

Devices and dressings to secure peripheral venous catheters: A Cochrane systematic review and meta-analysis[☆]



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ABSTRACT

Background: Peripheral venous catheterisation is the most frequent invasive procedure performed in hospitalised patients; yet over 30% of peripheral venous catheters fail before treatment ends.

Objectives: To assess the effects of peripheral venous catheter dressings and securement devices on the incidence of peripheral venous catheter failure.

Data sources: We searched the Cochrane Wounds Group Register, The Cochrane Central Register of Controlled Trials, MEDLINE; EMBASE and CINAHL for any randomised controlled trials comparing different dressings or securement devices used to stabilise peripheral venous catheters. The reference lists of included studies were also searched for any previously unidentified studies.

Results: We included six randomised controlled trials (1539 participants) that compared various dressings and securement devices (transparent dressings versus gauze; bordered transparent dressings versus a securement device; bordered transparent dressings versus tape; and transparent dressing versus sticking plaster). Trial sizes ranged from 50 to 703 participants. The quality of evidence ranged from low to very low. Catheter dislodgements or accidental removals were lower with transparent dressings compared with gauze (two studies, 278 participants, risk ratio (RR) 0.40; 95% confidence interval (CI) 0.17–0.92, $P = 0.03\%$). However, the relative effects of transparent dressings and gauze on phlebitis (RR 0.89; 95% CI 0.47–1.68) and infiltration (RR 0.80; 95% CI 0.48–1.33) are unclear. A single study identified less frequent dislodgement or accidental catheter removal with bordered transparent dressings compared to a securement device (RR 0.14, 95% CI 0.03–0.63) but more phlebitis with bordered dressings (RR 8.11, 95% CI 1.03–64.02). A comparison of a bordered transparent dressing and tape found more peripheral venous catheter failure with the bordered dressing (RR 1.84, 95% CI 1.08–3.11) but the relative effect on dislodgement was unclear.

Conclusions: There is no strong evidence to suggest that any one dressing or securement product for preventing peripheral venous catheter failure is more effective than any other product. All of the included trials were small, had high or unclear risk of bias for one or more of the quality elements we assessed, and wide confidence intervals, indicating that further randomised controlled trials are necessary. There is a need for suitably powered, high quality trials to evaluate the newer, high use products and novel – but expensive – securement methods, such as surgical grade glue.

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What is already known about the topic?

- A peripheral venous catheter is typically used for short-term delivery of intravascular fluids and medications, however they often fail before treatment is complete.
- Failure can occur due to inadequate securement of the device to the skin, resulting in the catheter falling out or complications such as phlebitis (irritation or inflammation to the vein wall), infiltration (fluid leaking into surrounding tissues) or occlusion (blockage).

- Inadequate securement may also increase the risk of a catheter-related bloodstream infection, as the peripheral venous catheter moving in and out of the vein allows migration of organisms along the catheter and into the bloodstream.
- Peripheral venous catheter dressings play a vital role in preventing catheter complications. However, despite the many dressings and securement devices available, the impact of different securement techniques for increasing peripheral venous catheter dwell time is still unclear.

What this paper adds

- There is no strong evidence to suggest that any dressing or securement product for peripheral venous catheters is more effective than any other.
- We found limited evidence that catheters were less likely to fail due to dislodgement or accidental removal when a transparent dressing was used, compared with gauze.
- Implications for the need of high quality research have been identified.

1. Background

Peripheral venous catheters are flexible, hollow, plastic tubes that are inserted in a peripheral vein, most commonly the metacarpal vein of the hand, or alternatively the cephalic or basilica vein of the lower forearm (Dougherty, 2008; Tagalakis et al., 2002). They are typically used for the short-term delivery of intravascular fluids and medications. Peripheral venous catheters are an essential element of modern medicine and their insertion is the most frequent invasive procedure performed in hospitals, with up to 80% of all hospitalised patients requiring one (Zingg and Pittet, 2009). In the United States of America, an estimated 330 million peripheral venous catheters are sold each year (Hadaway, 2012). However, catheters often fail before intravenous treatment is completed, which usually requires catheter replacement. Reported failure rates, or unscheduled restarts, range from 33% to 69% (Harwood et al., 1992; Rickard et al., 2010; Royer, 2003; Smith, 2006; Bolton, 2010). Peripheral venous catheters fail for a wide range of reasons; the most commonly identified causes of failure are partial dislodgement or accidental removal, phlebitis (irritation or inflammation to the vein wall), occlusion (blockage), infiltration (fluid moving into surrounding tissue), leakage and, rarely, infection (Rickard et al., 2010; Bolton, 2010; Webster et al., 2008).

Effective catheter stabilisation may reduce the incidence of catheter failure and prevent problems associated with re-siting. For example, a peripheral venous catheter must be inserted through the patient's skin, which normally acts as a protective barrier against bacteria entering the blood stream. Breaking the barrier may lead to phlebitis (Tagalakis et al., 2002; Monreal et al., 1999) or, more rarely catheter related blood stream infection (Maki et al., 2006). Repeated access attempts may also cause future venous access difficulties, including the need for a central venous catheter. In addition, waiting for a catheter to be re-sited can result in an interruption to the delivery of intravenous therapy and medicines with a potential increase in the duration of hospital stay and healthcare costs (Tagalakis et al., 2002; Monreal et al., 1999; Dillon et al., 2008).

Despite a plethora of dressings and devices marketed for securing peripheral venous catheters, only one other systematic review has addressed the effectiveness of these products in preventing catheter related complications. The authors found that there was an increased risk of catheter tip infection when transparent dressings were used compared with gauze but no differences were found in the incidence of phlebitis or

infiltration. However, the review was published before any randomised controlled trials in this area were available, so the inclusion criteria were wide, including abstracts, letters and observational studies (Hoffmann et al., 1992). The most effective method for securing peripheral venous catheters remains unclear, so there is a need to provide guidance for clinicians by synthesise evidence from randomised controlled trials on the efficacy of devices and dressings that are used to secure peripheral catheters.

2. Objective

To assess the effects of peripheral venous catheter dressings and securement devices on the incidence of peripheral venous catheter failure.

3. Methods

We included randomised controlled trials or cluster randomised trials (where the cluster represented randomisation at the ward or hospital level), comparing different dressings or securement devices for the stabilisation of peripheral venous catheters. Cross-over trials were ineligible for inclusion, unless data for the first treatment period could be obtained. Participants included any patients in any setting who required a peripheral venous catheter. The intervention of interest was any dressing or securement device that was compared with another dressing or securement device, for the protection or stabilisation of a peripheral venous catheter. Dressings or securement devices that were made from any type of product (e.g. polyurethane, gauze) were eligible. Our primary outcomes of interest were catheter failure (defined as any reason for the unplanned removal of the catheter); and adverse events associated with the dressing or device. Our secondary outcomes included the incidence of specific reasons for catheter failure (e.g. dislodgement/accidental removal; phlebitis; infiltration; occlusion); time to catheter failure and costs.

3.1. Search strategy

In April 2015 we conducted structured searches in the following electronic databases: the Cochrane Wounds Group Specialised Register (searched 8 April 2015); the Cochrane Central Register of Controlled Trials (CENTRAL; 2015, Issue 3); Ovid MEDLINE (1946 to March 7, 2015); Ovid MEDLINE (In-Process & Other Non-Indexed Citations, March 7, 2015); Ovid EMBASE (1974 to March 7, 2015); and EBSCO CINAHL (1982 to March 8, 2015). For the search strategy used in the Cochrane Central Register of Controlled Trials, refer to Supplementary material Table S1. We adapted this strategy to search Ovid MEDLINE, Ovid EMBASE and EBSCO CINAHL. We combined the Ovid MEDLINE search with the Cochrane Highly Sensitive Search Strategy for identifying randomised trials in MEDLINE: sensitivity- and precision-maximising version (Lefebvre et al., 2011). We combined the EMBASE search with the Ovid EMBASE filter developed by the UK Cochrane Centre (Lefebvre et al., 2011). We combined the CINAHL searches with the trial filters developed by the Scottish Intercollegiate Guidelines Network (SIGN, 2011). We did not restrict studies with respect to language, date of publication or study setting. We searched the following clinical trials registries: ClinicalTrials.gov (<http://www.clinicaltrials.gov/>); WHO International Clinical Trials Registry Platform (<http://apps.who.int/trialsearch/Default.aspx>); and EU Clinical Trials Register (<https://www.clinicaltrialsregister.eu/>). We searched the reference lists of all relevant publications we retrieved for other studies that had not been identified by the search methods described above.

3.2. Study selection

Studies were included in the review if two review authors (NM and JW) independently agreed that they met the inclusion criteria.

3.3. Data collection process

Data was extracted independently by one author (NM), using a standardised form and checked for accuracy by a second author (JW). The extracted information was entered into the Cochrane Collaboration review RevMan software by NM, and JW checked the data for accuracy. If information regarding any part of the data was unclear, we attempted to contact the study authors of the original reports and asked them to provide further details. We extracted the following information: participant characteristics and exclusions; type of dressing or securement device; setting; study dates; unit of investigation (participant or catheter); interventions; length of follow-up; information about ethics approval, consent and any declared conflicts of interest; and outcomes.

3.4. Assessment of risk of bias in included studies

Independently, two review authors (NM and JW) assessed the included studies for risk of bias using a standardised tool (Higgins et al., 2011). This tool addresses seven specific domains, namely: sequence generation; allocation concealment; blinding of participants and personnel; blinding of outcome assessment; incomplete outcome data; selective outcome reporting; other possible problems that could put the study at risk of bias, such as unequal numbers in the study groups or early stopping of a trial. Disagreements between the two review authors (NM and JW) were discussed and resolved by consensus. An overall risk of bias assessment for each study was completed (Supplementary material Fig. S1).

3.5. Data analysis

For dichotomous outcomes, we calculated risk ratio (RR) plus 95% confidence intervals (CI). For continuous outcomes we planned to calculate the mean difference (MD) plus 95% CI. We planned to analyse any time-to-event data (e.g. time to development of phlebitis) using hazard ratios; we did not analyse time-to-event data that were incorrectly presented as continuous data.

We expected to find a number of studies that reported on multiple devices per participant, which were unadjusted for clustering. In such cases we planned to contact the study authors and attempt to obtain: patient-level data or results; data or results for one device per participant; or device-level data. If we were unsuccessful in obtaining the additional data required, then we would exclude the study from the meta-analysis.

We identified the missing data for each study and attempted to contact the study authors to obtain the information necessary for analysis. Where the data could not be obtained, we performed an analysis on the available data. Data was pooled for meta-analysis as fixed effects models. The χ^2 test was used to assess statistical heterogeneity, with significance set at a P value of less than 0.10. The I^2 statistic was also calculated to quantify heterogeneity across studies (Deeks et al., 2011) (heterogeneity declared at >50%) (Deeks et al., 2011).

The following subgroup and sensitivity were planned where data was available: children (under 16 years of age) and adults; continuous versus intermittent IV therapy; additional bandaging versus dressing or securement device alone; adequate vs. inadequate concealment of allocation; size of studies (greater or fewer than 100 patients); follow-up period of less or more than 48 h; missing data – best/worst case scenarios.

4. Results

Fig. 1 shows the flow of studies through the selection process.

We identified 56 references (see Fig. 1). After reviewing titles and abstracts, we eliminated 47 clearly irrelevant references. We retrieved full text copies of the remaining nine potentially eligible papers. We included six of these trials (Bausone-Gazda et al., 2010; Chico-Adron et al., 2011; Forni et al., 2012; Livesley and Richardson, 1993; Rodriguez et al., 2002; Tripepi-Bova et al., 1997), and excluded one trial (Machado et al., 2005). Four further trials are awaiting classification (Calvino Gunther et al., 2014; Machado et al., 2008; Maki and Ringer, 1987; Marsh et al., 2014). We also identified one trial on ClinicalTrials.gov but this was a prospective cohort study.

4.1. Included studies

We included six trials in this review, with a total of 1539 participants, and trial sizes ranging from 50 to 703. Characteristics of the included studies are in Table 1. Two trials were conducted in the United States of America (Bausone-Gazda et al., 2010; Tripepi-Bova et al., 1997), two in Spain (Chico-Adron et al., 2011; Rodriguez et al., 2002), one in Italy (Forni et al., 2012), and one in England (Livesley and Richardson, 1993). All of the trials were

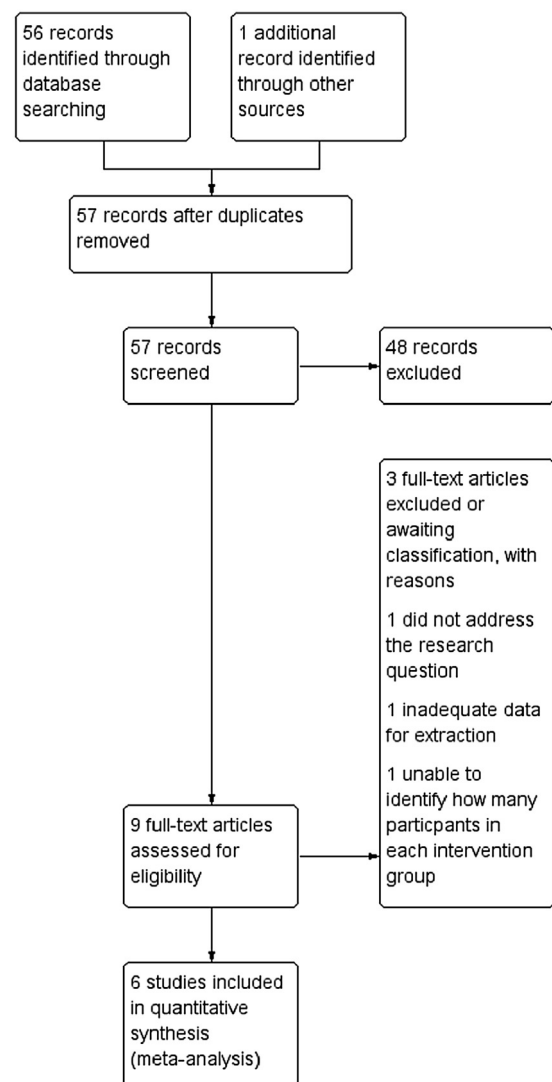


Fig. 1. PRISMA flow chart.

Table 1
Key characteristics of included studies.

Author	Method	Participants	Interventions	Outcomes
Bausone-Gazda et al., (2010)	Single-centre randomised controlled trial in the United States of America	302 medical-surgical patients with an anticipated 96-h need for a peripheral venous catheter.	Bordered transparent group: BD Nexiva Closed IV Catheter System with the insertion site covered with a 3M Tegaderm IV securement dressing. Securement device group: B Braun Introcath Safety Catheter with a Bard StatLock IV Ultra Stabilization Device and the insertion site covered by a transparent dressing.	Catheter failure; Dislodgement/ accidental removal; Phlebitis;
Chico-Padron et al., (2011)	Single-centre randomised controlled trial in Spain	50 patients admitted to general surgical ward and coronary intensive care unit.	Transparent dressing group: sterile strip and transparent dressing. Gauze dressing group: sterile strip and gauze dressing.	Dislodgement/ accidental removal; Phlebitis; Infiltration; Cost;
Forniet al., (2012)	Single-centre randomised controlled trial in Italy	703 paediatric and adult patients with orthopedic/traumatological problems and orthopaedic oncological disease.	Transparent dressing group: transparent sterile dressing made of highly permeable polythene film, with latex free hypoallergenic adhesive. Sticking plaster group: non sterile, elastic, vellum-like polyester lined sticking plaster with hypoallergenic adhesive.	Dislodgement/ accidental removal; Phlebitis; Infiltration; Occlusion;
Livesley and Richardson, (1993)	Single-centre randomised controlled trial in England	155 paediatric patients from a paediatric university teaching hospital (excluding intensive care, metabolic unit and bone marrow transplant unit)	Bordered transparent group: Venigard [®] bordered transparent dressing was used to cover the insertion site. A 'T' – piece extension set with a luer-lock was used between the cannula hub and extension set or administration set. Tape dressing group: Non sterile tape was used to secure the cannula with an extension or administration set fixed to the hub of the catheter.	Catheter failure; Dislodgement/ accidental removal;
Rodriguez et al., (2002)	Single-centre randomised controlled trial in Spain	100 patients participated in this trial	Transparent dressing group: 3M Tegaderm transparent [™] dressing Gauze dressing group: gauze dressing	Phlebitis; Infiltration;
Tripepi-Bova et al., (1997)	Single-centre randomised controlled trial in the United States of America	229 patients from 6 units (2 medical cardiology, surgical cardiology, general internal medicine, orthopaedic and neurological intensive care).	Transparent dressing group: Opsite [®] (Smith & Nephew, Quebec, Canada) applied directly over the insertion site. Tape applied to secure the intravenous tubing. Gauze dressing group: Mirasorb [®] sponges (5 cm × 5 cm; Johnson & Johnson Medical Inc, Arlington, Texas) applied directly over the insertion site. Tape applied to secure the intravenous tubing.	Dislodgement/ accidental removal; Phlebitis; infiltration;

conducted in a single-centre, acute inpatient setting with either paediatric only (Livesley and Richardson, 1993), adult and paediatric (Forni et al., 2012) or adult only participants (Bausone-Gazda et al., 2010; Chico-Padron et al., 2011; Rodriguez et al., 2002; Tripepi-Bova et al., 1997). Among the trials recruiting adults, the mean participant age ranged between 55 and 60 years. The majority of trials were conducted within a 10-year time frame, between 2000 and 2010 (Bausone-Gazda et al., 2010; Chico-Padron et al., 2011; Forni et al., 2012; Rodriguez et al., 2002), the Tripepi-Bova et al. trial (Tripepi-Bova et al., 1997) was undertaken between 1994 and 1995. It is unclear when the Livesley et al. study (Livesley and Richardson, 1993) was undertaken, but results were published in 1993. Evidence of institutional ethics approval was available for four of the trials (Bausone-Gazda et al., 2010; Chico-Padron et al., 2011; Forni et al., 2012; Tripepi-Bova et al., 1997), and participant consent in four trials (Bausone-Gazda et al., 2010; Chico-Padron et al., 2011; Forni et al., 2012; Livesley and Richardson, 1993). Tripepi-Bova et al., (1997) stated that consent was not required, as both dressings were considered non-experimental. One study acknowledged industry sponsorship (Bausone-Gazda et al., 2010).

Four comparisons of interventions were reported in the included trials. The first comparison was of transparent dressings compared with gauze (Chico-Padron et al., 2011; Rodriguez et al., 2002; Tripepi-Bova et al., 1997). The intervention dressing used by Chico-Padron et al., (2011) was described simply as a transparent dressing, Rodriguez et al. (2002) used a 3M Tegaderm[®] Film Dressing and the transparent dressing in the Tripepi-Bova et al.

study (Tripepi-Bova et al., 1997) was Smith & Nephew's Opsite[®]. The second comparison was of a bordered transparent dressing compared to a securement device (Bausone-Gazda et al., 2010), and the dressing used in the intervention arm was 3M Tegaderm IV[®]. The third comparison was of a bordered transparent dressing (Veni-Guard[®] Breathable I.V. Dressing) assessed against tape (Livesley and Richardson, 1993), and, the final comparison was of a transparent dressing – described as a sterile dressing made of highly permeable polythene film, with latex-free hypoallergenic adhesive – compared with sticking plaster (Forni et al., 2012).

4.2. Methodological quality of studies

Five of the investigators reported that they used computer generated randomisation (Bausone-Gazda et al., 2010; Forni et al., 2012; Livesley and Richardson, 1993; Tripepi-Bova et al., 1997) or a randomly generated number list (Chico-Padron et al., 2011). Rodriguez et al. (2002) did not describe the method used to generate the allocation sequence in the trial. Two studies (Forni et al., 2012; Tripepi-Bova et al., 1997) stated that sealed envelopes were used, but only Forni et al. (2012) stated that the envelopes were also opaque and numbered. One trial (Bausone-Gazda et al., 2010) stated that “randomization assignment was not provided to the venous access device team nurse until the subject had been assessed and the site determination had been made” but it was unclear how the allocation details were concealed. Allocation concealment was not described in reports of the other three trials

(Chico-Padron et al., 2011; Livesley and Richardson, 1993; Rodriguez et al., 2002).

The appearance of dressings and securement devices were dissimilar in all of the trials so it was not possible to blind participants or personnel in any of the included trials. Outcome assessors were not blinded to the intervention in any of the included trials. Two investigators had outcome assessments conducted by ward nursing staff (Livesley and Richardson, 1993; Tripepi-Bova et al., 1997), and another two did not identify clearly who performed the outcome assessments (Chico-Padron et al., 2011; Rodriguez et al., 2002). Forni et al., (2012) had assessments performed by research nurses and Bausone-Gazda et al., (2010) had assessments performed by the hospital's vascular access device team who also recruited the participants.

Four trials reported complete outcome data (Bausone-Gazda et al., 2010; Chico-Padron et al., 2011; Forni et al., 2012; Tripepi-Bova et al., 1997). In one study (Livesley and Richardson, 1993), the number of participants originally enrolled in the trial was not stated but group numbers reported in the results were quite unequal (69:86). This disparity may suggest either post-randomisation exclusions, drop outs or a failure to report. One trial (Rodriguez et al., 2002) was translated from Spanish to English; it was unclear from the translation whether data were incomplete and, if they were, whether losses had been explained. Study protocols were not available for any of the included trials, so it was impossible to determine if there was selective reporting bias. Two trials had unequal numbers in the intervention groups (Chico-Padron et al., 2011; Tripepi-Bova et al., 1997), and one trial stopped early (Bausone-Gazda et al., 2010). In this trial, which was manufacturer sponsored, the sample size was estimated to be 400 but only 302 patients were recruited. The reason provided for stopping the trial early was "enrolment issues and the project timeline".

4.3. Effectiveness of interventions

4.3.1. Transparent dressings versus gauze

Three trials compared transparent dressings versus gauze but none of the trials assessed our primary outcomes. Of the secondary outcomes, two trials (278 participants) reported on dislodgement/accidental removal (Chico-Padron et al., 2011; Tripepi-Bova et al., 1997); the evidence from these trials was assessed as very low quality; the method used for group allocation was unclear and neither the personnel nor the outcome assessors were blinded to group allocation. When results were combined, there were significantly fewer instances of dislodgement/accidental removal in the transparent dressing group (7/136) than in the gauze group (19/142) (RR 0.40; 95% CI 0.17–0.92) (Fig. 2). However, the confidence interval was wide suggesting that further trials are needed to decrease the uncertainty around the effect size (Fig. 2). Three trials (379 participants) at high risk of bias for at least two domains in the risk of bias tool, reported phlebitis as an outcome (Chico-Padron et al., 2011; Rodriguez et al., 2002; Tripepi-Bova et al., 1997). There was no evidence of a difference in rates of

phlebitis between transparent dressings (16/184) and gauze (17/195) (RR 0.89; 95% CI 0.47–1.68). Infiltration was reported in all three trials for this comparison (379 participants) (Chico-Padron et al., 2011; Rodriguez et al., 2002; Tripepi-Bova et al., 1997). All trials were assessed as being at high risk of bias. When results were combined, there was no evidence of a difference between groups in rates of infiltration (transparent dressing 21/184, gauze 29/195; RR 0.80; 95% CI 0.48–1.33). None of our other pre-determined secondary outcomes were assessed. Heterogeneity was not an issue for this comparison with I^2 values below 30% for all outcomes.

4.3.2. Bordered transparent dressing compared with a securement device

Only one trial, judged to be at high risk of performance and detection bias and at unclear risk for allocation concealment compared bordered transparent dressings with a securement device (Bausone-Gazda et al., 2010). This trial included 302 participants, 150 in the bordered transparent dressing group and 152 in the securement device group. There was no evidence of a difference between groups for one of our primary outcome, peripheral venous catheter failure from any cause, (bordered transparent dressing 50/150 and securement device 59/152; RR 0.86; CI 0.64–1.16). Results for three of our secondary outcomes were reported. The bordered transparent dressing group had fewer instances of dislodgement or accidental removal than the securement device group (P value 0.008; bordered transparent dressing 2/150 and securement device 14/152; RR 0.14; 95% CI 0.03–0.63). The securement device group had fewer cases of phlebitis compared with the bordered transparent dressing group (bordered transparent dressing 8/150 and securement device 1/152; RR 8.11; 95% CI 1.03–64.02). Very wide confidence intervals for this comparison indicate a very high level of uncertainty around the effect size. Type of dressing showed no evidence of effect on the frequency of infiltration between groups (bordered transparent dressing 21/150 and securement device 27/152; RR 0.79; 95% CI 0.47–1.33). Nor were there any differences between groups in terms of time to catheter failure (Bausone-Gazda et al., 2010).

4.3.3. Bordered transparent dressing compared with tape

One trial, which was assessed as being at high risk of bias (the method used for group allocation was unclear and neither the personnel nor the outcome assessors were blinded to group allocation), compared a bordered transparent dressing and tape (Livesley and Richardson, 1993). This trial included 153 participants with a large disparity in the number of participants in each group (68 in the bordered transparent dressing group and 85 in the tape group). No explanation was provided for the 20% difference in group numbers. Peripheral venous catheter failure occurred less frequently in the tape group than the bordered transparent dressing group (bordered transparent dressing 25/68 and tape 17/85; RR 1.84; 95% CI 1.09–3.11). There was no evidence of a difference in rates of dislodgement or accidental removal for either securement method nor of time to catheter failure (Livesley and Richardson, 1993).

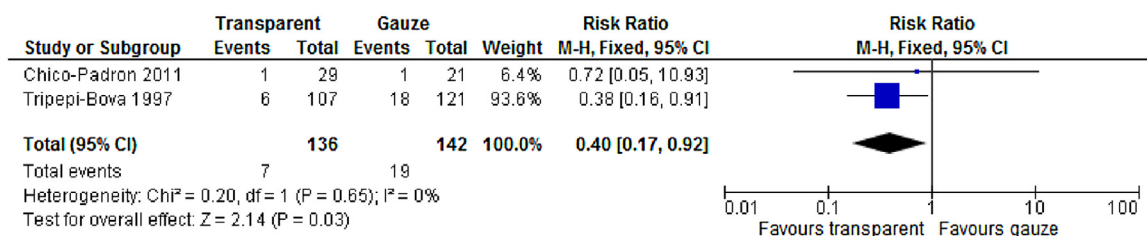


Fig. 2. Meta-analysis of studies reporting dislodgement or accidental removal when a transparent dressing was compared with a gauze dressing.

4.3.4. Transparent dressing compared with sticking plaster

Forni et al. (2012) was the only trial to compare a transparent dressing with a sticking plaster. We contacted the author who provided data for the first catheter per patient. This trial was at high risk of performance and detection bias and included 706 participants; 346 in the transparent dressing group and 357 in the sticking plaster group. Only one of our primary outcomes was reported, adverse events. These were five cases of allergy, three cases in the transparent dressing group and two in the sticking plaster group. However, information about how the allergic reaction presented and if further follow-up management of the allergy was required was not available (Forni et al., 2012). For our secondary outcomes there was no evidence of a difference between groups for dislodgement/accidental removal; phlebitis; infiltration or occlusion (Table 2).

5. Discussion

Although the main purpose of peripheral venous catheter dressings and securement devices is to prevent catheter failure, only two trials addressed this outcome. One showed no evidence of a difference between a bordered transparent dressing and a securement device (Bausone-Gazda et al., 2010), while in the other trial (Livesley and Richardson, 1993), tape alone was almost twice as effective in preventing catheter failure compared with a bordered transparent dressing (RR 1.84; 95% CI 1.09 to 3.11). However, in this trial, we were unable to determine reasons for a disparity in the number of participants in each group (68 bordered transparent dressing group and 85 tape group), so the results are inconclusive.

All of the trials reported on one or more of the individual components of the composite primary outcome. Transparent dressings, with or without a border, were more effective in preventing dislodgement or accidental removal compared with gauze or a securement device (Bausone-Gazda et al., 2010; Chico-Padron et al., 2011; Tripepi-Bova et al., 1997), but transparent dressings showed no evidence of benefit for any of the other secondary outcomes when compared with tape or sticking plaster (Forni et al., 2012; Livesley and Richardson, 1993). Phlebitis was eight times more likely to occur when a bordered transparent dressing was compared with a securement device (RR 8.11; 95% CI 1.03–64.02). However, extremely the wide confidence intervals for this result indicate that there is a great deal of uncertainty about the effect size. No evidence of a difference in phlebitis rates were shown when any other dressings or devices were compared. Nor did any of the five trials measuring infiltration show any evidence of effect; irrespective of the dressing or device used to secure the catheter. Similarly, catheter occlusion rates showed no evidence of a difference when transparent dressings were compared with

sticking plaster (Forni et al., 2012). Cost was the only other outcome measured; these results indicated that bordered transparent dressings were a cheaper securement method compared to a securement device. None of the single study comparisons was adequately powered to detect differences, so there is a possibility that type two errors could have occurred.

Dressings and securement devices for peripheral intravenous catheters continue to evolve, with new products regularly coming on to the market. A limited number of randomised controlled trials were available for this review, so most of the comparisons in the review had only one study contributing to the results. Consequently, some products in common use were not represented in this review. Another restriction on the completeness and applicability of the review is that many of our primary and secondary outcomes were poorly reported. For example, only two trials assessed our primary outcome of peripheral venous catheter failure – the prevention of which is the main reason for applying a dressing or securement device. Moreover, other outcomes of interest, such as entry site local infection, catheter related blood stream infection and patient satisfaction were not reported at all. These omissions make the selection of an effective securement device difficult for healthcare providers. Finally, participants for this review were drawn largely from adult populations and were predominately from general medical/surgical wards and orthopaedic specialties. Emergency departments and general cancer care areas, which are frequent users of peripheral venous catheters, were not included in this review. Additionally, the review included only those patients admitted to acute hospital settings, consequently, the applicability of results to other settings, such as community and rehabilitation facilities remains unknown.

The quality of the evidence was assessed as very low, using the GRADE approach (Schünemann et al., 2011). In summary, only one trial reported sufficient information for us to judge allocation concealment (Forni et al., 2012). It was not possible to blind personnel and participants to the intervention received, as dressings were clearly different. In one trial the participants also received a different peripheral venous catheter and extension tubing according to their randomised dressing or securement device (Bausone-Gazda et al., 2010), a co-intervention that may have had an impact on the results. Livesley and Richardson, (1993) reported unequal numbers in the intervention groups with more participants receiving a gauze dressing than a bordered transparent dressing, this may indicate incomplete follow-up or incomplete reporting. One of the included trials disclosed receiving manufacturer sponsorship (Bausone-Gazda et al., 2010). In all of the trials except one (Forni et al., 2012), the outcomes from the number of participants analysed matched the number randomised. We could not determine whether this was due to 'available case' reporting or whether there were, indeed, no losses to follow-up.

Table 2

Analysis for the primary outcome of peripheral venous catheter failure due to catheter complications for all four comparisons.

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
Peripheral venous catheter failure				
• Transparent dressing versus gauze	Nil			
• Bordered transparent dressing versus securement device	1	302	Risk Ratio (M-H, Fixed, 95% CI)	0.86 (0.64, 1.16)
• Bordered transparent dressing versus tape	1	153	Risk Ratio (M-H, Fixed, 95% CI)	1.84 (1.09, 3.11)
• Transparent dressing versus sticking plaster	Nil			

In all of the pooled outcomes, heterogeneity was less than 30% indicating that, although populations and interventions varied slightly across studies, they were similar enough to combine results. Confidence intervals were wide in the pooled outcomes, but few studies were included and sample sizes were small. Imprecise results may reflect differences in intervention products and outcome definitions. Confidence intervals were also wide in the single studies that showed evidence of effect.

We feel confident that our comprehensive electronic searches identified all existing, published randomised controlled trials addressing the review question, helping to limit bias in the review process. One manufacturer sponsored, observational study, comparing two different catheter stabilising systems was identified through ClinicalTrials.gov. The trial was completed in 2013 but results have not been published. The scant contribution of the six included trials, in the face of such wide use and evolving products for peripheral venous catheter stabilisation, seems unusual. This may or may not indicate publication bias. There were fewer than 10 studies, so we did not construct a funnel plot. In terms of potential biases in the review process itself, clearly described procedures were followed to prevent this occurrence. A careful literature search was conducted, and the methods used are transparent and reproducible.

One other systematic review has addressed a similar topic but inclusion criteria were wider (Hoffmann et al., 1992). The focus of the review was to compare transparent polyurethane dressing with a gauze dressing for peripheral catheters. Two of the outcomes assessed in the review (Hoffmann et al., 1992) were the same as ours (phlebitis and infiltration), so we were able to compare results. Although the inclusion criteria were quite different, our results for these outcomes were in agreement and no between group differences were found for either phlebitis or infiltration. Similarly, in an earlier, quasi-randomised controlled trial of 598 participants, published by the same author, no statistically significant differences were found in the rate of phlebitis between a transparent polyurethane group and a cotton gauze group (Hoffmann et al., 1988).

6. Conclusions

There is no strong evidence to suggest that any one dressing or securement product for peripheral catheters is more effective than any other dressing. We found limited evidence that catheters were less likely to fail due to dislodgement or accidental removal when a transparent dressing was used, compared with gauze. Other positive outcomes, favouring one dressing over another, were based on single studies, so further trials are required to support their findings. All of the included trials were small, had either high or unclear risk of bias for one or more of the quality elements we assessed, and wide confidence intervals, indicating that further randomised controlled trials are necessary.

Products included in this review were limited, as were the outcomes assessed. There is a need for suitably powered, high quality trials to evaluate the newer, high use products and novel – but expensive – securement methods, such as surgical grade glue. Following items in the CONSORT statement when planning and reporting future trials, would provide more transparency for those assessing the quality of the studies. Important outcomes such as catheter-related bloodstream infection, entry site local infection, skin damage and the patient's satisfaction with the product were not available for assessment in this review, but should be included in future studies. Given the large cost difference between different dressings and securement devices, we believe it is important to include a planned economic analysis, including the number of dressing changes required and staff time involved. This would enable decision makers to make rational and cost effective choices

when purchasing dressings and devices for peripheral catheter securement.

Conflict of interest

Griffith University has received unrestricted educational and research grants and consultancy payment for lectures from 3M (a manufacturer of PVC dressings and securement devices) to assist with the costs of Claire Rickard's (CR) research group. 3M supported research was not related to PVC dressings, nor are included in this review. Griffith University has received an unrestricted investigator-initiated research grants from Centurion Medical Products and Entrotech Lifesciences (manufacturers of PVC dressings) as part-funding for research led by CR and NM. No trials of CMP or Entrotech products are included in this review. Joan Webster and Gabor Mihala have no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.ijnurstu.2016.11.007>.

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