

**Guidance on  
the use of  
ultrasound  
locating devices  
for placing central  
venous catheters**

## Technology Appraisal No. 49

Guidance on the use of ultrasound locating devices for placing central venous catheters

Issue date: September 2002

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### Ordering Information:

Copies of this guidance can be obtained from the NHS Response Line by telephoning 0870 1555 455 and quoting ref: N0146. A patient version of this document can be obtained by quoting ref: N0148. A bi-lingual patient leaflet is also available, ref: N0149.

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## Distribution of guidance

This document has been circulated to the following:

- PCT Chief Executives
- NHS Trust Chief Executives in England and Wales
- Local Health Group General Managers
- Medical and Nursing Directors in England and Wales
- Consultant anaesthetists in England and Wales
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- Chief Medical, Nursing Officers and Pharmaceutical Officers in England and Wales
- Medical Director & Head of NHS Quality – Welsh Assembly Government
- Representative bodies for health services, professional organisations and statutory bodies, Royal Colleges

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### This guidance is written in the following context:

This guidance represents the view of the Institute which was arrived at after careful consideration of the available evidence. Health professionals are expected to take it fully into account when exercising their clinical judgement. This guidance does not, however, override the individual responsibility of health professionals to make appropriate decisions in the circumstances of the individual patient, in consultation with the patient and/or guardian or carer.

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# Guidance on the use of ultrasound locating devices for placing central venous catheters

## 1. Guidance

- 1.1 Two-dimensional (2-D) imaging ultrasound guidance is recommended as the preferred method for insertion of central venous catheters (CVCs) into the internal jugular vein (IJV) in adults and children in elective situations.
- 1.2 The use of two-dimensional (2-D) imaging ultrasound guidance should be considered in most clinical circumstances where CVC insertion is necessary either electively or in an emergency situation.
- 1.3 It is recommended that all those involved in placing CVCs using two-dimensional (2-D) imaging ultrasound guidance should undertake appropriate training to achieve competence.
- 1.4 Audio-guided Doppler ultrasound guidance is not recommended for CVC insertion.

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This section (Section 1) constitutes the Institute's guidance on the use of ultrasound locating devices for placing central venous catheters. The remainder of the document is structured in the following way:

2 Clinical need and practice	8 Related guidance
3 The technology	9 Review of guidance
4 Evidence and interpretation	Appendix A: Appraisal Committee
5 Recommendations for further research	Appendix B: Sources of evidence
6 Resource impact for the NHS	Appendix C: Information for the public
7 Implementation and audit	Appendix D: Technical detail on criteria for audit

A bi-lingual summary is available from our website at [www.nice.org.uk](http://www.nice.org.uk) or by telephoning 0870 1555 455 and quoting the reference number N0147.

Mae crynodeb ar gael yn Gymraeg ac yn Saesneg ar ein gwefan yn [www.nice.org.uk](http://www.nice.org.uk) neu drwy ffonio 0870 1555 455 gan ddyfynnu cyfeirnod N0147.

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- 2.1 Central venous catheters (CVCs) are inserted for a number of reasons including haemodynamic monitoring, intravenous delivery of blood products and drugs (for example, chemotherapy and antibiotics), haemodialysis, total parenteral nutrition, cardiac pacemaker placement and management of perioperative fluids. Central venous catheterisation may be required for patients undergoing cancer treatment, dialysis, or coronary or other major surgery, and for those admitted to intensive therapy units (ITUs), high dependency units (HDUs) or accident and emergency departments. It has been estimated that about 200,000 CVCs are inserted annually in the NHS.
- 2.2 Central venous access has traditionally been achieved by puncturing a central vein (venepuncture) and passing the needle along the anticipated line of the relevant vein by using surface anatomical landmarks and by knowing the expected anatomical relationship of the vein to its palpable companion artery. This is known as the 'landmark method'. Direct surgical access to a peripheral vein ('cut-down') is a less frequently used method for central venous access catheter insertion.
- 2.3 CVCs are inserted in a wide range of clinical settings by a diverse group of clinicians including radiologists, anaesthetists, nephrologists, oncologists, surgeons, general physicians and paediatricians. In the USA and increasingly in the UK, nurse specialists are also undertaking CVC procedures. The range of settings in which CVCs are inserted includes operating theatres, emergency rooms, nephrology, oncology and other wards, radiology departments, ITUs and HDUs.
- 2.4 Central venous access can be achieved using various puncture sites but the most common are the internal jugular vein (IJV), the subclavian vein (SV), the femoral vein (FV), and the upper limb veins (using peripherally inserted central catheters – PICCs). The choice of access route depends on multiple factors including the reason for CVC insertion, the anticipated duration of access, the intact venous sites available and the skills of the operator.
- 2.5 Whilst experienced operators using the landmark method can achieve relatively high success rates with few complications, in the literature failure rates for initial CVC insertion have been reported to be as high as 35%.
- 2.6 The most common complications associated with CVC placement are arterial puncture, arteriovenous fistula, pneumothorax, nerve injury and multiple unsuccessful attempts at catheterisation, which delay treatment. The risks and the consequences of complications vary substantially across different patient groups depending on the patient's anatomy (for example, morbid obesity, cachexia, short neck, or local scarring from surgery or radiation treatment), the circumstances in which CVC insertion is carried out (for

### 3

#### The technology

example, for a patient receiving mechanical ventilation or during emergencies such as cardiac arrest) and co-morbidities (for example, bullous emphysema or coagulopathy). The National Confidential Enquiry into Perioperative Deaths recently reported that in a survey of over 3000 CVC procedures undertaken in the NHS, one fatality occurred as a result of a procedure-induced pneumothorax.

- 3.1 Ultrasound technology has long been used in interventional radiology to guide percutaneous procedures at sites such as the kidneys, liver, arterial and venous circulation, pleural cavity, gallbladder and joints. Real-time ultrasound guidance of CVC insertion provides the operator with visualisation of the desired vein and the surrounding anatomical structures before and during the insertion. The advantages of ultrasound-guided central venous catheterisation include the identification of the precise position of the target vein and the detection of anatomical variants and of thrombosis within the vessel, together with the avoidance of inadvertent arterial puncture. Ultrasound guidance therefore has the potential to reduce the incidence of complications related to initial venous puncture, which is the first stage of CVC insertion.
- 3.2 Two types of real-time ultrasound guidance are described: two-dimensional (2-D) imaging ultrasound guidance and audio-guided Doppler ultrasound guidance. Two-dimensional imaging ultrasound, which is the more commonly used method, provides a real-time grey-scale imaging of the anatomy. Audio-guided Doppler ultrasound generates an audible sound from flowing venous blood, which helps the operator localise the vein and differentiate it from its companion artery. The portable ultrasound machines can be used in operating theatres, accident and emergency departments, ITUs, HDUs and radiology suites, as well as at the bedside on the hospital ward.
- 3.3 Operators need to be trained to use ultrasound-guided techniques. Training involves not only acquiring the necessary manual skills, but also having a basic understanding of ultrasound principles and being able to interpret ultrasound images.

### 4

#### Evidence and interpretation

The Appraisal Committee considered evidence from a number of sources (see Appendix B).

#### 4.1 Clinical effectiveness

- 4.1.1 Twenty randomised clinical trials (RCTs) were identified. Of these, six evaluated audio-guided Doppler ultrasound against the landmark method, thirteen evaluated 2-D ultrasound guidance against the landmark method and one evaluated both audio-guided Doppler ultrasound and 2-D ultrasound guidance against the landmark method. There were no

trials that compared the use of ultrasound locating devices (ULDs) against the surgical cut-down method.

- 4.1.2 Insertion sites were the IJV (fifteen trials), SV (four trials) or FV (one trial). One trial did not specify the insertion point, and one investigated both the IJV and the SV as insertion sites. None addressed the placement of PICCs or ports, both of which can be considered types of CVCs.
- 4.1.3 For most of the trials, the setting within the hospital where the cannulation took place was not reported clearly. In six of the trials the central venous catheterisation took place in an ITU or trauma unit, and in two trials catheterisations took place in emergency rooms. In the seven studies involving patients scheduled for cardiac surgery, the cannulation is most likely to have taken place on the way into theatre. In only three of the trials does it seem likely that CVCs were inserted on wards or in clinics.
- 4.1.4 The CVC procedure was carried out by anaesthetists in seven studies and by other medical staff in four studies. One study involved 2-D ultrasound-guided catheterisation by junior radiologists. None of the studies involved nurses. The remaining nine studies did not make the specialty or profession of the operator clear. The range of experience of the operator, both with respect to medical career and use of the intervention, differed greatly from study to study. Six studies described the operators as having up to 5 years' postgraduate experience, eight described them as having more than 5 years' experience, and two described them as varying in experience. Four trials did not record the career experience of the operator.

## **2-D ultrasound imaging**

### **Internal jugular vein**

- 4.1.5 Pooled results from seven RCTs suggested that real-time 2-D ultrasound guidance was significantly better than the landmark method for all five outcome variables measured for insertions into the IJV in adults. Compared with the landmark method, 2-D ultrasound guidance was associated with reduced risks of failed catheter placements (86% reduction in relative risk, 95% confidence interval [CI] 67% to 94%,  $p < 0.001$ ), catheter placement complications (57% reduction in relative risk, 95% CI 13% to 78%,  $p = 0.02$ ), and failure on the first catheter placement attempt (41% reduction in relative risk, 95% CI 12% to 61%,  $p = 0.009$ ), and fewer attempts to achieve successful catheterisation (on average, 1.5 fewer attempts, 95% CI 0.47 to 2.53,  $p = 0.004$ ).

- 4.1.6 The difference between the 2-D ultrasound method and the landmark method in the time taken to insert a catheter successfully was small and not statistically significant (2-D ultrasound-guided catheterisation was 20 seconds faster, 95% CI –83 to 124 seconds). However, there was significant heterogeneity for this endpoint ( $p < 0.01$ ), which indicated that it might not be appropriate to pool these results. In the study which reported the longest time to achieve a successful catheterisation, the time taken to set up the ULD was also included in the outcome measurement. When the analysis was repeated, excluding this study, heterogeneity was no longer significant and the pooled result from the included trials showed that catheterisation was, on average, 69 seconds faster (95% CI 46 to 92 seconds) with the ULD than with the landmark method, which was a highly statistically significant difference ( $p < 0.001$ ). It is acknowledged that the importance of this endpoint will vary between clinical situations.
- 4.1.7 Three trials evaluated the effect of 2-D ultrasound guidance on the cannulation of the IJV in infants. In these trials, 2-D ultrasound guidance was significantly better than the landmark method in terms of reductions in the risk of failed catheter placements (85% reduction in relative risk, 95% CI 36% to 97%,  $p = 0.01$ ), the risk of catheter placement complications (73% reduction in relative risk, 95% CI 8% to 92%,  $p = 0.03$ ), and the number of attempts required before catheterisation was successful (reduced by an average of 2, 95% CI 1.2 to 2.8,  $p = 0.001$ ). Using 2-D ultrasound guidance, successful cannulation was achieved, on average, 349 seconds (95% CI –103 to 802 seconds) more quickly than with the landmark method, although this result was not statistically significant.

### ***Subclavian vein***

- 4.1.8 Only one RCT was identified that analysed the effect of 2-D ultrasound guidance on SV catheterisation in adults. In the trial, in comparison with the landmark method, 2-D ultrasound guidance was associated with reduced risks of catheter placement failure (86% reduction in relative risk, 95% CI 43% to 96%,  $p = 0.006$ ) and catheter placement complications (90% reduction in relative risk, 95% CI 29% to 99%,  $p = 0.02$ ). However, in this trial, the operators were relatively inexperienced in both the landmark method and 2-D ultrasound guidance. The failure rate with the landmark method was 55%, which is higher than that reported in trials that involved more experienced operators (around 9–19%).

- 4.1.9 No studies were found that investigated the effect of 2-D ultrasound guidance on SV catheterisation in infants.

### ***Femoral vein***

- 4.1.10 One study was identified that evaluated the effect of 2-D ultrasound guidance on femoral catheterisation in adults. In this trial, the operators took, on average, 2.7 (95% CI 0.1 to 5.3) fewer attempts to insert a catheter using 2-D ultrasound guidance than using the landmark method ( $p = 0.04$ ). Compared with the landmark method, 2-D ultrasound guidance reduced the risk of failed catheter placement and the time to successful catheterisation, but the differences were not statistically significant. No studies in infants were found.
- 4.1.11 No studies were found that investigated the effect of 2-D ultrasound guidance on FV catheterisation in infants.

### ***Audio-guided Doppler ultrasound***

#### ***Internal jugular vein***

- 4.1.12 Four RCTs were found that compared audio-guided Doppler ultrasound guidance with the landmark method for IJV catheterisation in adults. Pooled results from these RCTs suggest that audio-guided Doppler ultrasound guidance was significantly better than the landmark method in terms of risk of failed catheter placement (61% reduction in relative risk, 95% CI 8% to 83%,  $p = 0.03$ ) and the risk of failure on the first catheter placement attempt (43% reduction in relative risk, 95% CI 12% to 63%,  $p = 0.01$ ). With the audio-guided Doppler ultrasound method, the risk of catheter placement complications was reduced (57% reduction in relative risk, 95% CI -5% to 83%) and there were fewer attempts to achieve successful catheterisation (0.6 fewer attempts, 95% CI -0.6 to 1.8); however, the differences did not reach statistical significance ( $p = 0.06$  and  $p = 0.40$ , respectively) so they could have arisen by chance. It took, on average, 35 seconds longer (95% CI -54 to 124 seconds) to successfully insert a catheter using Doppler ultrasound guidance than it did with the landmark method, although this difference was also not statistically significant.
- 4.1.13 Only one trial was identified that studied the effect of audio-guided Doppler ultrasound in infants. The sample size of this study was small ( $n = 29$ ) and so it lacked statistical power. It failed to show any differences with the landmark method.



## ***Subclavian vein***

- 4.1.14 The pooled results from three RCTs (all involving adults) suggest that for SV catheterisation there was a significantly increased risk of failed catheter placement when the audio-guided Doppler ultrasound method was used compared with the landmark method (48% increased in relative risk, 95% CI 3% to 114%,  $p = 0.03$ ) – in other words the landmark method was preferable to the audio-guided Doppler ultrasound guidance technique. In contrast, the pooled results from two of the trials, which reported the risk of catheter placement, showed a 43% fall (95% CI 89% to 188%) in relative risk in the audio-guided Doppler ultrasound group, although this result was not statistically significant.
- 4.1.15 Only one study reported the effect of audio-guided Doppler ultrasound guidance on the risk of failure of the first catheter placement in adults. There was a slight increase (4%, 95% CI –24% to 43%) in the risk of catheter placement complications associated with the use of audio-guided Doppler ultrasound guidance compared with the landmark method, although this result was not statistically significant. Only one study recorded the effect of audio-guided Doppler ultrasound guidance on the number of attempts required to achieve successful catheterisation. This study found that an average of 0.4 (95% CI 0.2 to 0.6) fewer attempts were needed to achieve successful catheterisation with the audio-guided Doppler ultrasound guidance method compared with the landmark method, a highly statistically significant difference ( $p < 0.001$ ). The same study was the only one to record the effect of Doppler ultrasound guidance on the time to achieve successful catheterisation. Catheterisation using the Doppler ultrasound guidance method was significantly (on average, 209 seconds, 95% CI 175 to 242) slower than catheterisation using the landmark method ( $p < 0.001$ ).

## **4.2 Cost effectiveness**


- 4.2.1 No relevant economic evaluations were identified in the literature. Furthermore, none of the submissions made to the Institute included economic evaluations.
- 4.2.2 The Assessment Group developed an economic analysis, based on the evidence from the systematic review of RCTs, to evaluate the cost effectiveness of 2-D ultrasound guidance compared with the landmark method. This model is a simple decision analytic model, and is based on a theoretical cohort of 1000

adult patients who required IJV cannulation before surgery and who had a low to moderate risk of complications.

- 4.2.3 This model adopted a set of conservative assumptions. It was assumed that: the operators were experienced in using the landmark method; the time to achieve successful puncture was the same for both methods; complications were limited to arterial puncture; there was a 10-minute delay between the prior failure and the new attempt at another insertion site; there was a 100% success rate at the second insertion site; and each machine was used for 15 procedures per week.
- 4.2.4 The results of the Assessment Group's model suggested that the ultrasound guidance not only avoided 90 arterial punctures for every 1000 patients treated, but also reduced costs by an average of almost £2 per patient. In other words the 2-D ultrasound guidance method was found to be both more effective and less costly than the landmark method.
- 4.2.5 A threshold sensitivity analysis was undertaken to examine by how much key variables in the model needed to change to make the ultrasound guidance method cost-neutral instead of cost-saving. The modelled result was most sensitive to the utilisation of the ultrasound equipment. The cost-saving result was eradicated if the number of ultrasound procedures assumed per machine per week was less than around 11, or if the number of ultrasound procedures carried out by an individual trained practitioner was less than around 3 per month on average.
- 4.2.6 Given that the model used relatively conservative estimates, the Assessment Group concluded that the results were probably generalisable to all anatomical catheter insertion sites, to infants, and to other sites within the hospital including the clinical wards.

### **4.3 Consideration of the evidence**

- 4.3.1 The Committee reviewed the evidence on both the clinical effectiveness and the cost effectiveness of ULDs for placing CVCs, having also considered the evidence from clinical experts. Furthermore, the Committee was mindful of the need to ensure that its advice took account of the efficient use of NHS resources.
- 4.3.2 The Committee took note of the fact that the evidence on the effectiveness of CVC placement into IJVs in adult patients was more robust than that available for other insertion sites. For infants, evidence was available



only from trials that evaluated central venous catheterisation of the IJV, and there was very limited evidence on the use of this technology in very small infants (i.e. those weighing less than 3 kg). In addition, the economic analysis presented to the Committee was based on an evaluation of the cost effectiveness of 2-D ultrasound-guided elective CVC placement into the IJV in the operating theatre prior to surgery. The Assessment Report provided justifications for extrapolating this analysis to other settings including ward-based management, other sites of CVC insertion and also to CVC placement in infants.

- 4.3.3 Given the constraints outlined in 4.2.2, the Committee concluded that there was evidence of both the clinical and cost effectiveness of 2-D imaging ultrasound guidance as an adjunct for placing CVCs in the majority of clinical scenarios, but that the degree to which this technology would be most suitably applied would vary according to the clinical situation and the competence/previous experience of the operator. In addition, there could be potential benefits for patients arising from reduced discomfort from the procedure and reduced risk of complications compared with the landmark method, particularly for IJV insertions.
- 4.3.4 The Committee found the evidence for the use of audio-guided Doppler ultrasound guidance less satisfactory, and therefore concluded that the 2-D imaging ultrasound guidance should be used in preference to audio-guided Doppler ultrasound guidance.
- 4.3.5 While accepting that, from a patient's perspective, 2-D ultrasound imaging guidance in CVC insertion might be more appropriate and probably superior to the traditionally used landmark method in many circumstances, the Committee also considered the financial and service implications of purchasing the required equipment and of training sufficient numbers of competent practitioners.
- 4.3.6 The Committee also considered that although 2-D ultrasound imaging guidance in CVC placement may eventually become the routine method for placing CVCs, the landmark method would remain important in some circumstances, such as emergency situations, when ultrasound equipment and/or expertise might not be immediately available. Consequently, the Committee thought it important that operators maintain their ability to use the landmark method and that the method continues to be taught alongside the 2-D-ultrasound-guided technique.

## 5

### Recommendations for further research

- 5.1 Good quality studies are needed:
- to investigate the possible economic and clinical implications to the NHS of nurse specialists or other healthcare practitioners carrying out routine insertion of CVCs
  - to evaluate the use of ultrasound-guided central venous catheterisation in small infants (i.e. those weighing less than 3 kg).

## 6

### Resource impact for the NHS

- 6.1 The purchase cost of a portable 2-D ultrasound machine currently lies between £7000 and £15,000. The additional disposables necessary for the ultrasound-guided procedure cost less than £1 per procedure. Estimates made by the Assessment Group analysis indicate that the additional cost of using ultrasound equipment for the CVC placement procedure is likely to be less than £10 per procedure.
- 6.2 It is likely that the NHS will need to invest in a significant number of additional 2-D ultrasound machines, although it is impossible to predict how many will be required, as local circumstances will vary considerably. Implementing the guidance will require local decisions regarding optimal number of machines, staff training and device service contracts.
- 6.3 The Assessment Group analysis suggests that in the long term the implementation of ultrasonic locating devices will be cost-saving. The majority of these savings are likely to be due to releasing resources such as staff, and operating theatre and ITU/HDU time and beds.
- 6.4 A constraint upon the implementation of this technology will be the need to ensure that there are adequately trained competent operators to support the services. Many CVC placement procedures are performed on an emergency basis at the bedside in a diverse number of locations and therefore the necessary skills need to be spread across several related disciplines.

## 7

### Implementation and audit

- 7.1 NHS Trusts in which CVCs are used, all those who routinely insert CVCs and those responsible for clinical training programmes should review policies and practices regarding the insertion of CVCs to take account of the guidance set out in Section 1. The recommendations in this guidance will represent a significant service development for most NHS organisations. The Appraisal Committee has advised the Institute that the nature of the resource consequences of the guidance and the time it will take to put them in place should be brought to the attention of the Department of Health and the Welsh Assembly Government.

- 7.2 Local guidelines or care pathways which relate to the use of CVCs should incorporate the guidance set out in Section 1.
- 7.3 To enable healthcare practitioners to audit their own compliance with this guidance, it is recommended that a system is available to identify patients who have a CVC inserted in either an elective or an emergency situation.
- 7.4 To measure compliance locally with the guidance in Section 1, the following criteria should be used. Further details on suggestions for audit are presented in Appendix D.
- When a CVC is being inserted into the IJV of an adult or a child in an elective situation, 2-dimensional (2-D) imaging ultrasound guidance is used.
  - All healthcare practitioners involved in the placement of CVCs using 2-D imaging ultrasound guidance undertake appropriate training to achieve competence in this technique.
  - Audio-guided Doppler ultrasound guidance is not used for CVC insertion.
- 7.5 All NHS Trusts in which CVCs are used should identify the number of 2-D imaging ultrasound units required and the appropriate location for each unit, should plan to train a sufficient number of healthcare practitioners from a range of disciplines in the proper use of the units and should identify other financial and service implications of implementing the guidance in Section 1.
- 7.6 Healthcare practitioners should consider the most appropriate method of CVC insertion that is in the best interest of the patient in his or her specific clinical situation, particularly in terms of minimising the risk of adverse events such as failed catheter placements or catheter placement complications. Trusts should recognise that the decision to use 2-D imaging ultrasound guidance or the landmark method will be informed by:
- the competence and previous experience of the operator(s)
  - the anatomical site of CVC insertion and other anticipated technical difficulties
  - the urgency of clinical need.

## 8

### Related guidance

- 8.1 There is no related NICE guidance for this technology.

- 9.1 The review date for a technology appraisal refers to the month and year in which the Guidance Executive will consider any new evidence on the technology, in the form of an updated Assessment Report, and decide whether the technology should be referred to the Appraisal Committee for review.
- 9.2 The guidance on this technology is reviewed in August 2005

Andrew Dillon  
Chief Executive

September 2002

## Appendix A

### Appraisal Committee members

**NOTE** The Appraisal Committee is a standing advisory committee of the Institute. Its members are appointed for a 3-year term. A list of the Committee members appears below. The Appraisal Committee meets twice a month other than in December, when there are no meetings. The Committee membership is split into two branches, with the Chairman, Vice-chairman and a number of other members attending meetings of both branches. Each branch considers its own list of technologies and topics are not moved between the branches.

Committee members are asked to declare any interests in the technology to be appraised. If there is a conflict of interest, the member is excluded from participating further in that appraisal.

The minutes of each Appraisal Committee meeting, which include the names of the members who attended and their declaration of interests, are posted on the NICE website.

**Dr Jane Adam**

Radiologist, St George's Hospital,  
London

**Professor R L Akehurst**

Dean, School of Health Related  
Research, Sheffield University

**Dr Sunil Angris**

General Practitioner, Waterhouses  
Medical Practice

**Professor David Barnett  
(Chairman)**

Professor of Clinical Pharmacology,  
University of Leicester

**Dr Sheila Bird**

MRC Biostatistics Unit, Cambridge

**Professor Carol Black**

Consultant Physician, Royal Free  
Hospital & UCL, London

**Professor John Brazier**

Health Economist, University of  
Sheffield

**Professor Martin Buxton**

Director of Health Economics Research  
Group, Brunel University

**Professor Mike Campbell**

Statistician, Institute of General  
Practice & Primary Care, Sheffield

**Dr Karl Claxton**

Health Economist, University of York

**Professor Sarah Cowley**

Professor of Community Practice  
Development, Kings College, London

**Professor Jack Dowie**

Health Economist, London School of  
Hygiene & Tropical Medicine, London

**Mr Chris Evennett**

Chief Executive, Mid-Hampshire  
Primary Care Trust

**Dr Paul Ewings**

Statistician, Taunton & Somerset NHS  
Trust

**Professor Terry Feest**

Clinical Director and Consultant  
Nephrologist, Richard Bright Renal  
Unit, and Chairman of the UK Renal  
Registry

**Professor Gary A Ford**

Professor of Pharmacology of Old Age/  
Consultant Physician, Wolfson Unit of  
Clinical Pharmacology, University of  
Newcastle

**Mrs Sue Gallagher**  
Chief Executive, Merton, Sutton and  
Wandsworth Health Authority

**Dr Trevor Gibbs**  
Head, Global Clinical Safety &  
Pharmacovigilance, GlaxoSmithKline

**Sally Gooch**  
Director of Nursing, Mid-Essex  
Hospital Services Trust

**Mr John Goulston**  
Director of Finance, The Royal Free  
Hampstead NHS Trust

**Professor Trisha Greenhalgh**  
Professor of Primary Health Care,  
University College London

**Miss Linda Hands**  
Consultant Vascular Surgeon, John  
Radcliffe Hospital, Oxford

**Professor Philip Home**  
Professor of Diabetes Medicine,  
University of Newcastle

**Dr Terry John**  
General Practitioner, The Firs, London

**Dr Diane Ketley**  
Research into Practice Programme  
Leader, NHS Modernisation Agency

**Dr Mayur Lakhani**  
General Practitioner, Highgate Surgery,  
Leicester, and Lecturer, University of  
Leicester

**Ruth Lesirge**  
Lay Representative; Director, Mental  
Health Foundation

**Dr George Levvy**  
Lay Representative; Chief Executive,  
Motor Neurone Disease Association

**Dr Gill Morgan**  
CEO, North & East Devon Health  
Authority

**Professor Miranda Mugford**  
Health Economist, University of East  
Anglia

**Mr M Mughal**  
Consultant Surgeon, Lancashire  
Teaching Hospitals NHS Trust

**Mr James Partridge**  
Lay Representative; Chief Executive,  
Changing Faces

**Siân Richards**  
General Manager, Cardiff Local Health  
Group

**Professor Philip Routledge**  
Professor of Clinical Pharmacology,  
University of Wales

**Dr Rhiannon Rowsell**  
Pharmaceutical Physician, AstraZeneca  
UK Ltd

**Dr Stephen Saltissi**  
Consultant Cardiologist, Royal  
Liverpool University Hospital

**Professor Andrew Stevens  
(Vice-Chairman)**  
Professor of Public Health, University  
of Birmingham

**Professor Ray Tallis**  
Consultant Physician, Hope Hospital,  
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**Dr Cathryn Thomas**  
General Practitioner, and Senior  
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and General Practice, University of  
Birmingham

**Professor Mary Watkins**  
Head of Institute of Health Studies,  
University of Plymouth

**Dr Norman Waugh**  
Public Health Consultant, University of  
Southampton



## Appendix B

### Sources of evidence considered by the Committee

The following documentation and opinion were made available to the Committee:

- A. Assessment report** prepared by the School of Health Related Research (SchARR), University of Sheffield: *The effectiveness and cost effectiveness of ultrasound locating devices for central venous access, 24 January 2002.*
- B. Manufacturer/sponsor submissions:**
  - KeyMed (Medical & Industrial Equipment) Ltd
  - Jade Medical UK and Dymax Corporation
  - SonoSite Inc
  - Siemens
  - Dynamic Imaging Limited
- C. Professional/specialist group submissions:**
  - British Association of Critical Care Nurses
  - Royal College of Physicians
  - Renal Association
  - Intensive Care Society
  - Royal College of Anaesthetists
  - Lincolnshire Health Authority/West Lincolnshire PCT
  - Royal College of Nursing
  - Royal College of Radiologists
  - Department of Health and Welsh Assembly Government
  - Health Technology Board for Scotland
- D. Patient/carer group submissions:**
  - No submissions received
- E. Expert perspective:**
  - Dr A R Bodenham, Consultant in Anaesthesia and Intensive Care, Leeds General Infirmary

## Appendix C

### Patient information

#### Guidance on the use of ultrasound locating devices for placing central venous catheters

The patient information in this appendix has been designed to support the production of your own information leaflets. You can download it from our website at [www.nice.org.uk](http://www.nice.org.uk) where it is available in English and Welsh. If you would like printed copies of the leaflets please ring the NHS Response Line on 0870 1555 455 and quote reference number N0148 for the English patient leaflet and N0149 for the bi-lingual patient leaflet.

#### What is NICE guidance?

The National Institute for Clinical Excellence (NICE) is part of the NHS. It produces guidance for both the NHS and patients on the use of medicines, medical equipment, diagnostic tests and clinical and surgical procedures and under what circumstances they should be used.

To produce this guidance, NICE looks at how well the medicine, equipment or procedure works and also how well it works in relation to how much it costs. This process is called an appraisal. The appraisal process involves the manufacturer of the medicine or equipment for which guidance is being produced and the organisations that represent the healthcare professionals, patients and carers who will be affected by the guidance. Each appraisal takes about 12 months to complete.

NICE was asked to look at the available evidence on ultrasound locating devices for placing central venous catheters and provide guidance that would help the NHS in England and Wales decide when they should be used.

#### What are central venous catheters and when are they used?

A central venous catheter is a tube that is inserted into a vein (a blood vessel that carries blood to the heart). There are many reasons why a patient might need a central venous catheter – for example, it might be necessary to slowly deliver blood products, certain liquid drugs or other fluids into the body (this is called an intravenous infusion or a ‘drip’) or to carry out certain surgical procedures such as fitting a heart pacemaker. And there lots of hospital situations in which central venous catheters are used – for example, for patients undergoing cancer treatment, dialysis, or major surgery, and for those admitted to accident and emergency departments or intensive therapy units.

The most common sites for insertion of a central venous catheter are the internal jugular vein (in the neck, carrying blood from the head to the heart), the subclavian vein (under the collar bone, carrying blood from the arm to the heart), the femoral vein (the main vein in the leg), and veins in the arm.

Central venous catheters are usually inserted by doctors, but sometimes a specialist nurse carries out the procedure. It has been estimated that about 200,000 CVCs are inserted annually in the NHS.

**How are ultrasound locating devices used?**

A vein has to be punctured to insert a central venous catheter. This is done by inserting a needle into the body and along the vein. Traditionally, doctors have found the right place to insert the needle by using their knowledge of body structure to look for certain features and to feel for the pulse in the artery that lies close to the vein. (An artery is a blood vessel that carries blood away from the heart. The catheter must be inserted into a vein, not into an artery.) This is known as the 'landmark method'.

Ultrasound devices are now available to help the doctor to guide the needle into the vein. There are two types of ultrasound device available to do this: two-dimensional (2-D) imaging ultrasound devices and audio-guided Doppler ultrasound devices. All ultrasound devices send very high frequency sound waves (which can't be heard by the human ear) into the body and detect the echoes that are reflected back. In 2-D imaging ultrasound, these echoes are analysed by the machine and translated into an image of the vein and the tissues surrounding it, which is displayed on a screen. Audio-guided Doppler ultrasound devices don't show a picture of the vein; instead they emit a sound when they detect blood flowing in a vein.

**Why might ultrasound locating devices be used?**

There are a number of complications that can be associated with inserting a central venous catheter. These include puncturing an artery instead of a vein, puncturing the wall of the pleural cavity that surrounds the lungs, causing injury to a nerve or having to make several attempts at inserting the catheter, which can delay treatment. The risks and the consequences of complications differ substantially across different patient groups depending on the patient's body structure, the circumstances in which the procedure is carried out and what illnesses or injuries the patient has.

Studies have investigated whether ultrasound locating devices have advantages over the landmark method for placing central venous in terms of factors such as failure to place a catheter, the number of attempts made before a catheter is placed successfully and the occurrence of complications. NICE has looked at the evidence available and has made recommendations to the NHS in England and Wales about when ultrasound locating devices should be used.

**What has NICE recommended?**

NICE has made the following recommendations.

- 2-D imaging ultrasound guidance should be the preferred method when inserting of central venous catheter into the internal jugular vein in adults and children in 'elective situations'. ('Elective situation' means that the operation, or other treatment, has been planned – that is, it is not an emergency.)

- 2-D imaging ultrasound guidance should be considered in most clinical situations where CVC insertion is necessary, whether the situation is elective or an emergency.
- Everyone who uses 2-D imaging ultrasound guidance to insert central venous catheters should have appropriate training to ensure they are competent to use the technique.
- Audio-guided Doppler ultrasound guidance is not recommended for use when inserting central venous catheters.

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**What should I do?**

If you or someone you care for is going to have a clinical procedure which might involve inserting a central venous catheter (for example, major surgery), you should discuss this guidance with your doctor or nurse.

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**Will NICE review its guidance?**

Yes. The guidance will be reviewed in August 2005.

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**Further information**

The NICE website ([www.nice.org.uk](http://www.nice.org.uk)) has further information on NICE and the full guidance on the use of ultrasound locating devices for placing intravenous catheters that has been issued to the NHS. The guidance can also be requested from the NHS Response Line by phoning 0870 1555 455 and quoting reference N0146.

## Appendix D

### Detail on criteria for audit of the use of ultrasound locating devices for placing central venous catheters

#### Possible objectives for an audit

An audit on the appropriate use of ultrasound locating devices could be carried out to ensure that:

- when a central venous catheter (CVC) is being inserted into the internal jugular vein (IJV) of an adult or a child in an elective situation, 2-dimensional (2-D) imaging ultrasound guidance is used
- healthcare practitioners involved in the placement of CVCs using 2-D imaging ultrasound guidance have appropriate training
- audio-guided Doppler ultrasound guidance is not used for CVC insertion.

If healthcare practitioners have agreed locally on the clinical circumstances where 2-D imaging ultrasound guidance is to be used when a CVC insertion is necessary, the audit also could be carried out to ensure that the technique is used as agreed locally.

#### Possible patients to be included in the audit and time period for selection

All patients who have a CVC inserted either in the IJV in an elective situation (or for any purpose on either an elective or emergency basis, if 2-D imaging ultrasound is more widely used) over a reasonable period of time for audit data collection, for example, for 1 to 3 months. A sample of patients stratified by clinical areas most likely to be involved, for example, critical care areas, theatres, and accident and emergency, could be used for the audit or the audit could be staged to include one clinical area at a time, working through all clinical areas.

## Measures to be used as a basis for an audit

The measures to be used in an audit of patients who have a CVC inserted are as follows.

Criterion	Standard
1. 2-D imaging ultrasound guidance is used when a CVC is being inserted in the IJV in an elective situation	100% of patients with a CVC inserted in the IJV in an elective situation
2. The healthcare practitioner involved in the placement of the CVC is trained in the use of 2-D imaging ultrasound guidance	100% of patients having a CVC inserted
3. Audio-guided Doppler ultrasound guidance is not used for CVC insertion	100% of patients having a CVC inserted

An additional measure that could be used when it has been agreed to use 2-D imaging ultrasound guidance for other clinical circumstances in which a patient has a CVC inserted is as follows.

Criterion	Standard
1. 2-D imaging ultrasound guidance is used when a CVC is being inserted	100% of patients having a CVC inserted for any purpose

### Calculation of compliance with the measure

Compliance with each measure described in the table is calculated as follows:

$$\frac{\text{Number of patients whose care is consistent with the **crit**erion *plus* the number of patients whose care is consistent with any locally agreed **ex**ception}}{\text{Number of patients to whom the **me**asure applies}} \times 100$$

Healthcare practitioners should review the findings of measurement, identify whether practice can be improved, agree on a plan to achieve any desired improvement and repeat the measurement of actual practice to confirm that desired improvement is being achieved.

Exception	Definition of Terms
None	Local clinical teams should agree on the types of elective situations to be included in the audit and should agree to any exceptions for the use of the technique such as an infant weighing less than 3 kg
None	For audit purposes, it should be agreed at NHS Trust level how training to achieve competence in the technique is documented
None	

Exception	Definition of Terms
None	Local healthcare practitioners may specify circumstances in which 2-D ultrasound guidance is to be used when a CVC is being inserted or may specify exceptions, for audit purposes



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