Illustrative estimates of costs and effects of the use of Doppler ultrasonography in high-risk pregnancies
Westergaard H B, Sorensen J, Langhoff-Roos J

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 Doppler ultrasonography (US) in high-risk pregnancies. The intervention could be delivered by three different organisational models in Denmark. These were a decentralised scenario that involved 32 obstetric units, a county scenario that involved 20 obstetric units, and a centralised scenario that involved 5 obstetric units.

Type of intervention
Diagnosis.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised high-risk pregnancies. In particular, high-risk pregnancies were restricted to singleton pregnancies that were assessed as being at high risk of foetal intrauterine growth retardation (IUGR).

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

Dates to which data relate
The effectiveness and resource use data were derived from studies published between 1992 and 2002. The price year was 2000.

Source of effectiveness data
The effectiveness evidence was derived from a synthesis of completed studies.

Outcomes assessed in the review
The outcomes estimated from the literature were:

- the odds ratios (ORs) for perinatal deaths, antenatal admissions, induction of labour, Caesarean sections and neonatal intensive care unit (NICU) admissions, resulting from the application of Doppler US in pregnancies with suspected IUGR in comparison with no Doppler US;

- pregnancies at risk of foetal IUGR;

- the number of births in one year;
the number of Doppler US examinations per pregnancy; and

perinatal deaths in pregnancies where an antenatal diagnosis of suspected IUGR or pre-eclampsia was made.

**Study designs and other criteria for inclusion in the review**

It was unclear whether a systematic review of the literature was undertaken to identify the primary studies. Data on the effectiveness of Doppler US were retrieved from a meta-analysis of 13 clinical trials. However, only data from 6 of these clinical trials were used in this study, because the analysis was restricted to singleton pregnancies with a high risk of foetal IUGR. Other data were obtained from a national Medical Birth Registry and from medical records gathered at the Copenhagen University Hospital.

**Sources searched to identify primary studies**

Not stated.

**Criteria used to ensure the validity of primary studies**

The use of a meta-analysis of randomised clinical trials ensured a high internal validity.

**Methods used to judge relevance and validity, and for extracting data**

Not stated.

**Number of primary studies included**

Five primary studies were included in the review.

**Methods of combining primary studies**

A narrative approach was used to combine the primary estimates. However, as already stated, data on the effectiveness of Doppler US had been combined by means of a meta-analysis (already published).

**Investigation of differences between primary studies**

Not stated.

**Results of the review**

The OR was:

0.67 (95% confidence interval, CI: 0.47 - 0.97) for perinatal deaths,

0.56 (95% CI: 0.43 - 0.72) for antenatal admissions,

0.78 (95% CI: 0.63 - 0.96) for induction of labour,

0.78 (95% CI: 0.65 - 0.94) for Caesarean sections, and

0.87 (95% CI: 0.70 - 1.00) for NICU admissions.

The proportion of pregnancies at risk of foetal IUGR was 3.1%. The number of births in one year in Denmark was 65,000. Thus, 1,500 Danish pregnancies were at risk of IUGR.

The average number of Doppler US examinations per pregnancy was 3.3, leading to an average of 5,000 Doppler US examinations per year in Denmark.
There were 29 perinatal deaths in pregnancies where an antenatal diagnosis of suspected IUGR or pre-eclampsia was made.

**Measure of benefits used in the economic analysis**
The summary benefit measure used was the number of avoided perinatal deaths as a result of using Doppler US, in comparison with no intervention. The reductions in antenatal admissions, induction of labour, Caesarean sections and NICU admissions were also reported.

**Direct costs**
The analysis of the costs adopted the perspectives of the health care service and the patients. The costs of Doppler US, antenatal admissions, admissions to the NICU and to maternal care units, and travel expenses were included in the analysis. The unit costs were presented separately from the quantities of resources used for most items. Resource use was based on data derived from hospital databases. The costs were estimated from the Copenhagen University Hospital and reflected hospital tariffs for the reimbursement of patients from all regions. The fixed cost of Doppler US included the cost of the device (depreciated over 10 years at an interest rate of 5%), as well as the costs for service and maintenance, the use of a room, and staff education. The variable costs included staff salaries and the costs of utensils. The number of Doppler US examinations performed annually was based on an assumption. It was also assumed that the number of Doppler US examinations was equally distributed across all available units. The price year was 2000. Discounting was not relevant since the costs per patient were incurred during a short time.

**Statistical analysis of costs**
The costs were treated deterministically.

**Indirect Costs**
The indirect costs were included in the economic evaluation since patient costs were taken into consideration. In particular, this included time or wages lost by one third of husbands who took their wives for Doppler US examination. Details on how the indirect costs were calculated were not provided, but the data were likely to have been derived from the same source of resource use and costs as those used in the analysis of the direct costs. Discounting does not appear to have been applied.

**Currency**
Danish kroner (DKK). The exchange rate between Danish kroner and US dollars ($) in October 2002 was DKK 100 = $13.46.

**Sensitivity analysis**
A sensitivity analysis was carried out to assess the robustness of the cost-effectiveness ratios to variations in the ORs of the clinical estimates. CIs were used as ranges of values.

**Estimated benefits used in the economic analysis**
The number of avoided perinatal deaths as a result of using Doppler US, compared with no intervention, was 7 (95% CI: 1 - 11).

The number of avoided antenatal admissions was 282 (95% CI: 164 - 375).

The number of avoided inductions at labour was 42 (95% CI: 8 - 71).

The number of avoided Caesarean sections was 54 (95% CI: 15 - 84).
The number of avoided admissions to the NICU was 43 (95% CI: 0 - 102).

Cost results
The total costs of Doppler US over no intervention were DKK 13,542,139 with the decentralised model, DKK 10,215,596 with the county model, and DKK 5,967,587 with the centralised model. However, the overall savings due to avoided antenatal admissions, avoided inductions at labour, avoided Caesarean sections and avoided admissions to the NICU were DKK 6,314,413.

Thus, the net costs would be DKK 7,227,726 (95% CI: 52,777 - 12,179,908) with the decentralised model, DKK 3,901,183 (95% CI: -3,273,766 - 8,853,365) with the county model, and -DKK 346,826 (95% CI: -7,521,775 - 4,605,356) with the centralised model.

Synthesis of costs and benefits
An incremental cost-effectiveness ratio was calculated to combine the costs and benefits of Doppler US in comparison with no intervention.

The incremental cost per avoided perinatal death was DKK 1,042,962 (95% CI: 649,391 - 11,472,581) in the decentralised model, DKK 562,941 (95% CI: 350,510 - 6,192,354) in the county model, and dominant (more effective and less costly) in the centralised model.

Thus, the centralised model dominated the other two models.

The sensitivity analysis showed that the cost-effectiveness ratio varied considerably, depending on the assumptions made in the model, but the rank order of the three models did not change.

Authors’ conclusions
Compared with no intervention, the use of Doppler ultrasonography (US) in high-risk pregnancies would appear to be a cost-effective diagnostic approach in Denmark. However, the cost-effectiveness of the intervention depended strongly on the assumptions made about cost and effectiveness. For example, given the rarity of foetal death, confidence intervals (CIs) around point estimates would be necessarily wide and the final estimates would not be robust. Similarly, a small change in the cost of Doppler US had a large impact on the total costs. The analysis highlighted the efficiency of a centralised model where Doppler US might work at full capacity.

CRD COMMENTARY - Selection of comparators
The comparator was “no diagnostic assessment”. This was appropriate for the study question since it represents the standard approach in several settings. You should decide whether this is a valid comparator in your own setting.

Validity of estimate of measure of effectiveness
The effectiveness evidence came from a synthesis of completed studies, which were presumably identified selectively. In effect, no details of a systematic review of the literature were provided. The authors gave some information on the characteristics of the primary studies. For example, most of the evidence on treatment efficacy came from a meta-analysis of clinical trials, which would usually have a high internal validity. Sensitivity analyses were carried out to assess the impact of clinical data on the cost-effectiveness results. Wide CIs were found because of the rarity of foetal death.

Validity of estimate of measure of benefit
The benefit measure was specific to the disease considered in the study. It is not comparable with the benefits of other health care interventions. The impact of the diagnostic evaluation on quality of life was not investigated since the study focused mainly on neonatal outcomes.
Validity of estimate of costs
The cost categories included in the analysis were consistent with the stated perspective. There was limited information on both the direct and indirect patient costs. The indirect costs appear to have been estimated using lost wages, although details of such an approach were not reported. The cost analysis relied on a previous HTA undertaken in Denmark, where much of the information on resource consumption and other economic data could presumably be found. Some assumptions were also made to facilitate the cost comparison among the different organisational models. The cost estimates were specific to the study setting, and the impact of using alternative cost estimates was not investigated in the sensitivity analysis. The unit costs were given for some items. The price year was reported, which enables reflation exercises in other time periods.

The authors noted that the analysis did not consider the long-term costs associated with obstetric interventions. It appears that the inclusion of such costs would have favoured the intervention examined in the study. The authors noted also that there were no adjustments for productivity gains that would have arisen from economics of scale, nor have the benefits of clinical specialisation been considered explicitly.

Other issues
The authors did not compare their findings with those from other studies. They did not explicitly address the issue of the generalisability of the study results to other settings. In effect, few sensitivity analyses were carried out. Although the analysis focused on the Denmark health care system, three different models of care were considered, which might resemble alternative systems. The study referred to high-risk pregnant women and this was reflected in the authors' conclusions.

Implications of the study
The study results supported the implementation of a Doppler US programme for high-risk pregnancies, even in a decentralised model of health care such as that developed in Denmark.

Source of funding
Funded by the Danish Institute of Health Technology Assessment.

Bibliographic details

PubMedID
15095768

Other publications of related interest


Indexing Status
Subject indexing assigned by NLM

**MeSH**
Cost-Benefit Analysis; Denmark; Diagnostic Techniques, Obstetrical and Gynecological /economics /utilization; Female; Fetal Growth Retardation /economics; Humans; Models, Economic; Patient Satisfaction; Pregnancy; Pregnancy Outcome; Pregnancy, High-Risk; Ultrasonography, Doppler /economics /utilization

**AccessionNumber**
22004008170

**Date bibliographic record published**
31/05/2006

**Date abstract record published**
31/05/2006