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Ultrasound guidance versus landmark method for peripheral venous cannulation in adults (Protocol)

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[Intervention Protocol]

Ultrasound guidance versus landmark method for peripheral venous cannulation in adults

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ABSTRACT

This is a protocol for a Cochrane Review (Intervention). The objectives are as follows:

To assess the effectiveness and safety of the ultrasound-guided method compared with the landmark method for peripheral intravenous cannulation in adults.

BACKGROUND

Description of the condition

Placing a peripheral intravenous line is one of the most essential procedures in hospitals. It is necessary when administering fluids, drugs, and drawing blood. It is usually done using a landmark method, comprising visualization and palpation of the veins. Placing a peripheral intravenous line is sometimes difficult, and the first attempt is unsuccessful in as many as 14% to 21% of adults in the emergency department (Carr 2016; Sebbane 2013), and in 9% to 26% of adults in the pre-hospital setting (Jones 1989; Lapostolle 2007; Minville 2006). This is mainly due to factors including obesity, chronic illness, intravenous drug use, dehydration and shock (Mills 2007; Ortega 2008; Sebbane 2013). The failure rate at the first attempt is much higher in people with more difficult intravenous access, reported to be between 34% and 93% (McCarthy 2016; Sebbane 2013; van Loon 2016). Multiple punctures lead to discomfort, anxiety, delay in subsequent interventions, and return of test results. If a peripheral intravenous line cannot be placed with a landmark method, a central venous line is often the next step in those with difficult intravenous access. However, central venous line placement is costly and time-consuming, and exposes people to more pain and discomfort. In addition, central venous line placement can have serious complications, such as infection, thrombosis, and pneumothorax, which are reported to occur in more than 15% of people (McGee 2003). Hence, insertion of a central venous line should be considered as a last resort. Placing a peripheral intravenous line with ultrasound guidance may offer an alternative way to achieve peripheral venous access in people with difficult intravenous access.

Description of the intervention

Ullman first reported the use of ultrasound for intravenous cannulation in 1978 (Ullman 1978). Since then, ultrasound guidance has been used widely for cannulation of central veins, and it has become the standard of care in recent years. Keyes and colleagues first reported ultrasound-guided peripheral intravenous cannulation in 1999 (Keyes 1999). There are two techniques for ultrasound guidance: short-axis (out-of-plane) and long-axis (in-plane). The short-axis technique uses the short-axis image of a targeted vein and has two methods: a static method and a dynamic method. In the static method, ultrasound is used to determine the location and the diameter of the vein and to evaluate important surrounding structures, such as arteries and nerves. Because cannulation is attempted without real-time ultrasound guidance, it risks losing the location of a targeted vein. In the dynamic method, the entire procedure is performed under real-time ultrasound guidance, which enables operators to visualize both the vein and the important surrounding structures. However, there is a risk of posterior wall punctuation, because it is sometimes difficult to find and keep visualizing the needle tip throughout the procedure. The long-axis technique uses the long-axis image of a targeted vein and a needle. Because it can visualize the entire length of the needle, the risk of posterior wall punctuation is theoretically low. However, it is difficult for operators to maintain the needle and targeted vein within the narrow width of the ultrasound beam, and they cannot visualize important surrounding structures. A small randomized controlled trial that compared the short-axis and long-axis techniques for peripheral venous cannulation showed a shorter procedure time and a tendency towards higher success rates in the short-axis group (Mahler 2011). However, the limited generalizability and potential biases of the trial mean that it is still unclear which of the two techniques is superior.

The depth of a targeted vein and length of the needle are important factors for the survival of intravenous catheters placed with the ultrasound guidance. The survival proportion of intravenous catheters placed with ultrasound guidance (using 4.8 cm or 6.35 cm catheters) is 53% to 75% at 24 hours, which is lower than those placed with the landmark method (74% to 99% at 24 hours) (Dargin 2010; Dillon 2008; Fields 2012). The depth of targeted veins is a key factor, with survival proportions (with a 4.8 cm catheter) reported to be 100% for veins at less than 0.4 cm depth, 62% for veins that are 0.41 cm to 1.19 cm deep, and 29% for veins that are more than 1.2 cm deep (Fields 2012). However, it is sometimes difficult to visualize a needle tip or a needle when the subcutaneous tissue between skin surface and a targeted vein is thin. The ideal depth of a targeted vein could be at least 0.5 cm, using a 4.57 cm catheter (Avila 2019). Long catheters (6 cm to 12 cm) survive longer and have similar success rates compared to short catheters; however, the Seldinger technique is used to place these, and they are more costly (Bahl 2019; Elia 2012).

How the intervention might work

If a targeted peripheral vein is visible or palpable, cannulation is usually straightforward with the landmark method, and will be successful at the first attempt in over 95% of cases (McCarthy 2016). However, because the location and diameters of peripheral veins differ substantially between people, it is often difficult to cannulate deep peripheral veins which are not visible and palpable from the skin surface. Ultrasound can help the operator to visualize the local anatomy of interest, and to identify the size and direction of veins and important surrounding structures, such as arteries and nerves, as well as making the diameter and route of these important structures clear. Furthermore, in the dynamic method, which visualizes the needle with ultrasound, the operator can see the spatial relationships between the vein, surrounding structures and the needle. Thus, ultrasound guidance may facilitate successful cannulation and prevent complications, especially in people with difficult intravenous access who would otherwise be candidates for central venous line placement. Shokoohi and colleagues reported data from a cohort study, where the number of central venous lines placed decreased by 80% during the six years following the introduction of ultrasound-guided peripheral intravenous cannulation (Shokoohi 2013).

Why it is important to do this review

The efficacy of ultrasound guidance for central venous cannulation has been established (Brass 2015b; Brass 2015a; Wu 2013). The National Institute for Health and Care Excellence (NTA Guidance 2002), and the American Society of Anesthesiologists (ASA Task Force 2012), both recommended using ultrasound guidance for central venous cannulation, especially for internal jugular veins, and it is currently the standard of care. However, the efficacy of ultrasound guidance for peripheral intravenous cannulation is not well established. Several meta-analyses have been conducted (Egan 2013; Heinrichs 2013; Liu 2014; Stolz 2015; van Loon 2018), and the results have shown a fairly consistent increase in the overall success rate with ultrasound guidance in people with difficult intravenous cannulation, but there are several weaknesses of the synthesized evidence on this topic to date. Most of their included studies had fewer than 60 participants. McCarthy 2016 has since pub-

lished a large study (1189 participants), and this should be included in the planned meta-analysis. Studies have seldom evaluated the first-pass success rate (successful cannulation at first attempt), reporting the overall success rate instead. Even if the overall success rate improves, it might not be beneficial if it subjects people to more skin punctures. There are methodological flaws in previous reviews, such as non-rigorous search methods, non-duplicated assessment of studies, inclusion of observational studies, and inappropriate methods for assessing study validity. As peripheral intravenous cannulation with the landmark method is usually straightforward for people with easy intravenous access, the efficacy of ultrasound guidance for peripheral intravenous cannulation varies according to the difficulty of intravenous access. However, the definition of difficult intravenous cannulation used is unclear in previous meta-analyses. An updated, methodologically rigorous meta-analysis, that will assess the influence of intravenous access difficulty and report patient-relevant outcomes, is therefore required.

OBJECTIVES

To assess the effectiveness and safety of the ultrasound-guided method compared with the landmark method for peripheral intravenous cannulation in adults.

METHODS

Criteria for considering studies for this review

Types of studies

We will include randomized controlled trials (RCTs), including cluster-controlled trials, cross-over trials, and quasi-RCTs (RCTs in which participants are allocated based on data such as date of birth or recruitment or medical record number).

Types of participants

We will include all adult participants (≥ 18 years old) with any clinical characteristic, in any setting, who require a peripheral intravenous line, irrespective of the difficulty of cannulation. We will define a peripheral intravenous line as a catheter placed in a peripheral vein. We will exclude central lines, intraosseous lines, and peripherally inserted central lines. We will exclude children, because the effect of ultrasound guidance will be different for them, due to smaller veins and extremities, as well as a possible lack of cooperation. We will carry out a subgroup analysis to evaluate participants according to the difficulty of peripheral intravenous cannulation.

Types of interventions

We will include studies comparing ultrasound-guided peripheral intravenous cannulation with the landmark method, irrespective of the profession of the operators, number of operators (one or two), methods (short-axis or long-axis, static or dynamic), or the sites of the peripheral veins. We will exclude studies on peripherally inserted central catheters. We will include all studies using ultrasonography, irrespective of the manufacturer or generation of ultrasound machines used.

Types of outcome measures

We will not use outcome measures as a criterion for excluding studies. All outcome measures below will be reported at time of cannulation.

Primary outcomes

- First-pass success rate of cannulation
- Overall success rate of cannulation
- Pain

We will define the overall success rate of cannulation as the success rate of cannulation irrespective of the number of attempts and procedure time. We anticipate that studies will use different pain intensity scales, with most studies using standard subjective scales, such as numerical rating scale (NRS) or visual analogue scale (VAS). We will define successful cannulation as stated by the study authors. A cutaneous puncture will be counted as one attempt, irrespective of the duration of subcutaneous exploration.

Secondary outcomes

- Procedure time for peripheral venous cannulation
- Number of attempts before successful cannulation
- Patient satisfaction
- Overall complication rate (including arterial puncture, hematoma, nerve injury)

Studies may report patient satisfaction results as either continuous or dichotomous data. Scales of patient satisfaction include Likert scales, and validated instruments such as the Client Satisfaction Questionnaire-18 (Attkisson 1982).

Search methods for identification of studies

Electronic searches

The Cochrane Vascular Information Specialist aims to identify all relevant RCTs regardless of language or publication status (published, unpublished, in press, or in progress).

The Information Specialist will search the following databases for relevant trials:

- the Cochrane Vascular Specialised Register via the Cochrane Register of Studies (CRS-Web);
- the Cochrane Central Register of Controlled Trials (CENTRAL) via the Cochrane Register of Studies Online (CRSO);
- MEDLINE (Ovid MEDLINE Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE Daily and Ovid MEDLINE; 1946 onwards);
- Embase Ovid (from 1974 onwards);
- CINAHL EBSCO (Cumulative Index to Nursing and Allied Health Literature; from 1982 onwards);
- LILACS BIREME (Latin American and Caribbean Health Science Information database; from 1987 onwards).

The Information Specialist has devised a draft search strategy for RCTs for MEDLINE (Appendix 1), and will use this as the basis for search strategies for the other databases listed.

The Information Specialist will search the following trials registries:

- the World Health Organization International Clinical Trials Registry Platform (who.int/trialsearch);
- ClinicalTrials.gov (clinicaltrials.gov).

Searching other resources

Four review authors (MT, TM, CT, NY) will check the reference lists of all identified studies and review articles to find additional studies. We will contact trial authors, experts in this field and manufacturers of ultrasound machines to identify unpublished studies.

Data collection and analysis

Selection of studies

We will use the reference management software Mendeley to collate the results of searches and to remove duplicates (Mendeley). We will use Rayyan software to screen the results of the search (Ouzzani 2016). Four review authors (MT, TM, CT, NY) will independently and in duplicate check titles and abstracts of the results of the search and will identify potentially relevant studies. We will obtain full texts of all potentially relevant studies if any of the authors judge them to be relevant or potentially relevant. We will exclude only the clearly irrelevant articles at this stage. Four review authors (MT, TM, CT, NY) will independently and in duplicate assess the full papers for eligibility using a pre-designed checklist. We will compare the results and resolve disagreements through discussion. If we are unable to reach a consensus, we will consult the sixth review author (NW). We will record the number of papers retrieved at each stage and will report this information using a PRISMA flow chart.

Data extraction and management

We will use Covidence software to extract data from individual studies, adapting their basic template data extraction form (Covidence). Four review authors (MT, TM, CT, NY) will independently and in duplicate extract the data using the abstraction form. We will resolve disagreements through discussions. If we cannot reach a consensus, we will consult the sixth review author (NW). If additional information is needed, one review author (MT) will contact the corresponding author of the relevant studies. When we have completed data extraction, one review author will enter the data into Review Manager software and another review author will check the data (Review Manager 2014).

Assessment of risk of bias in included studies

Four review authors (MT, TM, CT, NY) will independently assess the methodological quality of each included study using the Cochrane 'Risk of bias' tool (Higgins 2011). We will assess the following domains and rate them as low, unclear, or high risk of bias.

- Random sequence generation (selection bias)
- Allocation concealment (selection bias)
- Blinding of participants and providers (performance bias)
- Blinding of outcome adjudicators/assessment (detection bias)
- Incomplete outcome data (attrition bias)
- Selective outcome reporting (outcome reporting bias)
- Other biases

Due to the nature of the intervention, blinding of the operators will not be possible. This may cause some performance bias, but it is unavoidable and we do not expect it to be serious. It is also not possible to blind the participants, but this should not affect objective outcomes, such as success rate of cannulation. Thus, we will rate the performance bias domain as low risk irrespective of blinding status. Because outcome adjudicators need to observe the procedure on the scene to evaluate the outcomes, it is not possible to blind them to treatment allocation. We will rate a study as being at low risk of bias if a non-blinded independent outcome adjudicator reports the outcomes. We will rate a study as high risk of bias if the operator and the adjudicator are the same person.

We will define the overall risk of bias as follows.

- Low risk of bias: all seven domains rated as low risk
- Moderate risk of bias: one or more domains rated as being at unclear risk
- High risk of bias: one or more domains rated as being at high risk

We will review the assessments and resolve any disagreements through discussion. If needed, we will consult the sixth review author (NW).

Measures of treatment effect

We will calculate dichotomous data as risk ratios (RR) with 95% confidence intervals (CI). We will calculate continuous data as mean differences (MD) with 95% CI when the outcomes of all studies use the same scale. We will use a standardized mean difference (SMD) with 95% CIs if different scales are used.

Unit of analysis issues

The unit of analysis is the individual participant. If we include any cluster-randomized trials, we will adjust the sample size by the trial's intracluster correlation coefficient, using the method described in the *Cochrane Handbook for Systematic Reviews of Intervention* (Higgins 2011). We will exclude any cluster-randomized trials which do not report the intracluster correlation coefficient.

Dealing with missing data

We will contact the study authors when possible to obtain missing data. We will perform an intention-to-treat analysis when possible. We will impute data for binary outcomes using various scenarios such as 'best-case' and 'worst-case' scenarios. For continuous outcomes, we will use available-case analysis. We will calculate the standard deviation from P values, standard errors or CI according to the instructions given in the *Cochrane Handbook for Systematic Reviews of Intervention* (Higgins 2011). Otherwise, we will impute them from other studies in the meta-analysis according to the validated method (Furukawa 2006).

Assessment of heterogeneity

We will assess heterogeneity by inspecting forest plots visually, and will examine statistical heterogeneity by Chi^2 and I^2 statistic. We will use P = 0.10 as the predefined significance level of heterogeneity for the Chi^2 test. We will consider I^2 statistics of 25% or lower to indicate low heterogeneity, between 25% and 50% to indicate moderate heterogeneity, and 50% or more to indicate substantial heterogeneity. However, we will interpret this value in light of the size and direction of effect and the strength of the evidence for heterogeneity, based on the P value from the Chi^2 test (Higgins 2011). If we identify substantial heterogeneity, we will investigate and report potential reasons for this. We will define substantial heterogeneity as I^2 over 50%.

Assessment of reporting biases

We will try to minimize the effect of publication bias by performing well-designed comprehensive literature searches, by using tri-

al registries, such as ClinicalTrials.gov, and by contacting the manufacturers of ultrasound machines. If we include a sufficient number of studies in a meta-analysis (i.e. more than 10 studies; Higgins 2011), we will visually inspect funnel plots to evaluate small study effects and use contour-enhanced funnel plots to evaluate publication bias. We will evaluate reporting bias by checking the protocol of the study, if we can identify one from searching trial registries.

Data synthesis

We will review the data from the included studies and, if possible, synthesize and analyze data using Review Manager software (Review Manager 2014). We plan to use the random-effects model to pool data, because we expect the definitions of participants and operators to vary to some extent between studies, and also because the random-effects model is more conservative than the fixed-effect model. If it is not possible to pool data, we will provide clear reasons for this and report results narratively.

'Summary of findings' table

We will summarize the main findings of each relevant outcome regarding the magnitude of effect, total number of participants and the number of relevant studies, and assess the quality of evidence using the GRADE approach (GRADE 2004). We will use the GRADEpro software to assist in the preparation of the 'Summary of findings' table (GRADEpro GDT). A draft 'Summary of findings' table (Table 1) shows the outcomes we consider to be the most clinically relevant:

- first-pass success rate of cannulation;
- overall success rate of cannulation;
- pain;
- procedure time;
- number of attempts before successful cannulation;
- patient satisfaction;
- overall complication rate (arterial punctures, hematoma formations, and nerve injuries).

We will present the results of the subgroup analyses in additional 'Summary of findings' tables where sufficient data are available.

Subgroup analysis and investigation of heterogeneity

We plan to perform subgroup analyses for the following parameters, if we find sufficient data from the included studies.

- Difficulty of obtaining intravenous access: 'difficult' versus 'moderately difficult' versus 'easy'

Because the effectiveness of ultrasound guidance will vary depending on the difficulty of obtaining intravenous access in each participant, we will evaluate participants separately for each difficulty level, according to the following criteria:

- we will use the definition of the difficulty of peripheral intravenous cannulation adopted by original studies;
- we will define the difficulty based on the first-pass success rate or the overall success rate of cannulation using the landmark method.

Because we expect the definition of difficulty of peripheral intravenous cannulation to differ between studies (Egan 2013; Liu 2014), we will also define the difficulty based on the first-pass success rate or the overall success rate of cannulation using the landmark method. As in previous studies, we will categorize a success rate of less than 60% as 'difficult', a success rate of 60% to 80% as 'moderately difficult', and a success rate of over 80% as 'easy' (McCarthy 2016; Sebbane 2013; van Loon 2016).

- Practical difficulties of obtaining intravenous access: difficult versus not difficult

We will analyze participants separately where he or she satisfies the definition of a difficult case. A difficult case is defined as any of the following:

- the operator could not see and palpate the targeted vein;
- the operator identified a participant as a difficult case;
- the participant had a history of difficult intravenous access;
- the participant had multiple failed attempts.

- Experience of ultrasound-guided cannulation: training versus clinical experience versus training plus clinical experience

We will analyze separately if operators satisfy the following criteria:

- having finished any kind of training program for ultrasound-guided peripheral venous cannulation;
- having clinical experience of ultrasound-guided peripheral intravenous cannulation;
- having finished any kind of training program for ultrasound-guided peripheral venous cannulation plus having clinical experience of ultrasound-guided peripheral intravenous cannulation.

- Study settings: emergency departments or intensive care units (ICUs) versus operating rooms

Compared to participants in operating rooms, those in emergency departments or ICUs are more likely to be in shock or dehydrated. Since these factors are associated with difficult intravenous cannulation, the ultrasound-guided method may be more effective in the setting of emergency departments or ICUs than in operating rooms.

- Date of publication: 1999 to 2008 versus 2009 to 2019

Advances in machine technology may lead to improved ultrasound image quality, improving the effectiveness of ultrasound guidance. Therefore, we will stratify the studies by publication year into two groups: 1999 to 2008, and 2009 to 2019. If we include more than 10 studies, we will also perform univariate meta-regression with Stata software, using publication year as a continuous covariate (Stata).

- Types of ultrasound guidance

We will analyze studies separately according to type of ultrasound guidance:

- short-axis technique versus long-axis technique;
- dynamic method versus static method.

Sensitivity analysis

We plan to perform sensitivity analyses for the following factors, if applicable.

- We will limit the analysis to studies with low risk of bias. We define low risk of bias as satisfying all of the following domains: adequate allocation concealment, blinding of outcome

assessment, and data analysis performed according to the intention-to-treat principle.

- We will limit the analysis to RCTs only.

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ADDITIONAL TABLES

Table 1. Example 'Summary of findings' table

Ultrasound guidance compared with landmark method for peripheral venous cannulation						
Patient or population: all adults who require a peripheral intravenous line **Settings:** any setting (emergency departments, intensive care units, operating rooms, etc.) **Intervention:** ultrasound guidance **Comparison:** landmark method						
Outcomes	**Illustrative comparative risks* (95% CI)**		**Relative effect (95% CI)**	**No of Participants (studies)**	**Quality of the evidence (GRADE)**	**Comments**
	Assumed risk	**Corresponding risk**				
	Landmark method	**Ultrasound guidance**				
First-pass success rate of cannulation (follow-up: at time of cannulation)	**Study population**		**RR [value]** ([value] to [value])	[value] ([value])	[Delete as appropriate] ⊕⊝⊝⊝ **very low** ⊕⊕⊝⊝ **low** ⊕⊕⊕⊝ **moderate** ⊕⊕⊕⊕ **high**	
	[value] per 1000	**[value] per 1000** ([value] to [value])				
Overall success rate of cannulation (follow-up: at time of cannulation)	**Study population**		**RR [value]** ([value] to [value])	[value] ([value])	[Delete as appropriate] ⊕⊝⊝⊝ **very low** ⊕⊕⊝⊝ **low** ⊕⊕⊕⊝ **moderate** ⊕⊕⊕⊕ **high**	
	[value] per 1000	**[value] per 1000** ([value] to [value])				
Pain (Numerical rating scale from 0, no pain to 11, worst pain; follow-up: at time of cannulation)	The mean [outcome] ranged across control groups from	The mean [outcome] in the intervention groups was **[value] [low-**		[value] ([value])	[Delete as appropriate] ⊕⊝⊝⊝ **very low** ⊕⊕⊝⊝ **low**	

Table 1. Example 'Summary of findings' table *(Continued)*

	[value][measure]	**er/higher]** [(value to value lower/higher)]			⊕⊕⊕⊖ **moderate** ⊕⊕⊕⊕ **high**
Procedure time for peripheral venous cannulation (follow-up: at time of cannulation)	The mean [outcome] ranged across control groups from [value][measure]	The mean [outcome] in the intervention groups was **[value] [lower/higher]** [(value to value lower/higher)]		[value] ([value])	[Delete as appropriate] ⊕⊖⊖⊖ **very low** ⊕⊕⊖⊖ **low** ⊕⊕⊕⊖ **moderate** ⊕⊕⊕⊕ **high**
Number of attempts before successful cannulation (follow-up: at time of cannulation)	**Study population** **[value] per 1000**	**[value] per 1000** ([value] to [value])	**RR [value]** ([value] to [value])	[value] ([value])	[Delete as appropriate] ⊕⊖⊖⊖ **very low** ⊕⊕⊖⊖ **low** ⊕⊕⊕⊖ **moderate** ⊕⊕⊕⊕ **high**
Patient satisfaction (Likert scales; follow-up: at time of cannulation)	The mean [outcome] ranged across control groups from [value][measure]	The mean [outcome] in the intervention groups was **[value] [lower/higher]** [(value to value lower/higher)]		[value] ([value])	[Delete as appropriate] ⊕⊖⊖⊖ **very low** ⊕⊕⊖⊖ **low** ⊕⊕⊕⊖ **moderate** ⊕⊕⊕⊕ **high**
Overall complication rate (including arterial puncture, hematoma, nerve injury; follow-up: at time of cannulation)	**Study population** **[value] per 1000**	**[value] per 1000** ([value] to [value])	**RR [value]** ([value] to [value])	[value] ([value])	[Delete as appropriate] ⊕⊖⊖⊖ **very low** ⊕⊕⊖⊖ **low** ⊕⊕⊕⊖

Table 1. Example 'Summary of findings' table *(Continued)*

			moderate	
			⊕⊕⊕⊕ **high**	

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: confidence interval; **ICU**: intensive care unit **RR:** risk ratio.

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

APPENDICES

Appendix 1. MEDLINE search strategy

1 Catheterization, Peripheral/ 8259

2 Cathlon.ti,ab. 4

3 "intravenous cannul*".ti,ab. 816

4 "peripheral intravenous".ti,ab. 1064

5 "peripheral vein*".ti,ab. 2409

6 "peripheral venous".ti,ab. 4160

7 Venflon.ti,ab. 43

8 ((Catheter* or cannula* or puncture* or line or access) adj3 (peripher* or intravenous)).ti,ab. 9611

9 or/1-8 21349

10 exp ULTRASONOGRAPHY, INTERVENTIONAL/ 21889

11 ultrasonograph*.ti,ab. 97463

12 Ultrasound*.ti,ab. 216398

13 or/10-12 300295

14 9 and 13 1490

15 randomized controlled trial.pt. 469353

16 controlled clinical trial.pt. 92682

17 randomized.ab. 423387

18 placebo.ab. 192319

19 drug therapy.fs. 2052184

20 randomly.ab. 298375

21 trial.ab. 441082

22 groups.ab. 1839754

23 or/15-22 4293737

24 exp animals/ not humans.sh. 4502107

25 23 not 24 3711957

26 14 and 25 385

CONTRIBUTIONS OF AUTHORS

MT: designed and drafted protocol
TM: designed and drafted protocol
CT: designed and drafted protocol
NY: revised protocol
TF: revised protocol
NW: designed and revised protocol; guarantor of the review

DECLARATIONS OF INTEREST

MT: has received research grants from Nakatani Foundation (ongoing multicenter prospective cohort study for myocardial infarction in the emergency department) and Radiometer (ongoing multicenter prospective cohort study of myocardial infarction in the emergency department). His institution receives assistance from Roche, Abbott, and Siemens for an ongoing multicenter cohort study measuring troponin levels in myocardial infarction. None of these organizations and companies are related to ultrasound-guided peripheral intravenous cannulation. MT has co-authored a textbook about ultrasound-guided peripheral intravenous cannulation in emergency medicine, and has received royalties from Japan Medical Journal. The textbook is about the technical issues of the review intervention. It explains the review intervention as one of various options, and is not intended to promote the review intervention. Japan Medical Journal has no role in this Cochrane Review and meta-analysis.
TM: has received payment for lectures on emergency point-of-care ultrasound from Fujifilm.
CT: none known
NY: none known
TF: has received lecture fees from Meiji, Mitsubishi-Tanabe, Merck Sharp & Dohme Corp. (MSD) and Pfizer. He has received research support from Mitsubishi-Tanabe. He has received royalties from Igaku-Shoin and Nihon Bunka Kagaku-sha.
NW: his institution has received research funds from the Japanese Ministry of Health Labor and Welfare and the Japanese Ministry of Education, Science, and Technology. He has also received royalties from Sogensha and Akatsuki for writing a book and developing software about interventions for insomnia. This review is completely independent from the intention of these grants.

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