

# The effectiveness and cost-effectiveness of ultrasound locating devices for central venous access: a systematic review and economic evaluation

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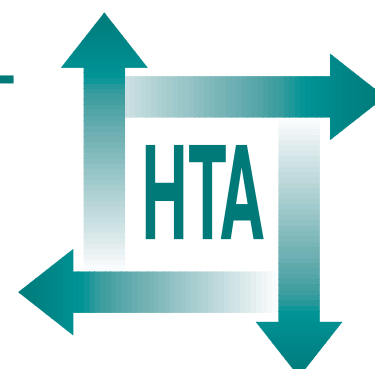
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## *Executive summary*

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## Executive summary

### Background

Approximately 200,000 central venous access (CVA) procedures are performed annually in the NHS.

CVA has traditionally been achieved by the landmark method of passing the needle along the anticipated line of the relevant vein using surface anatomical landmarks and the expected relationship of the vein to its palpable companion artery. While experienced operators can achieve relatively high success rates with the landmark method with few complications, such as arterial puncture and pneumothorax, failure rates in the literature have been reported to be as high as 35%.

The experience of radiologists suggests that CVA can be achieved quickly, with low failure and complication rates, using ultrasonic locating devices (ULD). There are two types: ultrasound (US) probes generating a two-dimensional (2-D) grey-scale image; and Doppler® US generating an audible sound from flowing venous blood. In practice the 2-D US is used in preference to Doppler US. A crude estimate of the cost of promoting 2-D US in the NHS is £29 million in the first year, reducing in following years.

### Objectives

- To investigate the clinical and cost-effectiveness of ULD.

### Methods

Major bibliographic databases were searched up to October 2001 for references on ULDs and central venous lines. Randomised controlled trials (RCTs) were targeted. Only studies with the following features were included:

- 2-D US or Doppler US compared with the landmark method or a surgical cut-down procedure
- study populations requiring the placement of central venous lines

- measuring outcomes such as the number of failed catheter placements, number of catheter placement complications, risk of failure on the first catheter placement attempt, number of attempts to successful catheterisation, number of seconds to successful catheterisation, rate of success after failure by the alternate method (where a crossover design was incorporated).

A systematic review of economic analyses was also undertaken.

### Results

#### Review of clinical effectiveness

Twenty RCTs of variable methodological quality were identified. Sample sizes were generally small. A total of 13 studies addressed 2-D US versus landmark procedures. Eight studies addressed internal jugular vein (IJV) venepuncture, one subclavian vein (SV) insertions, and one femoral vein (FV) insertions: all ten of these were in adults. Two studies analysed IJV insertions in infants. One reported neither the age of the population nor the insertion site. Six studies addressed Doppler US versus landmark, all in adults. In three of these studies, the insertion site was the IJV while in two it was the SV. One RCT had four arms, comparing Doppler US and landmark for insertion in both the IJV and the SV. Only one very small study compared 2-D US, Doppler US and landmark for the venepuncture of infants through the IJV.

The trial evidence suggests that 2-D US is significantly better than landmark for all five outcome variables measured for insertions into the IJV in adults. The results also favour 2-D US for insertions into the SV and FV in adults, although based on only one RCT each. For the three infant studies addressing insertion into the IJV, the results again suggest that 2-D US has a statistically significant beneficial effect.

For Doppler US, only insertions into the IJV in adults, reported in four RCTs, indicated improved failure and complication rates over landmark. The other three Doppler US RCTs

for SV insertions in adults and IJV insertions in children provide little support for Doppler over landmark methods. For clinically experienced operators, proficient with the landmark method, Doppler US increased the number of failed catheter placements in attempts to catheterise the SV. The extent to which it is possible to generalise from these results for Doppler US is unclear.

### **Economic analysis**

No studies were identified from the systematic review of economic analyses.

A spreadsheet decision-analytic model was carried out to assess cost-effectiveness. Because Doppler US is less common than 2-D US and the effectiveness evidence suggests Doppler is less effective compared with 2-D US, 2-D US compared with landmark was the focus. Costing analysis indicates that the marginal cost of using US for CVA is less than £10 per procedure. It is sensitive to assumptions about machine usage. The base scenario assumes that a machine is used for 15 procedures each week. Other base scenario assumptions are deliberately cautious about the potential economic costs and benefits of US.

Economic modelling results indicate that using 2-D US in CVA is likely to save NHS resources as well as improve failure and complication rates. For every 1000 procedures undertaken, a resource saving of £2000 has been suggested to result. Sensitivity analysis indicates that the results of modelling appear to be robust and that the resource saving result is likely to hold for the three main insertion sites, and for both adults and children. The modelling results are most sensitive to US machine usage assumptions implying that purchased machines should be used sufficiently often to make them economically efficient.

### **Conclusions**

There is evidence for the effectiveness and cost-effectiveness of 2-D US-guided CVA, particularly via the IJV in adults and children. However, some important implications of possible wider use of 2-D US for CVA are clearly identifiable.

### **Implications for the NHS**

There are significant training implications if the US-guided procedure is to be advocated. Economic modelling indicates that training schemes would need to be set up in a cost-effective way in order to ensure that the US procedure is itself cost-effective. Training of medical and nursing staff would need to be coordinated and agreed among professional bodies.

In emergency situations, where a line needs to be inserted without delay, landmark insertions may still be appropriate. It is important that training in US-guided access allows operators to remain skilled in the landmark methods.

If machines were purchased to guide IJV insertions, policy-makers would need to consider how US should be used for CVA for non-IJV insertions where evidence is more limited. If SV insertions were to be performed without US when machines are available, this could lead to avoidable complications, with medico-legal implications. If 2-D US were not to be recommended for SV insertions, a compromise policy of advocating US for patency checking and vessel localisation might be applicable. The possible implications of more widespread use of US for operators already skilled in the use of landmark methods, also needs to be considered. Again the compromise policy may be applicable.

### **Recommendations for research**

No RCT evidence was found for the effectiveness of using US for peripherally inserted central catheters or for US versus surgical cut-down. The possible economic and clinical implications of CVA by nurse operators in the NHS may be another useful area for further research, given that feasibility has already been demonstrated.

### **Publication**

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