Ultrasound for Vascular Access—

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Introduction

An estimated 300 million vascular catheters are placed every year in the United States—making vascular access the most commonly performed invasive procedure for patients. The vast majority of these procedures are peripheral intravenous (PIV) catheters. The remainder are peripherally inserted central catheters (PICCs), midlines, and central venous access devices (CVADs). CVADs (also called central venous catheters or CVCs) account for only 3 million of the catheters inserted annually in the United States.[1,2]

The value of ultrasound (US) imaging in establishing vascular access for the placement of catheters has been recognized for more than 20 years.[1,2] Ultrasound guidance has been shown to increase the rate of successful cannulations, decrease the number of complications, and lower the risk of infection.[1,2]

Ultrasound can be used to guide all stages of catheter insertion and management. It makes it possible for the health care practitioner (HCP) to assess the patient's vein before performing venipuncture, to see the needle going into the vein, and to confirm venous residence (ie, confirm that the needle or guide wire resides in the target vein and that placement of the line can then proceed). Fewer attempts at needle placement means fewer "sticks," less pain, less risk of infection—and, of course, may improve patient comfort and satisfaction.[3]

Evidence-based guidelines recommend ultrasound to assess and access veins

Ultrasound guidance in venous access is recommended in the clinical practice guidelines of many organizations, including:

- American College of Emergency Physicians (ACEP)[4]
- American Society of Anesthesiologists (ASA)[5]
- Emergency Nurses Association (ENA)[6]
- Infusion Nurses Society (INS)[7]
- American Institute of Ultrasound in Medicine (AIUM)[3]
- Centers for Disease Control and Prevention (CDC)[8]

The INS ***Infusion Therapy Standards of Practice***, revised in 2016, stresses the importance of selecting the most appropriate type of vascular access device (VAD)—peripheral or central—to accommodate the patient's needs. They advise that the VAD selected must be of the smallest outside diameter and must be the least invasive device necessary for the prescribed therapy, and that peripheral vein preservation must be considered when planning for vascular access.[7] The INS recommends using vascular visualization—including ultrasound—for inserting every type of VAD, including:

> **Short peripheral catheters:** "Use vascular visualization technology (eg, near infrared, ultrasound) to increase success for patients with difficult venous access…"[7]
>
> **Central vascular access devices:** "Measure the vein diameter using ultrasound before insertion and consider choosing a catheter with a catheter-to-vein ratio of 45% or less…"[7]
>
> **Central venous access via midline catheters:** "Consider using vascular visualization technologies that aid in vein identification and selection for difficult venous access…"[7]
>
> **Central venous access via PICCs:** "Use ultrasound (US) to aid in vein identification and selection for decreased adverse events and first-attempt success…"[7]

ULTRASOUND IS RECOMMENDED IN DIFFICULT VENOUS ACCESS[6]

Ultrasound guidance is particularly valuable in patients with difficult vascular access—including patient conditions such as obesity, chronic illness, hypovolemia, vasculopathy, and intravenous (IV) drug use.[6] Also, repeated attempts to insert catheters can cause peripheral vessel depletion—that is, a decrease in the number of usable veins.[9] Unfortunately, in many cases of difficult vascular access, HCPs decide to insert CVADs instead of peripheral lines, despite the inherent risks. There is evidence that this practice may be changing, due to the documented success of ultrasound guidance in difficult venous access.[10] There is also improved device selection guidance, as well as the implementation of nurse-led vascular access preservation programs in which ultrasound guidance is being used to reduce the use of nonessential PICCs.[9]

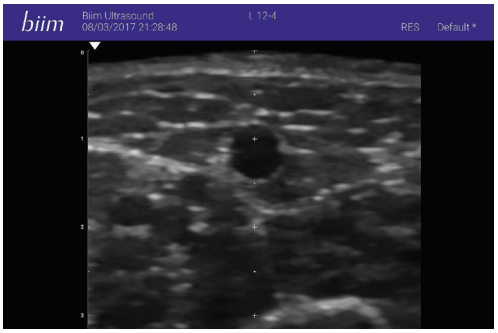

Figure 1
Biim Ultrasound image of basilic vein.

The ENA ***Clinical Practice Guideline: Difficult Venous Access*** makes the following Level A (High) recommendation for US-guided intravenous access:

> "Ultrasound-guided access should be considered for adult and pediatric patients with difficult access that have had unsuccessful PIV attempts using traditional methods. (Evidence Level A – High)"[6]

ULTRASOUND-GUIDED INSERTION OF CVADS LOWERS INFECTION RATE

The Joint Commission, in its report, ***Preventing Central Line-Associated Bloodstream Infections,*** reported that ultrasound guidance in CVAD insertion was associated with an increase in the number of successful first attempts and a decrease in the incidence of central line-associated bloodstream infections (CLABSI).[2] The CDC also recommends ultrasound guidance for the insertion of CVADs.[5,8]

> The CDC states: "Use ultrasound guidance to place central venous catheters (if this technology is available) to reduce the number of cannulation attempts and mechanical complications. Ultrasound guidance should be used only by those fully trained in this technique."[8]

Ultrasound has been underutilized—despite its value

In 2010, several emergency physicians (EPs) at Massachusetts General Hospital perceived that—despite growing evidence supporting EP-performed point-of-care ultrasound (PoC US)—there was a utilization gap between academic emergency departments (EDs) and other emergency settings. The EPs undertook a survey of ED directors in 5 states and identified the following barriers to use of ultrasound: lack of availability of PoC US, expense, limited training, and limited need (real or perceived).[11]

WHY HAVE HOSPITALS BEEN SLOW TO ADOPT THE USE OF ULTRASOUND, DESPITE THE MERITS OF THE TECHNOLOGY?

One explanation might be found in the CDC's recommendation that ultrasound should be used "when available" and that it should be used "only by those fully trained in this technique."[8]

Ultrasound requires specialized equipment. It also requires hours of training to handle a user-dependent technology. Other explanations are the cumbersomeness of the equipment. Traditional ultrasound machines are connected with cords and cables that can interfere with mobility. Another consideration is the expense of ultrasound systems. As health care organizations look to cut costs, it becomes difficult to purchase ultrasound systems for point of care.

Figure 2
A traditional ultrasound system. A cord connects to a machine that displays the images on a monitor screen.

Recent advances increase availability and affordability

In recent years, many of these barriers to the use of ultrasound have been overcome by educational and technological advances.

Emergency physicians are among those who have taken the lead in establishing training programs in clinical ultrasound. According to ACEP's Ultrasound Guidelines:

> "Ultrasonography has spread throughout all levels of medical education, integrated into medical school curricula through residency to postgraduate education of physicians, and extended to other providers such as nursing, advanced practice professionals, and prehospital providers."[4]

Vascular access specialists have also integrated the use of ultrasound into practice. Apheresis is yet another setting where ultrasound-guided peripheral access has been shown to greatly decrease the practice of inserting nonessential CVADs.[12,13]

Over the last decade, ultrasound imaging and information systems have become more digital. Ultrasound examinations are more mobile and versatile than ever. The actual devices have become much smaller—in some cases, pocket-sized. The newer devices are more portable—not only due to their small size, but due to the fact that the images can be viewed on a tablet or, in some cases, a smartphone—thus eliminating the need for a monitor altogether.[14] All of the newer, portable systems are much less expensive than the traditional ultrasound systems of only a few years ago.

Figure 3
The cordless, pocket-sized Biim ultrasound scanner. Images are displayed on a handheld tablet.

Conclusion

Ultrasound-guided vascular access is valuable at every stage of venous catheter insertion and management. It has been shown to increase the rate of successful cannulations and lower the rate of complications, including bloodstream infections.[1-14]

Recent advances in ultrasound technology have resulted in a new generation of portable ultrasound devices—small, handheld devices that transmit images to a tablet or smartphone and are small enough to be used in a patient's hospital room. These streamlined devices make it possible for HCPs to scan patients at the point of care, improve vascular access outcomes, and begin treatment earlier. In some cases, the new ultrasound devices are affordable enough for hospitals to put the technology into the hands—literally—of many more doctors and nurses.

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USA > 14 Plaza Drive, Latham, NY 12110 > tel: 800-772-6446 or 518-798-1215 > fax: 518-798-1360
International > Haaksbergweg 75 (Margriettoren), 1101 BR, Amsterdam Z-O > The Netherlands tel: +31 (0)20 753 2949 > fax: +31 (0)20 753 2939

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