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ORIGINAL ARTICLE

Insertion of peripheral intravenous cannulae in the Emergency Department: factors associated with first-time insertion success

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ABSTRACT

Background: We sought to identify the reasons for peripheral intravenous cannulae insertion in the emergency department (ED), and the first-time insertion success rate, along with patient and clinician factors influencing this phenomenon.

Methods: A prospective cohort study of patients requiring peripheral cannulae insertion in a tertiary ED. Clinical and clinician data were obtained.

Results: A total 734 peripheral intravenous cannula (PIVC) insertions were included in the study where 460 insertions were analysed. The first-time insertion success incidence was 86%. The antecubital fossa (ACF) site accounted for over 50% of insertions. Multivariate logistic regression modelling to predict first-time insertion success for patient factors found: age <40 versus 80+ years, emaciated versus normal patient size, having a visible or palpable vein/s, and ACF versus forearm insertion site to be statistically significant. Statistically significant clinician factors predicting success were: higher number of prior cannulation procedures performed, and increased clinician perception of the likelihood of a successful insertion. When patient and clinician factors were combined in a logistic regression model, emaciated versus normal, visible vein/s, ACF versus forearm site, higher number of prior PIVC procedures performed and increased clinician perceived likelihood of success were statistically associated with first-time insertion success.

Conclusions: Peripheral intravenous cannulation insertion success could be improved if performed by clinicians with greater procedural experience and increased perception of the likelihood of success. Some patient factors predict cannulation success: 'normal' body weight, visible vein/s and cubital fossa placement; venepuncture may be a cheaper alternative for others if intravenous therapy is not imperative.

Keywords: Peripheral intravenous cannula, Emergency department, Insertion success, Insertion failure

Introduction

Preserving venous anatomy from repeated skin punctures is a challenge in high paced clinical environments such as the emergency department (ED). Reports describe the use of peripheral intravenous cannula (PIVC) as the first choice vascular access device (VAD) for patient treatment in the ED (1, 2). ED studies suggest first-time insertion success incidence in adults range from 18%-79% (2-5). Contrast this with a 98% first-time success rate for dedicated teams who insert PIVCs on the general wards and specialist nurses in the paediatric setting (7, 8). Repeated needle insertion attempts subject patients to pain, stress, increased infection risk, and impact negatively on patient satisfaction (9, 10). This study sought to identify the rationale for PIVC use, and factors that influence first-time insertion success of PIVCs inserted in an Australian tertiary hospital ED.

A reduction in repeated and inappropriate PIVC insertions is advocated (11, 12). As a result, cost-saving strategies that can save tens of millions of dollars and pounds sterling for the

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Australian and UK healthcare services each year (13, 14). In one study, half of VADs inserted in EDs were never used, and many remained unused at 72 hours (11), suggesting clinicians are often unclear why they are attempting PIVC insertion.

Randomized controlled trials regarding insertion practice in EDs are limited to ultrasound placed peripheral cannula for patients with a previous insertion failure. A recent Cochrane Systematic Review compared the effectiveness of the PIVC as the VAD of choice in emergency care (6). Furthermore, an intervention study tested its efficacy as first-line VAD choice in the critical-care setting (15). However, the effectiveness of any particular VAD is likely dependent on both clinician and patient factors.

Studies in adults have identified a range of patient and clinician factors influencing first-time insertion success. A recent publication on difficult vascular access in the ED identified 12 patient variables that predicted PIVC insertion failure. These were: age, gender, race, body mass index (BMI), history of chemotherapy, diabetes, dialysis, intravenous drug abuse (IVDA), swelling, sickle-cell disease, and ED visit/recent hospitalisation within 90 days (16). Clinicians with greater PIVC insertion experience may overcome some of these risks, since procedural competency appears to be closely linked with the number of PIVC insertions previously performed (2, 4, 17).

Aims

Contributing to the evidence base for PIVC insertions in EDs are the central aims of this study. Our objectives were to determine: (i) first-time insertion success incidence for PIVCs inserted in adults presenting to a metropolitan ED; (ii) clinician rationale for PIVC use; and, (iii) understand the comparative predictive value of patient and clinician factors that contribute to first-time insertion success.

Methods

Study design

We conducted a prospective cohort study in December 2013 concluding in January 2014. The study was registered and approved by the hospital's human research ethics committee as a quality improvement activity (QI 3065).

Study setting and population

This study took place at a large tertiary ED in Western Australia. The ED provides a 24/hour day emergency service for adult patients. Approximately 64,000 patients present each year and on average 4,500 attend per month. There were 33,228 PIVCs recorded in the ED information system for 2012-2013. The study population included adult patients presenting to the ED and the clinicians who performed PIVC insertion during the study period.

Study protocol and measurements

A PIVC case report form (CRF) was conceptualised and underpinned by previous reports of difficult peripheral insertion tools, rules, algorithms and scores (2, 4, 5, 17-24). Vascular access researchers and senior ED clinicians assessed the CRF for clinical relevance and practicality for use in a busy ED. This ensured that our one-page (double-sided) CRF was developed with face validity from the underpinning literature and refined with content validity from clinician opinion. ED clinical staff members were made aware of the CRF content and how to complete it. Prior to cannulation, pre-insertion questions were completed with details of insertion success recorded after the procedure. Following this, completed CRFs were then placed into a marked folder on each PIVC procedure trolley. Each morning, completed forms were removed by the chief investigator and data was entered into a secure database. After 4 weeks we concluded the data collection and removed the forms from the PIVC trolleys.

Definitions

Rationale for insertion

To identify a rationale for PIVC insertion we asked if the reason for intravenous (IV) access was for (i) blood tests (no blood test, single set, serial tests); or (ii) for infusion therapy (no, possible, definite). Both options could be selected, i.e. blood tests and IV therapy. If IV therapy was selected, we also asked for the type of therapy: fluids, antibiotics, analgesia, and other.

Patient factors

We included: age; gender; patient observations including pulse and BP (mm Hg); patient skin shade (Fitzpatrick tool) (25); patient size (clinician's subjective assessment as emaciated, underweight, normal weight, overweight or obese); and, height (cm) and weight (kg) to calculate BMI. We collected: visible vein/s (yes, no); palpable vein/s (yes, no); number of sites (0, 1, 2, 3, >3); side of cannula (left, right); site of cannula (hand, low forearm, upper forearm, antecubital fossa); size of cannula (14G,16G, 18G, 20G, 22G and 24G); ultrasound used (yes, no); and, vein measurement using a 10 mm scale placed on the border of the data collection tool, which represented the variable vein diameter. The CRF allowed for comments to be detailed regarding any other factors that would contribute to making the insertion difficult.

Clinician factors

We included: clinician role; estimated number of successful PIVCs performed successfully (0-100, 101-800, >800); and, estimated length of time inserting PIVCs (0-2 years, 3-4 years, 5+ years). A visual analogue scale of 0-100 was used prior to any insertion attempt to document the clinician's perceived likelihood of first-time cannulation success.

Insertion success (primary outcome)

The clinician's first-time insertion success was recorded as yes/no along with PIVC site placement and PIVC size. If the clinician completing the CRF selected yes to first-time success, then the remaining questions were obsolete. If the clinician selected no, then we asked for the number of attempts

required to achieve PIVC success (2, 3, 4, 5, or >5, or if they were unable to place a PIVC at all). We also asked if any other clinician was asked to assist with the procedure, what their role was, and if ultrasound was used with additional comments (free text) requested about the cannulation procedure or use of alternative VADs.

Data analysis

Sample size was determined pragmatically, with all patients admitted over the course of one month eligible for inclusion. Summary statistics, including frequencies and percentages, were calculated for each of the variables. We conducted univariate and multivariate binary logistic regression to determine which factors were associated with first-time insertion success. Models were conducted for patient factors only, clinician factors only and all factors combined. Backwards selection was conducted using the Akaike's Information Criteria (AIC) to provide the final multivariate models. Adjusted odds ratios (OR) and 95% confidence intervals (CI) were calculated for all models. All analyses were restricted to variables with more than 90% complete observations. Categories for two variables were collapsed given the small numbers in some categories: size of cannula was collapsed to small (20-24G) and large (14-18G) and number of PIVCs inserted collapsed as 0-100 reflected novice inserters with the remaining inserters broken down into equal categories of 101-800 and >800. Additionally, the cut-offs for the age categories were determined by breaking the sample into four roughly equal components. We assessed performance using the area under the curve of the receiver-operating characteristic (ROC). Data were analysed using the R environment for statistical computing (26).

Results

We collected data on 734 PIVC insertions with 460 of these cases used for analysis. Table I displays insertion information including a first-time insertion success rate of all cases of 86% (629/734). Male gender accounted for 48% of those having a PIVC inserted with mean age 57 (range 16-98) (Tab. II). Poorly completed questions included weight, height, blood pressure and heart rate and therefore these variables were not included in any statistical analyses.

TABLE I - Insertion attempts

Insertion attempts	n (%)
1	629 (85.69)
2	73 (9.95)
3	22 (3.00)
4	3 (0.41)
Unsuccessful	3 (0.41)
Unknown	3 (0.41)
No second attempt*	1 (0.14)
Total	734

* Aborted.

Univariate patient and clinician factors

Of the cases included for analysis (n = 460, 63%), only 25 (5%) PIVCs were inserted by nurses, 383 (83%) were inserted by medical doctors or emergency registrars and the remaining 52 (11%) inserted by consultants. The majority of PIVC insertions were performed on patients with Caucasian skin shade (89%) and who appeared of normal body size (54%). The reasons for a PIVC insertion varied with 6% requiring no IV therapy or medicine, 42% possible IV therapy, 38% definitive IV therapy. Data were missing or unknown for 14% of patients. Blood sampling

TABLE II - All measures for successfully 1st time inserted PIVC (for analysed cases, n [%])

Variable	Successful (n = 402)	Unsuccessful (n = 58)	Total (n = 460)
Patient measures			
Age group			
<40	113 (92.62)	9 (7.38)	122 (26.52)
40-<60	104 (85.25)	18 (14.75)	122 (26.52)
60-<80	103 (86.55)	16 (13.45)	119 (25.87)
80+	82 (84.54)	15 (15.46)	97 (21.09)
Sex			
Male	195 (87.84)	27 (12.16)	222 (48.26)
Female	207 (86.97)	31 (13.03)	238 (51.74)
Patient size			
Emaciated	4 (40)	6 (60)	10 (2.17)
Underweight	62 (84.93)	11 (15.07)	73 (15.87)
Normal	228 (91.2)	22 (8.8)	250 (54.35)
Overweight	80 (87.91)	11 (12.09)	91 (19.78)
Obese	28 (77.78)	8 (22.22)	36 (7.83)
Patient skin shade			
Caucasian	357 (87.07)	53 (12.93)	410 (89.13)
Non-Caucasian	45 (90)	5 (10)	50 (10.87)
Visible vein			
Yes	343 (90.5)	36 (9.5)	379 (82.39)
No	59 (72.84)	22 (27.16)	81 (17.61)
Palpable vein			
Yes	393 (88.31)	52 (11.69)	445 (96.74)
No	9 (60)	6 (40)	15 (3.26)
Number of available sites			
0	5 (45.45)	6 (54.55)	11 (2.39)
1	94 (81.74)	21 (18.26)	115 (25)
2	159 (89.33)	19 (10.67)	178 (38.7)
3	63 (91.3)	6 (8.7)	69 (15)
>3	81 (93.1)	6 (6.9)	87 (18.91)

To be continued

TABLE II - Continued

Variable	Successful (n = 402)	Unsuccessful (n = 58)	Total (n = 460)
Side			
Left	131 (87.33)	19 (12.67)	150 (32.61)
Right	271 (87.42)	39 (12.58)	310 (67.39)
Site			
Hand	102 (89.47)	12 (10.53)	114 (24.78)
Forearm	75 (79.79)	19 (20.21)	94 (20.43)
Cubital fossa	225 (89.29)	27 (10.71)	252 (54.78)
Size*			
Large	213 (89.12)	26 (10.88)	239 (51.96)
Small	189 (85.52)	32 (14.48)	221 (48.04)
Diameter			
0-2mm	77 (76.24)	24 (23.76)	101 (21.96)
>2-3mm	148 (89.16)	18 (10.84)	166 (36.09)
>3-4mm	80 (87.91)	11 (12.09)	91 (19.78)
>4mm	97 (95.1)	5 (4.9)	102 (22.17)
Clinician measures			
Role level			
Nurses	21 (84)	4 (16)	25 (5.43)
Doctors	335 (87.47)	48 (12.53)	383 (83.26)
Consultants	46 (88.46)	6 (11.54)	52 (11.3)
IV cannulas ever**			
0-100	17 (65.38)	9 (34.62)	26 (5.65)
101-800	178 (86.83)	27 (13.17)	205 (44.57)
>800	207 (90.39)	22 (9.61)	229 (49.78)
Placing IVs			
0-2 yrs	117 (85.4)	20 (14.6)	137 (29.78)
3-4 yrs	134 (85.9)	22 (14.1)	156 (33.91)
5 + yrs	151 (90.42)	16 (9.58)	167 (36.3)

*Categories collapsed to large (14-18G) and small (20-24G) due to small numbers in some sizes.
**Categories were combined for data analysis purposes.

was performed in 85% of PIVC insertions 5% did not have any blood sampled, with 10% unknown (missing data). Only 6 insertions were performed using ultrasound.

Univariate statistics showed that, the percentage of patients with successful first-time insertion differed for the following: patient size (40% emaciated, 85% underweight, 91% normal, 88% overweight and 78% obese); visible vein (91% yes, 73% no), palpable vein (88% yes, 60% no); number of available sites (45% with none, 82% with one, 89% with two, 91% with three and 93% with more than three); cannula site (80% forearm, 89% hand, and 89% cubital fossa); diameter of vein (76% 0-2 mm, 89% >2-3 mm, 88% >3-4 mm, and 95% >4 mm); and, number of IV cannulas ever inserted by clinician (65% 0-100, 87% 101-800, and 90% >800) (Tab. II). The likelihood of success in the successful insertion group was 85.23% versus 63.02% in the non-successful group.

Modelling patient and clinician factors

Considering only the patient factors in the multivariate analysis, age <40 compared to 80+ years (p = 0.041), emaciated versus normal patient size (p<0.001), greater number of available sites (>3 vs. 0, p = 0.004), presence of a visible vein (p<0.001), presence of a palpable vein (p = 0.015) and insertion at the cubital fossa compared to the forearm (p = 0.008) were significant predictors of first-time successful insertion. In terms of the clinician factors, >800 cannulas ever inserted, compared to both 100-800 and <100 (p = 0.005 and p = 0.004, respectively), and clinician's likelihood of first-time insertion success (p<0.001) were significant predictors of first-time successful insertion. With reference to the variable 'likelihood of success', results showed that an increase in the likelihood of clinician's prediction of success was associated with an increase in successful insertion (OR 1.07, 95% CI 1.05-1.08) (Tab. III).

Comparison between the models revealed no significant difference between the patient only and clinician only models but the all measures model was statistically better than both these models: patient only versus clinician only: p = 0.59, patient only versus all: p = 0.02 clinician only versus all: p = 0.04. Based on the above predictors, ROC curves for three models were plotted (Fig. 1). The areas under the curve for the model containing patient only factors, clinician only factors, and all factors, were 0.80, 0.82 and 0.87, respectively. The areas under the curve suggest good discrimination for all models.

Discussion

The ED is a fast-paced environment and many clinical decisions occur under duress. Emergent life-threatening events may take precedent over complex algorithmic or prediction rules for PIVC insertion. Our results suggest that there is opportunity to stratify this risk since insertion success is greater in those patients with a number of visible and palpable veins. Previous studies related to insertion difficulty in adult and paediatric populations have employed regression techniques to identify predictors of successful insertion and included both clinician and patient factors The variety of predictors for successful insertion include: skin shade, BMI, skilled staff, favourable vein assessments, patients on chemotherapy, burns patients and nurses in training (2, 4, 18-21, 27, 28).

Our study reveals a first-time insertion success rate of 86%, higher than that of previous similar studies in the emergency setting by Sebbane et al (79%) and Lapostolle et al (74%) (2, 4). Our self-report design is perhaps one reason for an increased success rate, as both the aforementioned authors used an observational design. Lapostolle and colleagues reported that PIVCs placed by nurses specialised in emergency care had a greater first-time insertion success compared to anaesthesiologist/emergency physician, student of nursing/medicine, OR 3.96, CI 1.78-8.81, p = 0.0008 (4). We found no statistically significant difference between nurse versus medical doctor; however, medical doctors inserted the overwhelming volume of PIVCs.

TABLE III - Multivariate logistic regression models of *All* measures, *Patient only* measures and *Clinician only* measures for predicting first-time insertion success

Variable	All measures		Patient measures		Clinician measures	
	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value
Patient measures						
Age group						
<40 vs. 80+	NS		3.04 (1.05-8.83)	0.041		
40-<60 vs. 80+			1.01 (0.43-2.38)	0.982		
60-<80 vs. 80+			1.11 (0.46-2.68)	0.82		
Gender						
Male vs. female	NS		NS			
Patient weight status						
Emaciated vs. normal	0.07 (0.02-0.34)	0.001	0.05 (0.01-0.23)	<0.001		
Underweight vs. normal	0.4 (0.16-1.02)	0.054	0.42 (0.17-1.03)	0.396		
Overweight vs. normal	1.07 (0.43-2.64)	0.892	0.86 (0.37-1.97)	0.716		
Obese vs normal	0.71 (0.23-2.20)	0.548	0.64 (0.23-1.80)	0.058		
Patient skin shade						
Non-Caucasian vs. Caucasian	NS					
Visible vein						
Yes vs. no	2.7 (1.19-6.13)	0.018	4.62 (2.17-9.86)	<0.001		
Palpable vein						
Yes vs. no	NS		5.05 (1.37-18.64)	0.015	NA	
Number of sites available						
1 vs. 0	NS		5.81 (1.33-25.48)	0.02		
2 vs. 0			7.53 (1.71-33.22)	0.008		
3 vs. 0			6.55 (1.22-34.99)	0.028		
>3 vs. 0			12.43 (2.25-68.49)	0.004		
Side of cannula						
Right vs. left	NS		NS			
Site of cannula						
Cubital fossa vs forearm	2.82 (1.28-6.24)	0.01	2.79 (1.30-5.97)	0.008		
Hand vs. forearm	1.94 (0.75-5.05)	0.175	1.89 (0.77-4.66)	0.167		
Size of cannula*						
Large vs. small	NS		NS			
Diameter						
>2-3mm vs. 0-2 mm	NS		NS			
>3-4mm vs. 0-2 mm						
>4mm vs. 0-2 mm						
Clinician measures						
Role						
Doctors vs nurses	NS				NS	
Consultants vs. nurses						
IV cannulas ever**						
101-800 vs. 0-100	5.5 (1.86-16.30)	0.002	NA		4.259 (1.56-11.67)	0.005
>800 vs. 0-100	7.64 (2.48-23.51)	<0.001			4.404 (1.61-12.06)	0.004
Placing IVs						
3-4yrs vs. 0-2yrs	NS				NS	
5+yrs vs. 0-2yrs						
Likelihood						
Continuous	1.06 (1.04-1.07)	<0.001			1.07 (1.05-1.08)	<0.001

NS = not significant; NA = not included.
* Categories collapsed to large (14-18G) and small (20-24G) due to small numbers in some sizes.
** Categories were combined for data analysis purposes.

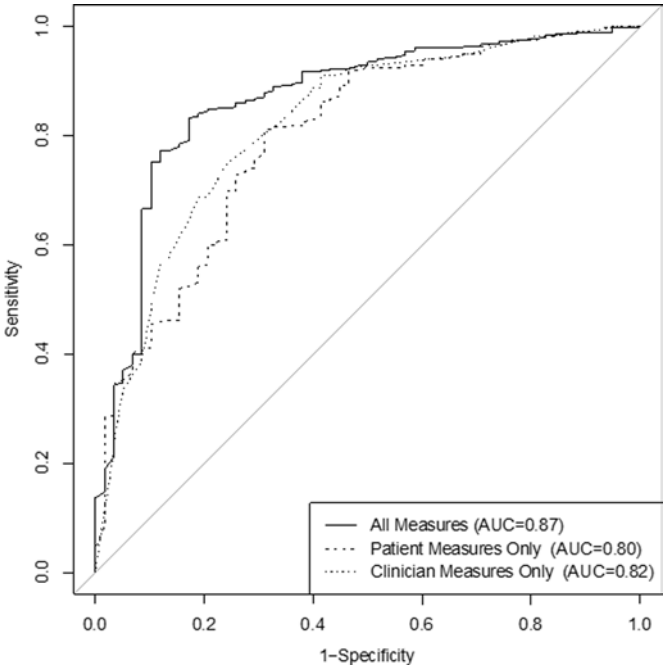

Fig. 1 - ROC curves for the three different models.

Patient factors

Our results can assist in identifying 'at risk' difficult-to-cannulate patients. We found having a palpable (univariate analysis), and more importantly, a visible vein (multivariate analysis) predicted insertion success. Sebbane and colleagues (2) similarly found that patients with many visible and palpable veins had greater first-time insertion success (85%) in comparison to those with non-visible and non-palpable veins (64%). Notwithstanding this, our results suggest that both patient factors as outlined by Sebbane et al, and factors related to the clinician attempting the insertion as Lapostelle et al reveal, are significantly associated with first-time PIVC insertion success (4). Previous studies have classified the quality of veins prior to insertion by level of difficulty (22) or categorised veins as good, fair or poor (23). Our results support that visible and/or palpable veins significantly predict insertion success. These results confirm previous reports that a strong predictor of insertion success is a visible and palpable vein (29, 30).

Other prospective observational studies have studied factors that influence successful PIVC insertion in the adult ED. Fields et al (2014), in a cohort study on difficult venous access, report finding the following independent risk factors: diabetes, sickle-cell disease, and intravenous drug abuse (16). There are equivocal findings with regards to BMI influencing insertion failure (4, 25). We did attempt to capture BMI; however, missing data make us question the feasibility in acquiring data for this variable in the ED. Even if we could prospectively record this information, it is unrealistic to ask a sick or very sick person to stand for height, and sit for weight measurements. Our ED does not normally capture accurate BMI unless absolutely necessary for clinical treatment. Similarly, a paediatric PIVC insertion study by Zhang et al also report BMI data capture an issue (31). To identify if body size is a predictor for insertion failure we relied on the clinician's subjective estimate. We found this alternative variable to be clinically and pragmatically useful and termed it patient size. This variable allowed clinicians to classify patients into emaciated, underweight, normal weight, overweight and obese. Although it was assumed ED clinicians can reliably determine overweight, normal weight and underweight patients further research is needed to establish the validity of clinician's judgements in comparison to BMI. Previous reports suggested dark skin shade a predictor of insertion failure (17). We used the Fitzpatrick skin shade tool (25) as this has been used in previous PIVC studies (32). We did not find any association between skin shade and insertion failure. We found that gender was not a risk factor for insertion failure, but found insertion failure significantly increased for patients over 80 years of age, compared to those aged <40 years.

The antecubital fossa (ACF) was the most common site cannulated in our study and had the best rates of insertion success. This is likely explained since the median cubital vein is more prominent than the forearm/hand, and is generally easier to locate. In addition, if ED staff repeatedly preference this location, their skills in achieving insertion at this site will become higher. A systematic review and meta-analysis of the practice of blood sampling in the ED found that if blood tests were required that the PIVCs inserted in the ACF site reduces haemolysis rates and therefore improves diagnostic accuracy of the blood sample (33). Other indications for ACF placement include the administration of a large bolus of fluids or lifesaving drugs into a large vein. However, not all ACF placements are beneficial to patients. Should the patient be admitted to the ward, then the ACF is a significant independent risk factor for occlusion and accidental removal (premature dislodgement) (10). This suggests that ED clinicians need to be able to predict with good-to-excellent reliability as to how likely the patient is to be admitted, and choose the PIVC site accordingly. Venepuncture is less costly than PIVC insertion and may result in less haemolysis than in blood drawn through PIVCs; furthermore, it removes the risk of unnecessary PIVC therapy (e.g. discourages IV fluids that could otherwise commence via the enteral route).

Clinician factors

Role of clinician who inserts PIVC

In a previous Australian publication regarding PIVCs inserted in the ED, nursing staff inserted 80% of the PIVCs (11). In contrast, 95% of our cannulae were inserted by medical officers and only 5% by ED nurses. It is also reported that specialist nurses and dedicated teams have reported levels of 98%-99% first-time insertion success rates (7, 21). The salary of an ED nurse in Australia is on average well less than an ED medical doctor and therefore it seems reasonable to suggest that using a nursing or allied health insertion team would be an alternative process that could save money whilst improving first-time insertion success.

Only six PIVC insertion failures were referred for ultrasound-guided insertion, suggesting the default after a primary insertion failure was a repeat traditional insertion by

the clinician. This is similar to previous studies concerning risk factors for insertion success and may be owing to the extra training and competency required to successfully perform ultrasound-guided PIVC insertion (16). ED processes may improve if medical personnel can focus on clinical assessment and decision making and patient flow issues, whilst vascular access provision could be performed by a dedicated team of ED-based vascular access clinicians. These processes may help develop procedural consistency of standardised insertion practice and could lead to higher success rates (34, 35). This could impact on hospital efficiencies by reducing waste (products used and the cost of repeat attempts) and an improved patient experience.

Rationale for insertion

Criteria to define whether a PIVC is clinically appropriate, is an issue of debate (12, 36) and ED researchers have not ignored this issue (11). In attempting to identify which ED patient should get a PIVC, Kelly and Egerton-Warburton suggest a clinically useful reference point for PIVC insertion is when likely use is estimated at over 80% (37). We support this and contend this is a clinician factor that is worth further evaluation, prospectively. Indications for PIVC use include the delivery of fluid and medicines or intravenous contrast (11); the delivery of blood products and IV medicines for cardiac arrhythmia; and, expectant access (will need a PIVC for any of the aforementioned) (1). Other indications include the patient requiring investigations (diagnostic scans with intravenous contrast) or IV therapy.

When the PIVC is inserted, diagnostic blood sampling and blood assay can be performed and this reduces the number of repeat venepunctures (38, 39). The insertion of a PIVC for the purpose of blood sampling is an attractive process for time poor ED clinicians as they attempt to meet national treatment targets to discharge patients from ED within 4 hours (40). Many favour the prevention of an additional follow-on skin puncture (41). Advocates believe it speeds up patient flow (39) and prevents repeated damage to the venous anatomy. Our results show that PIVCs are inserted for blood sampling far more than they are for definite IV therapy, and support a recent retrospective review of PIVC placed in ED, which reported that 50% of PIVC are unused (11).

Likelihood estimate

We collected data on the clinician's pre-procedural perception of the likelihood of first-insertion success. Whilst we did find it was a statistically significant predictor of insertion success, further research and analysis is needed to examine if this can be quantified further, that is, at what percentage point is a clinician more likely to achieve success. It is likely that our finding was influenced by clinician pre-assessment of patient variables such as patient size, visible and/or palpable veins and, vein location and size.

Limitations

The major limitation of this study is that it used self-reported data by clinicians, although we attempted to countenance this with motivational and educational sessions emphasising the importance of honest documentation of the number of insertion attempts. We did not have a 100% response rate and this may have been a result of the unwillingness of some clinicians to reveal unsuccessful insertion attempts. It may also have been that the collection form was not used on sicker patients or at busier times. As well, our pragmatic inclusion of all patients admitted over the course of one month may not have provided a sufficient sample size for the number of variables we considered. Peduzzi et al provide a "rule of thumb" recommendation of ten events per variable analysed (42) and there others who recommend that the number required could be reduced (43). Although we identified some factors significantly associated with first-time insertion success, inherent in our study design is that causation cannot be presumed. Another limitation is that we did not formally establish inter-rater reliability of the tool with particular reference to vein assessment and use of clinician assessment of body size. Vein palpability and visibility however have been extensively studied and inter-rater reliability of these variables previously reported as good (2).

Conclusions

Achieving greater first-time PIVC insertion success in ED would save money and impact positively on the patient experience. Our results suggest patients with few visible veins, and who are emaciated are most at risk of an unsuccessful insertion. Peripheral intravenous cannulation success would be improved if clinicians with greater procedural experience and an increased perception of the likelihood of success performed the insertion. The patient-only and clinician-only model did not significantly differ in their ability to predict first-time insertion success. However, the model including both patient and clinician measures was significantly better at prediction than the patient-only model and clinician-only model. Further savings could be accrued if venepuncture is instituted instead of many PIVC insertions, when only blood sampling is clinically required. In this case, a decision for PIVC insertion after blood laboratory results return could still occur. This would support infection prevention strategies in reducing the number of insertion attempts and idle or unused PIVCs (11, 12, 36). However, further research is needed with a larger sample size, an observational assessment of clinician insertion rather than self-report, and include validity and reliability evaluations of measurements.

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Conflict of interest: Peter J. Carr has received "speakers bureau" payment and conference travel from Becton Dickinson (BD) in 2014 for lectures on the subject of vascular access where the data and material in this paper were discussed.
Meeting presentation: WOCOVA 2014, Berlin, Germany, June 2014. 12th International Conference of Emergency Nurses, Perth, Western Australia 2014. Received CENA Best paper runner-up award.

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