Survey of Ultrasound-Guided Peripheral Intravenous Practices: A Report of Supply Usage and Variability Between Clinical Roles and Departments

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Highlights

- The survey confirms that UGPIV procedures are performed frequently with half of respondents reporting 5–20 procedures per day.
- Results demonstrate a wide variety of supply usage practices and inconsistencies between departments with UGPIV insertions.
- Sterile gel was used by 56% and more than 22% of survey respondents stated they sometimes used each of the gel categories of multi-use, single gel packet and sterile gel packet.
- In 41% of vascular access specialists and 51% of ED clinicians reported inadequate gel removal caused securement and dressing adherence issues.
- These results suggest the need for investigation of guideline application and policy development to ensure patient safety with UGPIV insertions.

Abstract

Background: The purpose of this study was to investigate ultrasound-guided peripheral intravenous (UGPIV) supply usage practices by clinicians working in vascular access, in emergency departments (EDs), or in other roles.

Methodology: In 2019, a voluntary cross-sectional descriptive survey was conducted via SurveyMonkey. Data collected included demographics, practice-oriented information, procedural activities, and supplies used for UGPIV insertions. Frequency distributions and results of Fisher's exact test and one-way analysis of variance were reported using R v.3.5.2.

Results: A total of 26,649 surveys were distributed with a response rate of 5.5% (n = 1475). Forty-eight percent of respondents (n = 709) indicated that they worked in a vascular access role, 310 (21%) worked in an ED, and 455 (31%) categorized their role as *other*. Clinically meaningful differences existed in all variables for UGPIV procedures and supplies between departments ($P < 0.0001$) and in all care settings. Using an investigator-constructed overall metric of supplies used, important differences were demonstrated between personnel supply use in vascular access roles and other roles ($P < 0.0001$) and personnel in EDs and other roles ($P < 0.0001$).

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Conclusions: Use of supplies for UGPIV insertions varies by department. The variability in supply usage for UGPIV insertions revealed by this survey suggests a need for clinical education on guideline application and evaluation of compliance with policies to promote standardization of supplies for UGPIV insertion.

Keywords: ultrasound, infection, intravenous, surveys and questionnaires, vascular access devices

Background

Peripheral intravenous (PIV) catheters are the most common devices used to deliver medications, fluids, blood products, and nutrition. Approximately 2 billion PIV catheters are inserted worldwide every year.[1] The impact of the aging population, increasing numbers of difficult access patients, and usage of irritating intravenous medication treatments make it increasingly difficult to successfully establish a PIV. Many other factors complicate successful PIV insertion including obesity, IV drug use, and conditions such as diabetes, cancer, and sickle cell disease.[2] Ultrasound-guided peripheral cannulation has made it possible to improve PIV access success for patients with known difficult access veins (Supplemental Figure S1, available online).[3,4]

Estimates for incidence of difficult access are nearly 60% of patients, or 1 of every 2 patients in acute care.[5] As a result, ultrasound-guided PIV (UGPIV) insertions are being used to ensure PIV placement success.[6,7] As new devices and practices emerge, it is necessary to consider gaps in procedural asepsis, evaluate areas of noncompliance, and apply current guidelines to policies to ensure ongoing safety for patients.

The purpose of this study was to collect data on supplies used for UGPIV insertion to compare vascular access practices among clinical departments, in the emergency department (ED) setting, and by personnel in other roles.

Methods

This investigation was approved under exemption by IntegReview Institutional Review Board and conducted in accordance with the tenets espoused in the Declaration of Helsinki.[8] No identifying information was collected, and completion of the survey was taken as assent to participate. The survey tool was developed, validated within 2 groups of clinicians, revised, and finalized in electronic format.

A voluntary cross-sectional descriptive online 34-question survey was developed and integrated into SurveyMonkey (SVMK, San Mateo, CA) software. The survey link was distributed to approximately 26,649 email addresses sourced from attendees at meetings of the Association for Vascular Access, the Emergency Nurses Association, and an online educational database (PICC Excellence, Hartwell, GA). In addition, survey link invitations were posted to clinical groups on Facebook (Menlo PArk, CA) and LinkedIn (Mountain View, CA).

Survey data were exported to a file for download in a comma-separated value format. Data collection included information on demographics, procedure, and perception of usage, the importance of supplies, timing of current and perceived procedural activities associated with UGPIV. *Specialty* was entered as free-form text and categorized into a vascular access position, an ED position, or another position.

Facilities were categorized into inpatient, outpatient, or other facilities. The number of beds in the facilities were also categorized. Frequencies and row percentages were calculated. Due to the small cell size, Fisher's exact test was used to assess data for associations. To assess lack of standardization in overall PIV insertion procedure, 13 survey questions dealing with supply use were coded numerically according to best practices. Two points were awarded if best practices were always followed, 1 point if those practices were sometimes followed, and 0 points if the practices were not followed. Five practices were chosen as best practices (e.g., using IV start kits) and reverse coded (i.e., coded as 0 for always being used and 2 for not being used). A composite score was constructed by summing the 13 scored variables. The composite score was assessed for normality using a normal probability plot, the Anderson-Darling, Shapiro-Francia, and Shapiro-Wilk tests. One-way analysis of variance was used to detect any differences in roles using an a priori α level of 0.05. In the event data were judged as not normally distributed, the composite score was rank transformed. To control the experiment-wise error rate for pairwise comparisons, the Tukey-Kramer methodology was used for post hoc pairwise comparisons. This procedure is known as the preferred test for all pairwise contrasts when sample sizes are unequal. All analyses were done using R v.3.5.2.

Results

Of the 26,649 potential respondents, 1475 (5.5%) participated in the survey. The response rate was consistent or higher than other similar surveys.[9] The demographics contained a high percentage of respondents (n = 1354, 92%) who were employed by inpatient hospital facilities. Ninety-seven respondents (7%) worked for outpatient facilities, 18 respondents (1%) worked in other types of facilities including home health, and 6 respondents did not indicate facility type. For the bed size of the facility, a small percentage of respondents (n = 212, 16%) worked in facilities with fewer than 100 beds, a quarter of respondents (n = 307, 23%) worked in facilities with 100 to 249 beds, one-third (n = 454, 34%) worked in facilities with 250 to 499 beds, 17% (n = 230) worked in facilities with 500 to 799 beds, 5% (n = 65) worked in institutions with 800 to 999 beds, and 5% (n = 70) worked in facilities with more than 1000 beds.

For the question assessing level of employment, most respondents (n = 1197, 83%) were full-time employees, 208 (14%) were employed part-time, and 35 (2%) were casual employees. Of the respondents who were clinicians, 30% had 6 to 15 years of work experience (n = 435, 30%) or 16 to 30 years

of work experience (n = 442, 30%). Twenty-three percent (n = 345) had 30 or more years of experience, and 16% percent (n = 233) had 0 to 5 years of experience. Almost half (n = 709, 48%) of respondents worked in a vascular access position, almost a quarter (n = 310, 21%) worked in an ED, and 455 (31%) worked in a department categorized as *other* inclusive of various departments of acute care, education, administration, home care, home infusion, and outpatient services.

Supply Use: Start Kits, Transducer/Probe Protection, Skin Antisepsis

Within respondents for supply use incorporating kits with UGPIV insertion, almost two-thirds (n = 667, 65%) of the respondents always used an IV start kit, with the remainder split between *sometimes* or *never use* (n = 176, 17% and n = 190, 18%, respectively). Over three-quarters of respondents (n = 779, 77%) do not use a kit designated specifically for UGPIV, and an almost equal number always (n = 145, 14%) or sometimes (n = 88, 9%) used an UGPIV kit.

For the transducer/probe protection question, respondents used a transparent dressing positioned over the face of the transducer/probe in 31% (n = 318). In a surprisingly large proportion of respondents, more than half of the vascular access clinicians surveyed (n = 172, 54%), nearly 1 in 5 of the ED personnel (n = 60), and 27% (n = 86) of respondents in other positions reported always using transparent dressing for the transducer/probe protection. One-quarter of respondents (n = 222, 22%) sometimes or always used an UGPIV-specific dressing that separates the transducer/probe and gel from skin contact.

Additional questions for transducer/probe protection measured importance and the use of sterile covers. When asked about the importance of using an ultrasound transducer/probe cover during the procedure, 11% (n = 111) stated it was not important, while 69% (n = 726) said it was very important. Over one-third of all respondents (n = 380, 37%) and over half of all vascular access personnel (n = 224, 59%) always use a sterile transducer/probe cover. The remainder of responses were approximately equally divided between *sometimes use* (n = 254, 24%) and *never use* (n = 405, 29%). In the group of respondents stating *sterile probe cover not used* (n = 406), slightly over half were vascular access personnel (n = 212, 59%), and approximately one-quarter for ED (n = 88, 22%) and other personnel (n = 105, 26%). In comparison of transparent dressing usage versus sterile probe cover, respondents were almost equally divided between *always used transparent dressings* (n = 319, 31%) and *always used sterile probe covers* (n = 380, 37%), with the remaining percentages split between *sometimes* and *never* in both categories.

In the category of skin disinfection, a supermajority of respondents always used chlorhexidine with alcohol (CHG + ETOH; n = 935, 89%) to clean the skin before procedure. Two percent (n = 26) of respondents sometimes use CHG + ETOH, while 8% (n = 85) indicated they did not use it. Twenty-two percent of participants (n = 215) sometimes use alcohol wipes, and 6% (n = 59) indicated they always use only alcohol wipes. It is interesting to note that *always* was selected for using an alcohol wipe only in 36% (n = 21) of vascular access positions, 34% (n = 14) in ED positions, and 41% (n = 24) of other. Nearly three-quarters of respondents (n = 723, 73%) do not use alcohol wipes alone, indicating they use a combined approach.

In consideration of overall supply usage, the row percentages, frequencies, and *P* values related to supply use are reported in Table 1. Meaningful statistical differences existed within most of the questions in terms of supply use. The only 2 questions for which differences were not clinically meaningful were whether an IV start kit was used ($P = 0.8334$) and whether individual supplies were used versus a kit ($P = 0.2897$). Use of an IV start kit or of individual supplies versus kits did not vary by the setting in which respondents practiced or their roles (Table 1). For almost all categories of supply use, those in vascular access positions always used supplies more than *sometimes*, reflecting a level of consistency in the choice of *always* or *never*, and these supply use choices never showed a monotonic decreasing pattern. The exceptions to this pattern were that 19% (n = 5) in a vascular access role did not use CHG + ETOH, 46% (n = 12) of those in ED positions *did not use*, and other positions 35% (n = 9) *did not use*. The only other exception was always using an alcohol wipe only 36% (n = 21) for vascular access, 24% (n = 14) for ED position, and 41% (n = 24) other position. In general, respondents who work in an ED used fewer supplies than the other personnel. Supplies were used most by those in vascular access positions, followed by those who chose *other* as their position. However, almost half (n = 12, 46%) those in ED positions indicated that they do not use CHG + ETOH (Table 1).

Supply Use: Gloves and Gels

The category reporting glove usage showed nearly 60% of respondents (n = 590, 58%) always use unsterile clean gloves for IV placement. The remainder were about equally divided on *sometimes using* or *never using* unsterile gloves (n = 201, 20% and n = 220, 22%, respectively). Almost half (n = 472, 45%) stated they did not use sterile gloves for IV placement. A slightly larger percentage of 30% (n = 312) versus 24% (n = 254) always used sterile gloves as compared with those who used sterile gloves only sometimes. Row percentages, frequencies, and *P* values of unsterile clean glove use and sterile glove use are reported in Table 2. As with supply use, respondents in vascular access positions were most likely to use sterile gloves (Table 2). Statistically significant, clinically meaningful differences existed in all variables ($P < 0.0001$). Generally, those in ED positions were less frequent users of sterile gloves.

For gel usage, the choices of *multi-use*, *nonsterile gel packet*, and *sterile gel packet* were reported by survey respondents. A little over half of the respondents (n = 553, 54%) did not use a multi-use gel, while the remaining respondents were almost equally split between *always* (n = 237, 23%) and *sometimes* using (n = 225, 22%) the multi-use gel. About two-thirds of respondents (n = 660, 66%) reported never using a nonsterile gel packet. About one-quarter of respondents (24%, n = 241, 24%) said they use a nonsterile gel packet sometimes, whereas only about 10% (n = 97) stated they always do so. Over half (n = 580, 56%) of respondents indicated they always use a sterile gel packet. About the same percentage stated they sometimes

Table 1. **Row Percentages (Frequencies) and *P* Values for Fisher's Exact Test for Nonrandom Association Between Respondent Position Versus Supply Use**

Question: How often do you use the following supplies with UGPIV insertions?	Positions			Totals	*P* value
	Vascular access	Emergency department	Other		
IV start kit					
Always used	56 (371)	19 (125)	26 (171)	65 (668)	0.8334
Sometimes used	56 (99)	16 (28)	28 (49)	17 (176)	
Not used	57 (108)	16 (30)	27 (52)	18 (190)	
Kit designated for UGPIV					
Always used	53 (77)	11 (16)	36 (52)	14 (145)	0.0086
Sometimes used	48 (42)	22 (19)	31 (27)	9 (88)	
Not used	57 (443)	19 (148)	24 (188)	77 (780)	
Separate individual supplies, not a kit					
Always used	59 (250)	17 (71)	24 (101)	41 (422)	0.2897
Sometimes used	55 (192)	17 (58)	29 (101)	34 (351)	
Not used	53 (134)	21 (53)	27 (68)	25 (256)	
Transparent dressing positioned over probe					
Always used	53 (170)	19 (61)	27 (87)	31 (319)	0.0019
Sometimes used	48 (101)	26 (54)	26 (55)	21 (210)	
Not used	61 (303)	14 (69)	25 (123)	48 (495)	
Sterile probe cover					
Always used	59 (224)	11 (43)	30 (113)	37 (380)	0.0004
Sometimes used	57 (144)	21 (54)	22 (56)	24 (254)	
Not used	52 (212)	22 (88)	26 (105)	39 (406)	
Other UGPIV-specific dressing for probe					
Always used	49 (46)	17 (16)	33 (31)	9 (93)	0.0485
Sometimes used	47 (61)	25 (32)	28 (36)	13 (129)	
Not used	58 (459)	17 (134)	25 (194)	78 (788)	
Chlorhexidine with alcohol					
Always used	59 (551)	16 (146)	25 (238)	89 (936)	<0.0001
Sometimes used	38 (32)	29 (25)	33 (28)	8 (85)	
Not used	19 (5)	46 (12)	35 (9)	2 (26)	
Alcohol wipe(s) only					
Always used	36 (21)	24 (14)	41 (24)	6 (59)	0.0229
Sometimes used	54 (117)	19 (40)	27 (58)	22 (215)	
Not used	58 (416)	17 (126)	25 (181)	73 (724)	

UGPIV = ultrasound-guided peripheral intravenous; IV = intravenous.

Table 2. **Row Percentages (Frequencies) and *P* Values for Fisher's Exact Test for Nonrandom Association Between Respondent Position Versus Multi-Use Gel Bottle Use, Aseptic and Sterile Glove Use, and Aseptic and Sterile Gel Use**

Question: How often do you use the following supplies with UGPIV insertions?	Positions			Totals	*P* value
	Vascular access	Emergency department	Other		
Unsterile glove usage					
Always used	55 (322)	23 (135)	23 (133)	58 (591)	<0.0001
Sometimes used	54 (109)	17 (34)	29 (58)	20 (201)	
Not used	60 (131)	6 (14)	34 (75)	22 (220)	
Sterile glove usage					
Always used	59 (183)	9 (27)	33 (102)	30 (312)	<0.0001
Sometimes used	57 (146)	19 (48)	24 (60)	24 (254)	
Not used	53 (251)	23 (109)	24 (112)	46 (473)	
Gel bottle multi-use					
Always used	51 (121)	21 (50)	28 (66)	23 (237)	0.0006
Sometimes used	46 (104)	24 (54)	30 (67)	22 (225)	
Not used	61 (338)	14 (79)	25 (136)	55 (554)	
Nonsterile gel packet usage					
Always used	48 (47)	25 (24)	27 (26)	10 (97)	<0.0001
Sometimes used	44 (107)	24 (59)	31 (75)	24 (241)	
Not used	60 (399)	15 (99)	25 (162)	66 (661)	
Sterile gel packet usage					
Always used	64 (371)	13 (75)	23 (134)	56 (581)	<0.0001
Sometimes used	49 (116)	21 (50)	30 (70)	23 (236)	
Not used	45 (100)	26 (57)	29 (64)	21 (221)	
Aseptic technique compromised during clean					
Yes	52 (61)	25 (29)	23 (27)	12 (118)	0.0010
Unsure/possibly	53 (258)	21 (101)	26 (128)	51 (487)	
No	63 (217)	11 (39)	25 (87)	36 (343)	
Has inadequate gel removal resulted in dressing failure?					
Yes	52 (222)	20 (86)	28 (117)	45 (425)	0.0210
Unsure/possibly	58 (141)	20 (48)	22 (54)	26 (244)	
No	62 (173)	13 (35)	25 (70)	29 (278)	
How many times has inadequate gel removal resulted in dressing or securement failure?					
1 out of 10 (10%)	59 (369)	16 (101)	25 (155)	70 (625)	0.0430
2 out of 10 (10%)	50 (74)	23 (35)	27 (40)	17 (150)	
3 out of 10 (10%)	36 (22)	30 (18)	34 (21)	7 (61)	
4 out of 10 (10%)	56 (9)	25 (4)	19 (3)	2 (16)	
5 out of 10 (10%)	46 (6)	15 (2)	38 (5)	2 (13)	
≥6 out of 10 (60% or greater)	63 (17)	15 (4)	22 (6)	3 (27)	

UGPIV = ultrasound-guided peripheral intravenous.

use (n = 236, 23%) or did not use (n = 221, 21%) a sterile gel packet. Row percentages, frequencies, and *P* values of nonsterile gel use and sterile gel use are reported in Table 2. As with supply use, respondents in vascular access positions were most likely to use nonsterile and sterile gel (Table 2). Statistically significant, clinically meaningful differences existed in all variables ($P < 0.0001$). Generally, those in ED positions were less frequent users of sterile gel, with an almost even distribution across all categories of multi-use, nonsterile gel packet, and sterile gel packets. Variation for the UGPIV procedure gel usage was most significant in the responses of *sometimes* and with responses showing even distribution throughout the answer categories.

The ability to maintain aseptic technique was an area of focus for the survey. Responses were collected on whether aseptic technique was ever compromised with gel clean-up after the procedure. A meaningful statistical difference existed in the responses, demonstrating compromise of aseptic technique during gel clean-up ($P = 0.0010$). Over half the vascular access specialists (n = 61, 52%) indicated it was compromised. However, substantially smaller percentages of ED personnel and other staff (n = 29, 25% versus n = 27, 23%, respectively) indicated the aseptic technique was not compromised during clean-up. Eleven percent (n = 61) of vascular access personnel said the aseptic technique was compromised, while 40% (n = 217) stated the aseptic technique was not compromised, and a surprising almost half (n = 258, 48%) reported they were unsure if aseptic technique was maintained. Seventeen percent of ED personnel (n = 29) responded that aseptic technique was compromised, while 23% (n = 39) stated aseptic technique was not compromised during clean-up. Eleven percent (n = 27) of other personnel indicated aseptic technique was compromised, and a little over one-third of other personnel (n = 87, 36%) indicated aseptic technique was not compromised.

In measuring responses for time during postprocedure UGPIV clean-up, 45% (n = 241) of vascular access personnel took less than 30 seconds to clean gel from the area after cannulation compared to 28% (n = 47) of ED personnel and 33% (n = 81) of other personnel. Forty percent (n = 214) of vascular access personnel took 30 seconds to 1 minute to clean gel from the area after cannulation compared to a little over half (n = 93, 56%) the ED personnel and 44% (n = 106) of others. Most of the balance of personnel took 1 to 2 minutes (13% vascular access, 12% ED personnel, and 19% other staff).

After clean-up of the gel from the procedure, some residual gel may remain on the skin and interfere with the adhesion of the dressing (Supplemental Figures S2 and S3, available online). A large margin of vascular access personnel (n = 222, 41%) reported inadequate gel removal, resulting in transparent dressing adhesion failure. A lower percentage of vascular access personnel reported inadequate gel removal compared to ED personnel and other staff (41% versus 51% versus 49%, respectively), while a higher percentage reported that inadequate gel removal did not result in adhesion (32% versus 21% versus 29%, respectively). Nearly equal numbers across the groups reported that inadequate gel removal caused dressing failure: 26% (n = 141), 28% (n = 48), and 22% (n = 54), respectively.

In consideration of the potential breaks in aseptic technique during clean-up and difficulties with residual gel on the skin, a question regarding use of specialty gel-free insertion dressings was added to the survey. Respondents were surveyed regarding their usage of specialty UGPIV gel-free dressings (Supplemental Figure S4, available online). Among all the respondents, a smaller margin of respondents (n = 82, 9%) indicated that they used a gel-free type of UGPIV dressing to separate the transducer/probe and gel from skin contact at the insertion site. Of this group, 54% (n = 44) were in a vascular access role, 29% (n = 16) ED, and 27% (n = 22) others.

Best Practices

Measurement of best practices with UGPIV supply selection and usage was established based on guidelines and consistency with supply selection. Descriptive results for the researcher-created best practice metric can be found in Table 3.

The best practice metric was judged as inconsistently distributed. Because the composite score was judged not to be normally distributed, it was rank transformed and used as the dependent variable in a 1-way analysis of variance. In other words, instead of the analysis being done on the mean values, it was done on the mean ranks. The omnibus F test demonstrated a meaningful difference between positions ($F_{2,1471} = 13.99$, $P < 0.0001$). Important differences were demonstrated between personnel in vascular access positions and in other positions ($P < 0.0001$) and personnel in ED positions and other positions ($P < 0.0001$). Overall, the individual survey questions and researcher-formulated composite scale can be interpreted to mean substantial and meaningful inconsistency in the supplies and procedures used by vascular access specialists, ED personnel, and others. These inconsistencies reflect much variation in the procedural supply usage practice with UGPIV insertions.

Discussion

Application of ultrasound has expanded beyond the doors of radiology and sonography into intensive care, EDs, and vascular access specialty teams to provide guidance for placement of PIVs. Over the past 2 decades, ultrasound application of vein visualization during catheter insertion has grown from peripherally inserted central catheters, midlines, chest-inserted central catheters, and femoral catheters to common use to facilitate

Table 3. Descriptive Statistics for Composite Score of 13 Peripheral Intravenous Insertion Use Survey Questions by Health Care Provider Role

Position	n	Mean ± SD	Median (IQR)
Vascular access	520	14 ± 3.9	14 (5)
Emergency department	171	13 ± 4.0	13 (5)
Other[a]	245	14 ± 4.6	14 (6)

IQR = interquartile range; SD = standard deviation.
[a] Other includes various departments and care settings of intensive care, rapid response team, telemetry, trauma, surgery, education, administration, home care, home infusion, and outpatient services.

PIVs for patients with difficult access. These data and survey results (Supplemental File, available online) represent the first known collection of clinical feedback on supplies used with the UGPIV procedure and differences associated with clinician usage in various departments and care settings.

Supplies commonly used with the PIV insertion procedure include IV start kits, transducer/probe protection dressings or covers, gel used for ultrasound visualization at the insertion site, skin antiseptic agents, and gloves. Insertion of PIV catheters has long been considered an aseptic procedure using sterile supplies and nonsterile gloves, as described in the work of Rowley and Clare with the Aseptic Non-Touch Technique (ANTT®), within standard ANTT practice.[10] Application of a sterile transducer/probe protection cover, sterile gloves, and sterile gel add a higher level of patient safety to a PIV procedure, which is inherently aseptic due to contact with the skin.

Guidelines recommend use of kits for central catheter placement as a method to promote infection prevention.[11,12] The Infusion Nurses Society (INS) infusion policies and procedures recommend an IV start kit as preferred for short peripheral catheter placement that may include ultrasound.[13] Most respondents in the survey (82%, n = 844) stated they used some type of IV start kit or designated UGPIV kit for the UGPIV procedure. Kits have been recommended as part of central line bundles to improve compliance with infection prevention and could be considered best practice for UGPIV insertions.[11] The clinicians whose survey responses indicated use of a designated UGPIV kit (23%, n = 233) were more likely to have sterile supplies for use, such as sterile gloves, sterile transducer/probe cover, and sterile gel.[14,15] While PIVs are considered a lower infection risk than central catheters, the risk of bacterial contamination with insertion of UGPIV remains a concern.[16–19]

According to the Association for Vascular Access (AVA) guidance document for transducer disinfection with peripheral and central catheters, a sterile transducer/probe cover should be used during any vascular access procedure including UGPIV.[20] The INS standards recommend use of a large, sterile, transparent membrane dressing over the transducer/probe or sterile sheath cover.[12] In this survey, almost one-third of all respondents reported no use of ultrasound transducer/probe cover or transparent dressing covers during the UGPIV procedure. The remaining two-thirds always or sometimes used transducer/probe protection. When asked how often they use transducer/probe protection, 22% (n = 232) said they did not use the protection. When asked about the importance of ultrasound transducer/probe cover protection for the UGPIV procedure, 11% (n = 111) said it was not important. Studies have shown bacterial contamination rates of up to 23% with transducer/probes.[21–23] Use of transducer/probe covers reduces risk of bacterial transmission, but covers or dressings do not guarantee protection. Needle penetration and cover failure have occurred.[24,25] The Canadian organization Community and Hospital Infection Control Association emphasizes, in their medical gel position paper, the need to use transducer/probe protection, to avoid multi-use gel bottles, and to use single gel packets to reduce risk and subsequent infection.[26] Clearly, the survey results demonstrate that the use of supplies for transducer/probe protection reflects some inconsistency within all departments surveyed.

The use of transparent dressings for transducer/probe protection is controversial and discouraged in publications related to the sticky residue left on the ultrasound transducer/probe that may ultimately result in damage to this sensitive surface.[6] Variation is present in size of transparent dressings used for transducer/probe protection, and application methods may not maintain asepsis. In this survey, almost one-third of respondents reported they always used transparent dressings for transducer/probe protection, with half reporting always or sometimes using this method of protection. Over 50% of vascular access personnel always used, and the combined always and sometimes represented the majority of users for transparent dressings as transducer/probe protection. Concerns over methods of application, maintenance of asepsis, and the impact of adhesives within the transparent dressing or any adhesive that contacts the ultrasound transducer/probe surface contribute to the need for further investigation in this area.

Maximum sterile barriers are not required for UGPIV insertions, although sterile gloves are suggested for use in the INS standards and the AVA guidance document.[12,20] Concerns over PIV bacterial infections are evident in the literature, causing many clinicians and hospitals to adopt use of sterile gloves and components. In this survey, one-third of respondents said they always used sterile gloves, one-quarter sometimes, and slightly less than half stated they used nonsterile gloves. It is those clinicians in the sometimes category who were uncertain with their supply usage with sterile gloves, sterile gel, or sterile transducer/probe protection.

In consideration for aseptic PIV insertion procedures as the standard of care, the survey reflected compromise in the clean-up time with UGPIV insertions and breaks in aseptic technique with 63% (n = 605) stating definitively *yes*, or they were *unsure/possibly* that breaks in asepsis occurred (Table 2). Only 36% (n = 343) confirmed that aseptic technique was maintained through the procedure including clean-up. The need for emphasis on aseptic practice was identified in 1 study where a protected clinical bundle resulted in a 37% reduction in primary bacteremia including PIVs and 19% reduction in PIV bacteremias alone.[27] In this initiative, clinicians incorporated alcoholic chlorhexidine for skin antisepsis, sterile gloves, surveillance, and other education to reduce the rate of infection and improve dwell time of PIVs.

Longer catheter dwell time is associated with increased risk of infection. Previously, guidelines from the Centers for Disease Control and Prevention recommended scheduled replacement of PIV catheters every 72 to 96 hours. Current evidence supports a clinically indicated replacement strategy, where catheters are replaced with complication identification or upon treatment completion.[28,29] Ultrasound-guided PIV insertions for patients with difficult access indicate a need to preserve available veins, thus allowing the PIV to dwell until removal is indicated based on clinical need or completion of therapy. These longer dwell times place greater emphasis on the need for monitoring and application of guidelines for supply usage leading to standardization of transducer/probe protection with

sterile gel to minimize the potential for contamination during the insertion procedure.[27]

Risk of infection with UGPIV is also affected by the type of gel used at the insertion site. Gel-needle contamination from skin, hands, or within the gel container is reflected in the literature.[22,30] Guidelines recommend use of sterile gel for procedures that involve nonintact skin and needle punctures into the bloodstream.[31] Some transducer/probe covers and gel-separating dressings may mitigate this contamination risk by removing the gel and transducer/probe from the insertion and needle puncture site. In that case, the transducer/probe and gel do not touch areas of nonintact skin or where skin is penetrated as in the insertion area; the contact could then be classified as noncritical. Gel-free insertion practices have been described in the literature and may increase procedural safety and aseptic technique, while reducing costs.[32,33]

Inadequate gel removal from skin after the UGPIV insertion procedure may affect the ability of transparent dressings to adhere to skin and promote accidental dislodgment. For 52% of vascular access specialists (n = 222) and 20% of ED clinicians (n = 86), inadequate gel removal caused securement and dressing adherence issues. Failure of dressings or securement can lead to catheter failure and accidental dislodgment.[34,35] Of note, 528 respondents failed to answer this category of questions, and a total of 26% (n = 244) were unsure if there was any effect of dressing adherence with residual gel. The lack of total responses is suggestive of a level of uncertainty with the gel removal and dressing adherence, likely related to the clinician role with insertion and not with patient bedside management.

Concerns over transducer/probe protective cover failure and needle penetration increase the need to consider the type of gel and covers used with UGPIV procedures.[36] Current recommendations include use of sterile gel for all UGPIV procedures.[12,20,26,37] Despite these recommendations, the survey shows variable gel use with multi-use gel bottles, single-use, and sterile gel with responses equally divided for each type of gel. More than 22% of survey respondents stated they sometimes used each of the gel categories for multi-use, single, and sterile gel packet. Vascular access specialists had the highest percentage of sterile gel use in comparison with those in EDs and others. In contrast, many vascular access respondents (n = 121, 52%) reported always using multi-use nonsterile gel. The reason for the high percentages in both multi-use gel and sterile gel categories is unclear and may be ascribed to use with pre-assessment vein selection versus the insertion procedure, indicating a possible limitation of the study and question structure. A survey of ultrasound practices in Europe reported similar low percentages of clinicians consistently using sterile gel or ultrasound transducer/probe covers.[36] These reported variables sow doubt, indicate a need for more investigation, and reflect much room for improvement within these UGPIV practices.

When considering antiseptic agents for skin prior to needle penetration, common substances are alcohol, alcoholic CHG, betadine, tincture of iodine, and povidone iodine. Research supports use of CHG + ETOH as the most effective agent for reducing microorganisms on the skin prior to insertion of an IV device.[38,39] In this survey, use of CHG + ETOH for skin antisepsis was reported as *always* by 59% of clinicians functioning as vascular access specialists and 16% of those who work in the ED. One-third of the vascular specialists reported usage of alcohol alone, and 46% of the ED personnel reported not using CHG + ETOH. Variation was present in the *sometimes* and *not used* responses. Skin antisepsis was reported with the least differentiation and highest certainty in practice, with 89% (n = 936) of all clinician respondents using CHG + ETOH before UGPIV insertions.

The clinical aim with vascular access initiation may vary by department in terms of urgency and speed of device insertion, insertion of the optimal size catheter, and concern for longer catheter dwell time. In this survey, the category of other for department or care setting included responses of intensive care, rapid response team, telemetry, trauma, surgery, education, administration, home care, home infusion, and outpatient services (Table 3). Each of these departmental variations may affect the consistency and type of supplies used in an UGPIV insertion, further punctuating the need for a level of standardization between departments and care settings. Meaningful differences were demonstrated regarding the lack of standardization for UGPIV practice and supply usage among all respondents and between the positions of vascular access specialists and ED clinicians. The supply usage variation was apparent in the ED group, as reflected in responses of use of items *sometimes*. One-quarter of all respondents stated sometimes in all categories, demonstrating clear uncertainty, variation in types and availability of UGPIV supplies used, while indicating a level of inconsistency within their UGPIV practice.

The survey confirms that UGPIV procedures are performed frequently with a high number, 49% (n = 478) of respondents reporting 5–20 procedures per day. These results and the apparent popularity of UGPIV insertion procedures in the literature underscore the need to establish consistent practices and reinforce policies with all clinicians who perform the procedures.[3,4,6,7,15] Increasing use of ultrasound for visualization of veins and real-time needle guidance has increased the cost of PIV insertions with the expense of equipment, clinician training, and supplies used for each procedure. Costs of supplies, including transducer/probe covers or dressings, sterile ultrasound transmission gel, and disinfection of equipment, may exceed the low rate of reimbursement. The increased cost may affect use, availability, and selection of certain supplies such as transducer/probe covers and sterile gel. As has been discussed, guidelines including UGPIV insertions underscore the need for consistent transducer/probe protection, sterile supplies for catheter insertion, gloves, skin antisepsis, and sterile gel for procedures involving nonintact skin.

Limitations

In this investigation, limitations are represented in the content derived from perceptions, observations, and self-reporting of clinicians performing the procedure. Self-reporting and estimations of patient outcomes are anecdotal, validated only within the strength of numbers and consistency of respondents. The analysis attempted to apply homogeneity within the comparative groups

of vascular access and ED specialties. The survey was primarily focused on clinicians within nursing associations and social media groups, underrepresenting physicians and others who may also be performing UGPIV insertions. Despite the limitations of self-reported data, this is the first known assessment of supply usage with ultrasound-guided peripheral catheter insertions for clinicians across multiple departments and care settings.

Another limitation is within the best practice measure. It is researcher constructed, without substantial evidence of psychometric validity or reliability. However, in the absence of such a measure, having an estimator to quantify the data was optimal. In addition, although statistically meaningful differences exist in mean and median composite values of the best practice measure, the differences may not be of practical importance. This is, no doubt, due to the overpowering of the investigation. There is a one-to-one relationship between sample size and statistical power; the greater the sample size, the greater the statistical power. Although the literature warns against calculating power retrospectively, there is a precedent.[40] Assuming the minimal and equal sample size of 171 and an a priori α level of 0.05, we calculate a 98% power to detect a small effect size ($f = 0.2$), suggesting the study is overpowered.

Conclusion

Current practices with supplies used with UGPIV insertions vary within different departments and care settings. Patient safety concerns, along with the need for heightened attention to the aseptic technique used during UGPIV insertion procedures, make the results of this survey pertinent. The data demonstrate a wide variety of practices, reflecting the need for policy consistency and identification of better methods to effectively apply guidelines for UGPIV insertions. These results and identified variabilities suggest the need for investigation of guideline application and evaluation of compliance within policies for all departments and care settings to promote standardization of safety practices with UGPIV insertions.

Disclosures

Nancy Moureau is the owner and working Chief Executive Officer for PICC Excellence, Inc. She performs research, is a consultant, and serves on the speaker's bureau in conjunction with 3M, Access Scientific, BBraun, Chiesi, Echonous, Linear Medical, Nexus Medical, Parker Laboratories, and Teleflex.

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N.M. conceived of, designed, and served as the principal investigator of the study. N.M. and G.E.G. jointly formulated the research question, specific aims, and hypotheses. N.M. drafted the Introduction and Discussion sections. G.E.G. drafted the Methods and Results sections. N.M. and G.E.G. provided critical revisions. Both authors contributed to subsequent revisions of the manuscript. N.M. formatted the final manuscript and serves as corresponding author. N.M. and G.E.G. approved the final manuscript.

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