FROM INSERTION TO REMOVAL OF EMERGENCY DEPARTMENT INSERTED PERIPHERAL INTRAVENOUS CATHETERS: A MULTI-CENTRE SURVIVAL ANALYSIS OF AN ADMITTED COHORT.

Peter J. Carr ^{1,2} James CR. Rippey ^{1,2,3} Marie L Cooke ² Niall S. Higgins ^{2,4,7} Michelle Trevenen ⁵ Aileen Foale ⁶ Claire Rickard ^{2,4}

1 School of Medicine, Faculty of Health and Medical Sciences, The University of Western Australia, Nedlands, Australia. 2 Alliance for Vascular Access Teaching & Research (AVATAR) Group, Menzies Health Institute Queensland, Griffith University, Brisbane, Australia. 3 Sir Charles Gairdner Hospital, QEII Medical Centre, Nedlands, Perth, Western Australia. 4 School of Nursing and Midwifery, Griffith University 5 Centre for Applied Statistics, The University of Western Australia, Nedlands, Australia. 6 Fiona Stanley Hospital, Murdoch, Australia. 7 Queensland University of Technology, Brisbane, Australia

Introduction

- The peripheral intravenous catheter/cannula (PIVC) is the most used vascular access device in healthcare today.
- Premature failure PIVC after insertion reveals undesirable rates of failure with 30-50% of devices failing before the completion of therapy.
- Most strategies are targeted to reduce infection; however, despite it being the most harmful to patients it is also the least likely to occur.
- Focusing on the Emergency Department (ED) clinical environment where many patients are exposed to their first hospital PIVC insertion could achieve implementation of improvement strategies at the clinical source.

Methods

- Design: Prospective multi-centre observational cohort of admitted ED patients.
- PIVC insertions were observed by trained data collectors and were followed up to identify if post insertion failure (PIF) occurred.
- The primary outcome was to establish the reasons for removal of the PIVC to identify rates of PIF and dwell times.
- Factors considered were: age, gender, skin shade, Australasian Triage Scale (ATS), ultrasound, site of insertion, the inserting clinician's role and the performance of an aseptic non-touch technique keeping key parts protected at insertion (defined as clinical breach or did not breach).

Table 1 Summary of baseline characteristics of the entire cohort as well as broken down by peripheral intravenous cannula (PIVC) failure

Variable	PIVC Failure		Overall (N=391)
	Yes (N=118; 30%)	No (N=273; 70%)	
Gender			
Male	56 (30%)	132 (70%)	188 (48%)
Female	62 (31%)	141 (69%)	203 (52%)
Age			
Continuous (Mean, SD)	69.4 (19.5)	60.7 (21.6)	63.3 (21.3)
Skin Condition			
Good	46 (24%)	144 (76%)	190 (49%)
Fair	31 (30%)	73 (70%)	104 (27%)
Poor	41 (42%)	56 (58%)	97 (25%)
Insertion Location			
Back of the Hand	16 (29%)	39 (71%)	55 (14%)
Wrist	12 (28%)	31 (72%)	43 (11%)
Forearm	21 (28%)	55 (72%)	76 (19%)
Ante Cubital Fossa	68 (31%)	137 (69%)	205 (52%)
Upper Arm	1 (8%)	11 (92%)	12 (3%)
**ATS			
Immediately/imminently life-threatening	53 (39%)	84 (61%)	137 (35%)
Less serious	65 (26%)	189 (74%)	254 (65%)
Clinician Role			
Intern	12 (29%)	29 (71%)	41 (10%)
Registered Medical Officer (RMO)	51 (30%)	117 (70%)	168 (43%)
Registrar	19 (33%)	38 (67%)	57 (15%)
Consultant	7 (27%)	19 (73%)	26 (7%)
Phlebologist	9 (20%)	36 (80%)	45 (12%)
**ANTT			
Did not breach	32 (22%)	111 (78%)	143 (37%)
Clinical breach	86 (35%)	162 (65%)	248 (63%)
Ultrasound			
Yes	4 (45%)	5 (55%)	9 (2%)
No	114 (30%)	268 (70%)	382 (98%)

* ATS Australasian Triage Scale ** Aseptic non-touch technique ANTT

Study Aim

- We sought to investigate insertion-related risk factors and predictors for post-insertion failure in patients who were admitted to hospital via the ED.
- The reason for removal is poorly recorded in the medical record, we prospectively followed up admitted patients who had a PIVC inserted in two EDs.

Results

- The rate of PIVC failure was 30%
- The median hospital length of stay was 2 (IQR 1-5) days and the median PIVC dwell-time of 28.5 (IQR 17.4-50.8) hours.
- PIVC failure had a median PIVC dwell time of 24.1 (IQR 11.7-50.8) hours
- Patients without PIVC failure had a median PIVC dwell time of 29.9 (IQR 20.7-49.8) hours.
- Infiltration and occlusion accounted for 15% of pivic failure.
- The first attempt insertion success rate was 79%.
- The percentage of PIVCs not used for any intravenous therapy intravenous medications and contrast scans was 25%.
- In ED seven unique clinician roles provide insertion.
- Table 1 displays summary statistics; Table 2 displays PIVC dwell time; and Table 3 displays multivariate analysis of PIVC failure.

Table 2: PIVC dwell time (hours) for the entire cohort as well as those with and without PIVC failure

Cohort	N	Median	Lower Quartile	Upper Quartile
PIVC Failure: Yes	118	24.1	11.7	50.8
PIVC Failure: No	273	29.9	20.7	49.8
Entire Cohort	391	28.5	17.4	50.8

Established highly prevalent forms of post insertion failure include: infiltration/extravasation; occlusion; dislodgement (accidental-securement device failure or purposeful removal); phlebitis/thrombophlebitis due to pharmacological, mechanical, and infective causes.

Statistical Analysis

- Forward stepwise model selection was performed where the variable entry and exit significance level was set at 5%.
- Proportional hazards assumption was tested by including the time-dependent covariates in the model and checking for significance.
- Hazard ratios (HR), 95% confidence intervals (CI), and P-values are provided.
- Data were analysed using the R environment for statistical computing (version 3.4.4).

Table 3 Multivariate results from analyzing time to PIVC failure (HR – hazard ratio, CI – confidence interval).

Variable	HR	95% CI	P-value
Patient Gender			
Female vs. Male		Not Significant	
Patient Age			
For a one year increase	1.02	1.01-1.03	<0.0001
Skin Condition			
Fair vs. Poor		Not Significant	
Good vs. Poor			
Insertion Site			
Forearm vs. Upper arm	6.86	0.82-57.68	
Wrist vs. Upper Arm	6.86	0.80-60.80	
Antecubital Fossa vs. Upper Arm	11.25	1.39-91.14	0.0337
Back of Hand vs. Upper Arm	12.75	1.47-110.31	
Triage Category			
Life-Threatening vs. Less Urgent	2.04	1.39-3.01	0.0003
Clinician Role			
Consultant vs. Med Student	0.43	0.16-1.15	
Intern vs. Med Student	0.21	0.09-0.49	
Nurse vs. Med Student	0.60	0.24-1.51	0.0095
Phlebologist vs. Med Student	0.27	0.11-0.67	
RMO vs. Med Student	0.37	0.19-0.72	
Registrar vs. Med Student	0.31	0.14-0.68	
Aseptic non-touch technique			
No clinical breach v Clinical breach	0.63	0.42-0.96	0.0326
Ultrasound			
Yes vs. No	6.52	2.11-20.10	0.0011

New Knowledge

- This is the first study to our knowledge to identify PIF is greatest when the PIVC is inserted by medical students.
- PIVC inserted with an aseptic non-touch technique are associated with reduced PIF.

Future Strategies

- Specific PIVC educational interventions for all staff inserting PIVCs and perhaps specifically for medical students to assess the validity of this result.
- Targeted educational and workforce strategies should be considered to reduce ATS 1 and 2 patients and USGPIVC experiencing PIF.

Conclusion

- Our results of 30% succumbing to PIF echoes recent reports of similar failure rates all from largely modifiable reasons.
- Where it is clinically achievable the ante cubital fossa region and back of the hand should be avoided in favour of the forearm veins for PIVC placement.

Clinical Trial Registration

Australian and New Zealand Trials Registry (ANZCTR12615000588594)

THE UNIVERSITY OF
WESTERN AUSTRALIA
Achieve International Excellence

Alliance for Vascular Access Teaching and Research

Queensland, Australia