

Ultrasound in adult patients with difficult peripheral intravenous access: Education intervention for clinicians

Stephen Wolstenhulme Luke McMenamin, Mohit Arora, Stuart Nutall, Asoka Weerwasinghe

INTRODUCTION

- Peripheral intravenous (PIV) access is fundamental in the treatment of patients with a wide variety of illnesses, whether it be for the delivery of fluids, medications, or blood products.
- Traditionally, PIV access has been established using a 'landmark technique (LM)', based on a knowledge of peripheral vascular surface anatomy, where the vein is palpated and or visualised prior to cannulation.
- PIV access is required in medical imaging departments.
- Clinicians can have difficulty in locating a suitable vein for cannulation.

AIM

- The primary aim of this systematic review (SR) was to evaluate, in patients, over the age of 18 years, with difficult peripheral intravenous (PIV) access, the efficacy and efficiency of ultrasound (US) guided PIV compared to the traditional 'landmark technique'.
- The secondary aim was to evaluate the US guided PIV access educational interventions used, to aid continuing professional development, for medical and non-medical clinical practitioners.

METHODS

- A literature search was undertaken using seven databases.
- Search terms were selected by an initial literature search.
- Quality assurance, data extraction, data analysis and synthesis were done.

FINDINGS

- Seven randomised studies with various study designs were included in the review (Table 1).
- Poor quality assurance was seen (Table 2).
- Heterogeneity in US equipment, probes (Table 3), practitioner education and technique (Table 4) were found.
- Two studies showed conflicting results for the time taken to gain PIV access using US. Two studies showed success rates of 88.6% and 96% using US. (Table 3)
- Three of seven studies (42%) stated the length and type of education for the clinician doing US guided PIV access (Table 4).
- The clinicians who did the US guided PIV included anaesthetists and anaesthesiologists; emergency department physicians and technicians; and nurses (Table 4)

DISCUSSION / CONCLUSION / RECOMMENDATION

- Limited evidence to demonstrate in patients with difficult access the efficiency and effectiveness of ultrasound guided PIV.
- Poor data on the type of education intervention used
- Standardised guidelines for ultrasound guided PIV access are required
- In-depth clinical and academic education for medical and non-medical clinicians is required
- The technique then has the potential to be done by medical and non medical US imaging practitioners when doing contrast studies.
- Multi-centre randomised controlled trial required to evaluate the effectiveness and patient experience is needed for the standardised education intervention.

REFERENCES

- Aponte H et al. The use of ultrasound for placement of intravenous catheters. AANA J. 2007;75(3):212-216.
- Darvish AH et al. Single-Operator Ultrasound-Guided IV Placement by Emergency Nurses. J Emerg Med. 2011;41(2):211-212.
- Kerforne T et al. Ultrasound-Guided Peripheral Venous Access in Severely Ill Patients With Suspected Difficult Vascular Puncture. Chest. 2012;141(1):279-280.
- McCarthy ML et al. Ultrasonography Versus Landmark for Peripheral Intravenous Cannulation: A Randomized Controlled Trial. Ann Emerg Med. 2016;68(1):10-18.
- Pappas NL et al. Ultrasound Guidance as a Rescue Technique for Peripheral Intravenous Cannulation. <http://www.dtic.mil/docs/citations/ADA455987>.
- River G et al. Nurse-Operated Ultrasound for Difficult Intravenous Access: A Randomized Trial. Ann Emerg Med. 2009;54(3):S87.
- Stein J et al. Ultrasonographically Guided Peripheral Intravenous Cannulation in Emergency Department Patients With Difficult Intravenous Access: A Randomized Trial. Ann Emerg Med. 2009;54(1):33-40.

| Study | Randomisation Method | Outcomes Measured | Outcomes (Us Vs Con) |
|-----------------|----------------------------------|---|---|
| Pappas et al. | Random number | No. of attempts, procedure time, patient pain perception | 1.7 vs 3.2 in Time in mins: 13.9 vs 11.3 |
| Aponte et al. | * | Successful rate on 1st attempt, number of attempts, procedure time | 74% vs 81% in Ultrasound vs ST 1.4 vs 1.3. Time in mins: 5.06 vs 2.87 |
| Stein et al. | Computer generated randomisation | Number of attempts, procedure time, patient satisfaction | 2.07 vs 2.37 (mean no) 2 vs 2 (median) Time in minutes: 26 vs 29 Patient satisfaction Likert scale: 8 vs 7 |
| River et al. | * | Success rate, total number of cannulation attempts, time to successful intravenous access | 87% Vs 72% success, average of 1.5 and 2.0 further attempts were required (mean difference of 0.5 attempts). Average time to cannulation in the ultrasound group was 26 minutes Vs 22 minutes (mean difference 4 minutes) |
| Darvish et al. | * | Number of attempts, procedure time, patient satisfaction, patient pain perception | No. of punctures: 1.9 vs 2.3 Time in minutes: 23.7 vs 8.1. Patient satisfaction: 93.3% vs 77.8% |
| Kerforne et al. | * | Successful PIV cannulation before and after crossover, procedure time | 21/30 (70%) vs 11/30 (37%) Time in mins: 6.6 vs 7.25 |
| McCarthy et al. | * | Successful PIV access on 1 st attempt | 81% vs 35% 1 st time success rate |

Table 1. Study design and Outcomes

| | | | | | | | |
|----------------|---------|---------|----|-----|-----|---------|---------|
| Aponte, 2007 | Unclear | Unclear | No | No | Yes | Yes | Unclear |
| Darvish, 2011 | Yes | Yes | No | Yes | Yes | Yes | Low |
| Kerforne, 2012 | Yes | Yes | No | Yes | Yes | Yes | Unclear |
| McCarthy, 2016 | No | Yes | No | Yes | Yes | Unclear | Unclear |
| Pappas, 2006 | Yes | Unclear | No | No | Yes | Yes | High |
| River, 2009 | Unclear | Unclear | No | Yes | Yes | Yes | Unclear |
| Stein, 2009 | Yes | Yes | No | Yes | Yes | Yes | Low |

Table 2 Quality assurance of the studies

| Study | US practitioner profession | US experience | US training | Practitioner (n) | Dynamic | Axis | Plane | | L.A Use | Anatomical location | Catheter insertion |
|-----------------|------------------------------|--|--|------------------|---------|-------|-------|-----|---------|--------------------------|--|
| | | | | | | | In | Out | | | |
| Pappas et al. | Anaesthetists | Anaesthesia training, 5 successful attempts | * | 1 | ✓ | Short | ✓ | ✓ | * | Wrist, ACF | 18 and 20 Gauge |
| Aponte et al. | Nurse anaesthetists | Used US for successful PIV cannulation 5 or more times | * | 1 | ✓ | Short | ✓ | ✓ | ✓ | Hand, wrist and ACF | Unknown catheter directly into vessels |
| Stein et al. | EM Doctors | ACEP US credentials | 1 hour didactic session + 1 hour training programme | 1/2 | ✓ | Short | ✓ | * | * | Elv, Hand, wrist and ACF | Unknown catheter directly into vessels |
| River et al. | Nurses | Several months | * | * | * | * | * | * | * | * | * |
| Darvish et al. | Nurses | Novice | 2 hour Tutorial | 1 | * | * | * | * | * | No restriction | * |
| Kerforne et al. | ICM Doctors | * | * | * | * | * | * | * | * | * | * |
| McCarthy et al. | ED technicians and ED nurses | Novice | 2 hours didactic teaching, skills lab, 10 successful USPIV | * | * | * | * | * | * | * | * |

Table 3 Year of study demographics, US equipment and probe

| Study | Year | Report Type | Origin | Setting | US Equipment | US Probe |
|-----------------|------|---|--------|-------------|--------------------|---------------------|
| Pappas et al. | 2006 | Conference abstract and internal report | USA | Anaesthesia | Site-Rite 3 | 9 MHz linear probe |
| Aponte et al. | 2007 | Journal article | USA | Anaesthesia | Site-Rite 3 | 9 MHz linear probe |
| Stein et al. | 2009 | Journal article | USA | ED | Sonosite titan | 10 MHz Linear probe |
| River et al. | 2009 | Conference abstract | USA | ED | * | * |
| Darvish et al. | 2011 | Journal article | USA | ED | * | * |
| Kerforne et al. | 2012 | Journal letter | France | ICU | Vivid e Ultrasound | 10 MHz Linear probe |
| McCarthy et al. | 2016 | Journal article | USA | ED | Sonosite | Unknown |

Table 4. US practitioner characteristics and technique