Australian Critical Care 28 (2015) 140–148

Contents lists available at ScienceDirect

Australian Critical Care

journal homepage: www.elsevier.com/locate/aucc

Research paper

Novel technologies can provide effective dressing and securement for peripheral arterial catheters: A pilot randomised controlled trial in the operating theatre and the intensive care unit

Heather Reynolds BA, BHthSc (Nursing), MN, MAP, PhD[a,b,c,d,*],
Kersi Taraporewalla MBBS, MClinEd[e],
Marion Tower PhD[f],
Gabor Mihala MEng (Mech), GCert (Biostat)[g],
Haitham W. Tuffaha BPharm, MSci, MBA[g],
John F. Fraser MBChB, PhD[h,a],
Claire M. Rickard PhD[a,b]

[a] NHMRC Centre of Research Excellence in Nursing, Griffith University, Nathan Campus, Queensland, Australia
[b] Centre for Health Practice Innovation, Griffith Health Institute, Griffith University, Nathan Campus, Queensland, Australia
[c] Department of Anaesthesiology, Royal Brisbane and Women's Hospital, Queensland, Australia
[d] The Burns, Trauma & Critical Care Research Centre, University of Queensland, Queensland, Australia
[e] Department of Anaesthesia and Perioperative Care, Royal Brisbane and Women's Hospital, Queensland, Australia
[f] University of Queensland Mater Clinical School, Mater Education, South Brisbane, Queensland, Australia
[g] Centre for Applied Health Economics, School of Medicine, Griffith University, Logan Campus, Queensland, Australia
[h] The Prince Charles Hospital, Critical Care Research Group, Intensive Care Services, Chermside, Queensland, Australia

ARTICLE INFORMATION

Article history:
Received 14 October 2014
Received in revised form 9 December 2014
Accepted 11 December 2014

Keywords:
Peripheral arterial catheters
Dressings
Securement
Nursing
Anaesthesia
Critical care
Randomised controlled trial
Evidence-based practice

ABSTRACT

Background: Peripheral arterial catheters are widely used in the care of intensive care patients for continuous blood pressure monitoring and blood sampling, yet failure – from dislodgement, accidental removal, and complications of phlebitis, pain, occlusion and infection – is common. While appropriate methods of dressing and securement are required to reduce these complications that cause failure, few studies have been conducted in this area.
Objectives: To determine initial effectiveness of one dressing and two securement methods versus usual care, in minimising failure in peripheral arterial catheters. Feasibility objectives were considered successful if 90/120 patients (75%) received the study intervention and protocol correctly, and had ease and satisfaction scores for the study dressing and securement devices of ≥7 on Numerical Rating Scale scores 1–10.
Methods: In this single-site, four-arm, parallel, pilot randomised controlled trial, patients with arterial catheters, inserted in the operating theatre and admitted to the intensive care unit postoperatively, were randomly assigned to either one of the three treatment groups (bordered polyurethane dressing ($n = 30$); a sutureless securement device ($n = 31$); tissue adhesive ($n = 32$)), or a control group (usual practice polyurethane dressing (not bordered) ($n = 30$)).
Results: One hundred and twenty-three patients completed the trial. The primary outcome of catheter failure was 2/32 (6.3%) for tissue adhesive, 4/30 (13.3%) for bordered polyurethane, 5/31 (16.1%) for the sutureless securement device, and 6/30 (20%) for the control usual care polyurethane. Feasibility criteria were fulfilled. Cost analysis suggested that tissue adhesive was the most cost effective.

* Corresponding author at: NHMRC Centre of Research Excellence in Nursing, Griffith University, Nathan Campus, Queensland, Australia. Tel.: +61 438869594.
E-mail address: h.reynolds@griffith.edu.au (H. Reynolds).

http://dx.doi.org/10.1016/j.aucc.2014.12.001

Conclusions: The pilot trial showed that the novel technologies were at least as effective as the present method of a polyurethane dressing for dressing and securement of arterial catheters, and may be cost effective. The trial also provided evidence that a larger, multicentre trial would be feasible.

1. Introduction

Peripheral arterial catheters are widely used in the care of critically ill patients. They are a vital component of contemporary management of patients in the operating theatre (OT) and intensive care unit (ICU), and are usually inserted into a peripheral artery for continuous blood pressure monitoring and blood sampling for frequent blood gas analysis. Worldwide annual usage of arterial catheters is extensive, and is reported as up to eight million in the USA, and 2.5 million in Europe.[1,2] Arterial catheters can fail before the completion of treatment due to complications of accidental removal, partial/complete dislodgement, occlusion, pain, phlebitis and infection, which may be either local or catheter-related. Catheter-related blood stream infections (CRBSI) incur hospital costs of $US 1.2 million annually in the USA,[3] and increase patients' length of hospital stay.[4,5] The insertion site of an arterial catheter is usually dressed with a commercially produced transparent dressing, which assists in maintaining the catheter's position and plays a role in the prevention of microbial entry to the wound. Catheter failure incidence in peripheral arterial catheters is not often reported in the literature, but the few studies available suggest that up to 69% (40/58) of arterial catheter insertion incidents are related to inadequate securement, and 24% (60/249) of catheter use problems involved dislodgement or inadvertent removal.[6] Further, high rates of accidental removal of arterial catheters have been described compared with accidental removal of central venous catheters in intensive care studies, with twice as many,[7] and four times as many reported.[8] Other literature acknowledges the importance of infection in peripheral arterial catheters, which also causes catheter failure. The incidence of arterial catheter-related infection in intensive care has been reported as 0.59 per 1000 catheter days, with 0.34% developing CRBSI,[9] and point prevalence rates stating 0.8% and 1.7 per 1000 catheter days.[10] Systematic review and meta-analysis have confirmed and consolidated impressions that arterial catheters may have a substantial burden of CRBSI, with pooled incidence of CRBSI in arterial catheters reporting a rate of 0.96 per 1000 catheter days.[11]

Inadequate peripheral intravascular catheter securement remains a poorly researched area of patient care, and has been identified as a priority for improvement.[12] There is a paucity of quality studies reporting efficacy of dressing and securement methods for peripheral arterial catheters, with only one previous study (not randomised),[13] and a recent pilot randomised controlled study in cardiac surgical intensive care patients.[14] Specialty anaesthetic and ICU nurses are largely responsible for post-insertion care of arterial catheters, in particular dressings and securement, and play a pivotal role in preventing the catheter-related complication of failure, including premature catheter removal.

1.1. Dressing/securement methods

The current Guidelines by the Centres for Disease Control (CDC) recommend covering the peripheral arterial catheter site with sterile gauze or a sterile, transparent, semipermeable dressing.[15] A sutureless securement device (SSD) is the specified recommended method for securement of the catheter instead of sutures, in order to reduce the risk of infection and needlestick injury.[15] Different dressings are available for use over the arterial catheter site. They are small and large transparent, semipermeable dressings, termed in this trial as usual care polyurethane, and include Tegaderm™[38,39] and Opsite®.[40] A more recent version of transparent dressing involving novel technology to enhance adhesion and including a reinforced opaque adhesive border is Tegaderm™ I.V. Advanced,[38,39] referred to in this study as Bordered Polyurethane (BPU). Traditionally, these dressings have been used in conjunction with adhesive tape to secure the arterial catheter tubing. An alternative to tape is a precision made SSD, specifically used with arterial catheters, such as the novel approaches of the StatLock® arterial stabilisation device[16] or the Grip-Lok® device.[44] Transparent dressings, tapes, and SSDs, which are used for arterial catheters, are also used for IV catheters. Skin glue, also termed tissue adhesive (TA), has had novel use in a limited capacity for the securement of intravascular catheters, providing another alternative to sutures or a SSD. There have been a few small reports of the use of Histoacryl® TA to secure central venous catheters and epidural catheters in the UK.[17–19] The effectiveness of the use of an SSD in arterial catheters has been reported,[13] and recent pilot work on the novel dressing and securement technologies of BPU, an SSD, and TA for arterial catheters, has been performed to inform of effectiveness and the feasibility of further study.[14]

1.2. Study aims

We aimed to determine and compare initial effectiveness of a BPU, SSD and TA versus usual care, in preventing failure in peripheral arterial catheters inserted in the operating theatre and cared for in the intensive care unit, as well as their suitability for study in a large multi-centre randomised trial. We modelled our approach on a previous pilot study, which set feasibility criteria to determine success.[20]

2. Methods

2.1. Study design, setting and participants

This pilot, single-site, four-arm, parallel, randomised controlled trial was conducted within the OT complex and the Department of Intensive Care Medicine at Royal Brisbane and Women's Hospital in Queensland, Australia. The Principal Investigator screened all surgical patients booked for post-operative ICU admission at the anaesthetic Pre-Admissions Clinic and inpatients, Monday to Friday, from September 1, 2012 to March 28, 2013. Patient inclusion criteria were: aged at least 18 years; scheduled elective major surgery requiring an arterial catheter; and booked ICU post-operative care. Patients were excluded if: they had known allergies to the study products; were non-English speaking and an interpreter was not available; the arterial catheter was to be inserted through burned, diseased, or damaged skin; and they were diaphoretic.

Since the primary aim of this pilot trial encompassed feasibility rather than hypothesis testing, formal power calculations were not appropriate. Thus, a sample size of $n = 120$, with three intervention