not discussed. Some estimates of effectiveness were derived from authors’ assumptions. However, the authors did not provide any explicit justification for their choice of assumptions. It is likely that the assumptions were based on evidence from the literature. Effectiveness parameters that were characterised by uncertainty were investigated in the sensitivity analysis.

Validity of estimate of measure of benefit
The authors used maternal lives saved as the measure of benefits. This was derived from the model. It was unclear
whether the decision tree used for this purpose was appropriate, as no descriptive presentation of the decision tree was provided in the paper.

**Validity of estimate of costs**
The cost analysis was performed from the perspective of a third-party payer. As such, it appears that all the relevant categories of costs have been included. A summary cost was reported for anticoagulation treatment, making it difficult to know what aspects of costs were included. The authors did not use charges to proxy costs and, although unit costs were reported, the omission of the price year will impede any future reflation exercise. However, the extensive sensitivity analyses undertaken improve the generalisability of the findings.

**Other issues**
Since the authors did not compare their results with published studies, it is not known how far their results agree with other published findings. The issue of generalisability of the results to other settings was not directly addressed. The authors do not appear to have presented their results selectively and their conclusions reflect the scope of the analysis. The study enrolled pregnant women with suspected PE and women in their puerperium, but the results mainly referred to pregnant women. The authors reported that they did not compare an alternative diagnostic method (i.e. magnetic resonance imaging), owing to the limited availability of a magnetic resonance diagnostic protocol. No further limitations of the study were reported.

**Implications of the study**
The authors did not make any explicit recommendations for changes in policy or practice, nor did they suggest areas where further research is needed.

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