NICE National Institute for Health and Care Excellence

Medical Technologies Evaluation Programme

MT 234 - Sherlock 3CG Tip Confirmation System for placement of peripherally inserted central catheters

Expert Adviser Questionnaire Responses

Name of Expert Advisers	Job Title	Professional Organisation/ Specialist Society	Nominated by	Ratified
Mr Andrew Barton	Clinical Nurse Specialist	Nursing and Midwifery Council	Sponsor	Yes
Dr Andrew Bodenham	Consultant in Anaesthesia and Intensive Care Medicine	National Infusion and Vascular Access Society	Specialist society	-
Dr Lisa Dougherty	Nurse Consultant	National Infusion and Vascular Access Society	Sponsor	Yes
Ms Dympna McParlan	Infusion Services Coordinator	Nursing and Midwifery Council	Sponsor	Yes
Dr Tim Jackson	Consultant Anaesthetist	National Infusion and Vascular Access Society	Specialist society	-
Dr Andrew Johnston	Consultant in Intensive Care. Medical Lead Vascular team	Royal College of Anaesthetists	Sponsor	Yes
Ms Elizabeth Elfleet	Advanced Radiographer Practitioner	Society of Radiographers	NICE	Yes
Dr Richard Leech	Consultant Anaesthetist	Royal College of Anaesthetists	Sponsor	Yes
Professor Richard McWilliams	Consultant Vascular Radiologist	Royal College of Radiologists	Sponsor	Yes

YOUR PERSONAL EXPERIENCE (IF ANY) WITH THIS TECHNOLOGY

Question 2: Please indicate your experience with this technology?

Expert Advisers	I have had direct involvement with this	I have referred patients for its use	I manage patients on whom it is used in another part of their care pathway	I would like to use this technology but it is not currently available to me
Mr Andrew Barton **Clinical Nurse Specialist**	**Yes**	Blank	Blank	Blank
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**Yes**	Blank	Blank	**Yes**
Dr Lisa Dougherty **Nurse Consultant**	**Yes**	Blank	Blank	Blank
Ms Dympna McParlan **Infusion Services Coordinator**	**Yes**	**Yes**	Blank	Blank
Dr Tim Jackson **Consultant Anaesthetist**	Blank	Blank	Blank	**Yes**
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	**Yes**	Blank	Blank	Blank
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**Yes**	Blank	Blank	**Yes**
Dr Richard Leech **Consultant Anaesthetist**	**Yes**	Blank	Blank	Blank
Professor Richard McWilliams **Consultant Vascular Radiologist**	**Yes**	Blank	Blank	Blank
Any Comments?				

Mr Andrew Barton **Clinical Nurse Specialist**	**Blank**
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**Blank**
Dr Lisa Dougherty **Nurse Consultant**	**Blank**
Ms Dympna McParlan **Infusion Services Coordinator**	**Blank**
Dr Tim Jackson **Consultant Anaesthetist**	**Blank**
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	**The vascular access team at Addenbrooke's hospital has used this technology for many hundreds of PICC insertions - primarily in ICU patients who are know to have a higher PICC malposition rate that the general hospital population**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**I have attended the training for this equipment and intend you use it for my Professional Doctorate Research Project to evaluate the cost and patient benefit. The equipment will be on loan from Bard and is currently awaiting Directorate approval.**
Dr Richard Leech **Consultant Anaesthetist**	**I have attempted inserting 6 PICCs using this system. The catheter tip in 5 of them was perfectly positioned and confirmed with fluoroscopy. The Sherlock system correctly identified that the 6th catheter kept entering the left Internal Jugular vein instead of passing into the left subclavian (from the left basilic). Under direct fluoroscopy this proceeded to be a very difficult insertion due to a stenosis of the left subclavian vein.**
Professor Richard McWilliams **Consultant Vascular Radiologist**	**I support the venous access team who use this device. I have been involved in the process whereby this technology was introduced to our hospital and I am involved in the audit which will hopefully allow us to stop performing CXR after PICC insertion based on performance**

Question 3: Have you been involved in any kind of research on this technology? If Yes, please describe?

Expert Advisers	Yes/No	Comment

Expert Advisers	Yes/No	Comment
Mr Andrew Barton **Clinical Nurse Specialist**	No	Blank
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	No	Blank
Dr Lisa Dougherty **Nurse Consultant**	No	Blank
Ms Dympna McParlan **Infusion Services Coordinator**	No	Blank
Dr Tim Jackson **Consultant Anaesthetist**	No	Blank
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	**Yes**	**We have done a service evaluation of 250 ICU PICC insertions using the Sherlock 3CG technology and have compared the malposition rate (as defined with post insertion chest radiograph) with our own historical data which used anthropometric techniques for posiitioning PICCs. These data are due to be puiblished in a peer reviewed journal. This technology does reduce the malposition rate but does not remove it - in my opinion patients still need a post insertion chest radiograph.**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**Yes**	**I am in the project planning stage of a Professional Doctorate and have completed a literature review of new technologies in PICC placement.**
Dr Richard Leech **Consultant Anaesthetist**	No	Blank
Professor Richard McWilliams **Consultant Vascular Radiologist**	No	**I have been involved in research aimed at assessing the value of CXR in determining the location of the cavo-atrial junction.**

THIS PRODUCT (TECHNOLOGY) AND ITS USE

Question 4: How would you best describe this technology?

Expert Advisers	It is a minor variation on existing technologies with little potential for different outcomes and impact	It is a significant modification of an existing technology with real potential for different outcomes and impact	It is thoroughly novel - different in concept and/ or design to any existing
Mr Andrew Barton **Clinical Nurse Specialist**	Blank	Blank	**Yes**
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	Blank	**Yes**	Blank
Dr Lisa Dougherty **Nurse Consultant**	Blank	Blank	**Yes**
Ms Dympna McParlan **Infusion Services Coordinator**	Blank	**Yes**	Blank
Dr Tim Jackson **Consultant Anaesthetist**	Blank	**Yes**	Blank
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	No	**Yes**	**Yes**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	No	No	**Yes**
Dr Richard Leech **Consultant Anaesthetist**	Blank	Blank	**Yes**
Professor Richard McWilliams **Consultant Vascular Radiologist**	Blank	**Yes**	Blank
Any Comments?			
Mr Andrew Barton **Clinical Nurse Specialist**	Blank		

Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**There are other commercially available devices which provide** **1. ECG element of guidance e.g. Vygon device,** **2. and ultrasound which can provide some guidance of the device into the chest as an alternative to the electromagnetic sensor. The cost effectiveness of these competing devices should be considered.**
Dr Lisa Dougherty **Nurse Consultant**	**Blank**
Ms Dympna McParlan **Infusion Services Coordinator**	**Blank**
Dr Tim Jackson **Consultant Anaesthetist**	**I understand this technology modifies the use of ECG tip location technology (available from other manufacturers) but includes magnet-based location to enhance the information given.**
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	**Other manufacturers have introduced ECG technology for positioning PICCs, this is the only technology that combines the magnetic and ECG approach - both of these technologies contribute to the improved malposition rate.**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**This is a combination of two existing technologies - ECG tip confirmation and tip location to provide a complete replacement for radiographic confirmation.**
Dr Richard Leech **Consultant Anaesthetist**	**It is novel. Other systems on the market only identify where the catheter tip is positioned once it has entered the subclavian vein/superior vena cava. The Sherlock 3CG also identifies if the catheter tip passes above the clavicle, below the clavicle or to the opposite side of the chest within the vascular system. Correct tip position in the lower third of the SVC is then confirmed with ECG changes (peaked P wave)**
Professor Richard McWilliams **Consultant Vascular Radiologist**	**ECG guidance of tip position has been reported for years but the combination of navigation and P wave monitoring is novel.**

Question 5: What is the most appropriate use (e.g. clinical indication) for the technology?

Expert Advisers	Comment
Mr Andrew Barton **Clinical Nurse Specialist**	**The placement of PICC lines accuratley and safely, which removes the need to use x-ray or fluroscopy. The technology can be used to snsure the PICC is sited in the correct position so that at the end of the procedure the PICC line tip placemnt can be confirmed and the line used straight away.**

Expert Advisers	Comment
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**Ward based insertion of PICCs where there is typically no xray guidance.**
Dr Lisa Dougherty **Nurse Consultant**	**We use this with all PICC placements**
Ms Dympna McParlan **Infusion Services Coordinator**	**Tracking and tip confirmation for placement of PICCs in Oncology/Haematology patients requiring chemotherapy and a variety of intravenous medications.**
Dr Tim Jackson **Consultant Anaesthetist**	**This device is intended for use with a specific make of PICC to aid bed side insertion to the correct length without need for any form of X-ray to confirm the position (?) . it is used in routine medium to longterm vascular access (eg chemotherapy, antibiotic therapy, TPN) to ensure correct placement.**
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	**Patients having PICCs inserted without fluoroscopic control would benefit from this technology. The only PICCs that can be inserted with this technology are Solo Power PICCs (valved PICCs that anecdotally may have a higher blockage rate)**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**This technology is applicable for any PICC line placement with the exception of patients where a 'P' wave is intermittent or not observed on their baseline ECG.**
Dr Richard Leech **Consultant Anaesthetist**	**Many patients would benefit from a PICC if they are receiving intravenous therapy for more than 7 days. The main advantage of PICCs (and other long term vascular access devices (LTVA)) is that the patient can be treated in the community rather than in hospital. The most common indications for clinicians requesting a PICC are:** **Oncology patients receiving chemotherapy** **Respiratory patients with long term conditions such as bronchiectasis** **Orthopaedic patients with osteomyelitis/joint replacement infections** **Medical patients with cellulitis** **Cardiac patents with subacute bacterial endocarditis** **Surgical patients requiring several weeks of TPN**
Professor Richard McWilliams **Consultant Vascular Radiologist**	**PICC placement in hospital settings. I think this is ideally in a dedicated unit.**

COMPARATORS (including both products in current routine use and also “competing products”)

Question 6: Given what you stated is the appropriate indication (clinical scenario) for its use, what are the most appropriate "comparators" for this technology which are in routine current use in the NHS?

Expert Advisers	Comment
Mr Andrew Barton **Clinical Nurse Specialist**	**I am not aware of any other device or technology which comparable.**
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**1. Placement of devices with no technological aids. Experienced operators will use patient position, breathing, external measurements of tape measure laid over the arm and chest and experience to get catheters in a reasonable position in a high proportion of cases 90% plus.** **2. Other ECG guidance systems from other manufacturers.** **3. The use of ultrasound guidance to guide devices centrally. Ultrasound is typically used to access upper arm veins so could be considered as already financed in most cases.** **4. Any other commercially available magnetic or other guidance systems. I have not searched all sources to identify these. I am aware of some transillumination devices.**
Dr Lisa Dougherty **Nurse Consultant**	**I am aware there are other systems that use ECG technology but not the tracking but otherwise we would send patient for a chest X ray**
Ms Dympna McParlan **Infusion Services Coordinator**	**Chest X-Ray**
Dr Tim Jackson **Consultant Anaesthetist**	**Static chest x-ray to confirm placement or fluoroscopy**
Dr Andrew Johnston **Consultant in Intensive Care.** **Medical Lead Vascular team**	**1. Blind insertion using anthropometric techniques (a common technique but high malpositon rate when properly looked for). 2. Insertion under fluoroscopic control - expensive and not suitable for ICU patients. 3. Other ECG technologies - these do not use the magnetic Sherlock technology and are therefore inferior to this product**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**I would compare this technology to our current practice of fluoroscopically inserted lines. You are able to visualise the pathway of the tip with the tip location system in the same way you could track with fluoroscopy and you can accurately place the tip with the ECG technology in the same way you would visualise the final tip position on fluoroscopy. Within most healthcare settings the comparator would be the post insertion chest x-ray which is used to confirm tip position prior to line use.**

Dr Richard Leech **Consultant Anaesthetist**	**PICCs are already used in the NHS. They tend to be inserted in one of two ways: The first is to insert a PICC and take a Chest Xray afterwards - this is less than ideal as it requires a skilled operator to correctly assess the correct length of catheter required and adjustment to the catheter if the tip positioning is inadequate. The second is to ensure that the catheter is placed correctly at the time of insertion so the PICC is inserted in the operating theatre under fluorsocopy - this is my current parctice.**
Professor Richard McWilliams **Consultant Vascular Radiologist**	**PICC insertion either with fluoroscopic guidance or without any imaging guidance other than US for venous access**

Question 7: "Competing products": Are you aware of any other products which have been introduced with the same purpose as this one?

Expert Advisers	Comment
Mr Andrew Barton **Clinical Nurse Specialist**	**I am only aware of one other company who manufactures a version of this technology which only uses ECG to confirm placemnt it dose not have the tip location technology and can only be used with open ended PICC lines. The BARD technology is a combination of both and is much more accurate. I have tried both devices.**
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**As above**
Dr Lisa Dougherty **Nurse Consultant**	**No I have not seen any in the UK**
Ms Dympna McParlan **Infusion Services Coordinator**	**Vygon Nautilus® ECG tip location system**
Dr Tim Jackson **Consultant Anaesthetist**	**Teleflex 'vasanova' VPS, Vygon Nautilus®**
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	**See above**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**No**
Dr Richard Leech **Consultant Anaesthetist**	**The Nautilus system produced by Vygon can also allow the operator to position the catheter tip of the PICC using ECG guidance. However it does not give a visual image of where the catheter tip is in relation to the patient's anatomy ie if the catheter has entered the internal jugular vein instead of the subclavian.**
Professor Richard McWilliams **Consultant Vascular Radiologist**	**I am not aware of any.**

POSSIBLE BENEFITS FOR PATIENTS

Question 8: What are the likely additional benefits for patients of using this technology, compared with current practice/comparators?

Expert Advisers	Comment
Mr Andrew Barton **Clinical Nurse Specialist**	**lower complications, lower malposition rates, no need for x-ray or fluroscopy, quicker insertion, don't need to wait for confirmation beofre use.**
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**Increased first time success rates in inserting catheters centrally, less duplicate use of devices or puncture sites, less exposure and inconvenience of Xrays, better central venous catheter position leading to less risk of thrombosis or other complications.**
Dr Lisa Dougherty **Nurse Consultant**	**benefits are that you can track the tip during insertion. ECG alone will tell you if it is in the right place or not but not where it has gone if not in SVC. The Sherlock tracking enables you to visualise if the tip is going up the jugular vein or coiling etc so you can then employ relevant techniques to prevent this and ensure tip is in SVC.** **Patients know at the time of insertion that it is all in correct place and they don't have to wait to have a chest xray and then find not palced correctly** **removes the need for a chest x ray, the cost and radiation exposure to the patient and the time delay in getting the X ray done and then verified**
Ms Dympna McParlan **Infusion Services Coordinator**	**Immediate confirmation of PICC tip position at insertion stage** **Increased placement efficiency and reduction in catheter malposition** **Eliminates repositioning and delay to therapy** **Reduced exposure of radiation to patients**
Dr Tim Jackson **Consultant Anaesthetist**	**Less radiation exposure, less time spent on injection, reduced complications due to malposition (?Vsxray**
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	**Reduced malposition rate. Most malpositions using this technology are easily correctable by withdrawing the catheter**

Expert Advisers	Comment
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**Lines could be confidently placed at the bedside with a reduced rate of malposition. There would be no requirement to remanipulate the line which can lead to increased risk of infection, irritation of the access vein and discomfort to the patient. Patients would not need to be transferred to the Radiology Department for a chest x-ray. Repeat x-rays which are required in the case of malposition would not be required. The process of a chest x-ray can be very uncomfortable for patients who have to lie on the hard detector plate and this would not be required. Delays from waiting for a chest x-ray would be removed as the tip confirmation would occur at the time of insertion, as per fluoroscopic placement, and the line could be accessed immediately. Procedure times could be kept to a minimum, improving the patient experience.**
Dr Richard Leech **Consultant Anaesthetist**	**More accurate placement of catheter tip of PICC (Xray position reporting is very subjective). Xray confimation is not required - this has 2 benefits for the patient - no radiation dose and PICC insertion at the bedside. Increased availability for patients requiring PICC insertion and decreased waiting time. These could also lead to a reduced length of stay for patients whose conditions are amenable for treatment in the community.**
Professor Richard McWilliams **Consultant Vascular Radiologist**	**If a unit does not use fluoroscopy then there is a number of cases where the tip is wrongly located and secondary procedures are performed and these should be avoided.**

Question 8.1: Is each additional benefit likely to be realised in practice? What are the likely obstacles?

Expert Advisers	Comment
Mr Andrew Barton **Clinical Nurse Specialist**	**The only obsticle is if the patient has AF, a pacemeker or any other junctional rythum which make the 'p' wave unrelable or abscent the ECG portion of the technology cannuot be used by the tip location technology can still place the line in the SVC, but an x-ray will be required.**
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**I think it all comes down to overall cost benefits. If the devices were less costly in disposables then I think there is little doubt that they would be used routinely to ensure rapid correct placment of devices in almost all cases.**
Dr Lisa Dougherty **Nurse Consultant**	**Yes at bedside. Only obstacle is if any reason they can't have tracking device used or ECG reading is unclear**

Expert Advisers	Comment
Ms Dympna McParlan **Infusion Services Coordinator**	**Yes, benefits realised in practice**
Dr Tim Jackson **Consultant Anaesthetist**	**Yes I believe the benefit of current practice are likely to be realised; obstacles are (?)practice regarding X-Ray use-practitioner may need to be familiar with ECG interpretation.**
Dr Andrew Johnston **Consultant in Intensive Care.** **Medical Lead Vascular team**	**In my view patients will still need a chest x-ray after insertion. The equipment is relatively easy to use but staff will require a reasonable amount of training. The blockage rate with the new PICCs needs to be defined.**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**I feel the benefits would be recognised in practice. The likely obstacles are for operators to accept and feel comfortable that the technology can replace current practice and provide an improved service.**
Dr Richard Leech **Consultant Anaesthetist**	**Yes they could be - but to ensure that patients receive a PICC in a timely manner, hospitals would need to formally set up a vascular access service so that there are a number of nurses/clinicians available who can insert these lines.**
Professor Richard McWilliams **Consultant Vascular Radiologist**	**I think these potential benefits should be realised. It is important to note that the Sherlock system seeks to place the line tip at the cavo-atrial junction. CXR is not a perfect test to locate the cavo-atrial junction so that comparison of the Sherlock system and CXR with regard to precise tip location is not straightforward.**

Question 8.2: How might these benefits be measured? What specific outcome measures would enable assessment of whether additional benefits for patients are being realised?

Expert Advisers	Comment
Mr Andrew Barton **Clinical Nurse Specialist**	**Through costs and time saved leading to higher productivity but also better patient outcomes.**
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**It needs a formal cost benefit analysis which to date I believe has not been performed.**
Dr Lisa Dougherty **Nurse Consultant**	**We have reviewed the number of malpositions before and since introduction of Sherlock and it is now rare that we have any malpositions**

Expert Advisers	Comment
Ms Dympna McParlan **Infusion Services Coordinator**	**Reduced time for each placement. Improved statistics for reduction in catheter malposition and repositioning. Reduced pressure on radiology services allowing greater access for other patients.**
Dr Tim Jackson **Consultant Anaesthetist**	**Initially comparison of tip position with other modalities (x-Ray) ;patient satisfaction, complication-takes time to insert etc**
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	**Units will need to know their baseline malposition rate and need to define how this is measured before they can be sure that this technology improves their mlaposition rate. In my opinion it does reduce malposition rates when compared with 'blind' insertion.**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**The benefits could be measured via procedure times and length of stay for patients. This system should reduce procedure times and therefore consequently allow operators to perform more procedures within a give timescale. The patient experience should also be improved and could be measured with patient satisfaction surveys. Procedural costs should also be reduced and can be calculated on a cost per case basis for comparison to existing practice.**
Dr Richard Leech **Consultant Anaesthetist**	**Reduced exposure to radiation dose (ie Xrays) is an obvious measure. Reduced number of cannulation attempts in patients with difficult venous access. Reduced use of central lines in patients with poor venous access which need to be replaced every 7 days due to the risk of catheter related infections. Reduced length of stay in hospital.**
Professor Richard McWilliams **Consultant Vascular Radiologist**	**Satisfactory placement without the need for secondary procedures.**

Question 8.3: How good is this evidence for each of these additional benefits?

Expert Advisers	Comment
Mr Andrew Barton **Clinical Nurse Specialist**	**The evidence is good, following a trial in my Turst, the first 60 PICC lines placed with the technology also had a chest x-ray, all 60 were placed correctly.**
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**As above**

Expert Advisers	Comment
Dr Lisa Dougherty **Nurse Consultant**	**There are research papers demomstrating the effectiveness of ECG tip location. We evaluated the system using the technology and comparing it with CXR done as well and we found that both the tracking and ECG were accurate.**
Ms Dympna McParlan **Infusion Services Coordinator**	**A service database will demonstrate the above benefits, however it is difficult to measure the benefits of reduced exposure to radiation.**
Dr Tim Jackson **Consultant Anaesthetist**	**I believe the evidence for ECG –tip- location is of good quality. I am unaware of any specific evidence for this specific device.**
Dr Andrew Johnston **Consultant in Intensive Care.** **Medical Lead Vascular team**	**There is very poor evidence and no RCTs of the technology. We have done the only formal assessment and this is not yet published. The manufacturers have data but this has never been published or peer reviewed**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**The evidence for the benefits is available via company leterature only. There is little published data around Sherlock 3CG. The existing literature focuses on ECG or tip location and not a joint system.**
Dr Richard Leech **Consultant Anaesthetist**	**Saving lives documentation has highlighted the importance of reducing infection from the use of peripheral cannulas and central lines. There is much higher vigilance on the wards but the risk still remains. Infection risk with PICCs is lower when placed in a controlled environment by trained individuals.**
Professor Richard McWilliams **Consultant Vascular Radiologist**	**Developing**

Question 8.4: Please add any further comment on the claimed benefits of the technology to patients, as you see applicable

Expert Advisers	Comment
Mr Andrew Barton **Clinical Nurse Specialist**	**The technology has completely changed the process of PICC insertion for the better, now when i leave a patient after inserting the PICC i am confident it is in the correct place and can be used straight away. Patients feel more confident when the see the technology in use.**
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**Blank**

Expert Advisers	Comment
Dr Lisa Dougherty **Nurse Consultant**	**As stated above patients are relieved that we can inform them at placement that it is in correct position and it can be used immediately so no delays for treatment**
Ms Dympna McParlan **Infusion Services Coordinator**	**Blank**
Dr Tim Jackson **Consultant Anaesthetist**	**Blank**
Dr Andrew Johnston **Consultant in Intensive Care.** **Medical Lead Vascular team**	**Blank**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**Blank**
Dr Richard Leech **Consultant Anaesthetist**	**The main benefit I can identify is the reduced delay in PICC insertion because of not having to coordinate Xray and identify a suitable clinical room. The Sherlock 3CG would enable me to insert PICCs at the bedside.**
Professor Richard McWilliams **Consultant Vascular Radiologist**	**Blank**

POSSIBLE BENEFITS FOR THE HEALTHCARE SYSTEM

Question 9: What are the likely additional benefits for the healthcare system of using this technology, compared with current practice/comparators?

Expert Advisers	Comment
Mr Andrew Barton **Clinical Nurse Specialist**	**savings in time and money as not using x-ray or fluroscopy to place line and as malposition rates are virtually non-existant the cost of additional PICC equipment is a line needs to be changed.**

Expert Advisers	Comment
Dr Andrew Bodenham Consultant in Anaesthesia and Intensive Care Medicine	Quicker more accurate procedures. Less repeat procedures Reduced number of Xrays Better catheter tip positions leading to lower risks of thrombosis and other complications
Dr Lisa Dougherty Nurse Consultant	Reduced need for Chest Xrays means less patietns having to attend radiology, less cost, less radiation exposure and less time dealys reduction in number of repeated procedures when malposition discovered so saving time and cost of PICC and kit
Ms Dympna McParlan Infusion Services Coordinator	Improved accuracy in catheter tip location. Reduction in costs associated with radiology and greater throughput of patients.
Dr Tim Jackson Consultant Anaesthetist	Cost reduction-:direct=reduced costs of radiology ; reduced cost of injection times. Indirect:-Reduced complications
Dr Andrew Johnston Consultant in Intensive Care. Medical Lead Vascular team	Reduced PICC malposition rates and those that are malpositioned are probably easier to correct - this will will lead to fewer interventions and reduced morbidity
Ms Elizabeth Elfleet Advanced Radiographer Practitioner	I would anticipate that there would be changes in practice which would lead to cost savings for the Healthcare System.
Dr Richard Leech Consultant Anaesthetist	Reducing the delay in inserting the PICC would potentially allow earlier discharge of patients from hospital. There may also be a reduction in infections related to peripheral cannulation or CVC insertion.
Professor Richard McWilliams Consultant Vascular Radiologist	It should speed up the process of line insertion and use. There are potential economic advantages if the need for fluoroscopy is avoided and post-procedural CXR is unnecessary and if treatment commences earlier.

Question 9.1: Is each additional benefit likely to be realised in practice? What are the likely obstacles?

Expert Advisers	Comment
Mr Andrew Barton Clinical Nurse Specialist	initial cost of the technology can be expensive however this can be ofset by the money svaed over the year.

Expert Advisers	Comment
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**Blank**
Dr Lisa Dougherty **Nurse Consultant**	**Yes**
Ms Dympna McParlan **Infusion Services Coordinator**	**Yes, realised in practice**
Dr Tim Jackson **Consultant Anaesthetist**	**For those using BARD PICCs this will be maximal. For others this technology requires changing PICC's which may be limiting.**
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	**See section 8**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**This will be variable and dependent on current practice but I feel cost savings will be achieved alongside an improved patient service.**
Dr Richard Leech **Consultant Anaesthetist**	**Community services would have to be in place to allow early discharge of patients to enable them to receive treatment at home (ie intravenous antibiotics for osteomyelitis/cellulitis)**
Professor Richard McWilliams **Consultant Vascular Radiologist**	**I think so but I have not done an economic analysis in our unit.**

Question 9.2: How might these benefits be measured? What specific outcome measures would enable assessment of whether additional benefits for the healthcare system are being realised?

Expert Advisers	Comment
Mr Andrew Barton **Clinical Nurse Specialist**	**The benfits for the technology can be measured in time saved, money saved from using radiation, and extra PICC's due to malposition. The only obsticle is the initial cost of the technology which can be recopued within a year**

Expert Advisers	Comment
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**Formal cost benefit analysis** **Time duration of procedures** **DIsposables used** **Xrays used** **catheter position success** **Catheter lifespan** **Longer term complications in relation to catheter.**
Dr Lisa Dougherty **Nurse Consultant**	**Cost of Chest Xrays and number of previous malpositions costed out as what can be saved**
Ms Dympna McParlan **Infusion Services Coordinator**	**Accuracy of tip location can be demonstrated on the service database. Reduction in costs and throughput of patients can be estimated.**
Dr Tim Jackson **Consultant Anaesthetist**	**Cost of insertion: PICC+x-Ray+time +disposables +excess cost of re-positioning +cost of complications vs the same: x-rays, ⇩complication offset**
Dr Andrew Johnston **Consultant in Intensive Care.** **Medical Lead Vascular team**	**See section 8**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**As in previous section 8**
Dr Richard Leech **Consultant Anaesthetist**	**Early discharge from hospital would significantly reduce hospital length of stay**
Professor Richard McWilliams **Consultant Vascular Radiologist**	**Health economic analysis**

Question 9.3: How good is this evidence for each of these additional benefits?

Expert Advisers	Comment

Expert Advisers	Comment
Mr Andrew Barton **Clinical Nurse Specialist**	**the technology has already be porven in America and in my Trust a buisness case was submitted showing at least a cost saving of £22,000 a year.**
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**There is reasonable evidence for ECG guidance for short term catheters and this technology is widely used on the continent. Other elements as above are more uncertain.**
Dr Lisa Dougherty **Nurse Consultant**	**As before**
Ms Dympna McParlan **Infusion Services Coordinator**	**Robust**
Dr Tim Jackson **Consultant Anaesthetist**	**Cost savings should have a good business plan to support them. I suspect that the evidence for length of stay –complication rates is more difficult.**
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	**See section 8. There is no formal economic evaluation of the technology which is more expensive than others**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**As in previous section 8**
Dr Richard Leech **Consultant Anaesthetist**	**In my Trust alone, I have identified approximately 250 patients per year who could potentially receive the majority of their treatment at home if they had a PICC inserted in a timely manner after admission to hospital.**
Professor Richard McWilliams **Consultant Vascular Radiologist**	**Developing**

Question 9.4: Please add any further comment on the claimed benefits of the technology to the healthcare system, as you see applicable

Expert Advisers	Comment

Expert Advisers	Comment
Mr Andrew Barton **Clinical Nurse Specialist**	Blank
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	Blank
Dr Lisa Dougherty **Nurse Consultant**	**As before**
Ms Dympna McParlan **Infusion Services Coordinator**	Blank
Dr Tim Jackson **Consultant Anaesthetist**	Blank
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	Blank
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	Blank
Dr Richard Leech **Consultant Anaesthetist**	**Reduced hospital acquired infections (from cannulation), reduced radiology costs, reduced length of stay for many patients.**
Professor Richard McWilliams **Consultant Vascular Radiologist**	Blank

FACILITIES, TRAINING AND FUNCTIONING

Question 10: Are there any particular facilities or infrastructure which needs to be in place for the safe and effective use of this technology?

Expert Advisers	Comment
Mr Andrew Barton **Clinical Nurse Specialist**	**The technology can be adopted into existing services.**
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**See 11**
Dr Lisa Dougherty **Nurse Consultant**	**No the device is in all in one stand and only requires access to electric sockets.**
Ms Dympna McParlan **Infusion Services Coordinator**	**Increased space in clinical area required as a result in additional technology.**
Dr Tim Jackson **Consultant Anaesthetist**	**It only works with BARD PICC's so any one (?) using it have to comfortable with the use and aftercare of this PICC.**
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	**PICC inserters will need training and it is very difficult to perform the procedure single handedly**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**The company have an excellent track record in the education and support of customers who use their products. Staff need to feel confident to use the technology and be familiar with the product but otherwise no particular facilities are required. Only trained PICC placers should use this technology. There is a common misconception than anyone can place a PICC line and direct visualisation of the chest x-ray allows poorly placed lines to be identified and rectified by appropriately trained personnel. This would not be the case with Sherlock 3CG and it would need to be clear that visualisation by the operator is not sufficient - a printed copy of the ECG within the patient's notes is required as per manufacturer's guidelines.**
Dr Richard Leech **Consultant Anaesthetist**	**Ideally as mentioned earlier, from the clinical governance perspective a vascular access team should lead and monitor this development.**
Professor Richard McWilliams **Consultant Vascular Radiologist**	**Standard location for PICC insertion with space for the machine**

Question 11: Is special training required to use this technology safely and effectively?

Expert Advisers	Comment
Mr Andrew Barton **Clinical Nurse Specialist**	**Yes, this was provided extensively by the company**
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**Yes but no special skills are required just knowledge and experience of how the devices work and their limitations.**
Dr Lisa Dougherty **Nurse Consultant**	**Yes**
Ms Dympna McParlan **Infusion Services Coordinator**	**Yes, particularly in relation to cardiology training**
Dr Tim Jackson **Consultant Anaesthetist**	**I believe so, but haven't had hands-on experience yet, so I am unsure as to how much**
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	**As above**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**It is necessary for PICC placers to understand the physiology of an ECG and to recognise the patterns for accurate tip placement. The training I have received was delivered by Bard and there is support through the implementation stage until the operator feels confident in the use of the technology. The actual process of insertion and the PICC kit will be familiar to operators and just a slight variance in technique is required.**
Dr Richard Leech **Consultant Anaesthetist**	**Yes but it is relatively straightforward for any clinician who is trained to use ultrasound for vascular access (such as CVC insertion).**
Professor Richard McWilliams **Consultant Vascular Radiologist**	**Yes**

Question 12: Please comment on any issues relating to the functioning, reliability and maintenance of this technology which may be important to consider if it is introduced

Expert Advisers	Comment
Mr Andrew Barton **Clinical Nurse Specialist**	**I have had no issues**
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**I have not used it enough to comment, but other devices using this technology have been used for many years reliably.**
Dr Lisa Dougherty **Nurse Consultant**	**The system has been reliable but have been using our own purchased systems for less than a year**
Ms Dympna McParlan **Infusion Services Coordinator**	**Blank**
Dr Tim Jackson **Consultant Anaesthetist**	**I have no experience**
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	**Can only be used in patients in sinus rhythm**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**I am not aware of any issues related to maintenance or reliability.**
Dr Richard Leech **Consultant Anaesthetist**	**I cannot comment on this at this stage. I have only placed 5 PICCs using this technology and have not experienced any issues so far.**
Professor Richard McWilliams **Consultant Vascular Radiologist**	**I think training of the staff is the important consideration as there is a learning curve associated with correct interpretation of the ECG trace.**

COSTS

Question 13: ***Please provide any comments on the likely cost consequences of introducing this technology. In particular, please comment on the implications of this technology replacing the comparator/s you have described above***

Expert Advisers	Comment
Mr Andrew Barton **Clinical Nurse Specialist**	**initial costs can be ofset by the costsavings over the year from not using x-ray or fluroscopy.**
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**At current costs this is considerable as it would be needed to be used in every case, as one cannot reliably identify which cases are likely to be difficult.**
Dr Lisa Dougherty **Nurse Consultant**	**The technology does cost a lot but we also updated our ultrasound machines at same time so it cost more. I think over time this would results in cost savings. A cost issue is the remote control which can easily get lost in the waste and we have lost 3 so far and this incurs a cost of £150 each time. Needs a better system for attaching remote to machine so it is harder to mislay. The other outlays are ECG leads and the paper.**
Ms Dympna McParlan **Infusion Services Coordinator**	**Initial outlay on the new technology**
Dr Tim Jackson **Consultant Anaesthetist**	**I understand the unit/machine costs approximately £7000 each, with a small cost of consumables for each insertion. For units which don't currently use BARD PICC's they are more expensive than most competitors and hence the switch incurs extra cost.**
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	**It is probably more expensive than blind insertion but there are potential cost savings. No formal economic evaluation has been performed.**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**In our case, Sherlock 3CG would present a cost saving. The aim of my research is to consider the cost benefits of this technology compared to our current practice alongside the perceived patient benefits. It is anticipated it would be significantly cheaper tah procedures performed within an angiography suite with the full staff available - radiographer, nurse, operator vs single operator for Sherlock 3CG**
Dr Richard Leech **Consultant Anaesthetist**	**Most hospitals will already have several portable ultrasound machines available for vascular access in the operating theatre and ICU. The 3CG equipment is approx £10,000 including printer. The PICCs are more expensive than conventional PICCs but the packs do include drapes, gowns etc. Savings would be made by reducing the number of Xrays taken and potentially discharging patients earlier by reducing the delay in PICC insertion.**
Professor Richard McWilliams **Consultant Vascular Radiologist**	**There are consumable costs per case and there is the additional cost of the Sherlock system. I do not think the machine is compatible with other manufacturers' US systems so existing machines may become redundant.**

GENERAL ADVICE BASED ON YOUR SPECIALIST KNOWLEDGE

Question 14: Is there controversy about any aspect of this technology or about the care pathway?

Expert Advisers	Comment
Mr Andrew Barton **Clinical Nurse Specialist**	**Some of the Doctors in my Trust felt that the PICC tip was placed to low in the SVC with the technology, however these conserns were removed when the technology was explained and demnostraighted.**
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**Only in relation to the overall cost benefits of the technology**
Dr Lisa Dougherty **Nurse Consultant**	**Not to my knowledge**
Ms Dympna McParlan **Infusion Services Coordinator**	**No**
Dr Tim Jackson **Consultant Anaesthetist**	**Not that I am aware of**
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	**The technology specifically targets the low superior cava/caval-atrial junction - there isn't good evidence of how important this is. There is virtually no evidence to support the claims that it reduces malposition rates; however, I believe it does. The manufacturers claim that chest radiographs are no longer required - I don't think this is fully accepted or evidence based**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**I am not aware of any**
Dr Richard Leech **Consultant Anaesthetist**	**Not that I am aware of**
Professor Richard McWilliams **Consultant Vascular Radiologist**	**No**

Question 15: If NICE were to develop guidance on this technology, how useful would this be to you and your colleagues?

Expert Advisers	Comment
Mr Andrew Barton **Clinical Nurse Specialist**	**NICE guidance would provide supporting eveidence and validation to Tursts who wanted the technology. This would be useful in supporting buisness cases for funding and cnahnges in practice.**
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**Useful but needs to be considered in comparison to other technologies available not just this individual technology.**
Dr Lisa Dougherty **Nurse Consultant**	**It would be useful**
Ms Dympna McParlan **Infusion Services Coordinator**	**Extremely**
Dr Tim Jackson **Consultant Anaesthetist**	**I am intending to evaluate this technology for use in my unit, hence this would be very useful guidance.**
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	**More evidence would be required, otherwise it would be based on personal opinion**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**It would be very helpful**
Dr Richard Leech **Consultant Anaesthetist**	**It would facilitate the use of this system in NHS Trusts.**
Professor Richard McWilliams **Consultant Vascular Radiologist**	**This would be welcome**

Question 16: Do any subgroups of patients need special consideration in relation to the technology (for example, because they have higher levels of ill health, poorer outcomes, problems accessing or using treatments or procedures)? Please explain why

Expert Advisers	Comment
Mr Andrew Barton **Clinical Nurse Specialist**	**No**
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**There may be identifiable patient groups of patients who are at higher risk of catheter misplacement e.g. patients in intensive care as opposed to on a general ward. Such patients may represent a group with a better risk benefit profile for this and other technologies.**
Dr Lisa Dougherty **Nurse Consultant**	**Only those that may have irregular heart rhythms which means that we cannot clearly verify exact tip location but can still use tracking system to ensure tip has headed in right direction.**
Ms Dympna McParlan **Infusion Services Coordinator**	**There are certain patient groups that this technology will not be suitable for i.e. patients with atrial fibrillation. However, the tracking device can still be used and we usually know these patients prior to commencement of the procedure.**
Dr Tim Jackson **Consultant Anaesthetist**	**As stated , any patients with abnormal ECG condition may adversely affect the reliability of this method.**
Dr Andrew Johnston **Consultant in Intensive Care.** **Medical Lead Vascular team**	**Probably more efficacious in ICU patients but, again, limited evidence**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**Patients with known cardiac arrhythmias and pacemakers are currently excluded because the 'P' wave may not be evident on the ECG. I am not aware of any other contraindications within patient groups.**
Dr Richard Leech **Consultant Anaesthetist**	**This technology is not suitable for patients whose underlying cardiac rthythm is not sinus rhythm or if they are pacemaker dependent.**
Professor Richard McWilliams **Consultant Vascular Radiologist**	**Those with cardiac rhythm disorders which preclude the use of P waves as a guide.**

CONFLICTS OF INTEREST

Question 18.1: Do you or a member of your family have a personal pecuniary interest? The main examples are as follows:

Expert Advisers	Consultancies or directorships	Fee-paid work	Shareholdings	Expenses and hospitality	Investments	Personal non-pecuniary interest
Mr Andrew Barton **Clinical Nurse Specialist**	No	No	No	No	No	**Yes**
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**Yes**	**Yes**	No	**Yes**	No	No
Dr Lisa Dougherty **Nurse Consultant**	No	**Yes**	No	No	No	No
Ms Dympna McParlan **Infusion Services Coordinator**	No	No	No	No	No	No
Dr Tim Jackson **Consultant Anaesthetist**	No	No	No	No	No	No
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	No	No	No	No	No	No
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	No	No	No	No	No	No
Dr Richard Leech **Consultant Anaesthetist**	No	No	No	No	No	No
Professor Richard McWilliams **Consultant Vascular Radiologist**	**Yes**	No	No	No	No	No

If you have answered YES to any of the above statements please describe the nature of the conflict(s) below.

Mr Andrew Barton **Clinical Nurse Specialist**	**I am the 2014 chair of the PICC Placers Preceptorship Group for London and the South East. This position is for a year only and then a new chair is elected who is a nurse specialist for another hospital. We receive $150 expenses for this role. I have also spoken this year at WoCoVA where I presented an abstract about my Sherlock research. Bard sponsored the flights to Berlin.**
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	**I have received occasional lecture fee honoraria from venous catheter manufacturers including the manufacturer of this device. I have also received consultancy payments from catheter companies. I earn income from private medical practice and medicolegal work.**
Dr Lisa Dougherty **Nurse Consultant**	**Blank**
Ms Dympna McParlan **Infusion Services Coordinator**	**Blank**
Dr Tim Jackson **Consultant Anaesthetist**	**Blank**
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	**Blank**
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	**Blank**
Dr Richard Leech **Consultant Anaesthetist**	**Blank**
Professor Richard McWilliams **Consultant Vascular Radiologist**	**I have received fees for lecturing on venous access courses from Sonosite.**

Question 18.2: Do you have a non-personal interest? The main examples are as follows:

Expert Advisers	Fellowships endowed by the healthcare industry	Support by the healthcare industry or NICE that benefits his/her position or department, e.g. grants, sponsorship of posts
Mr Andrew Barton **Clinical Nurse Specialist**	No	No
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	No	No
Dr Lisa Dougherty **Nurse Consultant**	No	No
Ms Dympna McParlan **Infusion Services Coordinator**	No	No
Dr Tim Jackson **Consultant Anaesthetist**	No	No
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	No	No
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	No	No
Dr Richard Leech **Consultant Anaesthetist**	No	No
Professor Richard McWilliams **Consultant Vascular Radiologist**	No	No
If you have answered YES to any of the above statements please describe the nature of the conflict(s) below.		
Mr Andrew Barton **Clinical Nurse Specialist**	Blank	

Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	Blank
Dr Lisa Dougherty **Nurse Consultant**	Blank
Ms Dympna McParlan **Infusion Services Coordinator**	Blank
Dr Tim Jackson **Consultant Anaesthetist**	Blank
Dr Andrew Johnston **Consultant in Intensive Care. Medical Lead Vascular team**	Blank
Ms Elizabeth Elfleet **Advanced Radiographer Practitioner**	Blank
Dr Richard Leech **Consultant Anaesthetist**	Blank
Professor Richard McWilliams **Consultant Vascular Radiologist**	Blank

Additional Expert Advice requested by NICE: 2 October 2014

Name of Expert Adviser	Job Title	Professional Organisation/ Specialist Society
Dr Andrew Bodenham	**Consultant in Anaesthesia and Intensive Care Medicine**	**National Infusion and Vascular Access Society**
Dr Lisa Dougherty	**Nurse Consultant**	**National Infusion and Vascular Access Society**
Dr Richard Leech	**Consultant Anaesthetist**	**National Infusion and Vascular Access Society**
Professor Richard McWilliams	**Consultant Vascular Radiologist**	**Royal College of Radiologists**

Question 1: What would you consider to be the likely clinical consequences of a malpositioned PICC, and when would you expect these consequences to manifest themselves?

Expert Adviser	Response / Comment
Dr Richard Leech **Consultant Anaesthetist**	Malposition of the catheter tip can be subdivided further: The catheter tip in the Right Atrium or Atrial Appendage may cause: Cardiac arrhythmia - usually early complication but may be late Perforation of the heart wall leading to tamponnade - very rare but potentially catastrophic The catheter tip in the upper part of the SVC has been shown to increase the thrombosis risk in patients and is also associated with a higher infection rate - this may occur several weeks after insertion. The catheter tip in the contralateral axillary vein or internal jugular vein would also increase thrombosis and infection risk but has the added risk of drugs being injected into a vein with a progressively narrower lumen (lumen size would normally progressively increase as the PICC is advanced into the SVC). The identification of a malpositioned PICC often occurs after a nurse cannot draw blood from the PICC - A Chest XR would then confirm the malposition.

Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	IN the context of this type of guidance the focus is on correct positioning in the central veins rather than at the site of insertion in the arm. It assumes the catheter is in the venous system as opposed to arterial system, pleura or other space which could give rise to the technology failing but this would be rare. The consequences of malposition are either: Early when the catheter is kinked or doesn't flush/aspirate blood, catheter then needs to be repositioned. Late when problems can occur with accelerated vein thrombosis with catheter failure and secondary complications, perforation with secondary complications, infection which is linked to thrombosis, arrhythmias and other rarer problems.
Professor Richard McWilliams **Consultant Vascular Radiologist**	The most likely consequence is that the PICC will be seen to have been wrongly positioned on a post-procedural radiograph and then it will be repositioned with a delay to treatment, inconvenience to the patient and cost.
Dr Lisa Dougherty **Nurse Consultant**	The consequences could be thrombosis and these might manifest anything form 3 days post insertion to weeks later

Question 2: Would you expect to see different clinical consequences depending on the location of the malposition? If so, please describe.

Expert Adviser	Response / Comment
Dr Richard Leech **Consultant Anaesthetist**	See response to Question 1
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	Yes in heart e.g. arrythmias, perforation, endocarditis In poor position in central veins perforation and thrombosis, embolus
Professor Richard McWilliams **Consultant Vascular Radiologist**	If it is placed too far then there is a risk of cardiac arrhythmia. If it is placed too high then there is a risk of venous thrombosis and poor flow rates.
Dr Lisa Dougherty **Nurse Consultant**	If the PICC was too short or flipped back down the arm the thrombosis might occur more quickly.

Question 3: Would the method of insertion of the PICC line have any impact on these effects, or would they be consistent across all methods of insertion?

Expert Adviser	Response / Comment
Dr Richard Leech **Consultant Anaesthetist**	*The method of insertion would not impact directly on the clinical consequences - a malpositioned PICC would still cause the problems above. However a PICC placed with Fluoroscopy or ECG guidance would identify the malposition earlier so action could be taken immediately.*
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	The method of insertion in the arm is a separate element of the procedure which is not altered by this technology. Most centres use ultrasound guidance and fine bore needles and catheters to reduce risk of damage to veins, arteries and nerves at the insertion site and avoid elbow flexure. Passage of the catheter centrally can either be blindly, using ecg/electromagnetic guidance, or with xray imaging, ultrasound can also be used outside the central veins of the chest.
Professor Richard McWilliams **Consultant Vascular Radiologist**	Blind insertion makes the risk of malpositioning unavoidable. My expectation is that the Sherlock system should largely eliminate these events.
Dr Lisa Dougherty **Nurse Consultant**	Not sure what you mean by method – if you are talking about using micro introducer and ultrasound then only in that the PICC would be placed in a bigger vein and therefore less likely to have thrombosis. If you are meaning using the tracking versus CXR then no as you would know where the tip was located in both and if there was a malposition. Only with CXR you would have to wait till you had it done and reviewed it whereas with Sherlock you know at bedside and can rectify then.

Question 4: Are there any particular patient populations who you would consider to be particularly vulnerable to insertion-related adverse events?

Expert Adviser	Response / Comment
Dr Richard Leech **Consultant Anaesthetist**	*Patients with cardiac problems (angina, cardiac arrthythmias etc) would be more prone to arrhythmias if the catheter tip was advanced too far. (Using ECG technology for PICC placement is relatively contraindicated in this group anyway)* *Patients with cancer receiving chemotherapy would be at higher risk of thrombosis and infection than the general population*
Dr Andrew Bodenham **Consultant in Anaesthesia and Intensive Care Medicine**	Yes patients with very small fragile veins, those with abnormal vein or other anatomy, coagulopathy, pervious problems, smaller child etc. Other problems can be inherently unpredictable and there are some risks to all procedures.

Professor Richard McWilliams **Consultant Vascular Radiologist**	I do not work in paediatrics but I would expect it to be most important in young children. I think there has been a DofH document on this years ago – due to adverse events from lines in the heart in children with severe consequences.
Dr Lisa Dougherty **Nurse Consultant**	If patients have low platelets or are on anticoagulants then they have a higher risk of haematoma, cancer patients and those with a history of thrombosis have a greater risk of thrombosis once in situ.