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The experience of patients at high risk of difficult peripheral intravenous cannulation: An Australian prospective observational study

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ABSTRACT

Introduction: Peripheral intravenous cannulation (PIVC) insertion is challenging for some patients, leading to delays in care and workflow. A few easy-to-identify risk factors can differentiate difficult to cannulate (DIVA) patients.
Methods: A prospective observational study of adults undergoing PIVC was undertaken. Nursing and medical staff inserted PIVC using their usual practices. Patient, PIVC characteristics, number of attempts and staff characteristics were captured. Indicators of high-risk-for-DIVA were: no vein seen, and/or no vein palpable, and/or a history of difficult PIVC. The experience and outcomes for high-risk-for-DIVA patients were compared to non-DIVA.
Results: 1084 adults with PIVCs inserted were observed; with (378 (34.9%)) qualifying as high-risk-for-DIVA. First attempt success was achieved for 831 (76.7%) patients overall, with high-risk-for-DIVA significantly less likely to require one attempt (61.1% vs 85.0%, $p < 0.001$). High-risk-for-DIVA were more likely to have: PIVC aborted, multiple attemptors, ultrasound -guidance, smaller gauge PIVC, and wrist or hand placement.
Conclusion: Simple predictors for difficult PIVC are known, and were present in about one-third of adults in this cohort. Earlier identification and escalation of these patients to more experienced cannulators, those experienced with US, and/or placement in the wrist/hand with a small gauge PIVC, may assist in avoiding unnecessary cannulation attempts and delays.
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Introduction

Peripheral intravenous catheters (PIVC) are the most frequent intravascular (IV) device used in the emergency department (ED), aiding blood sample collection, contrast administration for imaging, and IV treatments. The key contemporary concepts in PIVC research include three broad themes: (i) the appropriateness of placing a PIVC in the first place, (ii) how to minimise PIVC-related complications once it is placed, and (iii) how best to insert the PIVC if needed.

In regards to the first focus, literature suggests up to 26% of patients receive a PIVC in the ED, increasing to 80% for those admitted to hospital, but only half of these PIVCs placed are actually used [1]. A notable large, ED-based study published in 2018 by Hawkins et al., showed that a simple educational intervention to prompt clinical staff to be 80% sure prior to placement that the PIVC will be used, significantly reduced unnecessary PIVC [2].

Concerning the second focus, 1 in 3 peripheral catheters develop a complication causing it to fail [3]. The most frequent complication is occlusion, however infection is a major concern, with reported bloodstream infection incidence of 0.05%, or 0.14

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per 1000 PIVC-days [3,4]. Whether or not to leave a PIVC in situ for a limited time period (e.g. three days) has been a source of debate, with recent studies by the AVATAR group and others suggesting no change to infection risk if removal decisions are based on clinical judgement rather than policies to routinely remove them after a time-period [5].

As for the third focus, ED nurses and doctors are frequently the first to place a PIVC: the onus of successful and minimally painful insertion falls on us. While generally a simple procedure, inserting PIVCs can be difficult in certain patient groups. First attempt success rates, (i.e. one skin puncture leading to successful PIVC placement), range from 74% to 88% in adult populations, leaving approximately 12%–26% of patients as 'difficult to PIVC' [1,6,7]. Characteristics and predictors of difficult IV access have been well studied in the past, with commonly identified patient predictors including extremes of age, underweight BMI < 18.5, overweight BMI > 30, previous history of failed attempts, dehydration, diabetes, dialysis patients, upper limb swelling or scarring (i.e. burns), intravenous drug use (IVDU), cancer and recent chemotherapy, sickle cell disease, patient anxiety, recent hospitalisation or ED visit within 90 days [1,8–15]. Success rates also vary based on staff performing PIVC, with nursing or medical students requiring more attempts than emergency nurses, residents or senior doctors [13,16].

Across multiple studies, the most reliable predictors of difficulty appear to be non-visible vein or palpable, and a history of difficult IV access [11,12,15,17]. These studies vary in how they define 'difficult' intravenous access (DIVA, i.e. >1 attempt, >2 attempts, or if ultrasound was used), with 3 or more attempts the most common used. A recent systematic review and meta-analysis identified statistically significant risk ratios approaching 5.0 times greater risk for each of these three predictors [15]. From a patient perspective, it is likely that being classified as a "high risk for DIVA" patient before attempts occur is preferable to being classified as such after three or more attempts at PIVC insertion.

Difficulty placing PIVCs results in diagnostic delays due to delayed pathology results, and delayed contrast dye for computed tomography (CT) scans, as well as delays in management (e.g. intravenous fluids, intravenous antibiotics, and analgesia), which can affect patient outcome, departmental patient flow, hospital length of stay, and overall cost [6,18,19]. In addition, multiple IV attempts can increase patient's anxiety, increase overall procedural pain, reduce patient satisfaction, and increase risk of infection [6,9]. Therefore, reducing the number of unsuccessful PIVC attempts and time to PIVC insertion is important to improve patient and staff experience, patient outcomes, ED patient flow and overall cost to the department [8].

Ultrasound is arguably the leading adjunct to assist with PIVC insertion in difficult patients, with first time success rates of 53%–73% [1,20,21]. Ultrasound improves identification of suitable veins in patients with difficult IV access, and reduces the requirement for central venous lines, which are more time-consuming and carry a higher risk of complications [6,9,22,23]. Many studies also demonstrate improvements in overall success, number of attempts, procedure duration and patient satisfaction when using ultrasound compared to standard technique [1,9,24]. However, other studies suggest that ultrasound increases success rates, but has no improvement on time to PIVC insertion, number of attempts, or patient satisfaction [6,7,18,25,26]. These studies include small numbers of participants, and vary on experience/training of operators, recording of procedure time, and how 'difficult' IV access is defined, likely accounting for the variation of results.

Objective

The purpose of this study was to describe the PIVC insertion experience of adults who, on ED presentation, would be classified as high risk for DIVA using three simple criteria (no vein seen, no vein palpable, or a history of DIVA), compared to adults with none of these criteria.

Methods

Study design and setting

This was a prospective observational study conducted at Gold Coast University Hospital (GCUH), located in Southeast Queensland, Australia. GCUH is a large, public teaching hospital with 473 beds and approximately 110,000 ED presentations per year. Data collection occurred over two periods of time (February–March 2017 and January–February 2018). A training program occurred between the two observation periods. The two observation periods were combined for this study. Funding was received from the Emergency Medicine Foundation (grant EMTR-201R26-2016).

Study methodology

A dedicated research nurse completed a series of 67 × 4-h observation periods in the ED, including weekdays, weekends, after hours and night shifts. Patients were eligible to participate if they were: assigned to Australasian Triage Score 2, 3, 4, or 5, ≥18 years of age, not transferred from another hospital, did not already have a PIVC or central line (PICC) placed pre-hospital, and either had a PIVC placed during their ED stay, or were likely to receive one (Fig. 1). Research staff approached current patients, as well as those arriving during their observation time. They obtained a patient sticker and followed the patient through until PIVC insertion. Written informed consent was obtained. An exception to this occurred for patients who lacked capacity to consent, i.e. too unwell, intubated, drug or alcohol affected, cognitive decline, etc. A waiver of consent was applied in these cases given there was no change to their medical care, and therefore no risk of harm as a result of this observation.

The research nurse completed a data collection tool (Appendix A), collecting data on known predictors of difficulty. High risk of difficult PIVC insertion was defined as no vein seen or palpable and/or a history of difficult IV access as reported by the patient, because these are the most consistent risk factors identified for DIVA patients in the literature. The research nurse aimed to directly observe PIVC insertion, but where this was not possible, they relied on information provided by the patient and/or clinician.

To understand PIVC insertion practices in our department, we collected data on PIVC insertion success whilst patient was in the ED, number of attempts required for success, site and size of PIVC inserted, and staff level inserting on the first and last attempts. The electronic medical record was accessed retrospectively, for this admission only, to supplement prospective data regarding whether the patient's IVC was used during the following 24 h, and for what purpose(s). Unnecessarily inserted PIVCs were defined as a PIVC that was not used at all, or only used for blood tests, within 24 h.

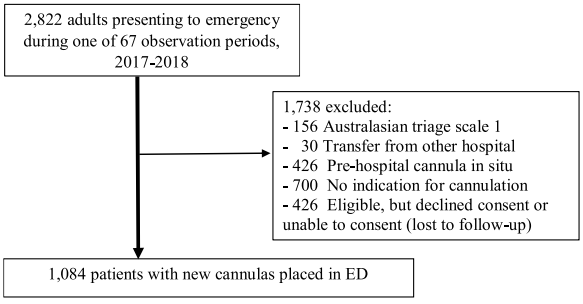

Fig. 1. Sample included in this study.

Table 1
Characteristics of 1084 adults with cannulas inserted in the emergency department.

	n	%
Shift		
Day (7–3)	489	45.1
Evening	438	40.4
Night (9–6)	157	14.5
Sex		
F	583	53.8
M	501	46.2
Age group (years)		
18–29	176	16.2
30–59	432	39.9
60–69	157	14.5
70–79	184	17.0
80+	135	12.5
Discharge status at 24 h		
Home	420	38.8
Ward/ Short Stay	663	61.2
Australasian triage scale		
2	386	35.6
3	619	57.1
4–5	79	7.3
Arrival by ambulance		
Yes	374	34.5
No	710	65.5
Characteristics relevant to cannulation success		
Presentation last 90 days	463	42.7
History of difficult IV access	366	33.8
Overweight	362	33.4
No vein seen	335	30.9
Diabetic	149	13.7
History of chemotherapy	84	7.7
History of chronic kidney disease	78	7.2
Underweight	55	5.1
No vein palpable	50	4.6
History of frequent IV injections	25	2.3
Dialysis patient	17	1.6
Upper limb swelling	13	1.2
Upper limb scarring	0	0.0
Any of: no vein palpable, no vein seen, history of difficult IV access	*378*	*34.9*
None of: no vein palpable, no vein seen, history of difficult IV access	*706*	*65.1*

Data analysis

Data analysis was done in SPSS v26.0. Simple proportions were calculated for categorical variables; means and medians were presented for ordinal variables. Chi-square tests compared the PIVC insertion experience between two groups of patients: high risk for DIVA, and otherwise. Odds ratios (OR) and 95% confidence intervals (CI) were produced to show the odds for each outcome (e.g. PIVC aborted, more than one attempt), for high risk vs the comparison group. Where observations in any category were <5, the Fisher's exact test was used. A p-value of <0.05 was considered statistically significant.

Ethics approval to undertake this study was obtained from the local Health Service Human Research Ethics Committee (HREC/17/QGC/189).

Results

Of the 2829 adult presentations occurring in the combined study periods, 1084 (67.1%) were eligible for inclusion, and were prospectively observed (Fig. 1). They had a mean age of 54.1 years (standard deviation 20.9): other demographic characteristics are presented in Table 1. About a third of patients (378, 34.9%) receiving a PIVC in the ED had one of the three risk-factors classifying them as high risk for DIVA according to this study (Table 1).

This high-risk group experienced a statistically significant greater number of attempts, smaller PIVC gauge used at first attempt, greater number of different cannulators, and more senior staff attempting PIVC insertion both at the beginning and on the successful PIVC insertion (Table 2). In addition, ultrasound use was more commonly observed in the high-risk group (8.2% vs 0.6% ($p < 0.001$)). Patients classified as high risk for DIVA had a 5.5-fold increased likelihood of requiring 3 attempts prior to successful cannulation, and nearly 11-fold increased likelihood of requiring 4 or more attempts prior to successful cannulation (OR (95% CI): 5.5 (3.1–9.6) and 10.7 (4.9–23.5), respectively).

Failure to achieve PIVC insertion was rare in our ED, with only seven PIVCs abandoned (0.6% (95% CI: 0.3–1.3). Of the seven unsuccessful insertions, six of these were in patients classified as high risk for DIVA; High-risk DIVA patients had an 11-fold increased likelihood of a failed PIVC insertion (OR (95% CI: 11.4 (1.4–94.8). A brief summary of the experience of these seven patients is presented in Box 1.

Box 1: Description of seven patients where PIVC insertion was attempted by emergency department staff and abandoned.

Patient 1: An 85 year old female, living at home, arrived by ambulance with upper abdominal pain. She was offered, but declined IV access in ambulance. She was triaged at 11:40 am into Australasian Triage Score (ATS) 3. She had an history of difficult intravenous access, had presented to the hospital in the last 90 days, and had chronic kidney disease. Her initial medical management plan did not include any IV treatment. A junior doctor tried twice unsuccessfully to insert a 20-gauge PIVC into her antecubital fossa. She was transferred to a ward without a PIVC. On the ward, a PIVC was placed at 19:45 (number of attempts unknown), and she received gentamycin IV at 20:00. She was discharged the next day

Patient 2. A 56 year old female, brought in by ambulance, where one unsuccessful attempt at PIVC occurred. She was triaged at 10:47 with epigastric pain. In ED, a nurse attempted to place a PIVC in her hand, but was not successful. Blood samples for pathology were taken using phlebotomy. The initial medical plan was for pain management only. Oral analgesia was given, patient was discharged home.

Patient 3. A 64 year old male self-presented and was triaged at 11:36 for investigation of a painful perianal abscess. Blood samples for pathology were taken using phlebotomy. Following a surgical review, IV access was requested for IV fluids and antibiotics. A junior doctor attempted PIVC placement twice in the hand but was unsuccessful. The patient was transferred to theatre without a PIVC, where one was placed. The patient received IV fluids and gentamycin pre-operatively at 14:24 and 14:30, respectively.

Patient 4. An 80 year old frail man with cognitive impairment was triaged at 07:51 following an unwitnessed fall at home. Following one PIVC attempt in the hand by a nurse, and three additional attempts by a junior doctor (one in the forearm, and one each in the right and left antecubital fossa), venupuncture was used to acquire the necessary blood for pathology. The patient was transferred to a ward without a PIVC, where one was placed at 18:00 (requiring an unknown number of attempts) for the purpose of IV fluids.

Patient 5. An 81 year old male with chest pain for investigation was triaged at 13:14. Following three attempts by one nurse at PIVC insertion (one attempt with a 20 gauge in the right antecubital fossa, second with a 22 gauge in the left antecubital fossa, and the third with a 22 gauge in the forearm), pathology bloods were taken at 16:30 (venupuncture). The patient was discharged the next day and did not receive IV treatment throughout his stay.

Patient 6: A 47 year-old female with unexplained syncope was brought in by ambulance. Ambulance administered IM ondasetron and there was no evidence of PIVC attempt in ambulance. She was triaged at 15:01, and a PIVC insertion was attempted by a senior doctor at 15:50 for an unknown purpose. Bloods for pathology were taken via venupuncture. She was provided with simple analgesia and discharged later that day.

Patient 7: A 27 year old female self-presented with abdominal pain. The medical plan was for pathology and analgesia only. Four attempts at PIVC insertion, all using a 20-gauge PIVC, were unsuccessful: the first two by a nurse in a hand and the antecubital fossa; the second two by a junior doctor using the alternative antecubital fossa. Pathology was then taken via venupuncture. The patient did not have any intravenous treatments during her two day hospital stay.

Table 2
PIVC insertion experience, comparing patients at high risk for a difficult intravenous vascular access (DIVA), compared to patients without these risk factors.

	All PIVC insertions (n = 1084)		High risk for DIVA (n = 378)		Comparison (n = 706)			
	n	%	n	%	n	%	p-Value	OR (95% CI)
PIVC placed successfully							0.009[a]	
Yes	1077	99.4	372	98.4	705	99.9		1.0 (reference)
No	7	0.6	6	1.6	1	0.1		11.4 (1.4–94.8)
Attempts at PIVC insertion								
–Median (minimum–maximum)	1 (1–10)		1 (1–10)		1 (1–4)			
–Mean 95% confidence interval])	1.4 (1.3–1.5)		1.8 (1.6–1.9)		1.2 (1.2–1.2)			
–Number of attempts							<0.001	
1	831	76.7	231	61.1	600	85.0		1.0 (reference)
2	153	14.1	74	19.6	79	11.2		2.4 (1.7–3.5)
3	59	5.4	40	10.6	19	2.7		5.5 (3.1–9.6)
≥4	41	3.8	33	8.7	8	1.1		10.7 (4.9–23.5)
Use of ultrasound to guide PIVC insertion							<0.001[a]	
Ultrasound used	35	3.2	31	8.2	4	0.6		15.7 (5.5–44.7)
Ultrasound not used	1049	96.8	347	91.8	702	99.4		1.0 (reference)
Distinct PIVC attemptors								
One	1002	92.4	322	85.2	680	96.3	<0.001	1.0 (reference)
Two	68	6.3	44	11.6	24	3.4		3.9 (2.3–6.5)
Three or more	14	1.3	12	3.2	2	0.3		12.7 (2.8–56.9)
First PIVC insertion attemptor							<0.001	
Nurse	726	67.0	224	59.3	502	71.1		1.0 (reference)
Junior doctor	234	21.6	91	24.1	143	20.3		1.4 (1.1–19)
Senior doctor	108	10.0	57	15.1	51	7.2		2.5 (1.7–3.8)
Last PIVC insertion attemptor							<0.001	
Nurse	691	63.7	204	54.0	487	69.0		1.0 (reference)
Junior doctor	231	21.3	88	23.3	143	20.3		1.5 (1.1–2.0)
Senior doctor	115	10.6	63	16.7	52	7.4		2.9 (1.9–4.3)
PIVC gauge at first attempt							<0.001	
18	165	15.2	43	11.4	122	17.3		1.0 (reference)
20	834	76.9	276	73.0	558	79.0		1.4 (1.0–2.0)
22	54	5.0	40	10.6	14	2.0		8.1 (4.0–16.3)
Other/unknown	31	2.9	19	5.0	12	1.7		4.5 (2.0–10.0)
Final placement site (n = 1077)							0.003	
Antecubital fossa	709	65.4	221	58.5	488	69.1		1.0 (reference)
Wrist/hand	217	20.0	96	25.4	121	17.1		1.8 (1.3–2.4)
Forearm	87	8.0	35	9.3	52	7.4		1.5 (0.9–2.3)
Other/unknown	64	5.9	20	5.3	44	6.2		1.0 (0.6–1.7)

High risk for DIVA defined as any of: no vein visible, no vein palpable, or history of difficult access.
[a] Fisher exact result used.

Data on ultrasound timing was available on the 35 patients who had ultrasound-guided PIVC insertion. Of these, eleven patients (31.4%) had their first attempt with ultrasound; an additional eleven were placed with ultrasound after only one prior attempt. The remaining 13 ultrasound-guided PIVC insertions occurred after two (n = 10), or three or more attempts (n = 3) at land-mark placement. Regardless of early or late use of ultrasound, the use of ultrasound in our setting achieved a first-attempt success rate for 21 patients (60%).

Discussion

ED staff are frequently faced with decision-making about which patients are appropriate for a PIVC. Over two-thirds of adults presenting to our ED received a PIVC (n = 1936 (69%)) either pre-hospital or in our department. This is likely an underestimate as it does not include ATS 1 patients. If we assume, all ATS 1 patients were cannulated, the proportion would increase to 74%. Thus, our cannulation rate is at the higher end of that suggested by current literature [1,2,27]. The reason for this is unclear, and is likely a cultural habit of the department. Over one-third of PIVCs inserted were not used in first 24 h, leaving 66% that were used. This is similar to previous literature suggesting between 50–70% use. A strategy such as that used in the CREDIT trial, where staff were to ensure they are 80 % sure the PIVC would be used prior to insertion, may improve PIVC wastage [2]. Their PIVC usage increased from 70.5% pre-intervention to 83.4% post-intervention [2].

ED insertion practices impact post-insertion PIVC complications, and choice of appropriate site and size of PIVC is important to allow longevity. We found 20-gauge PIVCs to be most frequently inserted, although 18-gauge PIVCs had the highest insertion success rate, presumably because they were only used for large, easily accessible veins. The ACF was the most commonly used site, similarly likely due to ease of insertion at this site. Given the tendency for PIVC failure at this location, other anatomical sites should be encouraged, and it would be interesting to re-evaluate PIVC success rate if we were not relying so heavily on the ACF [28].

Regarding insertion techniques, it is evident that the majority of PIVCs were inserted easily, with 76.7% 1st attempt success, consistent with that found in literature of 74–88%. In keeping with previous literature, experienced doctors and nurses had the most success, with CNs and consultants showing 1st attempt success rates of 93% and 91% respectively. Difficultly placing PIVCs was less common, yet still substantial, with 9.4% requiring 3 or more attempts.

A high number of patients had predictors of difficult cannulation, with 34% having a strong predictor of difficulty (history of difficult IV access or no vein seen or palpable). This group had the most failed cannulations, endured more attempts, had increased use of USS, and required more staff and more senior staff, which has cost implications. This is the high-risk group to target for practice improvements. If a patient requires a PIVC, and they have no visible or palpable vein and/or report a history of difficult IV access, this should trigger the clinician to escalate to a more experienced oper-

ator or consider use of an adjunct such as ultrasound, *before* the first insertion attempt. In our cohort, use of ultrasound was infrequent and mostly employed by senior medical staff. Its use often occurred only after a number of failed attempts. If we can predict difficult IV access, due to no vein seen or palpable and/or a history of difficult access, then early use of ultrasound to guide PIVC placement is clearly preferable to waiting until after failed attempts. Our study demonstrated first attempt success at USS-guided cannulation of 55.6%. This is on the lower side of that reported in the literature of 53–73%, suggesting further training/practice of our staff is required.

Limitations

A large amount of data collected was reliant on patient/doctor information which may be influenced by recall/reporting bias. However, the timeframe between the insertion of the PIVC and the collection of the data was not greater than a few hours in the cases of retrospective collection of the information.

The study is subject to observer bias, and whether or not being observed improves or worsens cannulation technique and decision making remains unknown.

Conclusions

PIVC insertion is the most common invasive procedure performed in the ED. In all patients, we should consider if cannula insertion is necessary or whether venepuncture will suffice to reduce unnecessary cannulations. When proceeding, we should consider whether the patient possesses the two most reliable predictors of difficult cannulation: no vein seen or palpable, and/or a history of difficulty. If so, escalation to an experienced operator and/or consideration of using ultrasound as an adjunct should occur prior to a first attempt. This message should be propagated to ED staff, training made available, and consideration given to a formal vein assessment tool and/or escalation pathway.

Authorship declaration

We declare that the authors list meet criteria as per the journal's authorship policy and that all authors have accepted the final manuscript.

AAJ SW and AS developed the study protocol.
AAJ SW and AS secured funding.
AAJ SW and AS conceived and designed the study.
AS developed the data analysis plan and analysed the data.
LJ and AG collected, entered and cleaned data and helped prepare the manuscript.
AAJ and AS assisted in preparing the manuscript.
SW and CR critically appraised and revised the manuscript.

Disclosure statement

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The authors have nothing further to disclose.

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Appendix A.

Data Collection Form (RODIE) - ED		
Patient Sticker		
Date		
Triage category		
Triage Time		
Mode of arrival	QAS □ Inter-hospital transfer □ Private □	
IVC already in-situ	Yes □ No □	
IVC Required	Yes □ No □	
Is the patient eligible?	Yes □ Consent - Yes □ - Waived □ - No □ Reason_____	No □ Category 1 □ Other □ <18yo □ Reason_____ IHT □

Reason for IVC	Intravenous fluids □ give blood □ take blood □ contrast for imaging□ analgesia□ IV ABs □ other medications□
Patient Characteristics	Hx of difficult IV access □ no vein seen □ no vein palpable □ recent hospital/ED presentation in past 90 days □ hx frequent IV injection □ diabetes □ underweight □ overweight □ upper limb swelling □ upper limb scarring □ hx of chronic kidney disease □ on dialysis □ hx of cancer on chemo □ hx other chronic illness □ other □_____

	1st Attempt	2nd Attempt	3rd Attempt	4th Attempt	Final
Time IVC insertion commenced					
Time IVC insertion complete					
IVC insertion successful? Y/N					

Number of attempts: _____
Failed to insert peripheral IVC □ If failed, what next? IVC not required □ Escalated □

Staff performing insertion	1st Attempt	2nd Attempt	3rd Attempt	4th Attempt	Final
Consultant					
Registrar					
Resident					
Intern					
RN					
CN					
CNC					
Medical student					
Other _____					
USS guidance used? Y/N					
If USS not used, why not?	Easy IV access □ Lack of confidence □ not trained □ machine broken □ machine not available □				

Site/Size of insertion	1st Attempt	2nd Attempt	3rd Attempt	4th Attempt	Final
Antecubital fossa					
Forearm					
Wrist/hand					
Other (specify)					
Size of IV Cannula and length					

Was IVC used within 24 hours of insertion:

Yes □ No □

Patient disposition:

Home □ Admitted ward □ Admitted observation ward (SSU) □

Time left ED: _____

References

[1] Sabri A, Szalas J, Holmes KS, Labib L, Mussivant T. Failed attempts and improvement strategies in peripheral intravenous catheterization. Biomed Mater Eng 2013;23(1–2):93–108.
[2] Hawkins T, Greenslade JH, Suna J, Williams J, Rickard C, Jensen M, et al. Peripheral intravenous cannula insertion and use in the emergency department: an intervention study. Acad Emerg Med 2018;25(1):26–32.
[3] Helm R, Klausner JD, Klemperer JD, Flint LM, Huang E. Accepted but unacceptable: peripheral IV catheter failure. J Infus Nurs 2015;38(3):189–203.
[4] Rickard C, Larsen E, Marsh N, Webster J, Mihala G, Runnegar N. The incidence and cumulative risk of primary bloodstream and venous infections in 12,942 peripheral intravenous catheters in Australia. Infect Dis Health 2018;23:S7–8.
[5] Rickard CM, Webster J, Wallis MC, Marsh N, McGrail MR, French V, et al. Routine versus clinically indicated replacement of peripheral intravenous catheters: a randomised controlled equivalence trial. Lancet 2012;380(9847):1066–74.
[6] Stolz LA, Stolz U, Howe C, Farrell IJ, Adhikari S. Ultrasound-guided peripheral venous access: a meta-analysis and systematic review. J Vasc Access 2015;16(4):321–6.
[7] Liu YT, Alsaawi A, Bjornsson HM. Ultrasound-guided peripheral venous access: a systematic review of randomized-controlled trials. Eur J Emerg Med 2014;21(1):18–23.
[8] Carr PJ, Rippey JCR, Cooke ML, Bharat C, Murray K, Higgins NS, et al. Development of a clinical prediction rule to improve peripheral intravenous cannulae first attempt success in the emergency department and reduce post insertion failure rates: the Vascular Access Decisions in the Emergency Room (VADER) study protocol. BMJ Open 2016;6(2):e009196.
[9] Laksonen RP, Gasiewicz NK. Implementing a program for ultrasound-guided peripheral venous access: training, policy and procedure development, protocol use, competency, and skill tracking. Nurs Clin North Am 2015;50(4):771–85.
[10] Brandt HG, Jepsen CH, Hendriksen OM, Lindekaer A, Skjonnemand M, et al. The use of ultrasound to identify veins for peripheral venous access in morbidly obese patients. Dan Med J 2016;63(2).
[11] Fields JM, Piela N, Au A, Townshend C, Dalsey K, Ku B. Prevalence and characteristics of patients presenting with difficult venous access to the emergency department. Acad Emerg Med 2013;20(5):S140–1.
[12] Fields JM, Piela N, Au A, Townshend C, Ku B. Risk factors associated with difficult venous access in adult ED patients. Am J Emerg Med 2014;32(10):1179–82.
[13] Lapostolle F, Catineau J, Garrigue B, Monmarteau V, Houssaye T, Vecci I, et al. Prospective evaluation of peripheral venous access difficulty in emergency care. Intensive Care Med 2007;33(8):1452–7.
[14] Sebbane M, Claret P-G, Lefebvre S, Mercier G, Rubenovitch J, Jreige R, et al. Predicting peripheral venous access difficulty in the emergency department using body mass index and a clinical evaluation of venous accessibility. J Emerg Med 2013;44(2):299–305.
[15] Rodríguez-Calero MA, Blanco-Mavillard I, Morales-Asencio JM, Fernández-Fernández I, Castro-Sánchez E, de Pedro-Gómez JE, et al. Defining risk factors associated with difficult peripheral venous Cannulation: a systematic review and meta-analysis. Heart & Lung 2020;49(3):273–86.
[16] Bensghir M, Chkoura K, Mounir K, Drissi M, Elwali A, Ahtil R, et al. Peripheral intravenous access in the operating room: characteristics and predictors of difficulty. Ann Fr Anesth Reanim 2012;31(7-8):600–4.
[17] Fields J, Renzi N, McCarter K, Paziana K. 69 does a history of difficult venous access mean the patient really needs an ultrasound-guided IV? Ann Emerg Med 2014;4(64):S25–6.
[18] Egan G, Healy D, O'Neill H, Clarke-Moloney M, Grace PA, Walsh SR. Ultrasound guidance for difficult peripheral venous access: systematic review and meta-analysis. Emerg Med J 2013;30(7):521–6.
[19] Shokoohi H, Loesche MA, Duggan NM, Liteplo AS, Huang C, Al Saud AA, et al. Difficult intravenous access as an independent predictor of delayed care and prolonged length of stay in the emergency department. J Am Coll Emerg Physicians Open 2020;1(6):1660–8.
[20] Gregg SC, Murthi SB, Sisley AC, Stein DM, Scalea TM. Ultrasound-guided peripheral intravenous access in the intensive care unit. J Crit Care 2010;25(3):514–9.
[21] Witting MD, Schenkel SM, Lawner BJ, Euerle BD. Effects of vein width and depth on ultrasound-guided peripheral intravenous success rates. J Emerg Med 2010;39(1):70–5.
[22] Shokoohi H, Boniface K, McCarthy M, Al-Tiae TK, Sattarian M, Ding R, et al. Ultrasound-guided peripheral intravenous access program is associated with a marked reduction in central venous catheter use in noncritically ill emergency department patients. Ann Emerg Med 2013;61(2):198–203.
[23] Au AK, Rotte MJ, Grzybowski RJ, Ku BS, Fields JM. Decrease in central venous catheter placement due to use of ultrasound guidance for peripheral intravenous catheters. Am J Emerg Med 2012;30(9):1950–4.
[24] Heinrichs J, Fritze Z, Vandermeer B, Klassen T, Curtis S. Ultrasonographically guided peripheral intravenous cannulation of children and adults: a systematic review and meta-analysis. Ann Emerg Med 2013;61(4), 444–454. e1.
[25] Stein J, George B, River G, Hebig A, McDermott D. Ultrasonographically guided peripheral intravenous cannulation in emergency department patients with difficult intravenous access: a randomized trial. Ann Emerg Med 2009;54(1):33–40.
[26] Weiner SG, Sarff AR, Esener DE, Shroff SD, Budhram GR, Switkowski KM, et al. Single-operator ultrasound-guided intravenous line placement by emergency nurses reduces the need for physician intervention in patients with difficult-to-establish intravenous access. J Emerg Med 2013;44(3):653–60.
[27] Decker K, Ireland S, O'Sullivan L, Boucher S, Kite L, Rhodes D, et al. Peripheral intravenous catheter insertion in the emergency department. Australas Emerg Nurs J 2016;19(3):138–42.
[28] Wallis MC, McGrail M, Webster J, Marsh N, Gowardman J, Playford EG, et al. Risk factors for peripheral intravenous catheter failure: a multivariate analysis of data from a randomized controlled trial. Infect Control Hosp Epidemiol 2014;35(1):63–8.