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**Advancing patient safety
with ultrasound**

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Advancing patient safety with ultrasound

As an increasing number of non-traditional users integrate point-of-care ultrasound into best practice, the technology is enabling faster diagnosis of life threatening conditions, reducing the risk of invasive procedures and improving patient outcomes. **LOUISE FRAMPTON** reports.

The first hand-held ultrasound system, developed by SonoSite, over ten years ago, was initially designed for use on the battlefield. Since then, the role of point-of-care ultrasound has expanded across a range of disciplines on the “frontline” of the health service – from critical care, cardiology and rheumatology, to anaesthesia, palliative care and orthopaedics.

It now plays an important role in improving the safety of procedures, reducing patient transfers around the hospital, cutting the risks associated with moving very ill patients, as well as helping in the fight to minimise the spread of

Dr Christian Egeler.



infection. At the same time, hand-carried, point-of-care ultrasound has freed up space, time and staff in radiology departments – allowing sonographers to concentrate on specialist applications requiring their expertise.

Safer catheter placement

The expanded role of ultrasound has, in part, been driven by NICE guidelines, which recommend that ultrasound is used to guide vascular access in order to prevent complications. In a report, published in 2002, NICE highlighted the fact that although experienced operators using surface anatomical landmarks can

achieve relatively high success rates with few complications, failure rates for initial central venous catheter (CVC) insertion were reported to be as high as 35%.¹

The guidelines pointed out that 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 example, for a patient receiving mechanical ventilation or during emergencies such as cardiac arrest) and co-morbidities (for example, bullous emphysema or coagulopathy).¹

Consequently, the NICE guidance recommended that two-dimensional imaging ultrasound guidance should be used as the preferred method for insertion of CVCs into the internal jugular vein. The use of ultrasound guidance should be considered in most clinical circumstances where CVC insertion is necessary, either electively or in an emergency situation, while all those involved in placing CVCs using ultrasound should undertake appropriate training to achieve competence.

“The NICE recommendations on ultrasound guided vascular access have taken around six years to become adopted on a mainstream basis, and still some Trusts have not yet been able to fully comply with the guidelines due to financial constraints,” commented Tracey Byard, SonoSite’s UK country manager.

“Trusts cannot afford *not* to use ultrasound guidance. If something goes wrong, they are likely to face litigation issues. In the event of an investigation into a patient safety incident, they will be asked: ‘Was ultrasound available? Was the

person performing the procedure proficient at using it and was ultrasound actually used?' Lawyers will be aware of the NICE guidelines and will want to know why they were not adhered to."

Paediatricians at Southampton General Hospital are currently using SonoSite's M-Turbo point-of-care ultrasound system to improve the safety of vascular access procedures, while ultrasound is also used to assess and monitor patients in the hospital's dedicated paediatric intensive care unit (ICU) and during transport.

Dr Gareth Jones, a consultant paediatric intensivist and anaesthetist at the hospital, explained the benefits of using bedside ultrasound for children: "Vascular access in small children can be a major challenge, and the development of point-of-care ultrasound has significantly helped in the placement of central lines in these potentially difficult patients. It has also helped us to develop our PICC line service, allowing us to target veins in the upper arm that were not accessible using conventional techniques. The large screen and image quality of the instrument ensure these lines are accurately placed, minimising risk for very young patients.

"The portability of the system also means that it can be used during our patient retrieval service; it can easily be taken in the ambulance or air ambulance to aid assessment and monitoring of critically ill young patients during transport from our satellite hospitals."

Ultrasound guidance is also crucial to improving the safety of other invasive procedures, such as suprapubic catheter insertion, which carries some risk of complications including peritoneal perforation (with or without bowel perforation), infection and haematuria.

In July 2009, The National Patient Safety Agency (NPSA) issued a Rapid Response Report on "Minimising risks of suprapubic catheter insertion", as a result



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of an incident, in September 2008, where a patient's bowel was perforated during the insertion of a suprapubic catheter. The incident, which was identified via the Reporting and Learning System (RLS), prompted a formal search for further incidents relating to the insertion of a suprapubic catheter. The NPSA found that three incidents causing death, and seven causing severe harm, were reported between September 2005 and June 2009, while nine of these incidents resulted in a bowel perforation.

The safety alert suggested a number of actions should be taken to reduce the risks of this procedure. Included in the recommendations was the comment that: "The use of ultrasound is a safer method for suprapubic catheterisation especially in complicated patients such as those with large body habitus, abdominal adhesions, and in uncooperative patients".

Regional anaesthesia

Advances in sonography are also improving other types of care. For example, peripheral nerve blocks traditionally relied on surface anatomical landmarks and electrical stimulation to localise nerves. However, this approach can be inaccurate and the resulting misplacement of the needle and spread of anaesthetic can cause blocks to fail. Even today the success rates of some block types are below 80%.² The technical demand of regional blocks means that, depending on the technique

used, failure rates range from 5% to 25%.³

As patients vary in shape and size, relying on traditional anatomical landmarks can result in multiple attempts at needle insertions, which can cause unnecessary pain to the patient, waste valuable time in theatre and, in some cases, lead to potentially serious complications.

Direct nerve injury can also sometimes occur during peripheral nerve blocks guided only by anatomical landmarks and nerve stimulation. The incidence of nerve injury resulting in symptoms lasting more than a week has been estimated at 1% to 5%.⁴ In addition, damage to blood vessels can lead to other complications such as haematoma in spinal and epidural injections.

Severe complications are infrequent but the implications are serious, particularly because very little effective therapeutic interventions are available to treat the complications, with permanent loss of function as the likely outcome.

Anaesthetists first started to use ultrasound imaging to guide nerve blocks, with the aim of reducing the risks, in the mid 1990s. This non-invasive approach

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was found to provide real-time visualisation of the target nerve and surrounding vasculature, as well as the needle and spread of injection.

More recently, evidence has been accumulating on the potential of this technique to reduce the number of failed blocks and risk of complications, as well as improving the efficacy of successful blocks.

Schwemmer *et al* (2006) directly compared ultrasound guidance and neurostimulation in axillary brachial plexus blocks and found that 19.7% of patients treated by nerve stimulation required an additional dose of opioid or general anaesthesia due to incomplete or insufficient block, compared to just 3.6% of patients treated by ultrasound guidance.

Furthermore, only 5.4% of patients in the ultrasound group required monitoring in the post-anaesthesia care unit, whereas 32.4% of the neurostimulation group required post-operative monitoring.

"Ultrasound guided regional anaesthesia allows Trusts to perform more day case surgeries, which means shorter waiting lists, as well as financial benefits," Tracey Byard explained.

"The evidence suggests that it is also safer for the patient, as you use less of the anaesthetic agent, which means less toxicity. If the regional anaesthesia is placed accurately and less of the agent is used, it can be 'topped up' – allowing the procedure to be carried out for longer. In the case of a failed block, where the maximum dose has been used, it is necessary to revert to a general anaesthetic which has significant cost implications for the hospital as patients spend longer in recovery. Not only is the ultrasound approach good for the hospital, therefore, but it is also good for the patient – particularly if they have contraindications such as cardiac problems."

At Morrision Hospital in Swansea, hand-held ultrasound has become an essential tool, especially in orthopaedic

Training courses

The increasing use of ultrasound by non-traditional users has prompted a need for training and, to meet this demand, SonoSite has developed a comprehensive programme of workshops for clinicians wishing to hone their skills. Run by consultant anaesthetists and vascular access practitioners, these workshops include accredited components on ultrasound physics and anatomy, along with hands-on practice with live models.

Most courses are held at the company's dedicated training and education centre in Hitchin, where an extra scanning room has been added to accommodate the increasing numbers of nurses, surgeons, consultants and anaesthetists wishing to further their training.

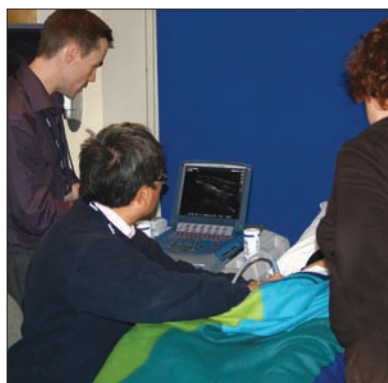
Topics include ultrasound guided venous access, ultrasound guided regional anaesthesia (accredited by the European Society of Regional Anaesthesia), ultrasound guided chronic pain management, critical care ultrasound, College of Emergency Medicine approved level 1 EMED ultrasound, and musculoskeletal ultrasound.

"The courses provide practical training on anatomy and visualisation on

live models," explained education manager, Dee Banks. "One of the user challenges is to identify what they are seeing on the screen. The courses help them to learn to interpret the image, optimise the system to ensure they get the best possible visualisation and understand the orientation of the image on the screen. Most of our faculty are also happy for people to shadow them for a day to help them polish their technique."

There is a competency assessment at the end of the course and delegates are expected to perform six scans with a faculty member to ensure they are confident and to identify any areas where further tuition may be required. This is for personal benefit rather than a formal certification of competency, however.

SonoSite has also set up a dedicated educational tool that can be accessed free of charge via iPhone. The "SonoAccess app" provides a comprehensive multimedia database of ultrasound resource materials, including scanning technique videos, tips for point-of-care ultrasound, case studies, as well as a clinical image gallery designed to assist anatomy recognition and provide a quick, comparative reference guide.



Delegates undergoing hands-on training on ultrasound techniques.

surgery, where approximately 75% of the regional blocks in the hospital are performed.

Dr Christian Egeler, consultant anaesthetist at Morrision Hospital, explained: "We have established a service where one anaesthetist using a hand-carried ultrasound system can perform regional blocks for two upper limb surgery lists simultaneously in a day surgical setting. This would clearly be impossible without ultrasound. Regional anaesthesia is far less traumatic for patients than general anaesthesia; they recover extremely quickly and are ready to go home within a few hours of surgery."

In the theatre and on the ward

Point-of-care ultrasound has also transformed vascular surgery, according to consultant vascular and endovascular surgeon, Dr Tom Browne, from Broomfield Hospital in Essex: "A lot of imaging that would previously have been performed in radiological departments can now be undertaken by a surgeon or physician, and this is very important – especially in venous disease. Patients want easy access to imaging and instant results, which has been made possible through the use of hand-held ultrasound.

"It is particularly useful for patients who are difficult to move – from intensive

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care, high dependency units or even in a resuscitation setting. In theatre, it is absolutely essential for pre-operative marking and peri-operative localisation of incompetent veins. It also allows you to see flow in the carotid vessels during surgery, and trace veins for bypass surgery."

Research by Dr John Postley, assistant clinical professor of medicine at Columbia University College of Physicians and Surgeons, New York, also shows that ultrasound is an effective tool to identify patients at risk for cardiovascular disease. CT scans can detect stiff, calcified arteries that are one of the hallmarks of heart disease, but not soft clumps of fatty plaque on vessel walls.

"These deposits are an important indicator that someone could be heading for a heart attack or stroke," said Dr Postley. In a study, he showed that ultrasound can even detect as little as 0.2 mm of fatty build-up on an arterial wall.

In addition, ultrasound systems are having a significant impact on the ability of cardiologists to carry out rapid and reliable echocardiography – as Dr Harald Becher, consultant cardiologist, John Radcliffe Hospital, explained:

"With hand-held ultrasound we can quickly carry out echocardiography for patients on the wards or in the theatre, most of whom need an urgent diagnosis. We are usually looking at left ventricular function, pericardial effusion, complications of myocardial infarction and severe mitral regurgitation. Many of these patients cannot be moved easily, so taking them to the scanner is not an option. With hand-held ultrasound we can be at the patient's bedside and ready to scan in under five minutes."

Dr Becher commented that the ability to review scan recordings also allows the team to establish whether or not there have been any changes or deterioration in the patient's condition, while the use of a special transoesophageal echocardiography (TOE) transducer

provides significant advantages.

"Access in the gullet means you are very close to the heart and there are no structures interfering with the ultrasound, unlike with a transthoracic view where the lungs, chest muscles and bones can cause artefacts. There are some structures that you can see much better with TOE, including parts of the atria and it is by far the best way of imaging valves," he commented. "There are other techniques, such as MRI, which can be helpful for more general disease indications, but you cannot use MRI for everyone – including patients with metallic implants or who are claustrophobic."

In such instances, TOE is often the most sensitive method for imaging valvular disease, particularly endocarditis, in his view. He added that the approach is also useful for monitoring the haemodynamics of the heart:

"In the past, the way to monitor heart problems in theatres was to insert a catheter into the vein and move it through the right heart, in the pulmonary artery, which is not an easy procedure and carries some risk of complications – including the potential for infection.

"However, when you put an ultrasound transducer into the oesophagus you can see the heart contracting very well, you can measure

the filling of the heart and the volume status quite easily. It is a very simple and useful technique that provides lots of information, which is why anaesthetists are now increasingly using this approach."

Other key areas where point-of-care ultrasound can benefit patient safety include:

- Detection of post surgery internal bleeding.
- Measurement of the optic nerve to test for intercranial pressure.
- Early diagnosis of carotid artery stenosis and DVT.
- Guided paracentesis (a procedure to remove fluid that has accumulated in the abdominal cavity).
- Guided thoracocentesis (a procedure to remove fluid or air from the pleural space).

Emergency medicine

In A&E, ultrasound helps provide rapid, bedside diagnosis of a patient's condition – allowing life-saving action to be taken without delay. The team may use the technology to detect fluid collections in the abdomen in cases of blunt trauma, diagnose aortic aneurysms, or assist with needle guidance, for example.

There is also significant interest in pre-hospital use and SonoSite has equipped a number of air ambulance teams with its NanoMaxx technology. Hand-held ultrasound allows the team attending the scene of a trauma to diagnose conditions such as a pneumothorax, so that they can alert the hospital that the patient will need a chest drain as soon as they arrive. It improves communication between the attending medics and the receiving trauma team, and can establish whether the patient's condition is stabilising or deteriorating.

"Ultrasound is now on the curriculum for emergency medicine trainees, which has meant that funding for equipment and training has become more mainstream for A&E departments. However, many

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‘Having ultrasound at the roadside allows those attending the scene to provide a more accurate assessment of the patient’s condition. The more information you can pass forward to the hospital about the condition of the patient the better.’

“At the beginning, there was resistance from radiologists – they believed the technology would take away their expertise and they were worried that they would not have control over it. Instead, it has worked in their favour – relieving them of the more routine, mundane work, so they can concentrate on more interesting and challenging cases.” +

roadside doctor services are delivered by volunteers from emergency medicine, so despite being a valuable tool, the use of the technology is often funded by charities,” commented Tracey Byard.

“Having ultrasound at the roadside allows those attending the scene to provide a more accurate assessment of the patient’s condition. The more information you can pass forward to the hospital about the condition of the patient the better, as this ensures that the patient not only receives the most appropriate treatment at the roadside, but also at the hospital when they arrive.

“By ensuring the right diagnosis and accurate information, clinicians can intervene more quickly, but the appropriateness of this care is also crucial – what is performed during this critical timeframe will affect the patient months ahead in terms of their recovery,” Tracey Byard continued.



It is also possible to establish cardiac death, so that a decision can be made about when not to continue intervening, she explained: “This is somewhat controversial, at present, as physicians at the receiving hospitals are not always comfortable with paramedics making this decision. However, there was a similar reticence when our first portable ultrasound system was launched which was aimed at non-traditional users.

- For further information on courses and to register online, visit: www.sonositeeducation.co.uk

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