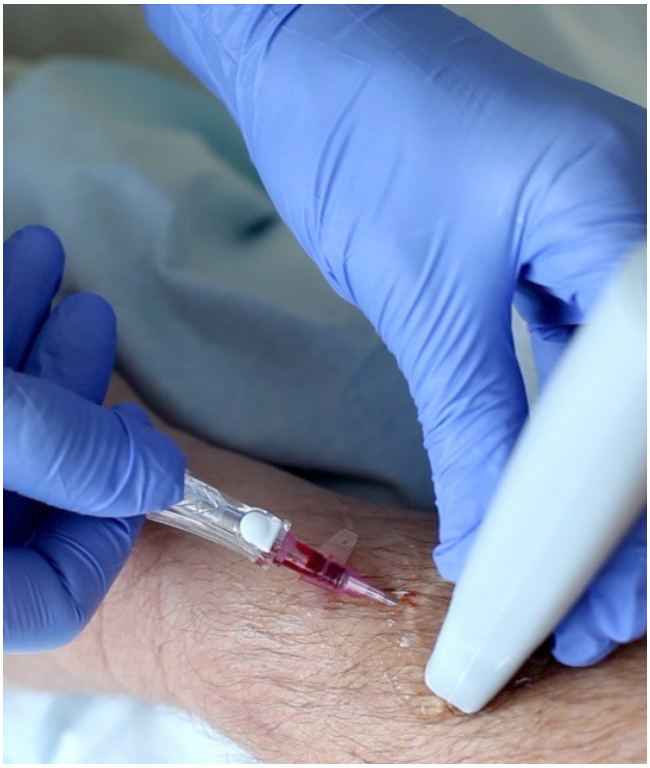
Ultrasound-Guided PIV Insertions and Patient Safety: How Practice Variations are Putting Patients at Risk

By Jaclyn Landon



This photo depicts an unprotected probe and gel all over the insertion site, which can be a patient safety hazard. Image courtesy of PICC Excellence

For organizations looking to move beyond a patchwork of quality and safety initiatives to create a culture of safety across every care setting, a good first step would be to take a closer look at a procedure that affects nearly every patient who walks through their doors: the insertion of a peripheral intravenous catheter (PIVC).

PIVC insertion is the most commonly performed invasive procedure in all of healthcare. It is estimated that 90 percent of hospitalized patients require a PIVC at some point during their stay. Each year, approximately 330 million PIVCs are sold in the United States, and some 2 billion are sold worldwide.[1-2] The number of U.S. patients requiring PIVC access is only expected to increase as the population ages and more treatments requiring intravenous access are required.[3]

However, researchers estimate that up to 60 percent of patients requiring a PIVC can be classified as presenting difficult vascular access (DiVA). This can be caused by aging veins, obesity, repeated cannulations, irritating medications, and IV drug use, in addition to such chronic conditions as cancer, diabetes, and sickle cell disease. The prevalence of DiVA patients has led to greater reliance on the use of ultrasound imaging to guide PIVC insertions. Approximately 12 million ultrasound-guided PIV (UGPIV) insertions are performed each year in North America.[4]

The benefits of UGPIV include improved IV success rates, faster procedures, and fewer needlesticks.[4] What is less clear is the most effective way to utilize and disinfect the technology so that it minimizes potential harm to the patient.

Part of this confusion can be attributed to conflicting practice recommendations from a variety of professional organizations, affecting everything from the selection of appropriate infection control supplies to the adoption of procedures for transducer disinfection. As a result, significant practice variations have been observed not only among hospital departments, but sometimes among individual clinicians within the same department. A recent survey published in the *Journal of the Association for Vascular Access* (JAVA) highlights this variability, bringing renewed attention to the patient safety risks associated with UGPIV insertion.[5]

The Rise of Point-of-Care Ultrasound in Vascular Access

While ultrasound imaging has been used to guide the insertion of vascular access devices (VADs) in a variety of clinical settings for more than 30 years, such applications have become increasingly common in the past decade. Today, numerous healthcare professional organizations support its use in this context, and the benefits of ultrasound guidance for PIV insertion are well documented.

By enabling the visualization of vessels, arteries, nerves and surrounding structures during assessment and insertion, ultrasound has been shown to improve IV success rates, decrease the number of placement attempts, and enable clinicians to achieve IV access in less time.[3-4,6] In addition, the use of ultrasound can help avoid the need to perform more-invasive vascular access procedures, such as the insertion of a central access venous device (CVAD) or an external jugular catheter—both of which are associated with much higher complication rates than PIV catheter insertion. According to the American Institute for Ultrasound in Medicine, ultrasound guidance can be invaluable for patients who are difficult or impossible to access.[7]

"Ideally, clinicians want to be able to insert a peripheral line on the first attempt, and the advent of better visualization technologies like ultrasound have made that much easier to accomplish," says Nancy Moureau, RN, PhD, CEO of PICC Excellence. "In addition to guiding insertion, ultrasound can be used to evaluate and select the best vein for PIV placement, and then facilitate assessment after insertion to ensure the catheter is positioned properly so that it will last for the duration of therapy."

Successfully placing a catheter on the first attempt and having it last until the end of treatment typically results in improved patient outcomes and lower costs associated with PIVCs. However, the use of ultrasound to guide PIV insertion is not without risks. Research shows that ultrasound probes can be frequently contaminated with bacteria, posing a serious risk of transmission between the ultrasound equipment, skin, and bloodstream.[8-10] Cross-contamination can occur from a variety of sources, including multi-use bottles of ultrasound transducer gel, skin and touch contamination, and inadequate probe disinfection practices.

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Mitigating cross-contamination is essential for protecting patient safety. Unfortunately, patient safety efforts are hampered by another concern surrounding the use of point-of-care ultrasound across all areas of medicine: lack of oversight and inadequate training.

According to ECRI, a healthcare quality and safety organization, the rapid rise in the use of point-of-care ultrasound has outpaced the ability of many healthcare facilities to ensure that all users have the necessary training, experience, and skill to use the technology effectively and appropriately. This observation led the nonprofit technology assessment group to add the modality to its list of "2020 Top 10 Health Technology Hazards," where the authors noted that the rapidly increasing use of point-of-care ultrasound devices has left many organizations struggling to keep up with appropriate safety measures.[11]

"Ultrasound is a powerful tool for guiding interventional procedures and its growth has expanded in many point-of-care settings, including vascular access," says Daniel A. Merton, BS, RDMS, FAIUM, FSDMS, a principal project officer and diagnostic ultrasound specialist in ECRI's health devices group. "But training is inconsistent, with some users having greater exposure to the technology than others, and the lack of sufficient oversight increases the potential that patients will be adversely affected."

Other than contamination concerns, says Merton, the biggest patient safety issue for vascular access procedures is not using ultrasound when it is clearly indicated. Even when ultrasound is available, a clinician without appropriate training may choose to use the standard blind technique, which can lead to multiple needlesticks and more discomfort for the patient. Such concerns are amplified by the sheer number of vascular access procedures, particularly PIV insertions, that are performed on any given day within a healthcare facility.

"The potential for harm obviously increases with the number of procedures that are performed by users of varying skill levels with very little oversight or guidance," Merton notes.

According to Merton, the rise of such safety issues can be attributed in part to the perceived simplicity of the ultrasound technology. Point-of-care ultrasound scanners are highly portable, relatively inexpensive, and seemingly easy to use. But these characteristics have led to such a rapid adoption of the modality that safety policies and practices have yet to catch up.

"These are serious safety concerns that are widely shared by many people in the industry, some of whom even refer to it as 'the Wild West of ultrasound,'" says Merton. "When there is a lack of guidance, it leads to a great deal of variability in terms of how and when the technology is used, which can directly impact patient safety."

Indeed, a growing body of research shows that a lack of standardization in healthcare can compromise clinical outcomes and threaten patient safety.[12] ECRI included fragmentation across care settings in its list of Top Patient Safety Concerns for 2020, noting that "policies and education must align across care settings to ensure patient safety."[13]

The Association for Vascular Access (AVA) has echoed the call for a more systematic approach. In a 2019 position paper, the association wrote that a standardized approach to the use of ultrasound guidance for vascular access procedures "minimizes variability in clinical practice, provides a framework for education and training, facilitates implementation, and enables quality analysis."[14]

Clinician Survey Confirms Significant Variation in UGPIV Practices

There is consensus that mitigating the risks of cross-contamination during UGPIV procedures is essential for protecting patient safety. However, there is still some variation among specific recommendations regarding infection control methods, probe disinfection, and proper aseptic technique.

Moureau has long been concerned about the lack of standardized UGPIV recommendations and the impact that practice variations could have on patient safety. Following this line of concern, in 2019 she conducted a survey to gain a better understanding of clinicians' beliefs and current practices regarding UGPIV insertion, while also identifying possible variability in supply usage across departments.

Responses from nearly 1,500 clinicians, primarily vascular access (VA) and emergency department (ED) clinicians, confirmed her hypothesis by revealing significant levels of variation across hospitals and other care settings.[5] The study marks one of the first attempts to quantify such variability and highlight important safety implications.

The survey results confirmed that UGPIV procedures are performed frequently: respondents indicated that they insert anywhere from five to 20 ultrasound-guided PIV catheters per day. But more than that, says Moureau, the results paint a clear picture of the fragmented landscape of UGPIV procedures, including widely varied use of transducer protection and gel.

While most organizations recommend sterile probe covers to minimize contamination during UGPIV procedures, only 59 percent of VA clinicians—and just 11 percent of ED clinicians—reported using a sterile probe cover. Gel use followed a similarly variable pattern, with 64 percent of VA personnel and just 13 percent of ED personnel reporting the use of sterile gel. In addition, more than 22 percent of all respondents indicated that they vary usage between multi-use gel bottles and single-use gel packets (both sterile and non-sterile).

The survey also highlighted safety concerns resulting from the presence of gel in the sterile insertion site area. Among the respondents, 41 percent of VA clinicians and 51 percent of ED clinicians reported instances of inadequate gel removal, which often results in securement and dressing adherence issues. Poor adherence of dressings can lead to catheter failure and accidental dislodgement.[15] More than half of all VA personnel (52 percent) said they felt that aseptic technique is often compromised by post-procedure gel clean-up.

"UGPIV has become increasingly common in the past 10 years,

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and within this length of time we would expect better policy development and standardization of practices," says Moureau. "But these results clearly demonstrate numerous gaps that need to be addressed, opening the door for performance improvements that will lead to safer ultrasound-guided PIV procedures."

Addressing Gaps in UGPIV Procedures

Effective policies must address the key areas that impact patient safety during ultrasound-guided PIV insertions, says Moureau. As we have seen, among the most important areas to be considered are establishing methods to perform proper aseptic technique, providing probe protection, using single packet gel, and maintaining appropriate levels of probe disinfection.

Aseptic Technique

According to the Association for Vascular Access (AVA), effective aseptic technique is critical for minimizing infection risk and protecting patient safety, particularly during the insertion and maintenance of such vascular access devices as PIV catheters. The importance of using aseptic technique arises from both the invasive nature of the procedure and the increasing frequency with which such procedures are being performed.[17]

AVA recommends the use of aseptic non-touch technique (ANTT), a protocol designed specifically to be used across care settings for all clinically invasive procedures. The ANTT protocol is based on the premise that reducing the variables in aseptic practice and standardizing aseptic technique reduces infection rates and improves patient safety.[17]

For any PIV insertion, ANTT includes attention to such details as using clean gloves, preventing the sterile needle from coming into contact with various connection points or contaminated gloves, properly disinfecting the skin, and not touching the skin after performing aseptic preparation.

"While we can never achieve full sterility with PIV catheter insertions due to the necessary contact between the needle and the skin, aseptic non-touch technique is a powerful tool to help prevent the spread of pathogens that cause infection," says Moureau. "However, the effectiveness of this technique is diminished if it's not done in a consistent manner, and my research indicates that many clinicians are not following the basic principles of ANTT."

In March 2019, Moureau conducted a poll of several hundred clinicians, which revealed a wide gap between clinicians' understanding of contamination risks and actual UGPIV practices.[4] While 86 percent of poll respondents said they recognized the risks of contamination associated with the ultrasound probe and gel, less than 33 percent said their facilities followed proper aseptic technique (including sterile probe covers and sterile gel) with every procedure. In Moureau's more recent survey, more than half of vascular access clinicians indicated that they felt aseptic technique is frequently compromised by post-procedure gel clean-up.[18]

Probe Protection

In addition to aseptic technique, barrier methods such as probe covers can provide an added level of protection and have been shown to be effective in preventing bacterial transmission from inadequately disinfected probes. Transparent dressings are no longer recommended by ultrasound manufacturers or organizations like AVA, as they may leave a film residue on the probe that can result in deterioration of the vital transmission surface.

There is a disconnect between these recommendations and what is happening during UGPIV procedures. According to Moureau's most recent survey, only 59 percent of vascular access (VA) clinicians and 11 percent of emergency department (ED) clinicians always use a sterile probe cover. Meanwhile, 31 percent of respondents said they use transparent dressings for probe protection, with more than half of vascular access clinicians and nearly 20 percent of ED clinicians reporting that they always use transparent dressings.[18]

Gel Use

Ultrasound-guided PIV insertion procedures require the use of gel to transmit sound waves through the skin. Gel applied at the insertion site can pose a significant contamination risk if not used properly. Gel applied near sterile needle insertion imposes a significant risk of contamination, as the gel can contact microorganisms from the skin, and sometimes even the clinician's gloves. Without proper precautions, the spreading of gel across the skin and various points of contact increases the risk of bacterial transmission into the bloodstream during the procedure.

"As we have seen, among the most important areas to be considered are establishing methods to perform proper aseptic technique, providing probe protection, using single packet gel, and maintaining appropriate levels of probe disinfection.

In response to such concerns, many organizations recommend the use of sterile gel to add a higher level of patient safety. In addition, there is a trend toward single-use gel packets to further minimize contamination risks associated with multi-use gel bottles. However, Moureau notes that even with sterile gel, application at the insertion site may result in contamination as it spreads across the skin.

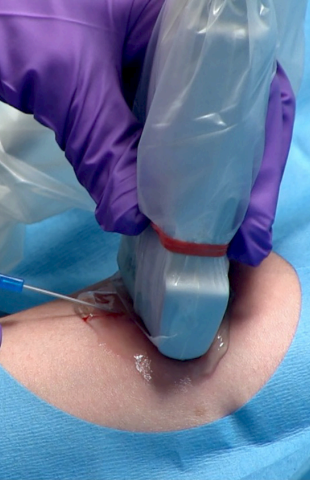
Moureau's recent survey revealed that there is great variation in gel use, sometimes even within an individual facility. More than 22 percent of all respondents indicated that they vary between multi-use gel bottles and single-use gel packets (both sterile and non-sterile). This suggests that clinicians are utilizing whatever supplies happen to be available rather than following a consistent protocol designed to maximize patient safety.[18]

The survey also identified issues with gel removal, with 41 percent of VA personnel and 51 percent of ED personnel reporting that inadequate gel removal led to securement and dressing adherence issues. Poor dressing adherence can result in catheter failure and accidental dislodgement, not to mention increased contamination rates.[19-20]

Transducer Disinfection

Ultrasound transducer disinfection is where many practice recommendations diverge, as evidenced by conflicting published guidelines regarding the appropriate level of disinfection a transducer must undergo between UGPIV procedures.

The differences among practice recommendations stem from differing interpretations of the Spaulding classification system, a widely accepted standard designed to determine the level of disinfection required for reusable medical devices based on the potential risk of infection posed to patients. The Spaulding system classifies device usage into three categories: critical, semi-critical, and non-critical. Devices that may contact sterile tissue or the bloodstream are classified as critical usage. Devices that contact



This image depicts proper technique. Image courtesy of PICC Excellence

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non-intact skin, mucous membranes, blood, or other body fluids are classified as semi-critical. Devices that contact only intact skin are considered non-critical.

Based on the Spaulding system, critical and semi-critical devices require high-level disinfection (HLD), which is defined as the complete destruction of all microorganisms on or in a device. By contrast, devices used in non-critical procedures require only low-level disinfection (LLD), typically achieved through use of a germicidal spray or wipe to eliminate most viruses and bacteria.

For UGPIV, the question remains whether sterile probe protection, or probe and gel separation from the insertion site and blood, coupled with LLD represent adequate protection. Differing interpretations of the Spaulding classifications, as well as data on the efficacy of various barrier methods, have led to differences among ultrasound transducer disinfection recommendations.

Some organizations, including AIUM and ACEP, consider LLD to be sufficient when protective covers and sterile gel are used. Other entities, including the Healthcare Infection Control Practices Advisory Committee (HICPAC) of the Centers for Disease Control and Prevention (CDC) have taken a different stance. These groups assert that even with the use of probe covers, ultrasound-guided PIV insertions should still be classified as semi-critical, thereby requiring HLD before and after any insertion.[6-7,21]

Many organizations appear to be moving in the direction of imposing greater safety controls by requiring HLD for ultrasound probes involved in any invasive procedure, including UGPIV. Nevertheless, experts point out that there is a delicate balance between the level of disinfection needed to ensure patient safety and the practices needed to make day-to-day performance of UGPIV procedures practical.

When requiring HLD for devices, there are important workflow issues to be considered, and some of these also have significant economic implications. Ensuring the proper use of HLD processes requires staff to undergo additional training, and also requires additional equipment and supplies. Furthermore, HLD reprocessing can add 10 to 15 minutes in between procedures. Without additional staffing, the imposition of HLD requirements would almost certainly increase costs and reduce the number of ultrasound-guided PIV insertions that an institution is capable of performing in a given day.

"First and foremost, we have to protect patient safety. There's no doubt about that," says Judy Thompson, MSNED, RN, VA-BC™, AVA's director of clinical education. "But we also have to consider the real-world implications of ultrasound reprocessing recommendations that would make compliance difficult, which could potentially discourage the use of ultrasound guidance for vascular access procedures."

Indeed, research has revealed a high degree of non-compliance with infection control guidelines for UGPIV. In a survey of U.S. infection preventionists, only 22 percent indicated using a probe that had undergone HLD before and after performing a UGPIV insertion.[22]

Moureau suggests that more research is necessary to determine whether low-level disinfection procedures could be sufficient if other patient safety measures—such as proper aseptic technique and adequate probe protection—are consistently applied to mitigate contamination risks.

"Unfortunately, we don't yet have enough research to provide clear proof of direction as to the most appropriate level of disinfection when adequate safety measures are employed,'" she says. "Further research on this topic should be done to provide much-needed clarity for clinicians."

Overall, the patient safety issues highlighted in Moureau's study seem to reflect the experience and observations of others within the field, including AVA's Thompson, who observes, "It is necessary for hospitals to address patient safety concerns and work together to establish standardization in accordance with evidence-based safety practices."

An Urgent Need for Standardization

Given such significant patient safety issues, are the benefits of point-of-care ultrasound worth the potential risks? "Absolutely," says ECRI's Merton, noting that "in the proper hands, it can expedite diagnoses, improve care, and save lives."

When it comes to ultrasound use to guide vascular access, an AVA position paper confirms that the benefits outweigh the negatives, as evidenced by improved rates of first-stick success.16

"With the correct training, ultrasound enables clinicians to gain access on the first attempt with little to no pain for patients," Thompson says. "But clearly there is work to be done in terms of improving patient safety."

This work includes incorporating research into recommendations that establish minimum requirements for UGPIV training, supplies, and insertion practices.

"The goal of all clinicians and infection practitioners should be to establish an evidence-based standardized process for UGPIV procedures in order to improve patient safety," says Moureau. "Fortunately, I think we're moving in the right direction."

A Multidisciplinary Approach to Patient Safety

Given the complex nature of vascular access, spanning across multiple specialties, clinicians and experts agree that the development of consistent, evidence-based UGPIV practice recommendations needs to be a multidisciplinary effort.

Moureau suggests that the ideal solution would be a consensus group of experts representing different specialties—including vascular access, emergency medicine, and infection control, among others—to conduct and assess research and ultimately agree on best practices to guide UGPIV procedures.

In addition, vascular access experts need to be included at the highest levels of patient safety discussions, says Jim Davis, MSN, RN, senior infection

> *Documenting factors like the number of insertion attempts, PIV failure rates, and infections will make it easier to quickly identify issues that need to be addressed, whether they arise with an individual clinician or are a team-wide problem."*

prevention and patient safety analyst at ECRI. Such experts include members of groups such as HICPAC, who are involved in creating national guidelines and educational requirements that will ultimately be reflected in the recommendations of other professional organizations.

"It's about people from different professions with different perspectives working together to have these important conversations," says Davis. "After more than 25 years of working in healthcare, I'm seeing more organizations form strategic partnerships with the overarching goal of improving patient safety, and I'm hopeful we'll continue moving in this direction of increased collaboration."

This multidisciplinary collaboration needs to happen even within individual institutions. ECRI recommends that facilities establish a point-of-care ultrasound committee made up of key stakeholders from various departments, including nursing, emergency medicine, radiology, risk analysis, and others. The committee should be responsible for establishing ultrasound policies and ensuring they are applied consistently across the entire organization, whether it is a single building or a multisite healthcare system.

Protecting Patients Through Quality Education and Monitoring Outcomes

In addition, clinicians need high-quality, comprehensive education and hands-on training in the use of ultrasound for the placement of vascular access devices in accordance with their facility's policies.

According to an AVA position paper, such education and training activities should encompass basic knowledge of anatomy, ultrasound physics, and imaging techniques. It should also encompass hands-on competence in aseptic technique, including the use of sterile probe covers, application of gel, and correct disinfection of the transducer.[23]

"In a skilled clinician's hands, the use of ultrasound technology can offer patients a safer, more reliable solution for achieving PIV access," says Thompson. "But this requires proper training. Ultrasound is not a modality where you can just wing it without seriously compromising patient safety."

Even after initial training, Moureau says there should be ongoing competency assessments to evaluate the skill of the inserter, as well as their compliance with the institution's policies. A key component of such ongoing assessment requires monitoring outcomes through data collection. Documenting factors like the number of insertion attempts, PIV failure rates, and infections will make it easier to quickly identify issues that need to be addressed, whether they arise with an individual clinician or are a team-wide problem.

"We know we can improve UGPIV patient safety with standardized procedures, quality training, and monitoring compliance," says Moureau. "The time has come to decide what these best practices are and implement them consistently across all departments."

Jaclyn Landon is a freelance medical writer who specializes in vascular access and women's health technologies.

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