Title: Establishing a hospital-based ultrasound-guided peripheral intravenous catheter training program: a narrative of a five-year experience

Authors and Affiliations:

Dr Amy ARCHER-JONES*¹ MBBS(Hons) FACEM BSc CCPU, Dr Peter James SNELLING*¹⁻

⁴ BSc MBBS(Hons) MPHTM FRACP FACEM CCPU Dr Stuart WATKINS¹ MBChB FACEM
FCEM CCPU

1. Emergency Department, Gold Coast University Hospital, Queensland, Australia

2. Sonography Innovation and Research (Sonar) Group, Queensland, Australia

3. School of Medicine, Griffith University, Southport, Queensland, Australia

4. Child Health Research Centre, University of Queensland, Queensland, Australia

*A Archer-Jones and PJ Snelling are dual first authors

Corresponding author:

Dr Peter James Snelling
Gold Coast University Hospital, Southport, Queensland, Australia.
Peter.j.snelling@gmail.com; peter.snelling@health.qld.gov.au

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Conflicts of Interest

None to declare

Authors' contributions

AAJ and PJS wrote the initial manuscript. All three authors reviewed and approved the final manuscript.

Abstract:

Despite ultrasound-guided peripheral intravenous catheter insertion being a well-established method for patients with difficult intravenous access, currently there are limited hospital-based training programs. We describe the training program that was established in our hospital over 5 years ago and how it can be replicated in other centres.

Keywords:

Ultrasound

Peripheral Intravenous Catheter

Vascular access

Training

Education

Background:

Peripheral intravenous catheter (PIVC) insertion is the most frequently performed procedure for patients attending hospital.¹ Ultrasound-guided (USG) PIVC insertion is a well-established method for patients with difficult intravenous access (DIVA).² Learning USG PIVC insertion is straightforward,³⁻⁴ however, quality training is poorly available within the hospital environment.⁵⁻⁶ As a result, in 2015 an USG PIVC training program was established to train or up-skill medical and nursing staff, within our emergency department (ED). Since then, there has been an increase in participants from other departments and external health services, attempting to meet similar objectives and develop local education programs with a minimal funding model, such as ours. To disseminate this training program more widely, with the goal of improving patient care, we describe the elements and our experience to date.

Program Description:

Establishment of the Program

The USG PIVC training workshops commenced within the Gold Coast Hospital and Health Service (HHS) in 2015, coinciding with the introduction of an Australasian College of Emergency Medicine accredited registrar training term in emergency ultrasound. Initially, the workshops ran twice per year and could be delivered with 2-3 faculty, comprising an emergency physician and trainees, credentialed in USG PIVC insertion. This has expanded over the past 5 years, now running 5-7 training days per year^[1] with a pool of 10-12 faculty members, including emergency physicians and advanced trainees, generally holding a Certificate in Clinician Performed Ultrasound (CCPU) qualification through the Australasian Society for Ultrasound in Medicine.

The key learning objectives include:

- Recognition of DIVA patients with indications for escalation to USG PIVC insertion
- Appropriate US machine orientation and handling, including infection control
- Appropriate US vein identification and device selection
- USG PIVC insertion techniques (out-of-plane and in-plane)

Training Day Elements

The training days comprise a series of 2-hour mini-courses, which are repeated 2-4 times throughout the day for different cohorts of participants. The mini-course is divided into a whole group didactic slide presentation (30 minutes), a practical session covering the basics of operating the ultrasound (US) machines and vein-mapping in pairs (30-45 minutes), then USG PIVC training using chicken breast phantom models⁷ (45-60 minutes). Further detail of these components is outlined in Table 1. An online video providing an overview of the training session can be accessed at: <https://www.youtube.com/watch?v=JPT86q4zsKs>.

Venue and Equipment

An appropriate venue is booked for the training day, which has both adequate space and consideration for the hygienic use of chicken models. Initially, non-utilised clinical space within the ED was used but, as this became less available and the participation size grew, a more formalised process with registrations, educational facility bookings and logistical planning was required. A large room with a sealed floor is typically set-up with tables and chairs grouped together with an US machine and chicken phantom model for each pair of participants, tailored to the size of the group (Figure 1).

Many of the expendables required for the day can be sourced within the ED (Table 2). Loan US machines are provided by industry groups. More recently a few machines can be borrowed from the ED, with minor effect on clinical workflow. Chicken phantom models⁷ were chosen and adapted after testing a variety of options, as they provide a realistic, cost-effective (\$3-4 per phantom model), high-fidelity experience, allowing participants to repeatedly insert PIVCs under USG in real-time. These involve a regular chicken breast, sliced in half lengthways, with two long cylindrical modelling balloons filled with coloured (food dye) water. The chicken breast is sealed in a piece of clear plastic wrap, ensuring all air is removed. These are made and refrigerated the day prior, with approximately one chicken model per pair of participants. As fluid from the model balloons leak after repeated use, a 25-gauge needle can be carefully inserted into the balloons to refill them, to maintain turgor (Figure 2). For training the transducers are covered in non-sterile^[2] freezer bags and standard ultrasound gel is utilised (Figure 3).

Participants

The number of participant bookings per mini-course is variable (6-24), which also depends on the availability of faculty and US machines. We aim to provide a 1:2 faculty and US machine to participant ratio to maximise the learning experience. Participants generally consist of a mixture of both medical and nursing staff at all levels of training. The program is advertised

internally to all doctors and nurses who insert PIVCs within the HHS, with a particular focus on staff from the ED. The course is advertised by email and posters in clinical and non-clinical areas. Course attendance comes at no cost to participants, voluntary, and is either completed in their own time, rostered clinical time or rostered non-clinical time. As the program has grown, it has attracted external participants by word of mouth, including representation from adult, paediatric and mixed centres within northern New South Wales and southeast Queensland. Leaders from these sites who enquire have been invited to attend to observe and adopt a similar USG PIVC training program within their own HHS. A local credentialing process is available to participants with evidence of successful completion of three USG PIVC insertions following attendance at the workshop.

Future Directions

The USG PIVC training workshop has now been running for over 5 years, with well over 1,200 medical and nursing staff trained within our HHS alone. This interdisciplinary, low cost model has been made freely available to external sites, with the goal of similar training courses being replicated for staff in their settings.

Our message is clear and simple: “make the first attempt, the best attempt” for patients identified as having DIVA. Given the realised benefits for patient care, our goal is for further knowledge translation and implementation of USG PIVC programs locally, regionally and nationally. Further research is required to evaluate the medium to long-term patient benefits from the widespread implementation of USG PIVC training programs.

Footnotes:

[1] Workshops have been disrupted by COVID-19 but are now recommencing with the easing of social distancing restrictions

[2] Sterile freezer bags and sterile ultrasound gel sachets are available in the ED for clinical use.

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Table 1: Elements of Training Workshop**1. 30-minute didactic lecture**

- Patient characteristics at risk of difficult IV access
- Indications for USG PIVC
- Basic US physics and operation
- Optimisation of ergonomics with 4 'P's: Patient, Practitioner, Probe and Preset
- Venous anatomy
- US artery/vein identification, including distinguishing features
- Appropriate device selection (longer PIVCs for deeper veins)
- USG PIVC techniques (short and long axis methods)
- Hygiene: probe cover, infection control, cleaning

2. 30-45-minute of US vein mapping

- Participants in pairs with a faculty member
- Orientation to US machine
- US image acquisition and optimisation skills
- US identification of anatomical landmarks and structures to avoid (valves, nerves, artery, venous thrombosis)
- Vein 'mapping': US identification and assess suitable veins for calibre, position and trajectory
- Use of US colour/power doppler for vein patency and post insertion checks

3. 45-60-minute USG PIVC phantom models

- USG PIVC insertion into modelling balloons within chicken models
- Device selection based on vein characteristics, depth, size and position
- In-plane and out-of-plane insertion techniques
- Post insertion checks

Table 2: Equipment list

- Table – 1x per 2-4 attendees (depending on size)
- Chair – 1x per attendee
- US machines with linear transducer – 1x per 2 attendees
- US gel bottles – 1x per US machine
- Probe covers (non-sterile) – 1x per US machine per session
- Rubber bands
- Tourniquets
- Chicken phantom models – 1x per 2 attendees
- Disposable gloves
- Plastic disposable aprons or gowns
- Absorbent mats/sheets – 1x per chicken model
- PIVCs – 3-4x per pair (advise not to retract the sharp until finished)
- 25G needles and 10mL syringes
- Small bowl with water ($\pm$ dye) to allow re-filling of balloons
- Clinical waste bins
- Sharps bins
- Detergent wipes to clean US probes and tables after use

Figure Legends:

Figure 1. Room and equipment set up

Figure 2. Refilling the balloon in the chicken phantom model

Figure 3. Final component of training

Figure 1. Room and equipment set up

80x52mm (300 x 300 DPI)

Figure 2. Refilling the balloon in the chicken phantom model
82x51mm (300 x 300 DPI)

Figure 3. Final component of training

71x61mm (300 x 300 DPI)