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Original Article

Comparison of Local Infection, Dwell Time and Pain in Peripheral Venous Cannulation passed by Experts versus General Inserters at a Tertiary Care Hospital

Elleyyeen Avais, Syed Anees Ahmed Gardezi, Muhammad Uzair, Muhammad Iqbal, Hassan Javed

Department of General Medicine, Pak Emirates Military Hospital/National University of Medical Sciences (NUMS), Rawalpindi Pakistan

ABSTRACT

Objective: To compare the incidence of local infection, Dwell time and pain associated with peripheral venous cannulation (PVC) when performed by experts versus general inserters in a tertiary care hospital.

Study Design: Randomized controlled trial (IRCT20230925059510N1).

Place and Duration of Study: Inpatient Departments, Pak Emirates Military Hospital, Rawalpindi Pakistan, from Apr to Sep 2023.

Methodology: Patients were randomized into Group-A (insertion by experts) and Group-B (insertion by general staff) with 175 participants each. Primary variables measured were total dwell time, incidence of local site infection, failure of insertion by the inserter, pain as assessed on the Visual Analog Scale (VAS), and patient satisfaction assessed by a 7-point standard Likert Scale (0=Extremely dissatisfied to 7=Extremely satisfied).

Results: Failure of insertion was seen in 05(2.9%) patients in Group-A versus 40(22.9%) patients in Group-B (p=0.045). Assessment of median pain scores on insertion on the Visual Analog Scale showed median scores of 3.00 (IQR=0.00) in Group-A versus 4.00 (IQR=1.00) in Group-B (p<0.001). Patient satisfaction post-procedure as assessed on standard 7-point Likert Scale showed median satisfaction scores of 6.00 (IQR=1.00) in Group-A versus 4.00 (IQR=1.00) in Group-B.

Conclusion: We concluded that even though expert inserters result in decreased failure rates and better patient pain scores and compliance, their availability as a separate team in resource constrained setups cannot be recommended at present.

Keywords: Cannulation, Infection, Pain, Visual Analogue Scale.

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INTRODUCTION

Peripheral venous cannulation (PVC) is the most common invasive procedure done at hospitals and medical care facilities to patients.[1] It is estimated that more than 2.5 billion procedurals, interventional and treatment needed peripheral venous cannulations are done globally.[2] It is then imperative that the medical professionals and staff should be trained in the procedure to prevent complications and patient discomfort. PVC demands practice and experience and is not reliant on qualifications and credentials alone.[3] In this regard, a nursing attendant or a laboratory technologist may acquire the same skill if properly trained and guided by an experienced person in the procedure.[3] Professionals and medical staff working in the intensive care units and high dependency units (HDUs), operating rooms, and including medical specialists, anesthetists, critical care specialists with staff including residents and nurses were found to fit the criteria in the majority of cases in major setups.[4]

Correspondence: Dr Elleyyeen Avais, Department of General Medicine, Pak Emirates Military Hospital, Rawalpindi Pakistan

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Procedural complications are common and result in double pricking, venous rupture, extravasation, occlusion, and insertion failure.[5] The incidence of these complications when performed by inexperienced staff can be from 50-72% in certain cases, with phlebitis seen in 12.9% of all cases.[6] There is no system of vascular access specialists in medical setups of our demographic area and whether or not tailor made, and trained professionals can decrease the incidence of complications in our resource constrained setups needs to be evaluated.

The objective of this study was to compare the incidence of local infection, dwell time and pain associated with peripheral venous cannulation (PVC) when performed by experts versus general inserters in a tertiary care hospital.

METHODOLOGY

This randomized controlled trial (Registration Number 73045 and Registration Ref IRCT20230925059510N1 registered under Iranian Registry of Clinical Trials) was carried out at the Departments of Medicine, Anesthesiology and Intensive Care, Pak Emirates Military Hospital

Rawalpindi, Pakistan from Apr to Sept 2023 after approval from the Institutional Ethical Review Board (vide letter no. A/28/ER/592/23).

Inclusion Criteria: Patients of either gender above the age of 18 years admitted to the medical wards of our setup, and requiring peripheral intravenous access for more than 24 hours were included.

Exclusion Criteria: Patients with peripheral vascular disease, infection of the upper limbs hindering or contraindicating peripheral venous line insertion, and those with a current bloodstream infection were excluded.

The sample size was calculated keeping the population proportion of peripheral venous cannulation success with inexperienced inserters on first attempt at 87% and those done by experts at 99%.[7] Minimum sample size using WHO calculator came out to be 174 and 16 participants respectively. We assessed 400 patients for our study protocol, and included 350 patients for randomization into allocated groups. Method of randomization was simple random sampling (Envelop method) according to the inclusion criteria furnished (Figure).

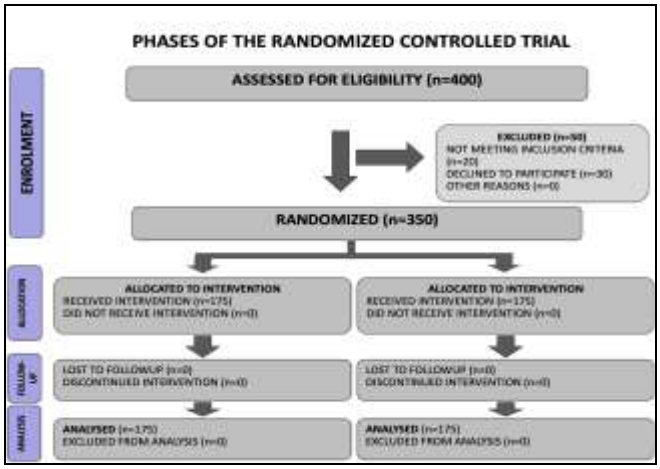

Figure: Phases Of The Randomized Controlled Trial

The patients were randomized into Group-A (insertion by experts) and Group-B (insertion by general staff) with equal number of patients (n=175) in each group. Informed written consent was taken, and patients in both groups were explained in detail about the procedure and possible complications. All procedures, whether performed by experts or general staff, were done according to the ethical policies and institutional SOPs.

For the purpose of our study, we defined what constitutes a skilled or expert inserter in our hospital setup. An expert group comprises of people with good understanding of vascular anatomy, ability to correctly identify major veins of the body, good understanding of venous lines, gauge sizes and correctly inserting the correct sized peripheral venous line, ability to use assistive devices for easier access in complicated or difficult cannulation including vein finders and ultrasound guided access.[4]

For the interventionist to be included in the expert group, a criterion was used which mandated the person of having excellent knowledge of venous anatomy of the upper limb, working in the hospital setups where difficult and challenging peripheral venous insertions are common including intensive care and HDU setups. All experts included had a minimum experience of five years working in these setups. This was a double-blind study and the person performing the intervention and the one analyzing was unaware of the study protocol and received pre-filled proformas for data analysis. Since feedback of patients undergoing the intervention was mandatory, they could not be blinded to the complete study protocol.

Both groups were inserted with a standard 20 G Braun Introcan Safety peripheral venous catheter of polyurethane material in the upper limb in the median antecubital or cephalic vein before through disinfection of the area with 70% isopropyl alcohol swab. Insertion failure was established after three failed attempts to successfully pass the cannula in the vein. Correct insertion was confirmed by ultrasound guided needle tip detection in the vein and by successful fluid delivery through the intravenous cannula. All peripheral cannulas were changed after 72 hours as standard institutional procedure and total dwell time was recorded accordingly.

Primary variables measured were total dwell time, incidence of local site infection, failure of insertion by the inserter, pain as assessed on the Visual Analog Scale (VAS) during procedure, and patient satisfaction assessed by a 7-point standard Likert Scale (0=Extremely dissatisfied to 7=Extremely satisfied).[8,9]

All statistical calculations were performed using Statistical Package for Social Sciences 26. Demographic data were statistically described in terms of mean and SD, frequencies, and percentages when appropriate. Independent samples t-test was used to compare statistically significant means. Chi-square was used to compare primary variables. Mann Whitney U test was used to compare median scores. A p-value of ≤ 0.05 was considered statistically significant.

RESULTS

A total of 350 patients were included after randomization into two equal groups: Group-A (n=175) and Group-B (n=175). Mean age of patients in Group-A was 25.26±3.18 years versus 25.35±.3.20 years in Group-B (p=0.789). Mean weight was 75.58±3.73 kg in Group-A versus 75.46±3.84 kg in Group-B (p=0.778). Gender distribution showed 120(68.57%) males and 55(31.43%) females in Group-A versus 115(65.71%) males and 60(34.29%) females in Group-B (Table-I).

Table-I: Age and Height Characteristics across Groups (n=350)

Variable	Group-A (n=175) Mean±SD	Group-B (n=175) Mean±SD	*p*-value
Mean age (years)	25.26±3.18	25.35±3.20	0.789
Mean weight (kg)	75.58±3.73	75.46±3.84	0.778
Gender distribution	**n(%)**		
Male	120(68.57%)	115(65.71%)	-
Female	55(31.43%)	60(34.29%)	-

When observing the primary variables in both groups, mean dwell time for the PVCs was 73.24±13.17 hours in Group-A versus 72.54±13.16 hours in Group-B (p=0.621). Multiple insertion attempts (≥2) were done in 10(5.71%) patients in Group-A versus 30(17.14%) patients in Group-B (p=0.139). Incidence of local site infection was seen in 14(8.00%) patients in Group-A versus 17(9.71%) patients in Group-B (p=0.735). Failure of insertion was seen in 05(2.86%) patients in Group-A versus 40(22.86%) patients in Group-B (p=0.045). Assessment of median pain scores on insertion on the Visual Analog Scale showed median scores of 3.00 (IQR=0.00) in Group-A versus 4.00 (IQR=1.00) in Group-B (p<0.001). Patient satisfaction post-procedure as assessed on standard 7-point Likert Scale showed median satisfaction scores of 6.00 (IQR=1.00) in Group-A versus 4.00 (IQR=1.00) in Group-B (p<0.001), as seen in Table-II.

Table-II: Comparison of Primary Variables across Groups (n=350)

Variable	Group-A (n=175)	Group-B (n=175)	*p*-value
Mean dwell time (hours) Mean±SD	73.24±13.17	72.54±13.16	0.621
Insertion in ≥ 2 attempts n(%)	10(5.71%)	30(17.14%)	0.139
Incidence of local site infection n(%)	14(8.00%)	17(9.71%)	0.735
Failure of insertion (3 unsuccessful attempts) n(%)	05(2.86%)	40(22.86%)	0.045
Median pain scores Median (IQR)	3.00 (IQR=0.00)	4.00 (IQR=1.00)	<0.001
Patient satisfaction on the Likert scale Median (IQR)	6.00 (IQR=1.00)	4.00 (IQR=1.00)	<0.001

When comparing the frequency of complications between both groups, phlebitis was observed in 16(9.14%) patients in Group-A versus 32(18.29%) patients in Group-B. PVC occlusion was seen in 10(5.71%) patients in Group-A versus 14(8.00%) patients in Group-B. Extravasation of blood was seen from vein in 05(2.86%) patients in Group-A versus 10(5.71%) patients in Group-B. Infiltration was seen in 08(4.57%) patients in Group-A versus 09(5.14%) patients in Group-B (Table-III).

Table-III: Frequency of Complications across Groups (n=350)

Complications	Group-A (n=175) n(%)	Group-B (n=175) n(%)
Phlebitis	16(9.14%)	32(18.29%)
Occlusion	10(5.71%)	14(8.00%)
Extravasation	05(2.86%)	10(5.71%)
Infiltration	08(4.57%)	09(5.14%)

DISCUSSION

The study was carried out at our institution as a first of its kind to assess whether there are considerable differences in the intervention level for PVCs in our setup and whether proposing special intervention teams or special venous inserters would offer any advantage over general medical staff. We aimed to assess whether the benefits are significant since employing resources and personnel for this purpose should justify it efficacy and cost-effectivity.

The expert group in our study were already fine-tuned not only in blind insertion of PVCs but also through ultrasound guidance using the dynamic needle tip insertion method. For the sake of comparison, we only used the blind method on the upper limbs of patients in our study to remove method bias. The general group were also trained in the insertion of PVCs according to guidance and literature furnished on the subject in the wards. Results of our study showed that demographic variables including age and weight were statistically comparable in our study and so was the mean dwell time. When comparing whether there was any difference in the number of attempts after trying for more than 2 times in the patients between both groups, the difference was statistically not significant but the number of tries needed to achieve successful cannulation was more in the general group. These results were in line with studies carried out by Plohal *et al.*, and Nickel *et al.*[10,11]

The total intravenous dwell time was comparable in both the groups with mean time of around 3 days in participants of both groups. Since we followed a

standard technique, location and strict aseptic methods in our study, the incidence of local infection was also statistically comparable in both groups with no relation to the expert or general experience affecting the outcome if the technique and disinfection methods were stringent and strictly followed. Similar studies were carried out by Shults *et al.*, and CM Rickard *et al.*, also concluding that disinfection remains one of the best barriers for prevention of infection.[12,13] Another added factor would be changing of the PVCs after 72 hours with a new one to decrease in-situ infections as was done in our study. Further studies are needed to form a causal link of whether any technique or procedures lessens the incidence of infection with proper disinfection.

A significant finding in our study was the statistically significant failure rate of insertion seen in the general group. Not only was it significant, but around one-fourth of all patients included had failure rates for insertion of PVCs which were later on successfully passe by experts for the same patient. Our study concludes that skill level and expertise decrease the incidence of failure exponentially. These results are in line with studies confirming that expert inserters provide better success rates for PVCs insertion which were done by Moreau *et al.*, and Walker *et al*.[14,15] It is the failure rate associated increased median pain scores reported by patients that resulted in overall better satisfaction in the expert group because patients remained more comfortable and satisfied when number of attempts and chance of failure was considerably less.[16]

Adverse effect profile showed phlebitis as the most common complication reported post-procedure in patients. None of the complications studied were significant or profound to warrant recommendation of an expert only approach for PVCs insertion. This was also advocated by studies carried in low-income and resource constrained setups.[17,18,19] Zhang *et al.*, also concluded that increased risk of infection is associated with PVCs.[20]

The study recommends that good training of general staff is preferable to maintaining an expert inserter team especially in resource constrained setups. However, failure of insertion should warrant help from an expert for good patient comfort and satisfaction.

LIMITATION OF STUDY

The limitations are that the study is single center only. Our randomized trial did not include many obese patients, where insertion can be challenging.

CONCLUSION

We concluded that even though expert inserters result in decreased failure rates and better patient pain scores and compliance, their availability as a separate team in resource constrained setups cannot be recommended at present.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

EA & SAAG: Data acquisition, data analysis, critical review, approval of the final version to be published.

MU & MI: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

HJ: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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