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The RELIABLE trial (RELiable Intravenous Access By Line Experts): A pilot randomised controlled trial protocol of expert versus generalist peripheral intravenous catheter insertion

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STRENGTHS AND LIMITATIONS OF THIS STUDY

- A pilot RCT allows testing of the adequacy of study methods and procedures for a future, large RCT with adequate power to test hypotheses.
- The study will determine feasibility of a larger RCT: 1) timelines; 2) participant recruitment; 3) protocol co-operation and support of key stakeholders; 4) appropriateness of facilities and equipment; 5) financial resources needed; 6) ethical requirements; 7) investigator expertise; and 8) educational requirements for staff for protocol adherence and adequacy of current training materials.
- Assess the adequacy of the data collection tool: refine and test collection instruments (for example, reliability and validity); test that the data analysis techniques are adequate.
- To strengthen future grant applications for a definitive study by showing the researchers' competency and the feasibility of the study.
- As a pilot trial, the sample size will not be adequate to provide a definitive answer regarding the effectiveness of PVC insertion by a VAS compared with a generalist inserter on clinical and economic outcome.

INTRODUCTION

Peripheral intravenous catheters (PVCs) are essential for the administration of intravenous fluids and medications for the treatment of hospitalised patients. They are the most commonly used of all vascular access devices (VADS) with annual sales of 330 million per year in the USA and 14 million in Australia[1,2]. Yet, for such an important device their failure rate remains unacceptably high, with reported resites required for up to 69% of PVCs[3-6].

In the past, hospitals often employed intravenous therapy teams (IVTT) to insert a majority of PVCs[7,8]. Increasing pressure on health care budgets has resulted in the disbanding of many IVTT[9]. Now, many hospitals have PVC insertions performed by generalist clinicians (nursing and medical) at the unit level, who, while assessed as competent, are typically not expert inserters. Unit-level inserters may provide superior continuity of care since clinical staff are familiar with the patient's diagnosis and medical history, and there is a belief that their lesser expertise rarely has negative outcomes[10]. This model of care focuses on the procedural skill of PVC insertion, rather than the broader approach of the discipline of infusion therapy, such as selecting the right catheter and site for a specific patient and therapy[11]. Other models advocate the benefit of vascular access specialist (VAS) inserters, either through an IVTT[12] or within existing nursing infrastructure[13] for PVC insertion and clinician education. The definition of a VAS for this research is a clinician with advanced knowledge of vascular access including catheter technology, insertion assistive devices, dressings and securement, modalities of catheter access, IV therapy management[14], in combination with expert inserter skills. It is argued that this expertise preserves veins, enhances the patient experience, decreases the incidence of infusion complications and ultimately saves costs associated with clinician time, materials and length of hospital stay[13]. The use of a VAS for PVC insertion exists in part due to an ongoing concern that a generalist approach results in multiple needlesticks (multiple insertion attempts) that cause great discomfort to patients and irreversible damage to the venous system, limiting current and future vascular access[11].

Successful PVC insertion and prevention of resultant catheter-related complications and device failure are important clinical objectives and patient outcomes[14]. The level of inserter skill has been identified as a risk factor for catheter failure[7,15]. However, there have been no high-quality randomised controlled trials (RCTs) investigating the benefit of a VAS. Observational studies and audits have found VAS-inserted PVCs to have longer functional dwell time[16]; fewer insertion attempts[7,17]; and less phlebitis[18,19], inflammation and catheter-related sepsis[20]. A number of these observational studies were conducted before the year 2000[18,19,21], so there is little contemporary information about the impact of VAS inserters in the context of modern PVC materials, dressings and securement and the trend to older, more obese patient populations. Some studies identified a benefit of VAS inserters in hospital settings, but their outcomes were not compared against a control group of generalist PVC inserters and thus have not been adequately assessed[7,8]. Previous studies in this area have only measured the immediate success of the PVC insertion procedure

and not the resultant impact on complications or device failure[7]. In addition, data has been collected retrospectively, risking recall bias[8], or clinical staff have assessed their own PVC insertion skill level, which may introduce detection bias[13].

Current local[22] and international guidelines[23-25] provide limited direction on PVC insertion and maintenance, often referring to local health institutions requirements. In Australia, there is no national credentialling for a minimum level of knowledge, expertise and decision-making skill for clinicians inserting a PVC. This results in a variation of knowledge, skill, experience and expertise for PVC inserters across health care settings[26]. The challenge for local and international guiding bodies is the lack of robust RCTs that have tested the effectiveness of different knowledge and skill level on successful PVC insertion and prevention of device failure and complications. Consequently, in the absence of evidence from high-quality RCTs, it is impossible to produce comprehensive clinical practice guidelines for best PVC insertion model of care. The objective of this pilot RCT is to test the feasibility of conducting a suitably powered RCT by assessing both the methodology and rigour of methods planned for the larger study[27,28].

METHODS AND ANALYSIS

Design

We will conduct a single-centre, parallel group, pilot RCT to compare PVC insertion by a VAS with the insertion by any clinician (generalist model, standard practice).

Hypothesis

Primary hypothesis

The feasibility of conducting a future, large RCT with adequate statistical power to test hypotheses will be established by meeting targets formulated *a priori.* These are based on results from previous PVC pilot trials[29,30]. Targets are as follows:

- Eligibility: over 90% of patients screened will be eligible.
- Recruitment: over 90% of eligible participants will agree to enrol.
- Retention and attrition: fewer than 5% of patients will be lost to attrition.
- Protocol adherence: over 90% of participants in the intervention groups will receive their allocated treatment.
- Missing data: less than 5% (primary endpoint).
- Patients and clinical staff will report greater than 80% satisfaction and acceptability with the vascular access expert.

Secondary hypothesis

Hypothesis 1

Patients whose PVC was inserted by a VAS will have fewer episodes of device failure (composite of phlebitis, infiltration, occlusion, accidental removal or dislodgement and local or catheter-related bloodstream infection (CRBSI)) than those whose PVC is inserted by standard practice (generalist approach).

Hypothesis 2

Patients whose PVC was inserted by a VAS will have fewer failed insertions, insertion attempts and associated patient-reported pain.

Hypothesis 3

Patients whose PVC was inserted by a VAS will have longer device dwell time compared to those whose PVC is inserted by standard practice (generalist approach).

Setting

The trial will be conducted in a single-centre, 929-bed referral teaching hospital, the largest provider of health care services in Queensland, Australia, with more than 90,000 patients admitted every year.

Ethics

The study has received approval from the RBWH Human Research Ethics Committee (**HREC/16/QRBW/386**) and the Griffith University Human Research Ethics committee (**2016/782**). Written consent will be obtained from participants and serious adverse events will be monitored and reported to both HRECs, although these are not expected. In accordance with the National Health and Medical Research Council, all data will be stored securely in a password-protected database or paper copies in a locked filing cabinet, and participants' confidentiality will be maintained with only aggregate data published[31].

Participants

Participants for this study will be patients admitted to general medical and surgical wards, over the age of 18 and expected to require their PVC for greater than 24 hours. They will be excluded from recruitment if they have a current bloodstream infection or have previously been in the study. Eligible patients will be advised of the study, provided with written information and consent to participate will be sought by a research nurse (ReN).

Sample size

Approximately 160 patients are discharged each month from medical and surgical wards of the hospital. For this pilot study, the recruitment target is 50 participants per group. The study will not be powered to detect statistical significance between groups, but rather to assess the feasibility of the methods to be used in a larger study. The sample size is recommended in the literature as adequate for the purposes of feasibility assessment[32,33].

Interventions

The control group of this trial will have PVCs inserted as per hospital policy by an accredited PVC inserter. This is a generalist approach. The access site, type of device and method of PVC securement will be at the inserting clinician's discretion.

For the intervention group, the PVC will be inserted by a VAS who is a registered nurse (RN) with advanced knowledge of vascular access, including catheter technology, insertion assistive devices, dressings, modalities of catheter access and intravenous therapy management, selecting the right VAD for the right patient in combination with expert insertion skills. The insertion will also follow the hospital's policy.

OUTCOME MEASURES AND DEFINITIONS

Primary outcomes

The feasibility of conducting a definitive RCT will be assessed against the following criteria: 1. *Eligibility* (percentage of eligible screened patients); 2. *Recruitment* (percentage of eligible patients who consent to trial participation); 3. *Retention and attrition* (percentage of participants lost to follow-up who withdraw consent); 4. *Protocol adherence* (percentage of participants who receive their randomised intervention); 5. *Missing data* (percentage of missing data); and 6. *Patient satisfaction* (of PVC at insertion and removal, scored on an 11-point scale of 0 = very dissatisfied to 10 = very satisfied).

Secondary outcomes

PVC failure defined as early device removal before the end of therapy because of:

- Phlebitis was considered to have occurred if one or more of the following signs and symptoms occur: pain or tenderness scored at 2 or more on an increasing pain increment scale, or redness or a palpable cord (all extending greater than 1 cm from the insertion site) or purulence (from site, with ulceration).
- Leakage (yes/no).
- Infiltration (the movement of IV fluids into the surrounding tissue[34,35], swelling greater than 1 cm from the insertion site).
- Occlusion (the PVC will not flush or leaks when flushed)[36].
- Accidental removal (partial or complete dislodgement of the PVC from the vein).
- Infection (laboratory-confirmed local or catheter-associated bloodstream infection)[25]: PVC skin swabs, PVC tip and blood cultures may be collected as per usual clinical practice if clinical suspicion of local infection or systemic infection.

PVC dwell time: from the time of PVC insertion until removal from either device failure, routine replacement or the completion of IV therapy.

PVC insertion: successful insertion and number of insertion attempts for 24 hours post randomisation.

Cost-effectiveness: estimates of costs of staff resources, equipment and PVC failure resource usage with previously developed cost estimations[37]. Detailed resources used for a PVC insertion and removal will be recorded for a subset of 15 patients per study group.

STUDY PROCEDURES

Randomisation

Once the ReN obtains written consent, a web-based central randomisation service provided by the Griffith University Clinical Trials Randomisation Service will be used to obtain group allocation. This process will provide a computer-generated ratio between groups of 1:1 and randomly varied small block sizes. Allocation will be concealed prior to randomisation.

Blinding

This trial is blinded for the secondary endpoint of PVC failure. This will be achieved as there are two ReNs for this study. The first will be responsible for recruitment and randomisation. The second ReN will collect daily PVC site and device failure information and will be blinded to the treatment group. The endpoint CRBSI will also be allocated by a blinded infectious disease expert using a pre-determined definition. Due to the nature of the study, blinding of patients and treating clinicians to the intervention received will not be possible. However, we have no reason to believe that clinicians and patient responses will be influenced to favour a particular intervention.

Other aspects of PVC care

PVCs will be inserted by hospital-accredited clinicians. Subsequently, PVCs will be managed by clinical staff using the standard hospital policies. If required, PVCs will be re-sited every 72 hours, following hospital policy.

Strategies to promote protocol adherence

To promote adherence to the study protocol, any clinical staff inserting PVCs or caring for study participants will be provided with education about the study protocol prio to, and during the trial. The researcher will be available to answer queries from clinicians during the course of the study.

Data collection

Data will be collected and entered directly into an electronic data platform supported by REDCap™ (Research Electronic Data Capture) (REDCap Software Version 6.10.6 © 2016 Vanderbilt University)[38]. The feasibility outcomes (eligibility, recruitment, retention and attrition, protocol adherence and sample size estimates) will be collected from enrolment screening logs (held at the study site) and the data entered into an electronic clinical research form on RedCap™. The screening log will have the patient's unique hospital number, eligibility and randomisation allocation.

At the time of recruitment, the ReN who is a VAS will assess all patients and collect the following patient demographic and clinical characteristics: age, gender, diagnosis, possible insertion sites and vein quality as per the *peripheral vein assessment tool*[39]. They will ask the patient about their preferred PVC insertion site, and decide based on patient assessment and the planned IV therapy whether a PVC is the appropriate VAD choice for the patient and discuss this with the treating team, if necessary[39,40]. After PVC insertion, data will be collected on the gauge size, clinician inserting the PVC, number of insertion attempts, place of insertion and type of securement/dressing will be collected. A convenience sample of 15 patients per intervention group will have the insertion procedure timed and data collected about the type of clinician (medical or nursing) and products used (for example, dressing type). The patient will be asked about the number of insertion attempts and the pain level as well as data extracted from the medical record. Inserters will be asked why they chose the insertion site and gauge of PVC, and to rate the difficulty of the insertion (0 = difficult and 10 = easy).

All participants will be visited daily by a second ReN blinded to the intervention group. They will ask patients to rate their satisfaction with the insertion procedure. They will perform daily assessments for PVC complications based on an inspection of the insertion site and patient-reported symptoms. On the day of PVC removal, the ReN (blinded to treatment group) will record the date, time and reason for PVC removal (device failure, routine resite, completion of treatment), as well as perform the daily site inspection. At removal, the participant's overall satisfaction with the PVC (11-point scale, with 0 = dissatisfied and 10 = satisfied) will be recorded.

Statistical analysis

Data related to the feasibility outcomes will be tabulated as percentages and means, reported descriptively and analysed against predetermined acceptability criteria, for example, <5% missing data. To pilot the inferential statistics, data will be exported into IBM SPSS Statistics version 22 (SPSS) for analysis. An intention-to-treat analysis framework will be used; the unit of analysis will be one PVC per patient. Proportions (%) will be reported for categorical data. Mean values and standard deviations (SD) will be reported for normally distributed continuous data; with median values and 25th/75th percentiles reported otherwise. Cox regression will be used to assess the effect of patients and treatment differences as well as for group comparisons. A graph of the Kaplan-Meier survival function by group will be generated, and the proportional hazards assumption checked with the log-log plot of survival, and log-rank test performed.

A cost analysis for the subset of 30 patients (15 patients per group), will calculate the mean and median values for the total cost of each IV insertion. Total cost = clinician (directly measured time x estimated hourly salary) + fixed cost (supplies).

Validity and reliability

Internal validity will be maintained by adhering to the study protocol and by using accepted definitions published in the literature for measuring PVC outcomes. Daily PVC site inspections and assessment of outcome measures will be performed in a standardised manner by clinically appropriate staff (for example, infectious diseases expert will allocate the outcome CRBSI).

To promote external validity, the characteristics of the target population and the inclusion and exclusion criteria are clearly defined[41]. The study will identify the type of clinician and level of experience of PVC inserters, and take the pragmatic approach of usual clinical PVC care to ensure results are clinically relevant.

Reliability will be assessed by conduction of inter-rater reliability testing for 10% of PVC site daily inspections and outcome assessments, between the daily assessor and an independent VAS. Ten per cent of the patients' data entry will also be cross-checked, with missing data and implausible values also queried and corrected, where possible.

Dissemination of results

Study results will be presented locally and at relevant international meetings. Participants will be informed at recruitment about how to access results. Results will be published in a peer-reviewed nursing or vascular access journal.

Trial status

Recruitment is planned to commence in June 2017 and will take approximately 12 weeks.

DISCUSSION

This study will be the first pilot RCT to investigate the potential benefits of employing a VAS for PVC insertions in an acute care setting. It will provide preliminary data to inform protocol development and funding applications to allow a larger definitive RCT to be undertaken. The study will aid in the development of PVC education as well as provide guidance for local and international clinical guidelines about the skill level required for PVC insertion. Currently, clinical guideline authors have limited high-quality research to inform their recommendations. This trial will also allow us to establish the adequacy and appropriateness of the study protocol, therefore ensuring the feasibility of conducting a large, multicentre RCT.

DISCLOSURES

On behalf of NM and CMR, Griffith University has received unrestricted educational and research grants and consultancy payment for lectures from 3M and Becton Dickinson. On behalf of NM, MC and CMR, Griffith University has received unrestricted investigator-initiated research grants from Centurion Medical Products and Entrotech Lifesciences (manufacturers of PVC dressings) and Becton Dickinson (manufacturer of PVCs). On behalf of MC, Griffith University has received a consultancy payment to develop education material from Baxter. On behalf of CMR, Griffith University has received unrestricted donations or investigator-initiated research grants unrelated to this research from: Adhezion, Angiodynamics, Baxter, Carefusion, Cook Medical, Hospira, Mayo, Smiths Medical Products and Vygon. On behalf of CMR, Griffith University has received consultancy payments for educational lectures or professional opinion from BBraun, Bard, Carefusion, Mayo, ResQDevices and Smiths Medical. On behalf of MC, Griffith University has received a consultancy payment to develop education material from Baxter. JW has no conflicts of interest.

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