AUSTRALIAN COMMISSION
ON **SAFETY** AND **QUALITY** IN **HEALTH CARE**

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Infections associated with peripheral venous access devices: A rapid review of the literature

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KPH

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Preface

The insertion of a peripheral intravenous catheter (PIVC) is one of the most common clinical procedures performed. About 30 million are used in Australia each year, with up to 70% of hospitalised patients requiring a PIVC at some point during their hospital stay. However studies estimate that 4% to 28% of PIVCs inserted are not actually needed, placing the patient unnecessarily at risk of infection.

Despite frequency in PIVC use, complications are reported to be as high as 70%. They can be prone to blockage and dislodgment, cause inflammation of the vein and infection. Nearly half of all first insertion attempts also fail, causing undue pain and anxiety for patients as a result of multiple failed attempts.

To reduce rates of PIVC-related complications, a number of evidence-based strategies have been suggested. Best practice guidelines recommend a range of strategies to reduce risk of complications and increase chances of PIVC success. Despite this, data from Australia and internationally suggest that a significant proportion of patients do not receive care as recommended to optimise use of PIVCs.

A clinical care standard on peripheral intravenous access will aim to support national consistency of best practice for the insertion and management of PIVCs. To inform development of this clinical care standard two literature reviews were undertaken.

The Commission engaged Dr Kelly Shaw, Dr Jennifer Makin and Professor Tania Winzenberg from KP Health and the Menzies Institute for Medical Research, University of Tasmania, to conduct a literature review to better understand the current clinical environment for infection prevention and control methods associated with the insertion and use of PIVCs.

Key findings

This report focuses on recommendations that are linked to risk of phlebitis, local infection, and/or catheter-related bloodstream infection (CRBSI) and the evidence on which these recommendations are based.

The report reviewed evidence regarding the following factors and their influence on infection rates:

- Dwell time – No clear difference in incidence of CRBSI between clinically indicated and routine removal of PIVCs; clinically indicated removal probably reduces costs.
- Choice of site – Veins in the upper extremities are preferable and that veins in the lower extremities should be avoided due to risk of infection. Avoid veins in areas of flexion.
- Site preparation – If required, remove hair with scissors/clippers instead of shaving, to reduce risk of infection. Preferred skin antiseptic agent for infection prevention is chlorhexidine in alcohol solution.
- Securement and dressings – Relative effectiveness of different dressings and securement devices in unclear. Evidence-based consensus recommends sterile transparent, semipermeable, occlusive dressings.
- Systemic antimicrobials – Routine intranasal and or prophylactic systemic antimicrobials before or during the use of an intravascular device should not be used to prevent catheter colonisation or CRBSIs.

The report highlights a number of gaps in the literature, including the effectiveness of the following factors on reducing infection rates:

- PIVC device types/materials
- Dressing/securement types
- Flushing regimens

- Specialist PIVC teams versus generalist inserters
- Multicomponent PIVC care bundles.

Recommendations of the report

The authors of the report conclude there is recent evidence to underpin development of a clinical care standard that aims to support clinicians and health service organisations deliver high-quality care, and reduce the risk of infections associated with the insertion, maintenance and removal of PIVC. Evidence sources include international and Australian guidelines, as well as systematic reviews and meta-analyses. The authors recommend that together, these evidence sources provide some guidance on drafting a clinical care standard to support reduced infection rates, however gaps in the literature should also be noted.

Next steps for the Commission

The Commission will consider the report's recommendations in the development of the Peripheral Intravenous Access Clinical Care Standard.

Contents

Executive Summary

Infections associated with PIVCs are relatively rare compared with other causes of PIVC failure (e.g. dislodgement, occlusion, infiltration), but are a serious adverse event meriting separate consideration. This rapid review sought to identify recent evidence to underpin a clinical care standard that aims to support clinicians and health services implement the delivery of high-quality care to reduce complications (specifically infections) associated with the insertion, management and removal of PIVCs.

Sources of evidence identified through a systematic search of the peer-reviewed and grey literature were 1) ten international and five Australian guidelines released or updated in the past 5 years, and 2) eight systematic reviews/meta-analyses published in the past 5 years (2014-19 February 2019). Together, these evidence sources provide some guidance on appropriate drafting of clinical care standard quality statements to support reduced infection rates, but also highlight numerous gaps in the literature.

Rationale for clinical care standard

Dwell time: No clear difference in incidence of CRBSI between clinically indicated and routine removal; clinically indicated removal probably reduces costs.

Type of device: PIVCs composed of polyurethane result in fewer complications and CRBSIs

Type of device: Closed system PIVCs are less likely to cause phlebitis than open system PIVCs.

Choice of site: Veins in the upper extremities are preferable and that veins in the lower extremities should be avoided due to risk of infection. Avoid veins in areas of flexion.

Site preparation: If required, remove hair with scissors/clippers instead of shaving, to reduce risk of infection.

Site preparation: Preferred skin antiseptic agent for infection prevention is chlorhexidine in alcohol solution.

Securement/dressings: Relative effectiveness of different dressings and securement devices is unclear. Evidence-based consensus recommends sterile transparent, semipermeable, occlusive dressing.

Flushing: 0.9% saline flush should be used in preference to heparin.

Specialist teams: Catheters should be placed by health care workers skilled in intravenous catheter placement to reduce rates of infection.

Multi-component care bundles recommended.

Routine intranasal and or prophylactic systemic antimicrobials before or during the use of an intravascular device should not be used to prevent catheter colonisation or CRBSIs.

Evidence gaps

- Relative effectiveness of different PIVC device types/materials on reducing infection rates.
- Relative effectiveness of different dressing/securement types on reducing PIVC-related infection rates.

- Relative effectiveness of different flushing regimens on reducing infection rates.
- Relative effectiveness of specialist PIVC teams vs. generalists on reducing infection rates.
- Relative effectiveness of multicomponent PIVC care bundles on reducing infection rates.

Background and introduction

The Australian Commission on Safety and Quality in Health Care engaged KP Health to conduct a rapid review of the evidence to better understand the current clinical environment for prevention and control methods for infections associated with the insertion and use of peripheral intravenous catheters (PIVCs) and to identify issues or gaps that may be addressed by clinical experts at a clinical roundtable.

Research questions

This rapid review addresses the following research questions:

1.   What relevant guidelines, policies and procedures, health programs or strategy documents are available in Australia or in absence of an Australian guideline, high quality guidelines from an equivalent healthcare system (UK, US, Canada)?

2.   What do the current guidelines recommend?

3.   What evidence is there regarding current clinical practice in Australia?

4.   What indictors are currently used to measure or report adverse outcomes (e.g. in routine monitoring, audits or other quality improvement activities)?

5.   What contributes to variations in infection rates associated with peripheral venous access? What are the evidence gaps?

6.   What is the literature on interventions to prevent infections associated with PIVC devices? What is the effectiveness of those interventions? What are the evidence gaps?

7.   What is the rationale for a clinical care standard (or of standardised interventions to improve care)?

Methods

Search strategy

Grey literature

We searched Commonwealth, State and Territory health department websites and clinical guideline portals for guidelines relating to infections associated with peripheral venous access devices in Australia, the UK, US and Canada. A full list of websites searched is included at Appendix A. We included guidelines published in the past 5 years (2014-current).

Peer-reviewed literature

We searched the following peer-reviewed databases for systematic reviews and meta-analyses of randomised controlled trials:

- Medline
- Embase
- Cochrane

Searches were limited to articles published in the past 5 years (2014-current).

Searches were limited to systematic reviews and meta-analyses of randomised controlled trials, using the CADTH Database systematic review/meta-analysis/health technology assessment search filter.[1]

The following search terms were used to identify relevant articles:

Embase via Ovid	
#1	catheter infection/ OR Sepsis/ OR Phlebitis/ OR infections.tw. OR infection.tw.
#2	Catheterization, Peripheral/ OR PIVC.tw. OR PIC.tw. OR peripheral.tw.
#3	meta-analysis/ or systematic review/ or meta-analysis as topic/ or "meta analysis (topic)"/ or "systematic review (topic)"/ or exp technology assessment, biomedical/ or ((systematic* adj3 (review* or overview*)) or (methodologic* adj3 (review* or overview*))).ti,ab,kw. or ((quantitative adj3 (review* or overview* or synthes*)) or (research adj3 (integrati* or overview*))).ti,ab,kw. or (((integrative adj3 (review* or overview*)) or (collaborative adj3 (review* or overview*)) or (pool* adj3 analy*)).ti,ab,kw. or (data synthes* or data extraction* or data abstraction*).ti,ab,kw. or (handsearch* or hand search*).ti,ab,kw. or (mantel haenszel or peto or der simonian or dersimonian or fixed effect* or latin square*).ti,ab,kw. or (met analy* or metanaly* or technology assessment* or HTA or HTAs or technology overview* or technology appraisal*).ti,ab,kw. or (meta regression* or metaregression*).ti,ab,kw. or (meta-analy* or metaanaly* or systematic review* or biomedical technology assessment* or bio-medical technology assessment*).mp,hw. or (medline or cochrane or pubmed or medlars or embase or cinahl).ti,ab,hw. or (cochrane or (health adj2 technology assessment) or evidence report).jw. or (meta-analysis or systematic review).mp. or (comparative adj3 (efficacy or effectiveness)).ti,ab,kw. or (outcomes research or relative effectiveness).ti,ab,kw. or ((indirect or indirect treatment or mixed-treatment) adj comparison*).ti,ab,kw.
#4	#1 AND #2 AND #3
#5	limit #4 to yr="2014 -Current"

Medline via Ovid	
#1	Catheter-Related Infections/ OR Sepsis/ OR Phlebitis/ OR infections.tw. OR infection.tw.
#2	Catheterization, Peripheral/ OR PIVC.tw. OR PIC.tw. OR peripheral.tw.
#3	meta-analysis.pt. or meta-analysis/ or systematic review/ or meta-analysis as topic/ or "meta analysis (topic)"/ or "systematic review (topic)"/ or exp technology assessment, biomedical/ or ((systematic* adj3 (review* or overview*)) or (methodologic* adj3 (review* or overview*))).ti,ab,kf,kw. or ((quantitative adj3 (review* or overview* or synthes*)) or (research adj3 (integrati* or overview*))).ti,ab,kf,kw. or (((integrative adj3 (review* or overview*)) or (collaborative adj3 (review* or overview*)) or (pool* adj3 analy*)).ti,ab,kf,kw. or (data synthes* or data extraction* or data abstraction*).ti,ab,kf,kw. or (handsearch* or hand search*).ti,ab,kf,kw. or (mantel haenszel or peto or der simonian or dersimonian or fixed effect* or latin square*).ti,ab,kf,kw. or (met analy* or metanaly* or technology assessment* or HTA or HTAs or technology overview* or technology appraisal*).ti,ab,kf,kw. or (meta regression* or metaregression*).ti,ab,kf,kw. or (meta-analy* or metaanaly* or systematic review* or biomedical technology assessment* or bio-medical technology assessment*).mp,hw. or (medline or cochrane or pubmed or medlars or embase or cinahl).ti,ab,hw. or (cochrane or (health adj2 technology assessment) or evidence report).jw. or (meta-analysis or systematic review).mp. or (comparative adj3 (efficacy or effectiveness)).ti,ab,kf,kw. or (outcomes research or relative effectiveness).ti,ab,kf,kw. or ((indirect or indirect treatment or mixed-treatment) adj comparison*).ti,ab,kf,kw.
#4	#1 AND #2 AND #3
#5	limit #4 to yr="2014 -Current"

Cochrane library (Reviews only)	
#1	Catheter-Related Infections/ OR Sepsis/ OR Phlebitis/ OR infections.tw. OR infection.tw.
#2	Catheterization, Peripheral/ OR PIVC.tw. OR PIC.tw. OR peripheral.tw.
#3	#1 AND #2 (Reviews only)
#4	limit #3 to yr="2014 -Current"

Criteria for inclusion and exclusion of articles

Types of studies

We considered all systematic reviews and meta-analyses of randomised controlled trials.

Where there were two or more reviews that addressed the same question we included all reviews that meet inclusion criteria with a focus on the highest level of evidence and most recent search date.

Only studies published from 2014 were considered for inclusion.

Types of participants

We considered all systematic reviews and meta-analyses of randomised controlled trials of human adults (age ≥ 18 years) of any gender.

Types of interventions

We considered all systematic reviews and meta-analyses of randomised controlled trials of interventions that aimed to reduce or prevent infections associated with Peripheral Intra-Venous Catheter (PIVC) devices. Reviews of interventions only with Central Venous Catheters and/or Peripherally-Inserted Central Catheters were excluded.

Interventions could include (but were not limited to) interventions relating to type of device used, choice of insertion site, securement/dressings, flushing of devices, and patients at increased risk of PIVC-related infection.

Types of comparators

We considered all systematic reviews and meta-analyses of randomised controlled trials that compared two (or more) interventions, or one intervention with usual care.

Types of outcome measures

We considered all systematic reviews and meta-analyses of randomised controlled trials that reported infection rates as an outcome measure.

Evidence in languages other than English

We did not apply any language restrictions to conduct searches of the literature. Studies in languages other than English were only considered where a full-text translation into English could be sourced.

Assessing the eligibility of identified articles

We downloaded all titles and abstracts retrieved by electronic searching to the reference management database EndNote. We removed duplicates and examined all references for their relevance. Full text articles were sourced for all potentially eligible reviews/meta-analyses, and these were assessed against the eligibility criteria.

Quality appraisal

We assessed the methodological quality of systematic reviews that met inclusion criteria using the AMSTAR measurement tool (see Appendix B).

Results

Figure 1 shows the PRISMA chart outlining the selection process.[1] Of the 19 full text articles screened for eligibility and excluded, the reasons for exclusion were:

- Six did not review intervention studies to reduce infections;
- Five related to other devices (central venous catheter, peripherally-inserted central catheter);
- Two did not report infection-related outcomes;
- Two did not review randomised controlled trials;
- One did not relate to catheterization;
- Two were not available in English; and
- One was an obsolete version of an included review.

A full list of excluded full-text articles is available at Appendix C.

Figure 1: PRISMA flow diagram
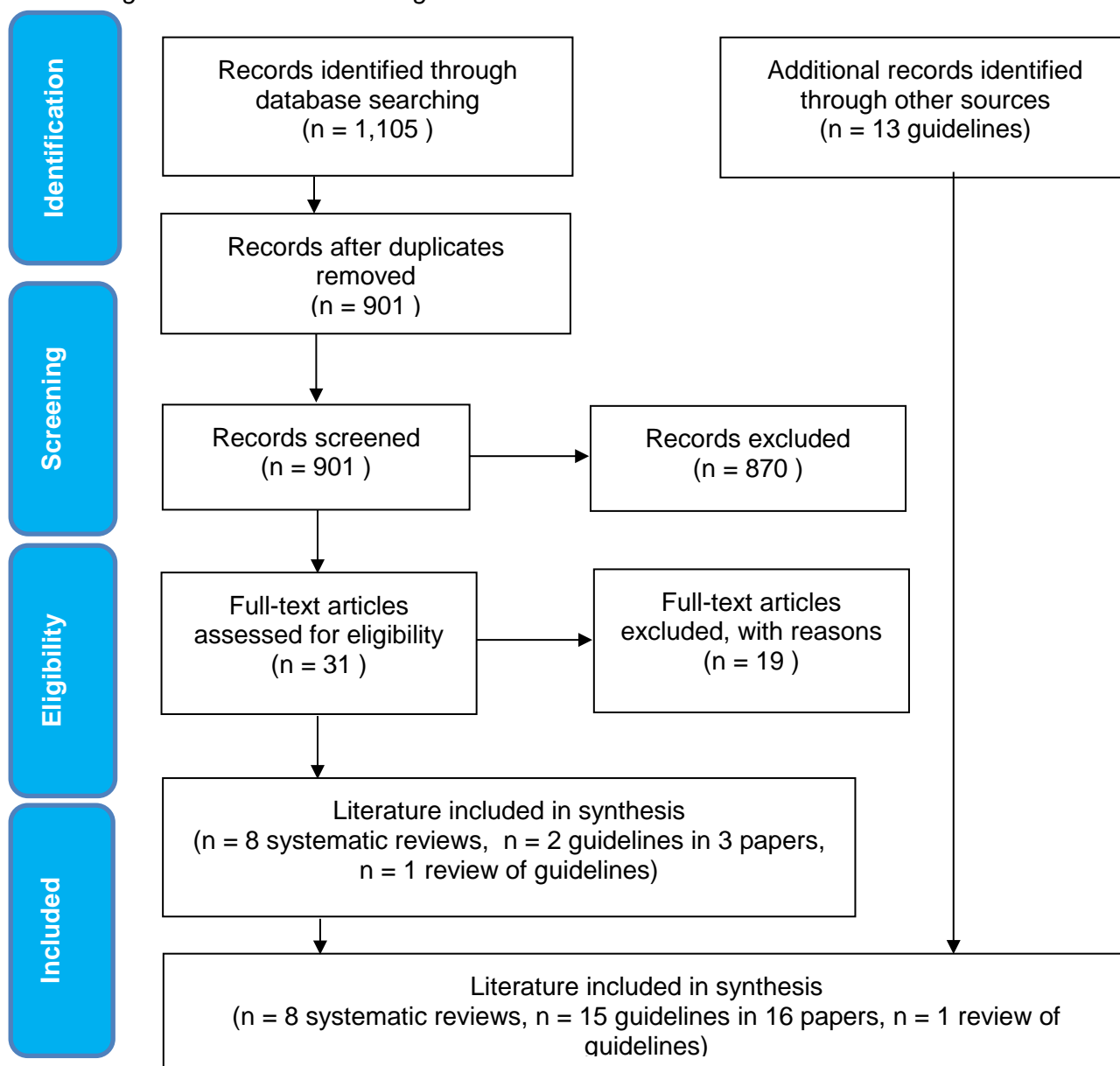
1. What relevant guidelines, policies and procedures, health programs or strategy documents are available?

The grey literature search identified 13 guidelines providing at least some recommendations relating to infections associated with PIVCs.[2-14] The database search identified an additional two guidelines reported in three papers[15-17] and one review of guidelines.[18] Five guideline documents were identified from Australian states and territories;[3, 8, 11, 12, 14] the remainder were international: three from the UK,[5, 10, 16] one from Ireland,[9] one from the UK and Ireland,[2] three from the USA,[6, 7, 15, 17] and one each from Spain[4] and Hong Kong.[13]

All of the international guidelines and two of the Australian guidelines provided evidence to support their recommendations. Four international guidelines and one Australian guideline specified the level of evidence on which each recommendation was based.

The scope of this rapid review did not permit rigorous quality appraisal of the guidelines by multiple reviewers according to AGREE II criteria. The review of guidelines identified through the search focussed on assessing the quality of international clinical practice guidelines for the selection and care of vascular access devices, but included only two of the guidelines identified for the current rapid review.[18]

Table 1: Characteristics of guidelines

Organisation	Year	Country/state	Evidence (level)
International			
Association of Anaesthetists of Great Britain and Ireland (AAGBI)[2]	2016	Great Britain & Ireland	Yes (no) *consensus*
Infusion Nurses Society[7]	2016	USA	Yes (yes)
UpToDate[6]	2019	USA	Yes (no)
Royal College of Nursing[5]	2016	UK	Yes (yes)
Hong Kong[13]	2018	Hong Kong	Yes (no)
SEICAV, SEMI, SEQ and SECTCV Societies[4]	2016	Spain	Yes (yes) *consensus*
Royal College of Physicians of Ireland[9]	2014	Ireland	Yes (no)
NICE/ Cochrane[10]	2015	UK	Yes (no)
MAGIC[15, 17]	2015	USA	Yes (no)
NICE/Epic3[16]	2014	UK	Yes (yes)
Australian (state/territory-based)			
ACT Health 2015[3]	2015	ACT	No
RCH Melbourne 2018[14]	2018	Victoria	Yes (yes)
SA Health 2019[12]	2019	South Australia	No
WA Health 2017[8]	2017	Western Australia	No
Qld Health 2015[11]	2015	Queensland	Yes (no)

2.   What do the current guidelines recommend?

The more extensive systematic review of guidelines and research conducted by Prof. Samantha Keogh and colleagues at QUT provides a broad summary of the quality of current guidelines and recommendations for insertion, maintenance and removal of PIVCs in adult and paediatric hospital populations.[19] Hence this summary focusses on recommendations that are explicitly linked to risk of phlebitis, local infection, and/or catheter-related bloodstream infection (CRBSI) and the evidence on which these recommendations are based. The five guidelines that reported the strength of the evidence on which each recommendation was based used slightly different levels and descriptors. The tables in this section report evidence levels as used by the Infusion Nurses Society and the Royal College of Nursing guidelines (from I-highest to V-lowest); full descriptors and conversion of evidence levels used by other guidelines are included in Appendix D.

2.1 Dwell time

All ten international guideline documents provided recommendations on dwell time (although only half referenced differences in infection rates in the justification for these recommendations). Nine of the ten recommended replacing only when clinically indicated (not routinely every 72-96 hours).[2, 4-7, 10, 13, 15-17] The remaining guideline specified there was no need to replace *more frequently* than every 72-96 hours, and that PIVCs can be maintained for longer periods *if sites are limited.*[9]

Of the Australian state-/territory-based guidelines, the two that provided supporting evidence recommended replacing only when clinically indicated,[14] or that institutions choose either replacement only when clinically indicated or routine replacement every 72-96 hours.[11] The remaining three Australian guidelines recommended routine replacement using slightly different wording – *within* 72 hours,[3] *after* 72 hours,[8] every 2-3 days.[12]

The recommendations were generally based on strong evidence. Most referred to the most recent update at the time of publishing of the series of Cochrane reviews of randomised controlled trials by Webster and colleagues, summarising the evidence on infection rates associated with clinically-indicated versus routine replacement of PIVCs.[20-22] With increasing numbers of included trials at each update, all of these reviews found no conclusive evidence that clinically-indicated replacement leads to different rates of CRBSI or phlebitis than routine replacement.

Six of the ten international guidelines provided recommendations regarding dwell time of catheters inserted in non-aseptic/emergent settings. There was more divergence in recommendations for these situations than for regular replacement. One guideline recommended replacing as soon as possible,[9] one as soon as possible but preferably within 24 to 48 hours,[7] two recommended replacing within 24 hours,[5, 6] one within 48 hours,[4] and one recommended replacing only if clinically indicated.[15, 17] The three Australian guidelines that provided recommendations regarding dwell time of catheters inserted in non-aseptic/emergent settings recommended that they be replaced within 24 hours.[3, 8, 11] One also recommended replacement on arrival for patients transferring from other healthcare facilities.[11] These recommendations were based principally on those from earlier guidelines – from the US Centers for Disease Control,[23] the Royal College of Nursing,[24] and NSW Health.[25]

Table 2.1a: International guideline recommendations relating to dwell time, noting those explicitly linked to risk of infection.

Guideline	Recommendation	Infection?	Evidence level
AAGBI 2016[2]	Clinically indicated.	N	
Infusion Nurses Society 2016[7]	Clinically indicated.	N	
	Emergent setting: a.s.a.p., preferably within 24 to 48 hours.	N	
UpToDate 2019[6]	Clinically indicated.	Y	Systematic review[21, 26]
	Emergent setting: within 24 hours.	Y	Guideline[23]
Royal College of Nursing 2016[5]	Clinically indicated.	N	III[16, 27]
	Emergent setting: within 24 hours.	N	V
Hong Kong 2018[13]	No need to replace more frequently than every 72-96 hours. If sites limited, can be maintained for longer period but close monitoring necessary.	N	[23]
SEICAV, SEMI, SEQ and SECTCV Societies 2016[4]	Clinically indicated	Y	I/II[20, 26, 28-37]
	Not more than 5 days	N	IV
	Emergent setting: within 48 hours (to avoid the risk of infection)	Y	II/III [38-40]
Royal College of Physicians of Ireland 2014[9]	Clinically indicated.	Y	Systematic review[21]
	Emergent setting: as soon as possible.	N	(Guideline[23])
NICE/ Cochrane 2015[10]	Clinically indicated.	Y	Systematic review[22]
MAGIC 2015[15, 17]	Clinically indicated.	N	(Guideline, RCTs[16, 27, 41-44])
	Emergent setting: clinically indicated.	N	
NICE/Epic3 2014[16]	Clinically indicated	Y	III[21, 27]

Table 2.1b: Australian guideline recommendations relating to dwell time, noting those explicitly linked to risk of infection.

Guideline	Recommendation	Infection?	Evidence level
ACT Health 2015[3]	Routinely replace within 72 hours.	N	
	Emergent setting: within 24 hours.	Y	-
RCH Melbourne 2018[14]	Clinically indicated.	Y	III/IV/V[27, 45, 46, 47 22 23]
SA Health 2019[12]	Routinely replace every 2-3 days (or sooner if clinically indicated).	N	
WA Health 2017[8]	Routinely replace after 72 hours.	N	
	Emergent setting: as soon as possible, within 24 hours.	N	
Qld Health 2015[11]	Locally determine through Infection Control Committee: OPTION 1: Routinely replace every 72-96 hours. OPTION 2: Clinically indicated.	Y	[21, 23, 24, 27, 45, 48-53]
	Emergent setting: within 24 hours. Transferring from other healthcare facilities: upon arrival.	N	[24, 25, 48, 49]

2.2 Type of device

There were few consistent recommendations regarding type of device, apart from the statement that the smallest size of catheter appropriate to the therapy and patient should be used. This was not generally linked to infection rates, although some guidelines did report limited evidence that larger catheters are associated with higher rates of phlebitis.[7, 11] One international guideline specified a 20- to 24-gauge catheter for most infusion therapies as catheters larger than 20 gauge are more likely to cause phlebitis.[7]

Two international guidelines and two Australian guidelines recommended maintaining closed infusion systems, as closed system PIVCs are less likely to cause phlebitis[5] and CRBSI[8, 11, 13] than open system PIVCs. This recommendation was based principally on the earlier guidelines from the US Centers for Disease Control.[23]

Two international guidelines and one Australian guideline noted that data from several studies suggest that peripheral intravenous catheters composed of polyurethane result in fewer complications and CRBSIs.[6, 11, 16] One noted that the use of small steel needles, which are associated with an appreciable risk of infection, no longer seems justifiable in most patients.[6]

One international guideline noted that there is no consensus on the design or type of needleless connector to prevent or reduce CRBSIs.[7] Another noted that there is no consensus on the type of connectors to be used, but that it is preferable to use a three-way stopcock than caps requiring connection-disconnection after every use.[4]

One international guideline noted that use of disinfection caps on peripheral catheters has limited evidence but should be considered.[7]

One international guideline recommended against routine use of filters for infection control, as there is no reliable evidence to support their efficacy in preventing BSI related to catheters, infusate or infusion systems, and also noted that antimicrobial- or antiseptic-impregnated catheters only offered marginal benefits in reducing CRBSI.[13]

Table 2.2a: International guideline recommendations relating to type of device, noting those explicitly linked to risk of infection.

Guideline	Recommendation	Infection?	Evidence level
AAGBI 2016[2]	The smallest practical size of cannula should be used.	N	
Infusion Nurses Society 2016[7]	Smallest practical size of cannula: Consider 20- to 24-gauge catheter for most therapies (>20 more likely to cause phlebitis).	Y	IV[44]
	There is no consensus on the design or type of needleless connector to prevent or reduce PIVC-related bloodstream infection.	Y	IV[23, 54-57]
	Use of disinfection caps should be considered (limited evidence, to reduce intraluminal microbial contamination and reduce CRBSI).	Y	Committee consensus.
UpToDate 2019[6]	Catheters composed of Teflon or polyurethane result in fewer complications and CRBSI. Small steel needles, associated with risk of infection, no longer seem justifiable in most patients.	Y	RCT[40, 58, 59]
Royal College of Nursing 2016[5]	Closed system peripheral intravenous catheters are less likely to cause phlebitis than open system peripheral intravenous catheters.	Y	III[60]
Hong Kong 2018[13]	Maintain a closed infusion system. The closed infusion system has been shown to result in significant reduction in the incidence of CRBSI.	Y	Guideline, prospective study[23, 61]
	Use of antimicrobial- or antiseptic-impregnated catheter to be based on need for CRBSI prevention after maximizing control measures.	Y	Guideline[16, 23, 56]
	Do not use filters routinely for infection-control purposes.	Y	Guideline[23, 62]
SEICAV, SEMI, SEQ and SECTCV Societies 2016[4]	No consensus on type of connectors. Preferable to use a three-way stopcock than caps requiring disconnection after use. Closed connectors can be used if disinfected with alcohol-impregnated wipes at every access.	Y	III[63]
Royal College of Physicians of Ireland 2014[9]	The smallest practical size of cannula should be used.	N	(Guideline[64])
NICE/Epic3 2014[16]	Polytetrafluroethylene (Teflon) and polyurethane catheters associated with fewer infections than polyvinyl chloride/polyethylene.	Y	NR[59]
	Use a catheter with the minimum number of ports or lumens essential for management.	Y	I[23, 65-72]

Table 2.2b: Australian guideline recommendations relating to type of device, noting those explicitly linked to risk of infection.

Guideline	Recommendation	Infection?	Evidence level
ACT Health 2015[3]	The PIVC should be the shortest and smallest gauge that can meet the anticipated clinical need.	N	
WA Health 2017[8]	The PIVC is to be the shortest and smallest gauge that is suitable for the anticipated clinical need.	N	
	As closed intravenous access systems are associated with fewer CRBSIs than open systems, needleless access ports are to be used on all lumens. Stopcocks are to be end-capped with a needleless access port when not in use.	Y	Guideline[23]
Qld Health 2015[11]	Clinicians should use the smallest gauge and shortest length PIVC that will accommodate the prescribed therapy to reduce the risk of phlebitis.	Y	[24, 73]
	Closed catheter access systems are associated with fewer CRBSIs than open systems. Therefore, needleless access ports should be used on all lumens. Stopcocks should be end-capped with a needleless access port/cap when not in use.	Y	[23, 74]
	PIVCs made of polyurethane have been shown to significantly reduce incidence of phlebitis compared to tetrafluorethylene-hexafluoropropylene (teflon) or silicone catheters.	Y	[73, 75]
	In-line filters are not recommended for infection control purposes.	Y	-
	Add-on equipment should be of luer-lock design.	N	[24]

2.3 Choice of site

Regarding choice of site, there was broad consensus that veins in the upper extremities are preferable and that veins in the lower extremities should be avoided. Several guidelines specified that this was due to increased risk of infection[5, 6, 16] or other adverse events.[3, 7, 9, 16] One international guideline noted that the risk of infection with PIVC is higher in the wrist or upper arm compared with the hand.[6] One international guideline recommended avoiding the femoral site in particular due to high risk of CRBSI.[5] One Australian guideline noted that PIVCs inserted into the antecubital fossa have been observed to have a higher risk of infection than in the forearm, potentially due to catheter movement with flexion.[11] This recommendation was based on relatively limited trial evidence, and on earlier guidelines.

Two guidelines recommended avoiding limbs affected by lymphoedema[2] or infection (e.g. cellulitis)[8] due to particular risk of infection.

Table 2.3a: International guideline recommendations relating to choice of site, noting those explicitly linked to risk of infection.

Guideline	Recommendation	Infection?	Evidence level
AAGBI 2016[2]	Insertion in a limb with lymphoedema should be avoided, except in acute situations due to increased risks of local infection.	Y	-
Infusion Nurses Society 2016[7]	Consider veins found on the dorsal and ventral surfaces of the upper extremities, including the metacarpal, cephalic, basilic, and median veins.	N	
	Do not use veins of the lower extremities unless necessary due to risk of tissue damage, thrombophlebitis, and ulceration.	Y	IV[23, 76]
UpToDate 2019[6]	The risk of infection with PIVCs is higher in the lower compared with the upper extremity and higher in the wrist or upper arm compared with the hand.	Y	Guideline, RCT[23, 40]
Royal College of Nursing 2016[5]	Veins that should be considered for peripheral cannulation are those in the forearm or hands.	N	[23]
	Veins in the lower extremities should not be used routinely in adults due to the risk of thrombosis, thrombophlebitis and infection.	Y	NR
	Avoiding the femoral site can assist in the reduction of CRBSIs.	Y	V[16]
Hong Kong 2018[13]	Use an upper-extremity site for catheter insertion. Replace a catheter inserted in a lower extremity site to an upper extremity site as soon as possible.	N	[23]
SEICAV, SEMI, SEQ and SECTCV Societies 2016[4]	Upper extremity veins preferable for lesser risk of contamination. Higher risk of phlebitis after lines placed at the cubital crease, preferable to avoid and use arm, forearm or dorsal hand/wrist.	Y	III[77, 78]
Royal College of Physicians of Ireland 2014[9]	PIVCs inserted into the lower limbs have a greater risk of thrombophlebitis than the upper limbs and should only be used for the short term or in emergencies. Initial sites should be in the distal areas of the upper extremities.	Y	-
NICE/Epic3 2014[16]	To reduce the risk of CRBSI and phlebitis, it is preferable to use an upper extremity site for inserting a PIVC and to replace a device inserted in a lower extremity to a site in the upper extremity as soon as possible.	Y	IV[23]

Table 2.3b: Austalian guideline recommendations relating to choice of site, noting those explicitly linked to risk of infection.

Guideline	Recommendation	Infection?	Evidence level
ACT Health 2015[3]	Use basilic or cephalic veins on the posterior (dorsal) forearm if possible. Avoid the use of veins in lower limbs.	N	
WA Health 2017[8]	PIVC are to be routinely sited in the distal areas of the upper limbs.	N	
	Avoid the use of veins in areas of flexion, e.g. antecubital fossa, or bony prominences due to increased risk of CRBSI. Avoid the use of veins in an infected limb, e.g. with cellulitis, due to increased risk of infection.	Y	Guideline[25]
Qld Health 2015[11]	The distal areas of the upper extremities are optimal for site selection. Catheters inserted into the lower limbs have a greater risk of phlebitis than the upper limbs. Recommended that catheters inserted in a lower extremity site should be replaced to an upper extremity site as soon as possible.	Y	23, 24, 48, 73, 75, 79
	A higher incidence of phlebitis has been observed when the PIVC is inserted in the wrist compared with the hand or forearm. PIVCs inserted into the antecubital fossa and forearm veins have a significantly lower risk of phlebitis than the dorsal veins of the hand. PIVCs inserted into the antecubital fossa have a higher risk of infection than in the forearm, potentially due to movement with flexion.	Y	25, 48, 49, 51, 73, 80

2.4 Site preparation

Among guidelines that provided recommendations on site preparation, there was broad consensus that hair should be removed with scissors/clippers and not shaved, to reduce the risk of infection.[5, 7, 8, 11] While most of these recommendations were justified only in that they followed those of earlier guidelines,[24, 25, 81] one guideline did reference a 2011 Cochrane review which included three trials showing significantly more surgical site infections with shaving compared to clipping.[82]

The preferred skin antiseptic agent for infection prevention was chlorhexidine in alcohol solution.[4-9, 12, 14, 16] One international and one Australian guideline did not specify a preferred antiseptic.[11, 13] This recommendation was based on earlier guidelines,[16, 23, 56, 62] and on good evidence that chlorhexidine is effective when used as a skin preparation solution for central venous catheters,[83] but there is no evidence for the comparative effectiveness of different solutions for PIVCs.[84]

Two international guidelines specified that prophylactic antibacterial/antimicrobial/ antifungal agents are not recommended at the time of insertion or during use of a PIVC to prevent infection, with evidence at the level of clinical consensus.[9, 16]

Table 2.4a: International guideline recommendations relating to site preparation, noting those explicitly linked to risk of infection.

Guideline	Recommendation	Infection?	Evidence level
Infusion Nurses Society 2016[7]	Remove excess hair at the insertion site using single patient-use scissors or disposable-head surgical clippers; do not shave as this may increase the risk for infection (limited research).	Y	V[82]
	Perform skin antisepsis using >5% chlorhexidine in alcohol solution. If there is a contraindication, tincture of iodine, an iodophor (povidone-iodine), or 70% alcohol may also be used. Allow the antiseptic agent to fully dry before insertion.	N	*(Evidence for reduced infection for CVCs)*
UpToDate 2019[6]	Use of antiseptic at the insertion site reduces risk of infection. >0.5% chlorhexidine preparation with alcohol is superior to both aqueous and alcohol-based povidone-iodine in reducing the risk for catheter colonization and CRBSI.	Y	Meta-analysis, RCTs[83, 85, 86]
Royal College of Nursing 2016[5]	Shaving with a razor should not be performed because of the increased risk of infection.	Y	Regulatory[81]
	To prevent the entry of micro-organisms into the vascular system, the injection access site should be decontaminated with an approved single-use antimicrobial solution, such as 2% chlorhexidine gluconate in 70% alcohol.	Y	V; Regulatory[16, 62]
Hong Kong 2018[13]	Prepare skin with an antiseptic, e.g. 70% alcohol for PIVC insertion.	N	(Guideline)[16, 23, 56, 62]
	Use clean gloves for peripheral intravascular catheter insertion; do not touch the insertion site after the application of skin antiseptics.	N	(Guideline)[23]
SEICAV, SEMI, SEQ and SECTCV Societies 2016[4]	The skin must be disinfected with 2% alcoholic chlorhexidine solution or, if not available, with a 70% iodine or alcohol solution	Y	I[23, 40, 84]
Royal College of Physicians of Ireland 2014[9]	Alcoholic chlorhexidine gluconate solution (preferably 2% chlorhexidine gluconate in 70% isopropyl alcohol) should be used and allowed to air dry.	N	
	Prophylactic antibacterial or antifungal agents are not recommended at the time of insertion or during use of a PIVC to prevent infection.	Y	
NICE/Epic3 2014[16]	Decontaminate the skin at the insertion site with a single-use application of 2% chlorhexidine gluconate in 70% isopropyl alcohol and allow to dry before inserting a PIVC.	Y	V *(Level I evidence for CVCs)*
	Do not apply antimicrobial ointment routinely to the catheter placement site prior to insertion to prevent CRBSI.	Y	V

Table 2.4b: Australian guideline recommendations relating to site preparation, noting those explicitly linked to risk of infection.

Guideline	Recommendation	Infection?	Evidence level
RCH Melbourne 2018[14]	Skin preparation using alcohol in 2% chlorhexidine is the preferred solution for dressings.	N	
SA Health 2019[12]	Decontaminate the insertion site using an appropriate skin disinfectant such as alcohol-based preparations containing 70% isopropyl alcohol v/v and at least 0.5% chlorhexidine. Allow to dry prior to insertion.	N	
WA Health 2017[8]	Use clippers to remove hair at the insertion site if necessary.	N	
	Perform skin disinfection of the site using 2% chlorhexidine gluconate in 70% isopropyl alcohol.	N	
Qld Health 2015[11]	Hair at the insertion site should only be removed by the clinician (prior to antiseptic application), using clippers (not shaved).	N	[24, 25]
	The most effective disinfectant (chlorhexidine or povidone iodine) to combine with alcohol has not been established in the literature. Either a solution containing 2% chlorhexidine gluconate (CHG) in ≥ 70% (ethyl or isopropyl) alcohol (alcoholic chlorhexidine) or a solution containing povidone-iodine 10% in 70% ethyl alcohol (ethanol) should be used.	N	[24, 25, 87, 88]

2.5 Securement/dressings

A majority of guidelines recommended using sterile, transparent, semipermeable dressings;[3, 5, 8, 9, 11, 14, 16] three international and one Australian guideline recommended either this or sterile gauze.[4, 6, 12, 13] Most of these relied on the recommendations of earlier guidelines.[16, 23, 62, 89] The Royal Children's Hospital in Melbourne reported their recommendation of a sterile transparent, semipermeable, occlusive dressing was supported by level I evidence, including several trials and a 2015 Cochrane review (also included in this rapid review).[23, 88, 90-95]

One international guideline recommended avoiding tape or sutures, due to increased infection risk,[7] based on limited evidence and consensus.[96, 97]

Table 2.5a: International guideline recommendations relating to securement/dressings, noting those explicitly linked to risk of infection.

Guideline	Recommendation	Infection?	Evidence level
Infusion Nurses Society 2016[7]	Avoid tape or sutures, as they are not effective alternatives to an adhesive-based engineered stabilization device (ESD). Rolls of nonsterile tape can become contaminated with pathogenic bacteria, although its contribution to infection has not been quantified. Sutures increase the risk of CRBSI.	Y	II[96, 97] Regulatory.
	Consider 2 options for stabilization: (1) an integrated stabilization feature on the hub combined with a bordered polyurethane securement dressing or (2) a standard round hub in combination with an adhesive ESD. Equivalent complication rates, although rates for both types not greatly reduced with either type of ESD.	Y	III[98, 99]
	Secure dressings to reduce the risk of loosening/ dislodgment, as more frequent dressing changes due to dislodgment are associated with increased risk for infection; more than 2 dressing changes for disruption were associated with a greater than 3-fold increase in risk of infection.	Y	III[100]
UpToDate 2019[6]	The type of dressing at the insertion site may affect the rate of catheter infection. Sterile gauze or sterile, transparent, semipermeable dressing should be used to cover the catheter site.	Y	[101]
Royal College of Nursing 2016[5]	Transparent film dressings should be used to cover intravascular insertion sites where possible.	N	(Guideline)[16, 62]
Hong Kong 2018[13]	Use sterile, transparent, semipermeable dressing or sterile gauze to cover the catheter site.	N	(Guideline)[16, 23, 62, 89]
SEICAV, SEMI, SEQ and SECTCV Societies 2016[4]	Sterile gauze dressing or semi permeable transparent sterile dressing to cover the insertion site will be used.	Y	II/III[102, 103]
Royal College of Physicians of Ireland 2014[9]	A sterile, transparent semipermeable dressing should be used to cover the insertion site.	N	-
NICE/Epic3 2014[16]	Use a sterile, transparent, semipermeable polyurethane dressing to cover the intravascular insertion site.	Y	V

Table 2.5b: Australian guideline recommendations relating to securement/dressings, noting those explicitly linked to risk of infection.

Guideline	Recommendation	Infection?	Evidence level
ACT Health 2015[3]	Secure the cannula with Steristrip, over the cannula hub and occlusive transparent dressing.	N	
RCH Melbourne 2018[14]	Cover the cannula insertion site with sterile transparent semipermeable, occlusive dressing (e.g. Tegadermtm, IV 3000tm).	Y	I[23, 88, 90-95]
SA Health 2019[12]	Chlorhexidine-impregnated sponge, and sterile gauze or transparent semitransparent dressing, should be used to cover the insertion site.	N	
WA Health 2017[8]	Use a sterile, transparent semi-permeable dressing to secure the PIVC.	N	
Qld Health 2015[11]	Sterile, transparent, semi-permeable, self-adhesive, (standard or hyperpermeable) polyurethane dressings should be used.	N	[24, 25, 48, 87, 88]

2.6 Flushing

A majority of guidelines recommended flushing and locking catheters after use, when used intermittently.

In terms of flushing solution, while one international guideline noted that it was not clear if catheters should be flushed with normal saline or heparin,[4] there was otherwise broad consensus that 0.9% saline flush should be used in preference to heparin.[5, 8, 9, 11, 13, 14, 16] Most guidelines based their recommendations on the UK National Institute for Health and Care Excellence recommendations,[16] which were based on level I evidence: systematic review and meta-analysis.[104-110] Several guidelines noted that their recommendations were due principally to increased risk of negative side effects with heparin, rather than superior infection/phlebitis rates with either solution. The Royal Children's Hospital in Melbourne also referenced a recent systematic review specific to children, with similar conclusions.[111]

There was also consensus that routine antimicrobial lock solutions should not be used to prevent CRBSI;[4, 5, 13, 16] evidence provided for this was principally earlier guidelines.[16, 23, 56, 62]

Table 2.6a: International guideline recommendations relating to flushing of catheters, noting those explicitly linked to risk of infection.

Guideline	Recommendation	Infection?	Evidence level
AAGBI 2016[2]	All cannulae must be flushed after use.	N	
Infusion Nurses Society 2016[7]	PIVCs are flushed and aspirated for a blood return prior to each infusion to prevent complications.	Y	NR
	Flush all PIVCs with preservative-free 0.9% sodium chloride (USP)	N	
	The PIVC is locked after final flush to decrease the risk of intraluminal occlusion and CRBSI.	Y	NR
	Commercially available prefilled syringes may reduce the risk of CRBSI.	Y	IV
Royal College of Nursing 2016[5]	The device should be flushed at established intervals.	N	
	Routine systemic anticoagulants should not be used to prevent CRBSIs. Sterile sodium chloride 0.9% should be used to flush and lock catheter lumens accessed on a frequent basis.	Y	V[16]
	Routine antimicrobial lock solutions should not be used to prevent CRBSI.	Y	V[16, 62]
Hong Kong 2018[13]	Flush the peripheral intravascular lock or needle free device with normal saline for lowering catheter-related complications though they are not necessarily infection related.	N	[16, 62, 110]
	Normal saline flush is superior and preferable to heparin.	N	[110, 112, 113]
	No conclusive evidence to adopt any agents to be the lock solution for preventing CRBSI.	Y	Guideline[23]
	Do not routinely use antibiotic lock solutions to prevent CRBSI.	Y	Guideline[16, 23, 56, 62]
SEICAV, SEMI, SEQ and SECTCV Societies 2016[4]	Unclear if catheters must be rinsed with normal saline or heparin. Risk of phlebitis reduced with heparin but is still 45%.	Y	NR[109]
	No evidence that antibiotic prophylaxis at insertion or antibiotic-lock are cost-efficient to keep PIVC free from infection.	Y	NR
Royal College of Physicians of Ireland 2014[9]	Optimal volume and frequency of flushing of PIVCs used intermittently is unclear. Recommend PIVCs flushed with minimum 2ml solution after placement and prior to and after infusion or injection, or at least every 12 hours.	N	
	Sterile 0.9% sodium chloride for injection is used to flush a PIVC.	N	
NICE/Epic3 2014[16]	Use sterile normal saline for injection to flush and lock catheter lumens accessed frequently.	Y	I[104-110]
	Antimicrobial lock solutions should not be used routinely to prevent CRBSIs.	Y	V

Table 2.6b: Australian guideline recommendations relating to flushing of catheters, noting those explicitly linked to risk of infection.

Guideline	Recommendation	Infection?	Evidence level
ACT Health 2015[3]	Flushing of PIVC in situ maintains PIVC patency, minimises adverse reactions and prevents thrombus formation.	N	
RCH Melbourne 2018[14]	The cannula should be flushed prior to infusion or at least once a shift.	N	(III[114])
	Sterile 0.9% sodium chloride for injection should be used to flush a catheter.	N	(I[111 115])
WA Health 2017[8]	PIVC are to be flushed with 5-10mls of sterile 0.9% sodium chloride for injection using a 10ml Luer-lock syringe or commercially available pre-filled syringe.	N	
Qld Health 2015[11]	If intermittent injections or infusions, flushing under positive pressure is recommended.	N	[24, 25]
	Sterile 0.9% sodium chloride for injection should be used by clinicians to flush a catheter.	N	[24, 25]

2.7 Other

Three international and one Australian guideline noted that catheters should be placed by health care workers skilled in intravenous catheter placement to reduce rates of infection,[6, 7, 11, 16] based on the recommendations of earlier guidelines,[16, 23, 25, 89] and on some trial evidence.[33, 44, 116-120]

Three international guidelines recommended the use of multi-component care bundles, checklists or quality improvement interventions,[4, 5, 16] based on trial evidence.[121-128, 131-134] Care bundles/quality improvement interventions may include education of the HCP, patient and carer; general asepsis including hand hygiene and standard precautions; protocols for insertion and maintenance; selection of appropriate device and site avoiding femoral site; maximum sterile barrier precautions during insertion; cutaneous antisepsis; catheter and catheter site care as well as general principles of replacement strategies and prompt removal, reminders to review continuing use or prompt removal; audit and feedback of compliance with guidelines; continuing professional education.

Three international and two Australian guidelines recommended that routine intranasal and or prophylactic systemic antimicrobials before or during the use of an intravascular device should not be used to prevent catheter colonisation or blood stream infections.[5, 8, 11, 13, 16] This recommendation mirrored recommendations from earlier guidelines,[11, 16, 23, 56, 62] which were based on level I evidence: systematic review (although this was focussed on central venous catheters).[129]

Table 2.7a: Other international guideline recommendations relating to infection rates

Guideline	Recommendation	Infection?	Evidence level
Infusion Nurses Society 2016[7]	A designated team for inserting PIVCs decreases CRBSIs and local infections.	Y	V[33, 44, 116-118]
	A designated team for managing VADs decreases CRBSIs/related costs and phlebitis.	Y	IV[116, 130-134]
	Strict attention to skin antisepsis and the use of sterile gloves when placing PIVCs.	Y	V[135, 136]
	Avoid the use of stopcocks due to the increased risk of infection.	Y	IV[137, 138]
UpToDate 2019[6]	Strict adherence to hand hygiene and aseptic technique during insertion/changes remain the most important for CRBSI prevention.	Y	Guideline[23, 56, 139]
	Catheters placed by skilled health care workers have lower rates of infection.	Y	RCT[119, 120]
Royal College of Nursing 2016[5]	Use recognised pre-insertion bundles/quality improvement interventions for the insertion and maintenance of PIVCs.	Y	III[16, 140-143]
	Consider dedicated lead nurse to standardise and facilitate good practice linked to PIVCs and the prevention of CRBSI.	Y	IV[144]
	Do not routinely administer intranasal or systemic antimicrobials before insertion or during use of an intravascular catheter to prevent catheter colonization or CRBSI.	Y	V[16]
Hong Kong 2018[13]	Do not routinely administer intranasal or systemic antimicrobials before insertion or during use of an intravascular catheter to prevent catheter colonization or CRBSI.	Y	Guideline[16, 23, 56, 62]
SEICAV, SEMI, SEQ and SECTCV Societies 2016[4]	Adhesion to checklist of recommendations is associated with reduced complications.	Y	I/II[121, 122]
	Techniques (e.g. laser, ultrasound) facilitating vein identification in patients with poor venous flow are recommended. These do not reduce risk of infection. Routine use not justified.	Y	I/II[145-147]
Royal College of Physicians of Ireland 2014[9]	Only competent, trained staff (or training staff supervised by competent staff) should insert and maintain PIVCs.	N	
NICE/Epic3 2014[16]	Do not routinely administer intranasal or systemic antimicrobials before insertion or during the use of an intravascular device to prevent catheter colonisation or CRBSI.	Y	I[23]
	Workers caring for patients with PIVCs should be trained and assessed as competent in using and consistently adhering to practices for the prevention of CRBSI.	Y	V
	Use quality improvement interventions to support appropriate use, management and timely removal.	Y	IV[122-128, 143]

Table 2.7b: Other Australian guideline recommendations relating to infection rates

Guideline	Recommendation	Infection?	Evidence level
WA Health 2017[8]	Prophylactic antibacterial or antifungal agents (topical, oral, intranasal, or parenteral) are not recommended to prevent catheter colonisation or CRBSI.	Y	Guideline[11, 16]
Qld Health 2015[11]	Only competent staff (or training staff supervised by competent staff) should insert PIVCs to minimise infection and other complications.	Y	23, 25, 89
	Prophylactic antibacterial or antifungal agents (oral, intranasal or parenteral) are not recommended at insertion or during use to prevent catheter colonisation or CRBSI.	Y	-

3. What evidence is there regarding current clinical practice in Australia?

Within the limited scope of this rapid review, we specified that we would report current clinical practice in Australia as reflected in recent guidelines. These guidelines do not reflect the full range of clinical practice currently in Australia, as they guide only specific states and/or institutions, and they also make no claims regarding the level of compliance with their recommendations. Indeed, widespread variation between guidelines and actual clinical practice have been identified in Australia and internationally.[148]

As can be seen in the response to Research Question 2 above, there are areas where clinical practice as reflected in Australian guidelines aligns with that recommended in international guidelines.

1. Type of device: Internationally and in Australia, it is recommended that the shortest and smallest PIVC suitable for the anticipated clinical need for that patient should be selected.
2. Type of device: While closed intravenous access systems are not mentioned in all guidelines, where they are, they are recommended both in Australia and internationally as they are associated with fewer CRBSIs than open systems.
3. Choice of site: Internationally and in Australia, it is recommended that veins in the distal areas of the upper limbs are preferable and that veins in the lower extremities should be avoided.
4. Site preparation: Internationally and in Australia, there is consensus that hair should be removed if necessary with scissors/clippers and not shaved, and that 2% chlorhexidine in 70% alcohol solution is the preferred skin antiseptic agent.
5. Securement/dressings: Internationally and in Australia, most guidelines recommend using sterile, transparent, semipermeable dressings, although one Australian guideline also allowed sterile gauze as a dressing choice.[12]
6. Flushing: Internationally and in Australia, most guidelines recommend 0.9% saline flush in preference to heparin.

There are also areas where clinical practice as reflected in Australian guidelines differs from that recommended in international guidelines.

1. Dwell time: international consensus is that PIVCs should be replaced only when clinically indicated, whereas in Australia routine replacement is recommended practice in most jurisdictions. For PIVCs inserted in emergent situations, Australian guidelines recommend prompt replacement (within 24 hours).

2. Type of device: Few guidelines in Australia or internationally included recommendations for type of catheter, but the Queensland guideline noted that phlebitis incidence is reduced with PIVCs made of polyurethane compared to Teflon or silicone,[11] whereas the UK NICE guideline and the US-based UpToDate recommended Teflon (and polyurethane), over polyvinyl chloride or polyethylene, based on older evidence of fewer infections.[6, 16]

4.   What indictors are currently used to measure or report adverse outcomes?

Within the limited scope of this rapid review, we specified that we would report indicators currently used to measure or report adverse outcomes from identified recent guidelines. Measuring and reporting adverse outcomes did not form a substantial part of a majority of international and Australian guidelines. Adverse outcomes were mostly framed generally, for example "process and outcome measures"[13] or "infection and complication rates".[4]

A small number of guidelines did provide more specific measures, recommending recording of a visual infusion phlebitis (VIP) score each shift,[5] peripheral intravenous assessment score (PIVAS) performed at least every eight hours while the PIVC is in situ and continued for 48 hours post removal,[8] peripheral phlebitis incidence rate (number of phlebitis incidents / total number of IV peripheral devices x 100),[5] and CRSBI incidence per 1,000 catheter patient days.[5, 9]

Table 4a: Adverse event indicators recommended in recent international guidelines

Adverse event indicators	
Royal College of Nursing 2016[5]	Infection rates per 1,000 catheter days. Morbidity and mortality rates associated with vascular access device related infections. Visual infusion phlebitis (VIP) score (each shift). Peripheral phlebitis incidence rate = number of phlebitis incidents / total number of IV peripheral devices x 100.
Hong Kong 2018[13]	Process and outcome measures. CRBSI per 1000 catheter patient days.
SEICAV, SEMI, SEQ and SECTCV Societies 2016[4]	Infection and complication rates. Adherence (of healthcare personnel) to checklist.
Royal College of Physicians of Ireland 2014[9]	European case definitions for catheter-related infection as agreed by the European Centre for Disease Prevention and Control (ECDC).

Table 4b: Adverse event indicators recommended in recent Australian guidelines

Adverse event indicators	
ACT Health 2015[3]	Any signs of adverse reactions, e.g. phlebitis, infiltration, pain, tenderness.
SA Health 2019[12]	Document any complications.
WA Health 2017[8]	All PIVC related BSIs are to be reported in accordance with the HCFs clinical incident reporting process and the WA health system policy on Clinical Incident Management. All PIVC are to have a peripheral intravenous assessment score (PIVAS) performed at least every eight hours while the PIVC is in situ and continued for 48 hours post removal, by assessing the PIVC site for patency, erythema, swelling, pain or tenderness.
Qld Health 2015[11]	(Monthly) Healthcare-associated (HCA) IVD-related Bloodstream Infection (BSI) rates in high-risk patient populations. Clusters of HCA IVD-related BSIs. Episodes of HCA IVD-related Staphylococcus aureus BSI.

5. What contributes to variations in infection rates associated with peripheral venous access?

6. What is the literature on interventions to prevent infections associated with PIVC devices?

The literature search identified eight systematic reviews of randomised controlled trials that aimed to reduce or prevent variation in catheter-related infections and/or phlebitis associated with Peripheral Intra-Venous Catheter (PIVC) devices.[84, 95, 149-154] Two additional reviews were not eligible for inclusion, as they were not reviews of randomised controlled trials, but these are nevertheless noted below as they provide preliminary information on domains not covered in other eligible reviews.[155, 156] The current rapid review specified studies conducted with adults in the eligibility criteria. In light of the interest at the Round Table meeting held in Sydney on 6 March in developing a clinical care standard that is relevant for all patients, two additional systematic reviews including studies with children are also noted below.

Table 5: Characteristics of included systematic reviews

Review	Topic	Search dates	Included trials
Included			
Webster et al 2019[152]	Dwell time	-2018	9 RCTs
Mermel 2017[150]	Dwell time	1980-2017	63 studies (design not specified)
Morrison and Holt 2015[151]	Dwell time	2009-2014	4 RCTs, 2 meta-analyses of 13 studies
CADTH 2014[84]	Site preparation (chlorhexidine)	2009-2014	2 evidence-based guidelines
Marsh et al 2015[95]	Securement/dressings	-2015	6 RCTs
You et al 2017[153]	Flushing (heparin)	-2016	32 RCTs
Carr et al 2018[149]	Vascular access specialist teams	-2018	0 trials (1 ongoing study, 1 unpublished study)
Zheng et al 2014[154]	Aloe vera (for prevention/ treatment)	-2014	43 trials (35 RCTs and eight qRCTs)
Additional			
Chang et al 2018[155]	Catheter size, catheter site, dwell time	2006-2017	17 studies (*0 RCTs*)
Foster et al 2015[157]	In-line filters *in neonates*	-2015	4 RCTs/qRCTs
Gunes et al 2018[111]	Flushing (heparin) *in children*	-2018	2 systematic reviews, 4 RCTs
Xu et al 2018[156]	PIVC bundle	2000-2018	8 studies (*0 RCTs*)

2.1 Dwell time

An updated Cochrane systematic review and meta-analysis published in 2019 (previous versions published in 2010 and 2015) reviewed the evidence for differences in catheter-related blood stream infection (CRBSI) rates when catheters were changed routinely every 72 to 96 hours compared with changing catheters only when clinically indicated.[152]

The review included nine randomized controlled trials with a total of 7,412 participants, of which seven trials with 7,323 participants were included in the meta-analysis. The meta-analysis found:

- No clear difference in the incidence of CRBSI between clinically indicated and routine change groups (low-certainty evidence).
- No clear difference in the incidence of thrombophlebitis between clinically indicated and routine change groups (moderate-certainty evidence).
- Three trials (n=4,244 participants) investigated costs; clinically indicated removal probably reduces device-related costs by approximately $7.00 compared with routine removal (moderate-certainty evidence).
- Four trials (n=4,606 participants) reported local infection rates: it was uncertain if there were differences between groups (very low-certainty evidence).

Two earlier reviews identified in the literature search also examined differences in infection rates between PIVCs replaced routinely compared with on clinical indication. One reviewed a subset of the trials included in the most recent Cochrane review, and as such is not further referred to here.[151] The other review, of very low quality, did not report study types or appraise study quality, and as such did not provide further useful evidence to inform practice.[150]

2.2 Type of device

No eligible systematic reviews were identified that reviewed the evidence for differences in infection rates for different types of device.

One additional review and meta-analysis that did not identify any RCTs (but included a variety of other study designs) did examine differences in rates of phlebitis between catheters of 20 gauge or smaller compared with those larger than 20 gauge (12 studies, 4,532 catheters) and found no statistically significant difference.[155]

A review of evidence in neonates included four low quality RCTs comparing the use of in-line filters compared with unfiltered fluids for intravenous infusion, and found no significant differences in septicaemia or phlebitis.[157]

2.3 Choice of site

No eligible systematic reviews were identified that reviewed the evidence for differences in infection rates for different catheter sites.

One additional review and meta-analysis that did not identify any RCTs (but included a variety of other study designs) did examine differences in rates of phlebitis between catheters inserted in the antecubital fossa and those inserted in other locations on the upper limbs (7 studies, 3,589 catheters) and found no statistically significant difference.[155]

2.4 Site preparation

A rapid review published in 2014 searched for evidence on infection rates associated with the use of chlorhexidine gluconate with alcohol as a topical antiseptic compared with other topical antiseptics.[84] The review found that while two clinical guidelines (NICE 2012 UK, I-CARE 2013 Qld) recommended decontamination of the skin at the insertion site with 1-2% chlorhexidine gluconate in ≥70% alcohol, no trial evidence on the clinical effectiveness, safety or cost effectiveness of chlorhexidine gluconate with alcohol could be identified.

2.5 Securement/dressings

A Cochrane review published in 2015 searched for evidence on devices and dressings to secure PIVCs to prevent complications, including phlebitis and infection.[95] The review identified six RCTs with a total of n=1,579 participants, comparing different dressings and securement devices. The review found that:

- The relative effectiveness of transparent dressings and gauze on phlebitis was unclear. (n=2 studies, n=278 participants)
- The relative effectiveness of a bordered transparent dressing and a securement device on overall PVC failure (a composite measure of unplanned PVC removal for any reason, such as phlebitis, infiltration, accidental removal, blockage) was unclear (assessed only in one small study).
- There was very low quality evidence from the same single study of more phlebitis with bordered dressings than securement devices.
- There was very low quality evidence from a small single study of more PVC failure with bordered dressings than tape.
- The relative effectiveness of transparent dressings compared with a sticking plaster on phlebitis is unclear (one small study).

No evidence was identified on CRBSI rates relating to different dressing/securement types.

2.6 Flushing

A systematic review and meta-analysis published in 2017 searched for evidence on phlebitis rates associated with heparin used for intermittent flushing or continuous infusion, compared with placebo.[153] The review identified 22 relevant RCTs, of which 13 reported results for intermittent flushing and nine reported results for continuous infusion. The meta-analysis found that the risk of phlebitis was significantly decreased by both continuous infusion and intermittent flushing of heparin in peripheral venous catheters. The overall effect of heparin on reducing phlebitis was also statistically significant. While the authors reported that a majority of included studies demonstrated a low or unclear risk of bias, several did not provide sufficient detail to assess the potential for selective reporting, and the authors recommended interpreting the results with caution due to a series of limitations.

Additional evidence is available from a recent systematic review of studies with children, cited by the guideline from Royal Children's Hospital in Melbourne.[14] This review searched for evidence comparing heparin and sodium chloride for prolonging PIVC use in children, and identified two relevant systematic reviews and four randomized controlled trials.[111] The review authors concluded that the available evidence was contradictory, and that as no clear outcomes favouring heparin were found and heparin is known to have negative side effects, no guidelines could be developed as a result.

2.7 Other

A Cochrane review published in 2018 searched for evidence on the effectiveness of vascular access specialist teams on premature device failure rates, including as a result of phlebitis and infection, but did not identify any RCTs comparing specialist teams with the generalist model.[149]

No eligible systematic reviews were identified that reviewed the evidence for differences in infection rates associated with multicomponent PIVC care bundles. A recent conference abstract did report on a review conducted using Cochrane methods, of PIVC insertion or maintenance care bundles with two or more components.[156] No RCTs were found, but eight studies with other designs were identified, of which two reported reduction in BSI rates with

chlorhexidine gluconate skin prep and integrated closed catheter system. However, study design quality was poor, with small sample sizes.

A Cochrane review published in 2014 searched for evidence on prevention and treatment of phlebitis with topical aloe vera products.[154] The review identified 43 trials (35 RCTs and eight qRCTs): 22 trials (n=5,546 participants) involved in prevention of phlebitis, and 21 trials (n=1,919 participants) involved in treatment of phlebitis. Reported effects of external application of aloe vera varied across the identified studies, and hence no meta-analysis was performed. While there were some reported positive effects observed, the review authors cautioned against translating this into clinical practice due to the poor methodological quality and risk of selective outcome reporting of the included studies, and the variation in the size of effect across identified studies.

Conclusion

7. What is the rationale for a clinical care standard?

Infections associated with PIVCs are relatively rare compared with other causes of PIVC failure (e.g. dislodgement, occlusion, infiltration),[148] but are a serious adverse event meriting separate consideration. This rapid review sought to identify recent evidence to underpin a clinical care standard that aims to support clinicians and health services implement the delivery of high-quality care to reduce complications (specifically infections) associated with the insertion, management and removal of PIVCs. Sources of evidence were 1) international and Australian guidelines released or updated in the past 5 years, and 2) systematic reviews/meta-analyses published in the past 5 years. Together, these evidence sources provide some guidance on appropriate drafting of clinical care standard quality statements to support reduced infection rates (see Table 7), but also highlight numerous gaps in the literature. These include:

- Relative effectiveness of different PIVC device types/materials on reducing infection rates.
- Relative effectiveness of different dressing/securement types on reducing PIVC-related infection rates.
- Relative effectiveness of different flushing regimens on reducing infection rates.
- Relative effectiveness of specialist PIVC teams vs. generalists on reducing infection rates.
- Relative effectiveness of multicomponent PIVC care bundles on reducing infection rates.

Table 7: Rationale for clinical care standard statements linked to risk of infection.

Topic	Finding	Level of evidence
Dwell time	No clear difference in incidence of CRBSI between clinically indicated and routine removal; clinically indicated removal probably reduces costs.	Systematic review (7 trials, n=7,323 ppts): specifies evidence is low-certainty
Type of device	PIVCs composed of polyurethane result in fewer complications and CRBSIs	No recent systematic review
		Some trial evidence
	Closed system PIVCs are less likely to cause phlebitis than open system PIVCs.	Some trial evidence
Choice of site	Veins in the upper extremities are preferable and that veins in the lower extremities should be avoided due to risk of infection. Avoid veins in areas of flexion.	No recent systematic review
		Recent guidelines relying on limited trial evidence
Site preparation	If required, remove hair with scissors/clippers instead of shaving, to reduce risk of infection.	Recent guidelines relying on earlier systematic review
	Preferred skin antiseptic agent for infection prevention is chlorhexidine in alcohol solution.	Systematic review found no trial evidence on infection rates with PIVCs. Recent guidelines relying on strong evidence for central catheters.
Securement/ dressings	Relative effectiveness of different dressings and securement devices is unclear. Consensus recommends sterile transparent, semipermeable, occlusive dressing.	Systematic review (6 RCTs, n=1,579 ppts). Guidelines consensus.
Flushing	Risk of phlebitis significantly decreased by both continuous infusion and intermittent flushing of heparin in peripheral venous catheters.	Systematic review (22 RCTs)
	Available evidence comparing heparin and sodium chloride contradictory, negative side effects, no guidance possible.	Systematic review (2 systematic reviews, 4 RCTs) *in children*
	0.9% saline flush should be used in preference to heparin.	Consensus of recent guidelines based on earlier systematic review evidence.
Specialist teams	Catheters should be placed by health care workers skilled in intravenous catheter placement to reduce rates of infection.	Systematic review found no trial evidence comparing specialist teams with generalists
		Recent guidelines relying on some trial evidence.
Multicomponent PIVC care bundles	Multi-component care bundles recommended.	Systematic review found no RCTs
		Recent guidelines relying on some trial evidence.
Systemic antimicrobials	Routine intranasal and or prophylactic systemic antimicrobials before or during the use of an intravascular device should not be used to prevent catheter colonisation or CRBSIs.	Recent guidelines relying on systematic review evidence for central catheters.

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152.   Webster J, Osborne S, Rickard CM, Marsh N. Clinically-indicated replacement versus routine replacement of peripheral venous catheters. Cochrane Database Syst Rev. 2019;1:CD007798.

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Appendix A: Grey literature search

We searched the websites of:

- Joanna Briggs Institute (JBI, Australia)
- National Health and Medical Research Council (NHMRC, Australia)
- Clinical Guidelines Portal (Australia, clinicalguidelines.gov.au)
- Health department websites:
    - Queensland
    - NSW
    - ACT
    - Victoria
    - Tasmania
    - South Australia
    - Western Australia
    - Northern Territory
    - Australia
    - USA
    - Canada
    - UK
- The National Institute for Health and Care Excellence (NICE, UK)
- National Health Service (NHS, UK)
- Clinical Guidelines Portal (UK, guidelines.co.uk)
- Scottish Intercollegiate Guidelines Network (UK)
- Registered Nurses Association of Ontario (Canada)
- US Centres for Disease Control (CDC, USA)
- Alliance for Vascular Access Teaching and Research Clinical Guidelines Portal (AVATAR, Australia)
- Google (first five pages)

Appendix B: AMSTAR 2 critical appraisal tool

For systematic reviews that include randomised studies of healthcare interventions.[158]

1. Was an 'a priori' design provided? The research question and inclusion criteria should be established before the conduct of the review.	☐Yes ☐No ☐Can't answer ☐Not applicable
2. Was there duplicate study selection and data extraction? There should be at least two independent data extractors and a consensus procedure for disagreements should be in place.	☐Yes ☐No ☐Can't answer ☐Not applicable
3. Was a comprehensive literature search performed? At least two electronic sources should be searched. The report must include years and databases used (e.g. Central, EMBASE, and MEDLINE). Key words and/or MESH terms must be stated and where feasible the search strategy should be provided. All searches should be supplemented by consulting current contents, reviews, textbooks, specialized registers, or experts in the particular field of study, and by reviewing the references in the studies found.	☐Yes ☐No ☐Can't answer ☐Not applicable
4. Was the status of publication (i.e. grey literature) used as an inclusion criterion? The authors should state that they searched for reports regardless of their publication type. The authors should state whether or not they excluded any reports (from the systematic review), based on their publication status, language etc.	☐Yes ☐No ☐Can't answer ☐Not applicable
5. Was a list of studies (included and excluded) provided? A list of included and excluded studies should be provided.	☐Yes ☐No ☐Can't answer ☐Not applicable
6. Were the characteristics of the included studies provided? In an aggregated form such as a table, data from the original studies should be provided on the participants, interventions and outcomes. The ranges of characteristics in all the studies analyzed e.g. age, race, sex, relevant socioeconomic data, disease status, duration, severity, or other diseases should be reported.	☐Yes ☐No ☐Can't answer ☐Not applicable
7. Was the scientific quality of the included studies assessed and documented? 'A priori' methods of assessment should be provided (e.g., for effectiveness studies if the author(s) chose to include only randomized, double-blind, placebo controlled studies, or allocation concealment as inclusion criteria); for other types of studies alternative items will be relevant.	☐Yes ☐No ☐Can't answer ☐Not applicable

8. Was the scientific quality of the included studies used appropriately in formulating conclusions? The results of the methodological rigor and scientific quality should be considered in the analysis and the conclusions of the review, and explicitly stated in formulating recommendations.	☐Yes ☐No ☐Can't answer ☐Not applicable
9. Were the methods used to combine the findings of studies appropriate? For the pooled results, a test should be done to ensure the studies were combinable, to assess their homogeneity (i.e. Chi-squared test for homogeneity, I^2). If heterogeneity exists a random effects model should be used and/or the clinical appropriateness of combining should be taken into consideration (i.e. is it sensible to combine?).	☐Yes ☐No ☐Can't answer ☐Not applicable
10. Was the likelihood of publication bias assessed? An assessment of publication bias should include a combination of graphical aids (e.g., funnel plot, other available tests) and/or statistical tests (e.g., Egger regression test).	☐Yes ☐No ☐Can't answer ☐Not applicable
11. Was the conflict of interest stated? Potential sources of support should be clearly acknowledged in both the systematic review and the included studies.	☐Yes ☐No ☐Can't answer ☐Not applicable

Appendix C: Excluded articles, with reasons

	Article	Reason for exclusion
1	Bal V, Tripathi S, Yang W. Examining global occurrence of complications related to peripheral iv catheters using a focused literature review. Value in Health. 2017;20 (9):A599.	Not interventions
2	Fiorini J, Venturini G, Conti F, Funaro E, Caruso R, Kangasniemi M, et al. Vessel health and preservation: An integrative review. J Clin Nurs. 2018;25:25.	
3	Marsh N, Webster J, Ullman A, Mihala G, Cooke M, Rickard C. How often are patients experiencing local and catheter-related bloodstream infections within an adult population? A systematic review of peripheral venous catheter complications and failure. Infection, Disease and Health. 2018;23 (Supplement 1):S12.	
4	Ray-Barruel G, Polit DF, Murfield JE, Rickard CM. Infusion phlebitis assessment measures: a systematic review. J Eval Clin Pract. 2014;20(2):191-202.	
5	Dantas SR, Fagnani R, Lima TC, Silva VA, Azevedo MO, Bueno GC, et al. Effectiveness of the peripherally inserted central venous catheter in adult and pediatric patients. Value in Health. 2017;20 (9):A870.	Compared PIVC with other VAD
6	Robinson A, Souied O, Bota AB, Levasseur N, Stober C, Hilton J, et al. Optimal vascular access strategies for patients receiving chemotherapy for early-stage breast cancer: a systematic review. Breast Cancer Res Treat. 2018;171(3):607-20.	
7	Arechabala MC, Catoni MI, Claro JC, Rojas NP, Rubio ME, Calvo MA, et al. Antimicrobial lock solutions for preventing catheter-related infections in haemodialysis. Cochrane Database Syst Rev. 2018(4).	Central (not peripheral) venous catheter
8	Loveday HP, Wilson JA, Prieto J, Wilcox MH. epic3: revised recommendation for intravenous catheter and catheter site care. J Hosp Infect. 2015;92:346-8.	
9	Shore J, Bartlett C, Wood H, Glanville J, Jenks M. Systematic Review and Economic Analysis of Antiseptic Barrier Caps in Patients with Central or Peripheral Line Catheters. Value in Health. 2018;21 (Supplement 3):S254.	
10	Seckold T, Walker S, Dwyer T. A comparison of silicone and polyurethane PICC lines and postinsertion complication rates: a systematic review. J. 2015;16(3):167-77.	Peripherally inserted central catheter
11	Moureau NL, Flynn J. Disinfection of Needleless Connector Hubs: Clinical Evidence Systematic Review. Nurs Res Pract. 2015;2015:796762.	Catheter type not specified

12	Bal V, Culiner J, Nyarko E. Comparison of catheter-related complications between manually-prepared saline flush syringes and commercially available pre-filled saline flush syringes. Value in Health. 2017;20 (9):A599.	No relevant outcomes
13	Barry S. Reducing costs-proposed benefits of changing from scheduled replacement of peripheral venous cannulae. Irish Journal of Medical Science. 2016;185 (12 Supplement 1):S537-S8.	
14	Chang WP, Peng YX. Occurrence of Phlebitis: A Systematic Review and Meta-analysis. Nursing research. 2018;67(3):252-60.	Did not review RCTs
15	Xu HG, Ray-Barruel G, Cooke M, Rickard C. Can the implementation of a PIVC bundle reduce bloodstream infection? A systematic review. Infection, Disease and Health. 2018;23 (Supplement 1):S4.	
16	Wu S, Li W, Zhang Q, Li S, Wang L. Comparison of complications between peripheral arm ports and central chest ports: A meta-analysis. J Adv Nurs. 2018;74(11):2484-96.	Not catheterisation
17	Comparcini D, Simonetti V, Blot S, Tomietto M, Cicolini G. Relationship between peripheral insertion site and catheter-related phlebitis in adult hospitalized patients: a systematic review. Prof Inferm. 2017;70(1):51-60.	Full text not in English
18	Gomez-Neva E, Bayona JG, Rosselli D. Peripheral venous catheter associated phlebitis in children: A systematic review. [Spanish]. Infectio. 2015;19(2):92-7.	
19	Webster J, Osborne S, Rickard CM, New K. Clinically-indicated replacement versus routine replacement of peripheral venous catheters. Cochrane Database Syst Rev. 2015(8):CD007798.	Obsolete version

Appendix D: Levels of evidence for guideline recommendations

Infusion Nurses Society[7] and Royal College of Nursing[5]		Spanish Societies[4]	NICE/ Epic3[16]	RCH[14]
I	Meta-analysis, systematic literature review, guideline based on randomized controlled trials (RCTs), or at least 3 well-designed RCTs.	I	A	I
II	Two well-designed RCTs, 2 or more multicenter, well-designed clinical trials without randomization, or systematic literature review of varied prospective study designs.	I/II	A	II
III	One well-designed RCT, several well-designed clinical trials without randomization, or several studies with quasi-experimental designs focused on the same question. Includes 2 or more well-designed laboratory studies.	II	B	II/III
IV	Well-designed quasi-experimental study, case-control study, cohort study, correlational study, time series study, systematic literature review of descriptive and qualitative studies, or narrative literature review, psychometric study. Includes 1 well-designed laboratory study.	III	C	IV/V
V	Clinical article, clinical/professional book, consensus report, case report, guideline based on consensus, descriptive study, well-designed quality improvement project, theoretical basis, recommendations by accrediting bodies and professional organizations, or manufacturer directions for use for products or services. Includes standard of practice that is generally accepted but does not have a research basis (eg, patient identification). May also be noted as Committee Consensus, although rarely used.	III	D	VI/VII

Appendix E: Guidelines evidence tables

Data extraction	
Scope	International – UK/Ireland
Title	Safe vascular access
Author(s)	Bodenham A, Babu S, Bennett J, Binks R, Fee P, Fox B, Johnston AJ, Klein AA, Langton JA, Mclure H, Tighe SQM.
Institution	The Association of Anaesthetists of Great Britain & Ireland
Year	2016
Last search for evidence	Consensus document produced by members of a Working Party established by the Association of Anaesthetists of Great Britain and Ireland
Recommendations – dwell time	Routine changes of peripheral cannulae at 72–96 h is not advocated.
Recommendations – type of device	The smallest practical size of cannula should be used.
Recommendations – choice of site	-
Recommendations – securement	-
Recommendations – flushing	All cannulae must be flushed after use.
Recommendations – high risk patients	Insertion in a limb with lymphoedema should be avoided, except in acute situations due to increased risks of local infection.
Recommendations – other	Needle guards to reduce needle stick injury are recommended in all procedures. Peripheral insertion is inappropriate for infusion of fluid with high osmolality (> 500 mOsm.l_1) or low (< 5) or high pH (> 9) or intravenous access for more than 2 weeks.

The relative safety of peripheral administration of vasopressors/inotropes is contentious, but likely to be dependent on vein size and its blood flow, infusion rate, individual drug effect and dilution.

Transillumination, ultrasound and infra-red devices may be useful. |
| **Indicators of adverse outcomes** | - |

Data extraction	
Scope	International - USA
Title	Infusion Therapy Standards of Practice (esp. Section Three: Infection Prevention and Control; Section Five: Vascular Access Device Selection and Placement)
Author(s)	Gorski L, Hadaway L, Hagle ME, McGoldrick M, Orr M, Doellman D.
Institution	Infusion Nurses Society
Year	2016
Last search for evidence	July 2015
Recommendations – dwell time	44.1 The clinical need for each peripheral and nontunneled central vascular access device (CVAD) is assessed on a daily basis. 44.2 Vascular access devices (VADs) are removed upon an unresolved complication, discontinuation of infusion therapy, or when deemed no longer necessary for the plan of care. 44.3 VADs are not removed based solely on length of dwell time because there is no known optimum dwell time. A. Remove the short peripheral catheter if it is no longer included in the plan of care or has not been used for 24 hours or more. (IV) B. Remove short peripheral catheters when clinically indicated, based on findings from site assessment and/or clinical signs and symptoms of systemic complications (eg, bloodstream infection). Signs and symptoms of complications with or without infusion through the catheter include, but are not limited to, the presence of: 1. Any level of pain and/or tenderness with or without palpation. 2. Changes in color (erythema or blanching). 3. Changes in skin temperature (hot or cold). 4. Edema. 5. Induration. 6. Leakage of fluid or purulent drainage from the puncture site. 7. Other types of dysfunction (eg, resistance when flushing, absence of a blood return). (I) C. Consider labeling catheters inserted under suboptimal aseptic conditions in any health care setting (eg, "emergent"). Remove and insert a new catheter as soon as possible, preferably within 24 to 48 hours. (IV) E. Notify the licensed independent practitioner LIP about signs and symptoms of suspected catheter-related infection and discuss the need for obtaining cultures (eg, drainage, blood culture) before removing a peripheral catheter.
Recommendations – type of device	A. Choose a short peripheral catheter as follows: 1. Consider the infusate characteristics (eg, irritant, vesicant, osmolarity) in conjunction with anticipated duration of infusion therapy (eg, less than 6 days) and availability of peripheral vascular access sites. (IV) 2. Use vascular visualization technology (eg, near infrared, ultrasound) to increase success for patients with difficult venous access. 3. Do not use peripheral catheters for continuous vesicant therapy, parenteral nutrition, or infusates with an osmolarity greater than 900 mOsm/L. (IV) B. Select the smallest-gauge peripheral catheter that will accommodate the prescribed therapy and patient need. (V)

	1. Consider a 20- to 24-gauge catheter for most infusion therapies. Peripheral catheters larger than 20 gauge are more likely to cause phlebitis. (IV)
2. Consider a 22- to 24- gauge catheter for neonates, pediatric patients, and older adults to minimize insertion-related trauma. (V)
3. Consider a larger-gauge catheter (16-20 gauge) when rapid fluid replacement is required, such as with trauma patients, or a fenestrated catheter for a contrast-based radiographic study. (IV)
4. Use a 20- to 24- gauge catheter based on vein size for blood transfusion: when rapid transfusion is required, a larger-size catheter gauge is recommended.
5. Use steel winged devices only for single-dose administration. The device is not left in place. (IV)
C. Recognize that needleless connectors are potential sites for intraluminal microbial contamination and require careful adherence to infection prevention practices. There is no consensus on the design or type of needleless connector to prevent or reduce VAD-related bloodstream infection. (IV)
F. Perform a vigorous mechanical scrub for manual disinfection of the needleless connector prior to each VAD access and allow it to dry.
1. Acceptable disinfecting agents include 70% isopropyl alcohol, iodophors (ie, povidone-iodine), or >0.5% chlorhexidine in alcohol solution. (II)
2. Length of contact time for scrubbing and drying depends on the design of the needleless connector and the properties of the disinfecting agent. For 70% isopropyl alcohol, reported scrub times range from 5 to 60 seconds with biocide activity occurring when the solution is wet and immediately after drying. More research is needed for other agents or combinations of agents due to conflicting reports regarding the optimal scrub time. (II)
3. Use vigorous mechanical scrubbing methods even when disinfecting needleless connectors with antimicrobial properties (eg, silver coatings). (IV)
G. Use of passive disinfection caps containing disinfecting agents (eg, isopropyl alcohol) has been shown to reduce intraluminal microbial contamination and reduce the rates of central line-associated bloodstream infection (CLABSI). Use of disinfection caps on peripheral catheters has limited evidence but should be considered.
H. Change the needleless connector no more frequently than 96-hour intervals. Changing on a more frequent time interval adds no benefit and has been shown to increase the risk of CLABSI.
1. When used within a continuous infusion system, the needleless connector is changed when the primary administration set is changed (eg, 96 hours).
2. For peripheral catheters with dwell times longer than 96 hours, there are no studies on changing the attached needleless connector/extension set.
3. Additionally, the needleless connector should be changed in the following circumstances: if the needleless connector is removed for any reason; if there is residual blood or debris within the needleless connector; prior to drawing a sample for blood culture from the VAD; upon contamination; per organizational policies, procedures, and/or practice guidelines; or per the manufacturer's directions for use. (IV)
Recommendations – choice of site	1. Use the venous site most likely to last the full length of the prescribed therapy, using the forearm to increase dwell time, decrease pain during dwell time, promote self-care, and prevent accidental removal and occlusions. Consider veins found on the dorsal and ventral surfaces of the upper extremities, including the metacarpal, cephalic, basilic, and median veins. (IV)
2. Do not use veins of the lower extremities unless necessary due to risk of tissue damage, thrombophlebitis, and ulceration. (IV)

	1. Discuss with the patient the arm preference for VAD site selection, including a recommendation to use sites in the nondominant arm. (V)
	2. Avoid the ventral surface of the wrist due to pain on insertion and possible nerve damage.
	3. Avoid areas of flexion and areas of pain on palpation; avoid compromised areas and sites distal to these compromised areas, such as areas with open wounds; areas on an extremity with an infection; veins that are compromised (eg, bruised, infiltrated, phlebitic, sclerosed, corded, or engorged); areas of valves; areas of previous infiltration or extravasation; and areas of planned procedures. (V)
	4. Avoid veins in an upper extremity on the side of breast surgery with axillary node dissection, with lymphedema, or with an arteriovenous fistula/ graft; after radiation therapy to that side of the body; or the affected extremity from a cerebrovascular accident. For patients with chronic kidney disease, avoid unnecessary venipuncture of peripheral veins in the upper extremity intended for future vascular access. A collaborative discussion with the patient and the licensed independent practitioner (LIP) is needed to discuss the benefits and risks of using a vein in an affected extremity. (V)
	5. Cannulation of hemodialysis fistulas, grafts, and catheters for infusion therapy requires the order of a nephrologist or LIP, unless an emergency situation exists. (V)
	6. Use ultrasonography (US) for short peripheral catheter placement in adult and pediatric patients with difficult venous access and/or after failed venipuncture attempts. (I)
Recommendations – securement	Remove excess hair at the insertion site if needed to facilitate application of VAD dressings; use single patient-use scissors or disposable-head surgical clippers; do not shave as this may increase the risk for infection (although research is limited). (V)
	D. Perform skin antisepsis using the preferred skin antiseptic agent of >5% chlorhexidine in alcohol solution. If there is a contraindication to alcoholic chlorhexidine solution, tincture of iodine, an iodophor (povidone-iodine), or 70% alcohol may also be used. Allow the antiseptic agent to fully dry before insertion. (I)
	E. Adhere to and maintain aseptic technique with short peripheral catheter insertion: 1. Use a new pair of disposable, nonsterile gloves in conjunction with a "no-touch" technique for peripheral IV insertion, meaning that the insertion site is not palpated after skin antisepsis. (V) 2. Consider increased attention to aseptic technique, including strict attention to skin antisepsis and the use of sterile gloves, when placing short peripheral catheters. While there is a lack of evidence comparing bloodstream infection (BSI) rates with or without use of sterile gloves, longer dwell times have raised concerns regarding risk for BSI. Furthermore, contamination of nonsterile gloves is documented. (V, Committee Consensus)
	Standard
	37.1 Stabilize and secure vascular access devices (VADs) to prevent VAD complications and unintentional loss of access.
	37.2 Methods used to stabilize the VAD will not interfere with assessment and monitoring of the access site and will not impede vascular circulation or delivery of the prescribed therapy.
	Practice Criteria
	A. Consider use of an engineered stabilization device (ESD) to stabilize and secure VADs as inadequate stabilization and securement can cause unintentional dislodgment and complications requiring premature VAD removal. ESDs promote consistent practice among all clinicians, reduce VAD motion that

	can lead to complications, reduce interruption of needed infusion therapy, and may decrease cost of care.
	1. The effect of adhesive ESDs on peripheral catheter complication rates is unclear due to the limited number and quality of randomized trials.
	2. Studies on central vascular access devices (CVADs) are limited to small populations or descriptive study design.
	3. Many devices merge the interventions of catheter stabilization with the dressing of the VAD, yet there is an absence of data for these combination devices.
	4. Decisions about the most appropriate method for VAD stabilization and securement include patient age, skin turgor and integrity, previous adhesive skin injury, and any type of drainage from the insertion site. (IV)
	B. Avoid use of tape or sutures, as they are not effective alternatives to an ESD. Rolls of nonsterile tape can become contaminated with pathogenic bacteria, although its contribution to VAD infection has not been quantified. Sutures are associated with needlestick injury, in addition to supporting the growth of biofilm and increasing the risk of catheter-related bloodstream infection. (II, Regulatory)
	C. Do not rely on VAD dressings (ie, standard, nonbordered transparent semipermeable membrane [TSM] dressings, gauze and tape dressings) as a means for VAD stabilization as there is insufficient evidence supporting their benefits as stabilization devices. (I)
	D. For peripheral catheters, consider 2 options for catheter stabilization: (1) an integrated stabilization feature on the peripheral catheter hub combined with a bordered polyurethane securement dressing or (2) a standard round hub peripheral catheter in combination with an adhesive ESD. Both have demonstrated equivalent complication rates, although complication rates for both types were not greatly reduced with either type of ESD. (III)
Recommendations – flushing	40.1 Vascular access devices (VADs) are flushed and aspirated for a blood return prior to each infusion to assess catheter function and prevent complications.
	40.3 The VAD is locked after completion of the final flush to decrease the risk of intraluminal occlusion and catheter-related bloodstream infection (CR-BSI), depending on the solution used. A. Use single-dose systems (eg, single-dose vials or prefilled labeled syringes) for all VAD flushing and locking.
	1. Commercially available prefilled syringes may reduce the risk of CR-BSI and save staff time for syringe preparation. (IV)
	2. If multiple-dose vials must be used, dedicate a vial to a single patient. (V)
	3. Do not use intravenous (IV) solution containers (eg, bags or bottles) as a source for obtaining flush solutions. (IV)
	4. Inform patients that disturbances in taste and odor may occur with prefilled flush syringes and may be related to several causes including systemic conditions (eg, diabetes, Crohn's disease), medications (eg, antineoplastics), and radiation. Leaching of substances from the plastic syringe into the saline has been reported, although it is not thought to be harmful to health. (II)
	B. Perform disinfection of connection surfaces (ie, needleless connectors, injection ports) before flushing and locking procedures.
	C. Flush all VADs with preservative-free 0.9% sodium chloride (USP).
	1. Use a minimum volume equal to twice the internal volume of the catheter system (eg, catheter plus add-on devices). Larger volumes (eg, 5 mL for peripheral VAD) may remove more fibrin deposits, drug precipitate, and other debris from the lumen. Factors to consider when choosing the flush volume include the type and size of catheter, age of the patient, and type of infusion

	therapy being given. Infusion of blood components, parenteral nutrition, contrast media, and other viscous solutions may require larger flush volumes. (IV) G. Lock short peripheral catheters immediately following each use. 1. In adults, use preservative-free 0.9% sodium chloride (USP) for locking. (I) I. Perform dressing changes on short peripheral catheters if the dressing becomes damp, loosened, and/or visibly soiled and at least every 5 to 7 days. (V, Committee Consensus)
Recommendations – high risk patients	-
Recommendations – other	A. Perform hand hygiene with an alcohol-based hand rub or antimicrobial soap and water during patient care: 3. Before inserting a peripheral vascular catheter.
Indicators of adverse outcomes	A. Assess regularly, based on patient population, type of therapy, and risk factors, the vascular access sites of short peripheral catheters for signs and symptoms of phlebitis using a standardized tool or definition. Instruct the patient to report pain or discomfort at the vascular access site. Signs and symptoms of phlebitis include pain/tenderness, erythema, warmth, swelling, induration, purulence, or palpable venous cord. The number or severity of signs and symptoms that indicate phlebitis differs among published clinicians and researchers. (III) A. Assess for signs and symptoms of a VAD-related infection which may include, but is not limited to, erythema; edema; any pain or tenderness or drainage; fluid in the subcutaneous pocket of a totally implanted intravascular device or subcutaneous tunnel for any tunneled catheter; induration at the exit site or over the pocket; spontaneous rupture and drainage; necrosis of the overlying skin at the VAD insertion site; and/or body temperature elevation. Immediately notify the licensed independent practitioner (LIP) when signs and symptoms of a VAD-related infection are present, and implement planned interventions. (IV)

Data extraction	
Scope	International – USA
Title	Intravascular catheter-related infection: Prevention
Author(s)	Gaynes R, Jacob J.
Institution	UpToDate
Year	2019
Last search for evidence	January 2019
Recommendations – dwell time	Leave peripheral venous catheters in place until intravenous therapy is completed, unless a complication occurs. For catheters inserted under emergency conditions, insert a new catheter at a different site within 24 hours.
Recommendations – type of device	Data from several studies suggest that peripheral intravenous catheters composed of Teflon or polyurethane result in fewer complications and BSIs. The use of small steel needles, which are associated with an appreciable risk of infection, no longer seemed justifiable in most patients.
Recommendations – choice of site	The risk of infection with peripheral intravenous catheters is higher in the lower compared with the upper extremity and higher in the wrist or upper arm compared with the hand.
Recommendations – securement	Use of antiseptic solution for skin disinfection at the catheter insertion site reduces the risk of infection. Chlorhexidine-based solutions (>0.5% chlorhexidine preparation with alcohol) are superior to both aqueous and alcohol-based povidone-iodine in reducing the risk for catheter colonization and catheter-related bloodstream infection (CRBSI).
	If there is a contraindication to chlorhexidine, tincture of iodine, an iodophor, or 70% alcohol can be used as alternatives.
	The type of dressing at the insertion site may affect the rate of catheter infection.
	Sterile gauze or sterile, transparent, semipermeable dressing should be used to cover the catheter site. If the patient is diaphoretic or if the site is bleeding or oozing, a gauze dressing should be used. The catheter site dressing should be replaced if the dressing becomes damp, loosened, or visibly soiled.
Recommendations – flushing	-
Recommendations – high risk patients	Data from several studies suggest that catheters placed under emergency conditions are associated with higher rates of infection. In contrast, catheters placed by health care workers skilled in intravenous catheter placement have lower rates of infection.
Recommendations – other	A specialized team for peripheral intravenous catheters was associated with a significantly lower frequency of signs or symptoms of inflammation (7.9 versus 21.7 percent with the house staff nursing approach), no episodes of bacteremia versus three (2.2 percent), and a higher number of catheters placed per patient (2.1 versus 1.6).
Indicators of adverse outcomes	-

Data extraction	
Scope	International - UK
Title	Standards for infusion therapy
Author(s)	Andrea Denton – Lead author
Institution	Royal College of Nursing
Year	2016 *(under review 2019)*
Last search for evidence	NR
Recommendations – dwell time	Peripheral cannula should be re-sited when clinically indicated and not routinely, unless device-specific recommendations provided by the manufacturer indicate otherwise (Loveday et al., 2014; Rickard et al., 2012). [III] A peripheral cannula inserted in an emergency situation, where aseptic technique has been compromised, should be replaced within 24 hours. [Expert consensus/V]
Recommendations – type of device	Any new safety device system, for example a needlefree system, should be monitored for increase in infection rates and any suspected increases should be reported to the MHRA (Loveday et al., 2014). [V] For peripheral catheters, closed system peripheral intravenous catheters are less likely to cause phlebitis than open system peripheral intravenous catheters (Gonzalez-Lopez et al., 2014). The vein/vessel/artery should accommodate the gauge and length of the device required by the prescribed therapy (INS, 2016). Patient's lifestyle, body image, any known abnormalities, relevant past medical history (PMH) patient preference, and therapy duration and setting should all be considered for site and device selection (Hallam, et al., 2016). [V]
Recommendations – choice of site	If infusion therapy is required, site and device selection for vascular access should then include assessment of the patient's condition, age and diagnosis; vascular condition; infusion device history; and the type and duration of the therapy as well as the potential complications associated with vascular access devices (Hallam et al., 2016). [V] Patient's lifestyle, body image, any known abnormalities, relevant past medical history (PMH) patient preference, and therapy duration and setting should all be considered for site and device selection (Hallam, et al., 2016). [V] Using the same criteria, any device initially placed should be reviewed after 48 hours (Hallam et al., 2016). [V] • Veins that should be considered for peripheral cannulation are those found in the forearm or hands (O'Grady et al., 2011). • Site selection should be routinely initiated in the distal areas of the upper extremities; subsequent cannulation should be made proximal to the previously cannulated site. • Where possible, use non dominant forearm for peripheral cannulation following policy and procedure. • Veins in the lower extremities should not be used routinely in adults due to the risk of thrombosis, thrombophlebitis and increased infection risk. • When selecting the most appropriate intravascular insertion site, HCPs should assess risk of infection against the risk of mechanical complication and patient comfort (Loveday et al., 2014). • Avoiding the femoral site can assist in the reduction of CR-BSIs (Hsu et al., 2014).

Recommendations – securement	• To prevent the entry of micro-organisms into the vascular system, the injection access site should be decontaminated with an approved single-use antimicrobial solution, such as 2% chlorhexidine gluconate in 70% alcohol (unless contraindicated by manufacturers' recommendations) (Loveday et al., 2014; NICE 2012). The solution should be applied with friction and allowed to dry, immediately before and after use (Loveday et al., 2014)
	Hair removal around the insertion site and area for adhesive dressing should be accomplished using clippers (NICE, 2013). [V]
	Shaving with a razor should not be performed because of the increased risk of infection (NICE, 2013).
	Wear clean non-sterile gloves for insertion of the cannula (Loveday et al., 2014).
	Products employed to stabilise peripheral cannulae, midlines or central venous catheters include transparent film dressings, sutures, engineered stabilisation devices and sterile wound closure strips.
	A sterile transparent film dressing must be applied and maintained on vascular and non-vascular access devices. All dressings must be changed at established intervals in accordance with organisational policies/procedures and manufacturers guidelines, and immediately if the integrity of the dressing is compromised (Loveday et al., 2014). [V]
	Criteria for the choice of securement dressing should include the type of VAD, its site of placement, expected duration, the opportunity it provides for site assessment and patient characteristics including skin condition. [Expert consensus/V]
	Removal of site protection material should be done at established intervals, if a transparent dressing cannot be used, to allow visual inspection of the access site and monitoring of skin integrity in order to minimise the potential for infection (Loveday et al., 2014). [V]
	• Protocols for the use of sterile gauze and/or transparent semi-permeable polyurethane dressings should be set out in organizational policies and procedures.
	• Transparent film dressings should be used to cover intravascular insertion sites where possible (Loveday et al., 2014; NICE, 2012).
	• In some circumstances a sterile gauze dressing may have to be used; for example, if the patient has profuse perspiration or the insertion site is leaking or bleeding. In these instances the intravascular site should be checked regularly and the gauze dressing replaced as soon as possible with a transparent film dressing (Loveday et al., 2014; NICE, 2012).
	• Transparent film dressings should be changed every seven days, or sooner if the integrity of the dressing is compromised or moisture collects under the dressing (Loveday et al., 2014).
Recommendations – flushing	The device should be flushed at established intervals to promote and maintain patency and to prevent the mixing of incompatible medications and/or solutions. [Expert consensus/V]
	• The volume of the flush solution can vary depending on the patient, device, catheter size and nature and type of infusion/medication. A minimum is at least twice the volume of the catheter (INS, 2016).
	• Routine systemic anticoagulants should not be used to prevent CR-BSIs. Sterile sodium chloride 0.9% should be used to flush and lock catheter lumens that are accessed on a frequent basis (Loveday et al., 2014).
	• Routine antimicrobial lock solutions should not be used to prevent CR-BSI (Loveday et al., 2014; NICE, 2012).
Recommendations	Patients with diabetes should not generally be cannulated in their feet.

– high risk patients	A relevant HCP should be consulted, and the decision documented, prior to cannulation of the arm of a patient who has undergone axillary node dissection/radiotherapy with risk of lymphoedema (for example, following a mastectomy) or who may have existing AV fistula access or other contraindications; for example, they require future fistula formation (RA, 2015b).
Recommendations – other	HCPs should use recognised pre-insertion bundles/ quality improvement interventions for the insertion and maintenance of any vascular access device.
	This should include education of the HCP, patient and carer; general asepsis including hand hygiene and standard precautions; selection of appropriate device and site avoiding femoral site; maximum sterile barrier precautions during insertion; cutaneous antisepsis; catheter and catheter site care as well as general principles of replacement strategies and prompt removal (Dumyati et al., 2014; Hsu et al., 2014; Loveday et al., 2014; Marsteller et al., 2012; Munoz-Price et al., 2012). Consideration of the introduction of a dedicated lead nurse to standardise and facilitate good practice linked to CVADs and the prevention of CR-BSI (Thom et al., 2014; O'Connor et al, 2012).
	Routine intranasal and or prophylactic systemic antimicrobials before or during the use of an intravascular device should not be used to prevent catheter colonisation or blood stream infections (Loveday et al., 2014).
	Consideration should be given to new intravascular devices and components and these should be monitored for any adverse reaction and increase in device related infections (Loveday et al., 2014). Any increase should be reported to the MHRA (MHRA, 2016b; MHRA, 2015a).
	When safer sharps devices are used, HCPs should ensure that all components are compatible and secured to minimise any leaks or breaks in the system (Loveday et al., 2014; Jacob et al., 2015).
	• Standard precautions and aseptic technique should be adopted when accessing any component of the device, site or line (Loveday et al., 2014).
Indicators of adverse outcomes	Infective episodes and other adverse events should also be included and the data used to develop improvement measures.
	Each area should monitor their infection rates per 1,000 catheter days to observe any changes or trends in infection rates.
	Morbidity and mortality rates associated with vascular access device related infections should be monitored, reviewed, evaluated and reported on a regular basis. [V]
	The insertion site should be visually inspected at a minimum during each shift and, in the case of peripheral vascular catheters, a visual infusion phlebitis (VIP) score (Jackson, 1998) should be recorded (Loveday et al., 2014).
	If removal is related to actual or suspected catheter-related blood stream infection the catheter tip should sent to the microbiology laboratory for culture and antimicrobial sensitivity. This action should be documented in the patient's records (INS, 2016).
	Organisational policies and procedures should consider calculation of phlebitis rates as a means of outcome assessment and performance improvement. The peripheral phlebitis incidence rate can be calculated according to the following formula: number of phlebitis % incidents ÅÄ total number of IV peripheral devices x 100 = %peripheral phlebitis.

Data extraction	
Scope	International – Hong Kong
Title	Recommendations on Prevention of Intravascular Catheter Associated Bloodstream Infection Version 2.0
Author(s)	-
Institution	Scientific Committee on Infection Control, and Infection Control Branch, Centre for Health Protection, Department of Health, Hong Kong
Year	2018
Last search for evidence	
Recommendations – dwell time	Remove the catheter when it is no longer used. Remove the peripheral intravascular catheter if there is sign of phlebitis or malfunctioning. No need to replace catheters more frequently than every 72-96 hours. If sites for venous access are limited, catheter can be maintained for longer period but close monitoring of insertion site is necessary.
Recommendations – type of device	-
Recommendations – choice of site	For adults, use an upper-extremity site for catheter insertion. Replace a catheter inserted in a lower extremity site to an upper extremity site as soon as possible.
Recommendations – securement	Prepare skin with an antiseptic, e.g. 70% alcohol for peripheral venous catheter insertion. Use clean gloves for peripheral intravascular catheter insertion; do not touch the insertion site after the application of skin antiseptics. Use sterile, transparent, semipermeable dressing or sterile gauze to cover the catheter site. A gauze dressing is preferred if the site is bleeding, oozing or the patient is diaphoretic. Replace dressing if it becomes damp, loosened, or visibly soiled. Leave the transparent semipermeable membrane dressing applied to a peripheral cannula insertion site in situ for the life of the cannula, provided that the integrity of the dressing is retained. Secure the catheter after insertion. Evaluate the catheter insertion site daily by palpation to discern tenderness and by inspection if a transparent dressing is in use. Gauze and opaque dressings should not be removed if the patient has no clinical signs of infection. If the patient has local tenderness or other signs of possible CABSI, an opaque dressing should be removed and the site inspected.
Recommendations – flushing	Flush the peripheral intravascular lock or needle free device with normal saline for maintaining the patency and lowering the overall catheter-related complications though they are not necessarily infection related. Efficacy of normal saline solution as an alternative to heparin solution for the maintenance of peripheral IV devices is to eliminate the risk of heparin-induced thrombocytopenia, thrombus, haemorrhage and medication incompatibility which can provide a safer therapy for patient as well as cost savings. Therefore, normal saline flush is superior and preferable. There is no conclusive evidence to adopt any kinds of agents to be the lock solution for preventing CABSI. Do not routinely use antibiotic lock solutions to prevent CABSI.

	The use of an antimicrobial- or antiseptic-impregnated catheter should be based on the need to enhance prevention of CABSI after maximizing the adherence of infection control measures (educating personnel, using maximal sterile barrier precautions and using 2% Chlorhexidine skin antisepsis). However, both of them only offer marginal benefit in reducing CABSI.
Recommendations – high risk patients	
Recommendations – other	Maintain a closed infusion system. The closed infusion system has been shown to result in significant reduction in the incidence of CABSI. The closed infusion system is defined as: 1) the container of intravenous solution is fully collapsible (the residue after administration does not exceed 5% of the nominal volume), and hence does not require external air vent to allow the solution to empty AND 2) the connecting administration set has no air-vent. The whole infusion system is maintained closed to the external environment while infusing. In the situation when intravenous solution or medication is delivered by a semi-rigid plastic or glass bottle, an air vent to empty the solution is allowed.

In-line filters: Do not use filters routinely for infection-control purposes. There is no reliable evidence to support their efficacy in preventing BSI related to catheters, infusate or infusion system. They may become blocked, especially with certain solutions, e.g., dextran, lipids, mannitol, thereby increasing the number of line manipulations and decreasing the availability of administered drugs. However, they may have a role for parenteral nutrition solutions for reasons other than infection prevention. Prophylactic antimicrobials: Do not administer intranasal or systemic antimicrobial prophylaxis routinely before insertion or during use of an intravascular catheter to prevent catheter colonization or bloodstream infection. |
| **Indicators of adverse outcomes** | Both process and outcome measures on the care of intravascular catheter should be monitored. For the infection rate, it is preferable to express it by an incidence density such as "CABSI per 1000 catheter patient days". |

Data extraction	
Scope	International – Spain
Title	2016 Expert consensus document on prevention, diagnosis and treatment of short-term peripheral venous catheter-related infections in adults
Author(s)	Capdevila JA, Guembeb M, Barberánc J, de Alarcónd A, Bouzab E, Fariñase MC, Gálvez J, Goenagag MA, Gutiérrez F, Kestlerb M, Llinaresh P, Miró JM, Montejo M, Muñoz P, Rodriguez-Creixems M, Sousa D, Cuenca J, Mestresi C-A.,l,1,4, on behalf the SEICAV, SEMI, SEQ and SECTCV Societies
Institution	SEICAV, SEMI, SEQ and SECTCV Societies
Year	2016
Last search for evidence	2015
Recommendations – dwell time	PVCs placed on urgent basis or without considering minimal hygiene rules must be removed and replaced before 48 h to avoid the risk of infection (II-A).
	The catheter and the need for usage have to be assessed daily. It is advisable to remove the PVC if it is not necessary as the risk of infection or phlebitis gradually increases as PVC days go by (II-A).
	A meta-analysis revealed that there are no advantages of replacing the infusion system earlier than 96 h (I-A) other when they are used for blood transfusion or infusion of lipid emulsions (should this be the case, they have to be replaced every time).
	Observations support the replacement of PVC only when indicated (I-A). Systematic removal of PVC after 3–4 days is not supported, although it is not advised to keep PVC in place beyond 5 days.
	PVC must be removed if the following circumstances apply: end of therapy, signs of chemical phlebitis, malfunction, suspicion of infection or suspicion of inappropriate insertion or manipulation as in cases of vital emergency (II-A).
Recommendations – type of device	There is no consensus on the type of connectors to be used. It is preferable a three-way stopcock than caps requiring connection-disconnection after every use. Closed connectors for catheter access can be used as long as they are disinfected with alcohol-impregnated wipes at every attempt to access the catheter (II-A).
Recommendations – choice of site	A PVC can be inserted in every accessible vein. However, upper extremity veins are preferable for patient comfort and lesser risk of contamination. Some studies reported a higher risk of phlebitis after lines were placed at the cubital crease, thus becoming preferable avoiding this site in benefit of arm, forearm or dorsal aspect of the hand/wrist (II-A).
Recommendations – securement	The skin must be disinfected with 2% alcoholic chlorhexidine solution or, if not available, with a 70% iodine or alcohol solution (I-A). Sterile gauze dressing or semi permeable transparent sterile dressing to cover the insertion site will be used (II-A). Sterile gauze dressing will be inspected and replaced every other day and transparent dressing should not stay in place over 7 days. If there is humidity, sweating or blood it is more appropriate to use non-occlusive gauze dressing (III-B).
Recommendations – flushing	There is no evidence that neither antibiotic prophylaxis at insertion nor the antibiotic-lock are cost-efficient to keep PVC free from infection.
	Although keeping in place an unused catheter increases the risk of phlebitis, it is not clear if they must be rinsed with normal saline or heparin. It seems that the risk of phlebitis is reduced with heparin but it continues to be at 45%, thus being

	removal advisable if unused.
Recommendations – high risk patients	-
Recommendations – other	The use of techniques facilitating identification of veins as laser or ultrasound in patients with poor venous flow are also recommended for insertion. However, these techniques do not reduce the risk of infection. A meta-analysis on this topic showed that its routine use is not justified (I-A).
Indicators of adverse outcomes	The status of the insertion site must also be assessed daily, seeking for eventual discomfort/symptoms at the endovascular segment suggesting early stages of phlebitis and checking its functional status. Phlebitis should be suspected if any of the following signs develop: warmth, tenderness, erythema or palpable cord. In an abnormality at the insertion site is detected, dressing must be removed and the site inspected (III-A). The catheter must then be removed and its tip sent for Microbiology according to the criterion of the attending physician (III-A).
	It is advisable that the infection and complication rates are periodically disclosed to the staff in charge of inserting PVCs. This is positive reinforcement on guideline/protocol follow-up and a warning if deviations occur. Furthermore, the adherence to the checklist can be monitored

Data extraction	
Scope	International – Ireland
Title	Prevention of Intravascular Catheter-related Infection in Ireland. Update of 2009 National Guidelines.
Author(s)	This review was lead by Dr. Joanne O Gorman in conjunction with the members of the multidisciplinary clinical advisory group.
Institution	HSE Health Protection Surveillance Centre, Royal College of Physicians of Ireland
Year	2014
Last search for evidence	As other international groups had recently reviewed the evidence base, it was agreed not to repeat this process, rather review the 2009 guidelines in relation to these recent publications. The review focused on the prevention of IV catheter infection and incorporated aspects of the following publications that are acknowledged as the most authoritative reference guidelines currently available; • epic3: National Evidence-Based Guidelines for Preventing Healthcare-Associated Infections in NHS hospitals in England. (National Institute for Health and Clinical Excellence (NICE) accredited) 2014. • Infection: prevention and control of healthcare-associated infections in primary and community care (NICE Clinical Guideline) 2012. • Guidelines for Prevention of Intravascular Catheter-Related Infection (Centre for Disease Control /Healthcare Infection Control Practices Advisory Committee (CDC/HICPAC)) 2011. • IBTS - National Blood Users Group. Guidelines for the Administration of Blood and Blood Components. 2004.
Recommendations – dwell time	Patients transferring from other healthcare facilities with a PIVC in situ should have this device reviewed upon arrival to ensure it is still needed. When adherence to aseptic technique cannot be ensured (i.e., when PIVCs are inserted during a medical emergency), the PIVC should be replaced as soon as possible. All PIVCs should be reviewed daily, and those that are no longer needed should be promptly removed. Details of the review and the decision to remove or not should be clearly documented. All PIVCs must be removed promptly when there is clinical evidence that the PIVC is infected. The PIVC insertion site should be visually inspected at least twice daily (on every shift) for evidence of complications. This assessment should be clearly documented. PIVC should be re-sited when clinically indicated and not routinely.
Recommendations – type of device	Select the PIVC and insertion site with the lowest risk for complications for the anticipated type and duration of IV therapy.
Recommendations – choice of site	Select the PIVC and insertion site with the lowest risk for complications for the anticipated type and duration of IV therapy. In general, it is recommended that the smallest gauge cannula for the treatment that is required should be used. • Non-dominant forearm is preferred • Avoid areas of flexion and bony prominences • The basilic or cephalic veins on the posterior forearm are the preferred site. The metacarpal veins on the dorsum of the hand are easiest to visualise but are more liable to block, difficult to stabilise, and prone to infusate or medication induced vessel damage.

	• The antecubital fossa veins should be reserved for emergency use • The dorsum of the hand should be used in patients with chronic renal failure. The use of the anterior (ventral) forearm veins (particularly the cephalic veins) is not recommended in patients with impending need for dialysis in whom preservation of upper extremity veins is needed for fistula implantation. When venipuncture of the arm veins is necessary, sites should be rotated • PIVCs inserted into the lower limbs have a greater risk of thrombophlebitis and thrombosis than the upper limbs and should only be used for the short term or in emergencies Initial sites should be in the distal areas of the upper extremities; subsequent PIVCs should be proximal to the previous PIVC
Recommendations – securement	A single patient use application of alcoholic chlorhexidine gluconate solution (preferably 2% chlorhexidine gluconate in 70% isopropyl alcohol if compatible with the PIVC) should be used and allowed to air dry; • For skin disinfection prior to the insertion of a PIVC. • To disinfect the PIVC insertion site during dressing changes. • Prior to accessing the PIVC hub. A sterile, transparent semipermeable dressing should be used to cover the PIVC insertion site. Routine dressing change is not recommended unless the dressing is no longer intact or moisture collects under the dressing Prophylactic antibacterial or antifungal agents are not recommended at the time of insertion or during use of a PIVC to prevent infection.

Recommendations – flushing	Flushing is recommended to promote and maintain patency and prevent the mixing of incompatible medications and solutions. The optimal volume and frequency of flushing of PIVCs used for intermittent injections or infusions is unclear. It is recommended that;
	• PIVCs are flushed with a minimum of 2ml solution:
	    o After placement.
	    o Prior to and after fluid infusion or injection.
	    o Or at least every 12 hours.
	• Sterile 0.9% sodium chloride for injection is used to flush a PIVC.
	• Only single-dose solutions are used. A 10mL (or larger) syringe should be used to avoid excessive pressure (syringes smaller than 10mL can produce higher pressure in the PIVC).
	• Flush in a pulsatile (push-pause or start-stop-start) motion.
	• The flush solution and flushing intervals is documented.

Recommendations – high risk patients	-
Recommendations – other	Only competent, trained staff (or training staff supervised by competent staff) should insert and maintain PIVCs.
Indicators of adverse outcomes	Since publication of the 2009 guidelines, European case definitions for catheter-related infection were agreed by the European Centre for Disease Prevention and Control (ECDC). The clinical advisory group recommend that these definitions are used for surveillance of catheter-related infection.

Data extraction	
Scope	International – UK
Title	Routine 72-96 hour replacement of peripheral venous catheters
Author(s)	-
Institution	National Institute for Health and Care Excellence
Year	2015
Last search for evidence	March 2015 (Derived from Cochrane review Webster J, Osborne S, Rickard CM, New K. Clinically-indicated replacement versus routine replacement of peripheral venous catheters. Cochrane Database Syst Rev. 2015(8):CD007798.)
Recommendations – dwell time	"The review found no difference in catheter-related bloodstream infection or phlebitis rates whether peripheral intravenous catheters are changed routinely every 72 to 96 hours or when clinically indicated. The consistency in these results, which include a very large multi-site study, indicate that healthcare organisations should adopt a clinically-indicated replacement policy. This would provide significant cost savings and would also be welcomed by patients, who would be spared the unnecessary pain of routine re-sites in the absence of clinical indications. Busy clinical staff would also reduce time spent on this intervention. To minimise peripheral catheter-related complications, the insertion site should be inspected at each shift change and the catheter removed if signs of inflammation, infiltration, or blockage are present."
Recommendations – type of device	-
Recommendations – choice of site	-
Recommendations – securement	-
Recommendations – flushing	-
Recommendations – high risk patients	-
Recommendations – other	-
Indicators of adverse outcomes	-

Data extraction	
Scope	International – USA
Title	The Michigan Appropriateness Guide for Intravenous Catheters (MAGIC): Results From a Multispecialty Panel Using the RAND/UCLA Appropriateness Method (also summarized in 1. Moureau N, Chopra V. Indications for Peripheral, Midline, and Central Catheters: Summary of the Michigan Appropriateness Guide for Intravenous Catheters Recommendations. JAVA - Journal of the Association for Vascular Access. 2016;21(3):140-8.)
Author(s)	Chopra V, Flanders SA, Saint S, Woller SC, O'Grady NP, Safdar N, et al.
Institution	-
Year	2015
Last search for evidence	July 2013
Recommendations – dwell time	Remove peripheral intravenous catheters in the setting of redness, swelling, or phlebitis over the vein of insertion. Removal of peripheral intravenous catheters on the basis of a routine schedule or in the absence of redness, swelling, or other signs of inflammation is inappropriate; site rotation should be driven by clinically warranted change. Removal of a functioning peripheral intravenous catheter that has been inserted in the field (e.g., ambulance or nonhospital site) in the absence of redness, tenderness, or swelling over the insertion site is inappropriate.
Recommendations – type of device	-
Recommendations – choice of site	Insert a peripheral intravenous catheter in the external jugular vein if the proposed duration of use is ≤4 d or an emergent/life-threatening situation exists. Place a peripheral intravenous catheter in the foot only in the setting of an emergent, life-threatening situation. Placement of peripheral intravenous catheters on the same side as prior breast surgery, axillary node dissection, or arteriovenous fistulae (regardless of whether the fistula is functional or not) is inappropriate.
Recommendations – securement	-
Recommendations – flushing	-
Recommendations – high risk patients	-
Recommendations – other	Use ultrasonographic guidance to place short or long peripheral intravenous catheters in patients with difficult venous access who require treatment for ≤5 d.
Indicators of adverse outcomes	

Data extraction	
Scope	International – UK
Title	Epic3: National evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. J Hosp Infect. 2014;86(S1):S1-S70. Section 4 Guidelines for Preventing Infections Associated with the Use of Intravascular Access Devices Used as the evidence base for NICE guidelines
Author(s)	Loveday HP, Wilson JA, Pratt RJ, Golsorkhi M, Tingle A, Bak A, et al.
Institution	NICE
Year	2014
Last search for evidence	2012
Recommendations – dwell time	IVAD28 Peripheral vascular catheter insertion sites should be inspected at a minimum during each shift, and a Visual Infusion Phlebitis score should be recorded. The catheter should be removed when complications occur or as soon as it is no longer required. (Class D/GPP) IVAD29 Peripheral vascular catheters should be re-sited when clinically indicated and not routinely, unless device-specific recommendations from the manufacturer indicate otherwise. (Class B)
Recommendations – type of device	IVAD6 Use a catheter with the minimum number of ports or lumens essential for management of the patient. (Class A) IVAD7 Preferably use a designated single-lumen catheter to administer lipid-containing parenteral nutrition or other lipid-based solutions. (Class D/GPP) Catheter material Intravascular catheter material may be an important determinant in the development of catheter-related infection. Polytetrauroethylene (Teflon) and polyurethane catheters have been associated with fewer infections than catheters made of polyvinyl chloride or polyethylene. Number of catheter lumens Multi-lumen intravascular access devices may be used because they permit the concurrent administration of fluids and medications, parenteral nutrition and haemodynamic monitoring among critically ill patients. Several RCTs and other studies suggest that multi-lumen catheters are associated with a higher risk of infection than single-lumen catheters. However, other studies examined by HICPAC failed to demonstrate a difference in the rates of CR-BSI.
Recommendations – choice of site	IVAD12 Use the upper extremity for nontunnelled catheter placement unless medically contraindicated. (Class C) To reduce the risk of CR-BSI and phlebitis, it is preferable to use an upper extremity site for inserting a PVC in adults and to replace a device inserted in a lower extremity to a site in the upper extremity as soon as possible.
Recommendations – securement	IVAD15 Decontaminate the skin at the insertion site with a single-use application of 2% chlorhexidine gluconate in 70% isopropyl alcohol (or povidone iodine in alcohol for patients with sensitivity to chlorhexidine) and allow to dry before inserting a peripheral vascular access device. (Class D/GPP) IVAD16 Do not apply antimicrobial ointment routinely to the catheter placement site prior to insertion to prevent catheter-related bloodstream infection. (Class D/GPP) IVAD17 Use a sterile, transparent, semipermeable polyurethane dressing to

	cover the intravascular insertion site. (Class D/GPP)
	IVAD18 Transparent, semi-permeable polyurethane dressings should be changed every 7 days, or sooner, if they are no longer intact or if moisture collects under the dressing. (Class D/GPP)
	IVAD19 Use a sterile gauze dressing if a patient has profuse perspiration or if the insertion site is bleeding or leaking, and change when inspection of the insertion site is necessary or when the dressing becomes damp, loosened or soiled. Replace with a transparent semi-permeable dressing as soon as possible. (Class D/GPP)
Recommendations – flushing	IVAD31 Antimicrobial lock solutions should not be used routinely to prevent catheterrelated bloodstream infections. (Class D/GPP)
	IVAD32 Do not routinely administer intranasal or systemic antimicrobials before insertion or during the use of an intravascular device to prevent catheter colonisation or bloodstream infection. (Class A)
	IVAD33 Do not use systemic anticoagulants routinely to prevent catheter-related bloodstream infection. (Class D/GPP)
	IVAD34 Use sterile normal saline for injection to flush and lock catheter lumens that are accessed frequently. (Class A)
Recommendations – high risk patients	-
Recommendations – other	Healthcare workers caring for patients with intravascular catheters should be trained and assessed as competent in using and consistently adhering to practices for the prevention of catheter-related bloodstream infection. (Class D/GPP)
	IVAD40 Use quality improvement interventions to support the appropriate use and management of intravascular access devices (central and peripheral venous catheters) and ensure their timely removal. These may include: - protocols for device insertion and maintenance; - reminders to review the continuing - use or prompt the removal of - intravascular devices; - audit and feedback of compliance - with practice guidelines; and - continuing professional education. New recommendation Class C/GPP
Indicators of adverse outcomes	-

Data extraction	
Scope	State(territory)-based – ACT
Title	Canberra Hospital and Health Services Procedure Peripheral Intravenous Cannula, Adults and Children (Not neonates)
Author(s)	-
Institution	ACT Government Health, Canberra Hospital and Health Services
Year	2015 (amended 2017)
Last search for evidence	Not reported
Recommendations – dwell time	Where the PIVC has been inserted in an emergency situation where aseptic technique cannot be assured, the cannula must be replaced within 24 hours, in order to prevent infection. All other PIVC must be replaced WITHIN 72 hours, or earlier when there are local or systemic signs of inflammation/infection. Exceptions Life threatening situations where a PIVC older than 72 hours is in situ and functional and alternative appropriate access has not yet been inserted. The reason for retaining a PIVC beyond 72 hours must be clearly documented in the patient's medical records.
Recommendations – type of device	When selecting a PIVC, ensure that it is equipped with safety engineered device with sharps injury protection. The size of the PIVC should be determined by the intended use (e.g. blood and blood products, drug therapy, hydration etc), the condition of the patient's veins, likely length of time PIVC is expected to remain in situ and the insertion site. The PIVC should be the shortest and smallest gauge that can meet the anticipated clinical need (i.e. operating theatre, trauma, labour) to ensure optimal flow.
Recommendations – choice of site	Select the most appropriate vein for insertion of the PIVC. Points to consider include: - Patient's activity level - Size and condition of patient's veins - Indication for PIVC and expected duration of PIVC - Position of patient during any planned procedure(s) - Use non-dominant forearm if practical - Use basilic or cephalic veins on the posterior (dorsal) forearm if possible - The metacarpal veins on the dorsum of the hand are easier to visualise but are more liable to clot, difficult to stabilise, and prone to vessel damage - In patients with chronic renal failure, the use of the anterior (ventral) forearm veins (especially the cephalic vein) should be avoided, as these may be required for fistula formation for dialysis. Avoid the use of veins in the following sites: - Areas of flexion, e.g. antecubital fossa, or bony prominences (Vein easily damaged, Uncomfortable) - Areas below previous cannulation site (Vein may be damaged) - Bruised or phlebitic areas (Poor venous return, Pieces of clot can be dislodged into the system) - A limb with an arteriovenous fistulae or shunt (May compromise haemodialysis access)

	• An arm on the same side as a previous lymph node dissection, mastectomy or affected by cerebrovascular accident (Poor venous and/or lymphatic return) • An infected limb e.g. with cellulitis • A limb with a peripherally inserted central catheter (PICC) or implanted venous access device (port-a-cath) • Lower limbs (Risk of deep vein thrombosis, Limits access, patient comfort and mobility.)
Recommendations – securement	PIVC insertion is a Standard Aseptic Technique procedure. Standard Aseptic non touch technique can be performed by experienced staff without touching key areas (i.e. insertion site). If staff do not feel confident to complete the procedure without touching these areas, then sterile gloves must be used. Secure the IV cannula with Steristrip, over the hub of the cannula and occlusive transparent dressing.
Recommendations – flushing	Flushing of PIVC in situ maintains PIVC patency, minimises adverse reactions and prevents thrombus formation. Flushing of a PIVC must be performed for the following: • Pre and post administration of routine intravenous therapy including chemotherapy • Pre and post medication administration • Pre and post routine blood administration and/or blood sampling • Prescribed order from a medical officer • 6th hourly to keep the vein patent. Draw 0.9% NaCl solution into 10ml syringe using drawing up needle (label as per National Recommendations for User-applied Labelling of Injectable Medicines, Fluids and Lines as applicable) or use pre filled 0.9% NaCl syringe. Swab needleless injection valves vigorously for 10 seconds with an 70% alcohol swab and allow to dry (30-60 seconds). Check PIVC site for signs of infiltration and /or phlebitis or infection. If present remove the PIVC and arrange for insertion of a new PIVC (refer to section 1). Slowly inject the 0.9% NaCl to flush the PIVC.
Recommendations – high risk patients	-
Recommendations – other	-
Indicators of adverse outcomes	If there are any signs of adverse reactions, e.g. phlebitis, infiltration, pain, tenderness, the PIVC needs to be removed and reported to the medical officer. The initiation of the removal of the PIVC is by a registered nurse or medical officer only.

Data extraction	
Scope	State-based *Children's Hospital, so principally paediatric* – Vic
Title	Peripheral intravenous (IV) device management
Author(s)	-
Institution	The Royal Children's Hospital Melbourne
Year	2018
Last search for evidence	NR
Recommendations – dwell time	There is no evidence for routine replacement of PIVC unless clinically indicated. PIVC's should be maintained with regular assessment and documentation of complications.
	The possible reasons for removal of PIVC's include a number of complications which range from infiltration, extravasation, phlebitis, occlusion, dislodgement and migration.
Recommendations – type of device	-
Recommendations – choice of site	-
Recommendations – securement	Dressings to PIVC sites are the first line of defence against infection and dislodgements. The dressing must be kept secure, clean dry and intact.
	Indications for dressing change: when it becomes insecure or if there is blood or fluid leakage under the dressing.
	Skin preparation using alcohol in 2% chlorhexidine is the preferred solution for dressings.
	If desired, place sterile tape over the hub of the device before placing the transparent dressing.
	Cover the cannula insertion site with sterile transparent semipermeable, occlusive dressing (e.g. Tegadermtm, IV 3000tm) placed using an aseptic non touch technique over the catheter. This will allow continuous observation of the site and to help stabilise and secure the catheter.
Recommendations – flushing	If the cannula is accessed intermittently for the administration of medications or fluids, the cannula should be flushed prior to infusion or at least once a shift.
	Sterile 0.9% sodium chloride for injection should be used to flush a catheter. This must be prescribed as a medication.
	The optimal volume used for intermittent injections or infusions is unclear. The literature suggests the volume of flush should equal at least twice the volume of the catheter and add on devices and a minimum of 2mL normal saline flush is recommended.
	Use 10ml syringe for flushing to avoid excessive pressure and catheter rupture. Syringes with an internal diameter smaller than that of a 10mL syringe can produce higher pressure in the lumen and rupture the catheter. If resistance is felt during flushing and force is applied this may result in extravasation.
	Use aseptic non touch techniques including cleaning the access port (scrub the hub) with a dual disinfectant agent (e.g. chlorhexidine and alcohol) vigorously for at least 15 seconds and allowing to dry prior to accessing the system.
	Flush in a pulsatile (push-pause) motion.
	Flush catheters:

	Immediately after placement
	Prior to and after fluid infusion (as an empty fluid container lacks infusion pressure and will allow blood reflux into the catheter lumen from normal venous pressure) or injection.
	Prior to and after blood drawing.
Recommendations – high risk patients	-
Recommendations – other	-
Indicators of adverse outcomes	-

Data extraction	
Scope	State-based – SA
Title	Vascular access device management
Author(s)	-
Institution	SA Health
Year	2019
Last search for evidence	NR
Recommendations – dwell time	Routinely replace peripheral intravenous devices every 2-3 days (or sooner if clinically indicated), if access still required.
Recommendations – type of device	-
Recommendations – choice of site	-
Recommendations – securement	Decontaminate the insertion site using an appropriate skin disinfectant such as alcohol-based preparations containing 70% isopropyl alcohol v/v and at least 0.5% chlorhexidine. Allow to dry prior to insertion. In most circumstances, chlorhexidine-impregnated sponge, and sterile gauze or transparent semitransparent dressing, should be used to cover the insertion site. Inspect dressings daily, change if soiled or loose.
Recommendations – flushing	-
Recommendations – high risk patients	-
Recommendations – other	-
Indicators of adverse outcomes	Document the patient's records, insertion details and any complications.

Data extraction	
Scope	State-based – WA
Title	Insertion and Management of Peripheral Intravenous Cannulae in Western Australian Healthcare Facilities Policy
Author(s)	-
Institution	Government of Western Australia Department of Health
Year	2017
Last search for evidence	NR
Recommendations – dwell time	All PIVC are to be removed as soon as they are no longer required and are in adults are not to remain in situ longer than 72 hours. The responsible medical officer is to review the need for PIVC access daily, and if ongoing access is required past 72 hours, planned resiting of the PIVC is to occur. Remove the PIVC if PIVAS is ≥ 2, or fever >38°C, or signs of sepsis are evident. Remove PIVCs that may have been inserted without adherence to aseptic technique e.g resuscitation as soon as practical and within 24 hours of insertion.
Recommendations – type of device	All PIVC are to have an extension set attached, e.g. j-loop, except for those PIVC utilised for short stay therapy in an outpatient, emergency or procedural setting, where the use of a needleless valve is acceptable. Extension sets help maintain stability and reduce trauma to the vein. The use of PIVC that are classed as safety-engineered medical devices (SEMDs) is preferred. The exceptions to this are PIVC required for specialised procedures for which no SEMD is available or where the use of a SEMD interferes with provision of care. The size of the PIVC is to be determined by the intended use, e.g. hydration, blood products, the condition of the patient's veins and the insertion site. The PIVC is to be the shortest and smallest gauge that is suitable for the anticipated clinical need. As closed intravenous access systems are associated with fewer BSIs than open systems, needleless access ports are to be used on all lumens. Stopcocks are to be end-capped with a needleless access port when not in use. All PIVC access ports are to be disinfected by rubbing with a single-use 70% alcohol-impregnated swab and allowed to dry prior to accessing the system. A 2% alcoholic chlorhexidine swab can be utilised, however 70% alcohol has significant and immediate antimicrobial activity and reduces unnecessary exposure to chlorhexidine as the residual activity of chlorhexidine is not required on inanimate surfaces.
Recommendations – choice of site	PIVC are to be routinely sited in the distal areas of the upper limbs. Subsequent PIVC are to be inserted, where possible, proximal to the previous site. Select the most appropriate vein for insertion of the PIVC with consideration of: • indication and expected duration of PIVC • size and condition of patient's veins • position of patient during any planned procedure(s) • utilising the patient's non-dominant forearm if practical • utilising basilic or cephalic veins on the posterior (dorsal) forearm if possible. If possible, avoid the use of veins in the following sites: • the anterior (ventral) forearm veins, especially the cephalic vein, in

	patients with chronic renal failure, as these may be required for fistula formation for dialysis
	• areas of flexion, e.g. antecubital fossa, or bony prominences due to increased risk of BSI and discomfort for the patient
	• areas below previous cannulation sites, bruised or phlebitic areas due to poor venous return and possibility of clots being dislodged
	• a limb with an arteriovenous fistulae or shunt as this may compromise access for haemodialysis
	• an arm on the same side as a previous axillary clearance, mastectomy or affected by a cerebrovascular accident
	• an infected limb, e.g. with cellulitis, due to increased risk of infection
	• a limb with a PICC or implanted venous access device
	• lower limbs due to the risk of deep vein thrombosis, reduces access, patient comfort and mobility.
Recommendations – securement	Use clippers to remove hair at the insertion site if necessary.
	Clean the skin with neutral soap and water if the insertion site is visibly soiled.
	Perform skin disinfection of the site using 2% chlorhexidine gluconate in 70% isopropyl alcohol by liberally swabbing a large area of skin around the chosen insertion site to ensure the site for the dressing is also disinfected.
	Allow skin antiseptic to air dry to ensure sufficient contact time. Do not wipe or blot skin dry.
	For patients with a history of chlorhexidine sensitivity / allergy, use povidone iodine 10% in 70% ethyl alcohol, and allow to air dry. If alcohol is contraindicated, use an aqueous 10% povidone-iodine solution.
	Use a sterile, transparent semi-permeable dressing to secure the PIVC, extension set, or needleless valve if short stay device, to stabilise and secure the PIVC, allow continuous observation of the site and protect the insertion site from contamination.
	Secure the dressing, taking care not to contaminate the adhesive part of the dressing, where the cannula hub and the extension set connect and ensuring the dressing is firmly adhered to the skin.
	The insertion site should remain visible for inspection, therefore, do not place opaque tape directly over the insertion site.
	Record the date and time of insertion and the signature of the inserter on the adhesive strip of the IV dressing.
	The dressing is to be replaced if it becomes wet, soiled or loose using an aseptic technique.
	If a PIVC becomes accidentally or inadvertently partially withdrawn or dislodged, the PIVC is to be removed and a new PIVC inserted as soon as practical.
Recommendations – flushing	Where possible, PIVC are to have a continuous flow of IV fluids through them.
	If the patient is receiving intermittent injections or infusions, flushing under positive pressure is recommended to promote and maintain patency and prevent the mixing of incompatible medications and solutions.
	PIVC are to be flushed with 5-10mls of sterile 0.9% sodium chloride for injection using a 10ml Luer-lock syringe or commercially available pre-filled syringe to help avoid excessive pressure.
	HCWs are to flush PIVC, using a pulsatile motion (push-pause):
	• after the PIVC is inserted and prior to use to confirm placement
	• before each medication or infusion is given to ensure the PIVC is still patent
	• after each injection / infusion to remove irritant material from the vein
	• between multiple infusions or medications to prevent interactions and

	incompatibilities
Recommendations – high risk patients	-
Recommendations – other	Strict adherence to hand hygiene and aseptic technique is required for the insertion of PIVC. Sterile gloves are to be used and skin antisepsis is to be achieved with the use of a 2% chlorhexidine in 70% alcohol solution, except in the case of a documented allergy. All PIVC are to have a peripheral intravenous assessment score (PIVAS) performed at least every eight hours while the PIVC is insitu and continued for 48 hours post removal. Prophylactic antibacterial or antifungal agents (topical, oral, intranasal, or parenteral) are not recommended to prevent catheter colonisation or BSI.
Indicators of adverse outcomes	All PIVC related BSIs are to be reported in accordance with the HCFs clinical incident reporting process and the WA health system policy on Clinical Incident Management. These events are to be subject to root cause analysis and findings fed back to relevant stakeholders in order to facilitate improved patient safety and outcomes. Nursing / midwifery staff are responsible for recording a PIVAS each shift by assessing the PIVC site for patency, erythema, swelling, pain or tenderness. Any actions taken are to be documented in the patient's medical record. If infection is suspected, inform the treating medical officer. Two sets of blood cultures are to be collected. Blood culture samples are to be drawn from another peripheral vein. Blood must not be drawn from the existing PIVC. Ensure aseptic technique during sampling. Any PIVC site discharge should be swabbed and sent for culture. On removal of the PIVC send catheter tip for culture in a sterile screw top container NB: blood cultures must accompany tip. All actions are to be documented in the patient's medical record. Report significant local and PIVC related site infection, in accordance with the HCF incident reporting processes and the Department of Health Western Australia, Clinical Incident Management Policy 2015.

Data extraction	
Scope	State-based – Qld
Title	Guideline for Peripheral Intravenous Catheter (PIVC) (I-Care)
Author(s)	-
Institution	Queensland Department of Health
Year	2015
Last search for evidence	NR
Recommendations – dwell time	It is recommended that facilities locally determine through their Infection Control Committee which of the following two options they will adopt. A single option should be selected for the entire facility. The decision to use option two is to be based on a formal risk assessment including a point prevalence survey. Additional factors to be considered as part of the risk assessment include: • availability of a dedicated IV Service which includes monitoring for complications • patient and staffing profiles • local Healthcare Associated Blood Stream Infection data related to PIVC • PRIME incident reporting data • availability of staff appropriately trained to insert PIVCs on all shifts • whether stringent documentation processes are in place to prompt and record regular review of devices. OPTION 1: Replace every 72-96 hours unless extenuating circumstance criteria is met. PIVCs should be removed as soon as they are no longer required. If it can be forecast that a PIVC would be in situ for more than 96 hours, an alternative device should be considered such as a peripherally inserted central catheter (PICC). If the PIVC is in situ for 72-96 hours and is necessary for an extended period it should be removed and resited at this time. Some studies have indicated that the incidence of thrombophlebitis and bacterial colonization increases when catheters are left in place >72 hours, and that the incidence of phlebitis is highest when catheters are left in place >96 hours. In extenuating circumstances a cannula may be left in situ after 96 hours if the all of the following criteria are fulfilled: • the patient has very poor peripheral access • no one else can cannulate the patient • the patient still requires peripheral access • the cannula is patent • there is no sign of phlebitis or infection. If the PIVC is not re-sited, the following criteria should be fulfilled: • the risk assessment for the above must be carried out and documented each shift while the PIVC remains in-situ • reasons for not re-siting the cannula must be clearly documented. PIVCs should be removed by the clinician at the first sign of phlebitis (warmth, tenderness, erythema, palpable venous cord). Catheters inserted in emergency situations, when adherence to asepsis cannot be ensured, should be replaced by a clinician within 24 hours or sooner if the patient's condition is stabilised.

	Patients transferring from other healthcare facilities with a PIVC in situ should have this device removed by a clinician upon arrival, unless otherwise clinically indicated.
	Clinicians should replace all fluid administration tubing and connectors when the PIVC is replaced.
	OPTION 2:
	Replacement of a PIVC when clinically indicated
	Clinically indicated replacement of PIVCs, with daily and random PIVC site assessment, has been shown in some studies to lower healthcare expenditures without posing any additional risk of complication including phlebitis or catheter-related bloodstream infection.
	A recent study observed the highest incidence of phlebitis within the first 48 hours of insertion, which decreased for catheters remaining in place 49-96 hours, and was lowest between 97-120 hours.
	It has also been observed that the first PIVC is the least likely to fail, with subsequent resites failing more often due to occlusion and phlebitis.
	Clinicians should remove PIVCs at the first sign of phlebitis, as well as when no longer required.
	Catheters inserted in emergency situations, when adherence to asepsis cannot be ensured, should be replaced by a clinician within 24 hours or sooner if the patient's condition is stabilised.
	Patients transferring from other healthcare facilities with a PIVC in situ should have this device removed by a clinician upon arrival, unless otherwise clinically indicated. There may be emergency situations where access via the original device is necessary; in this case the device should be replaced in 24 hours.
	Clinicians should replace all fluid administration tubing and connectors when the PIVC is replaced.
	Needleless access ports should be changed as per manufacturer's instructions, or if the integrity of the port is compromised. In general, a lot of manufacturers recommend that their needleless components be changed weekly or when there are signs of blood, precipitate, leaks or other defects.
	• CDC guidelines currently recommend that needleless components be changed at least as frequently as the administration set, but no more frequently than every 72 hours. A recent study has identified an increased CLABSI rate when needleless access ports were changed every 24 hours with lines containing blood products or lipids. • More frequent changing of access ports may reduce the burden of access port contamination that could lead to bloodstream infection, however more frequent manipulation of the catheter for access port changes could increase the risk of infection.
Recommendations – type of device	The clinician should choose an appropriate Intravascular Device (IVD) – consider catheter type, number of lumens, length, type of therapy, site of insertion, risk of complications including infection, and patient factors.
	It is recommended that the use of steel needles should be avoided due to the risk of extravasation and needlestick injury.
	PIVCs made of polyurethane have been shown to significantly reduce incidence of phlebitis compared to tetrafluorethylene-hexafluoropropylene (teflon) or silicone catheters.
	PIVC and steel-winged infusion sets (if used) should incorporate safety-engineered protection mechanisms.

	Size/gauge
	It is recommended that specific characteristics of the patient and anticipated therapy are considered in the selection of PIVC gauge and length. These include:
	- age - condition of veins - degree of cardiovascular stability - medical or surgical interventions.
	Clinicians should use the smallest gauge and shortest length PIVC that will accommodate the prescribed therapy to reduce the risk of phlebitis.
	Large gauge and longer PIVCs have been observed to increase risk of phlebitis
	In-line filters are not recommended for infection control purposes.
	Add-on equipment should be of luer-lock design.
	Closed catheter access systems are associated with fewer CRBSIs than open systems. Therefore, needleless access ports should be used on all lumens. Stopcocks should be end-capped with a needleless access port/cap when not in use.
Recommendations – choice of site	The distal areas of the upper extremities are optimal for site selection. Subsequent catheterisation should be made proximal to the previously catheterised site.
	Catheters inserted into the lower limbs have a greater risk of phlebitis, thrombophlebitis and thrombosis than the upper limbs. It is recommended that catheters inserted in a lower extremity site should be replaced to an upper extremity site as soon as possible.
	Veins should be selected on the non-dominant forearm (especially if the catheter is to remain in position for any length of time).
	The basilic or cephalic veins on the posterior (dorsal) forearm are the preferred site for catheterisation.
	The metacarpal veins on the dorsum of the hand are easiest to visualise but are more liable to block, difficult to stabilise, and prone to infusate or medication induced vessel damage.
	The use of antecubital fossa or forearm veins has been observed to have a significantly lower risk of phlebitis than the dorsal veins of the hand.
	The use of the anterior (ventral) forearm veins (particularly the cephalic veins) should be avoided in patients with chronic kidney disease and impending need for dialysis in whom preservation of upper-extremity veins is needed for fistula or graft implantation.
	It is recommended that the dorsum of the hand should be used for PIVC in patients with chronic kidney disease.
	Site selection should avoid areas of flexion as this may predispose to phlebitis due to excessive movement causing vessel wall trauma. This may not always be possible in an emergency situation (e.g. resuscitation) when the antecubital fossa is recommended due to the need for a larger vessel.
	When venepuncture of the arm veins is necessary, sites should be rotated.
	A higher incidence of phlebitis has been observed when the PIVC is inserted in the wrist compared with the hand or forearm.
	PIVCs inserted into the antecubital fossa and forearm veins have been observed to have a significantly lower risk of phlebitis than the dorsal veins of the hand. PIVCs inserted into the antecubital fossa have been observed to have a higher risk of infection than in the forearm, potentially due to catheter

	movement with flexion.
Recommendations – securement	Hair at the insertion site should only be removed by the clinician (prior to antiseptic application), using clippers (not shaved) to improve adherence of the dressing. • The skin should be physically cleaned with soap and water (if necessary) prior to applying the antiseptic solution and inserting the catheter. • Removal of skin lipids (defatting) with alcohol, ether or acetone is not recommended. • Use alcohol-containing preoperative skin preparatory agents if no contraindication exists. The most effective disinfectant (chlorhexidine or povidone iodine) to combine with alcohol has not been established in the literature (be aware that either agent may be contraindicated e.g. sensitivity, allergy) • A solution containing 2% chlorhexidine gluconate (CHG) in ≥ 70% (ethyl or isopropyl) alcohol (alcoholic chlorhexidine) should be used by clinicians for preparation of the insertion site. or • A solution containing povidone-iodine 10% in 70% ethyl alcohol (ethanol) (povidone-iodine should remain on the skin for at least two minutes and until dry before inserting the catheter). If alcohol is contraindicated (e.g. allergy, sensitivity, skin condition) clinicians should use aqueous povidone-iodine 10%* or sterile normal saline 0.9% (*NB: the drying time for aqueous based antiseptics is longer than alcohol based products). Clinicians should not use antimicrobial ointment or creams under the dressing at the insertion site. Topical venodilators (e.g. glyceryl trinitrate) or anti-inflammatory agents (e.g. cortisone) should not be used near the insertion site. The catheter should be stabilised by the clinician with a transparent dressing and sterile adhesive tape or sterile adhesive/wound closure strips, to prevent catheter dislodgement. Clinicians should not: • use adhesive tape directly on the insertion site • apply non-sterile adhesive tape under the transparent dressing • obscure the ability to visualise the PIVC site and surrounding tissues with adhesive tape. Sterile, transparent, semi-permeable, self-adhesive, (standard or hyperpermeable) polyurethane dressings should be used by clinicians to protect the site from extrinsic contamination, allow continuous observation of the insertion site, and to help stabilise and secure the catheter. The dressing (including polyurethane types) should not be immersed or submerged in water. Clinicians should replace dressing on insertion site routinely every seven days or if the dressing becomes damp, loosened, no longer occlusive or adherent, soiled, or if there is excessive accumulation of fluid under the dressing.
Recommendations – flushing	If the patient is receiving intermittent injections or infusions, flushing under positive pressure is recommended to promote and maintain patency and prevent the mixing of incompatible medications and solutions. The optimal volume and frequency of flushing of catheters used for intermittent injections or infusions is unclear. • The literature suggests the volume of flush should equal at least twice

	the volume of the catheter and add on devices.
	• The volume of the lumen is approximately 0.5mL, a small extension set approximately 0.2mL +/- access device 0.1mL, therefore a minimum of 2mL flushing solution should be sufficient (check manufacturers advice).
	• Sterile 0.9% sodium chloride for injection should be used by clinicians to flush a catheter.
	• Only single-dose solutions should be used.
	Clinicians should flush catheters immediately:
	• after placement
	• prior to and after fluid infusion (as an empty fluid container lacks infusion pressure and will allow blood reflux into the catheter lumen from normal venous pressure) or injection
	• prior to and after blood drawing, or
	• at least every 24 hours if not in use (strong consideration should be given to removing the PIVC if not in use).
Recommendations – high risk patients	-
Recommendations – other	Only competent staff (or training staff supervised by competent staff) should insert IVDs to minimise infection and other complications.
	Prophylactic antibacterial or antifungal agents (oral, intranasal or parenteral) are not recommended at the time of insertion or during use of a PIVC to prevent catheter colonisation or bloodstream infection.
Indicators of adverse outcomes	It is recommended that surveillance be conducted in high-risk patient populations by a facility appointed person to determine healthcare associated (HCA) IVD-related Bloodstream Infection (BSI) rates, monitor trends in rates and assist in identifying lapses in infection control practices.
	A facility-appointed person should:
	• report HCA IVD-related BSIs at least monthly to all stakeholders
	• investigate all clusters of HCA IVD-related BSIs for common cause problems
	• investigate all episodes of HCA IVD-related Staphylococcus aureus BSI using an Investigation Checklist e.g. The Staphylococcus aureus BSI Checklist available from: https://www.health.qld.gov.au/publications/clinical-practice/guidelines-procedures/diseases-infection/infection-prevention/icare-bsi-checklist.pdf
	It is recommended that the introduction of new products or processes should be monitored to identify any increase or decrease in the occurrence of device associated infection.

Appendix F: Systematic reviews evidence tables and quality appraisal

Data extraction	
Bibliographic reference	CADTH Rapid Response Unit. Use of Chlorhexidine Gluconate with Alcohol for the Prevention of Peripheral Intravenous Device Infections: A Review of Clinical and Cost Effectiveness, and Guidelines. Canadian Agency for Drugs and Technologies in Health. 2014;04:03.
Study type	Rapid review
Number of included trials	0 studies, 2 evidence-based clinical guidelines (NICE 2012 UK; I-CARE 2013 Qld Australia).
Search strategy	A limited literature search was conducted on key resources including PubMed, The Cochrane Library (2014, Issue 3), University of York Centre for Reviews and Dissemination (CRD) databases, Canadian and major international health technology agencies, as well as a focused Internet search. No filters were applied to limit the retrieval by study type. Where possible, retrieval was limited to the human population. The search was also limited to documents published between January 1, 2009 and March 5, 2014.
Number of participants	0
Population	Adults and Children with peripheral intravenous devices
Intervention	Chlorhexidine gluconate with alcohol as topical antiseptic
Comparison	Alcohol alone Povidone iodine Chlorhexidine gluconate without alcohol Other antiseptic
Relevant outcome measures	Prevention of infections Adverse events Cost-effectiveness Guidelines
Study designs	Health technology assessments (HTA), systematic reviews (SRs), meta-analyses (MAs), randomized controlled trials (RCTs), economic evaluations, and guidelines. If few HTA/SR/MA/RCTs were found, non-RCTs were to be included.
Outcomes	The literature search did not find evidence on the clinical effectiveness, safety or cost effectiveness of chlorhexidine gluconate with alcohol compared to other antiseptics for the prevention of infections associated with peripheral intravenous devices. Guidelines recommend decontamination of the skin at the insertion site with 1-2% chlorhexidine gluconate in ≥70% alcohol before inserting a peripheral intravenous catheter. No grading of evidence or recommendations was provided.
Source of funding	NR
Quality appraisal (AMSTAR)	
1. 'A priori' design	☐ Can't answer
2. Duplicate study selection and data extraction	☐ No

3. Comprehensive literature search	☐No
4. Status of publication (i.e. grey literature) used as inclusion criterion	☐No
5. List of studies (included and excluded) provided	☐No
6. Characteristics of the included studies provided	☐Yes
7. Scientific quality of the included studies assessed and documented	☐Yes
8. Scientific quality of the included studies used appropriately	☐Not applicable
9. Appropriate methods used to combine the findings of studies?	☐Not applicable
10. Likelihood of publication bias assessed	☐Not applicable
11. Conflict of interest stated	☐No

Data extraction	
Bibliographic reference	Carr PJ, Higgins NS, Cooke ML, Mihala G, Rickard CM. Vascular access specialist teams for device insertion and prevention of failure. Cochrane Database Syst Rev. 2018(3).
Study type	Systematic (Cochrane) review
Number of included trials	0 trials (1 ongoing study, 1 unpublished study awaiting classification)
Search strategy	We adapted an Ovid MEDLINE search strategy to search CENTRAL, Ovid Embase, and EBSCO CINAHL and ISI Web of Science. We combined the Ovid MEDLINE search with the Cochrane Highly Sensitive Search Strategy for identifying randomized trials in MEDLINE and Embase: sensitivity and precision-maximizing version. We placed no date, language, or publication restrictions. We performed our search on 7 February 2018.
Number of participants	0
Population	Hospitalized or community participants requiring vascular access. Age was not an excluding factor.
Intervention	Intravenous/vascular access teams or specialist inserters providing insertion or maintenance (or both) of venous access devices.
Comparison	Any
Relevant outcome measures	*(Secondary outcomes)* 1. Premature device failure rates as a result of the following: i) phlebitis/thrombophlebitis: pain, induration, and erythema with a palpable thrombosis of the cannulated vein, or as defined by the study authors; v) catheter-related or catheter-associated bloodstream infection: laboratory-confirmed bloodstream infection attributed to the catheter
Study designs	RCTs, controlled clinical trials.
Outcomes	This systematic review failed to locate relevant published RCTs to support or refute the assertion that vascular access specialist teams are superior to the generalist model. A vascular access specialist team has advanced knowledge with regard to insertion techniques, clinical care, and management of vascular access devices, whereas a generalist model comprises nurses, doctors, or other designated healthcare professionals in the healthcare facility who may have less advanced insertion techniques and who care for vascular access devices amongst other competing clinical tasks. However, this conclusion may change once the one study awaiting classification and one ongoing study are published. There is a need for good-quality RCTs to evaluate the efficacy of a vascular access specialist team approach for vascular access device insertion and care for the prevention of failure.
Source of funding	Division of Emergency Medicine, School of Medicine, The University of Western Australia, Australia.
Quality appraisal (AMSTAR)	
1. 'A priori' design	☐Yes
2. Duplicate study selection and data extraction	☐Yes
3. Comprehensive literature search	☐Yes

4. Status of publication (i.e. grey literature) used as inclusion criterion	☐No
5. List of studies (included and excluded) provided	☐Yes
6. Characteristics of the included studies provided	☐Not applicable
7. Scientific quality of the included studies assessed and documented	☐Not applicable
8. Scientific quality of the included studies used appropriately	☐Not applicable
9. Appropriate methods used to combine the findings of studies?	☐Not applicable
10. Likelihood of publication bias assessed	☐Not applicable
11. Conflict of interest stated	☐Yes

Data extraction	
Bibliographic reference	Marsh N, Webster J, Mihala G, Rickard CM. Devices and dressings to secure peripheral venous catheters to prevent complications. Cochrane Database Syst Rev. 2015(6):CD011070.
Study type	Systematic (Cochrane) review
Number of included trials	6 RCTs
Search strategy	In April 2015 searched: The Cochrane Wounds Group Specialised Register; The Cochrane Central Register of Controlled Trials; Ovid MEDLINE; Ovid MEDLINE; Ovid EMBASE; EBSCO CINAHL; ClinicalTrials.gov; WHO International Clinical Trials Registry Platform; EU Clinical Trials Register.
Search terms included: [Catheterization, Peripheral], (peripheral venous catheter* or PVC):ti,ab,kw, [Occlusive Dressings], (securement device* or Statlock or Hubguard):ti,ab,kw, ((occlusive or gauze or tape or polyurethane or permeable or nonpermeable or non-permeable or transparent or antimicrobial) near/3 dressing*):ti,ab,kw, (opsite or tegaderm or micropore or hypafix):ti,ab,kw
No restriction with respect to language, date of publication or study setting.
Searched reference lists of all relevant publications that had not been identified by the search methods described above. Contacted manufacturers of dressings and devices.
Number of participants	N=1,539
Population	Any patients in any setting who require a PVC.
Intervention	Any dressings or securement devices for the protection or stabilization of a PVC, made from any type of product (e.g. polyurethane, gauze).
Comparison	Another dressing or securement device.
Relevant outcome measures	*Primary outcomes*
• PVC failure (a composite measure of unplanned PVC removal for any reason, such as phlebitis, infiltration, accidental removal, blockage).
• Adverse events (such as allergic skin reaction; blisters).
Secondary outcomes
• Phlebitis, as identified by the trial investigator.
• Catheter-related blood stream infection (CRBSI) with laboratory confirmation of the catheter as the source of the infection.
• Suspected CRBSI, as identified by the trial investigator.
• Entry site local infection, as described by the trial investigator.
Study designs	RCTs or cluster RCTs
Outcomes	Six trials made four comparisons, namely: transparent dressings versus gauze; bordered transparent dressings versus a securement device; bordered transparent dressings versus tape; and transparent dressing versus sticking plaster.
The relative effects of transparent dressings and gauze on phlebitis (RR 0.89; 95% CI 0.47 to 1.68) and infiltration (RR 0.80; 95% CI 0.48 to 1.33) are unclear.
The relative effects on PVC failure of a bordered transparent dressing and a securement device have been assessed in only one small study and these were unclear.
There was very low quality evidence from the same single study of more phlebitis with

	bordered dressings than securement devices (RR 8.11, 95% CI 1.03 to 64.02) (very low quality evidence).
	A small single study compared bordered transparent dressings with tape and found very low quality evidence of more PVC failure with the bordered dressing (RR 1.84, 95% CI 1.08 to 3.11).
	The relative effects of transparent dressings and a sticking plaster have only been compared in one small study and are unclear.
	More high quality RCTs are required to determine the relative effects of alternative PVC dressings and securement devices.
Source of funding	National Institute for Health Research, via Cochrane Infrastructure funding to Cochrane Wounds.
Additional comments	There were only a limited number of studies available for consideration in this review, and they did not investigate some securement products that are in common use.

Quality appraisal (AMSTAR)	
1. 'A priori' design	☐Yes
2. Duplicate study selection and data extraction	☐Yes
3. Comprehensive literature search	☐Yes
4. Status of publication (i.e. grey literature) used as inclusion criterion	☐No
5. List of studies (included and excluded) provided	☐Yes
6. Characteristics of the included studies provided	☐Yes
7. Scientific quality of the included studies assessed and documented	☐Yes
8. Scientific quality of the included studies used appropriately	☐Yes
9. Appropriate methods used to combine the findings of studies?	☐Yes
10. Likelihood of publication bias assessed	☐Not applicable
11. Conflict of interest stated	☐Yes

Data extraction	
Bibliographic reference	Mermel LA. Short-term Peripheral Venous Catheter-Related Bloodstream Infections: A Systematic Review. Clin Infect Dis. 2017;65(10):1757-62.
Study type	Systematic review
Number of included trials	n=63
Search strategy	PubMed was used to search for articles published from 1 January 1980 through 1 January 2017 using the combined search terms "Staphylococcus aureus bacteremia" AND "peripheral intravenous catheter," as well as "peripheral intravenous catheter" AND "bacteremia". Articles were also found by reviewing bibliographies from the above search. Last, articles were searched from the author's file of publications collected over the last 29 years.
Number of participants	N=85063 PVCs
Population	Adult patients, with non-steel needle PVCs, not in home care settings.
Intervention	Short-term PVCs
Comparison	Different dwell times
Relevant outcome measures	Peripheral venous catheter–related bloodstream infection (PVCR-BSI).
Study designs	Not specified
Outcomes	In the present review, the incidence of PVCR-BSIs was 0.18% among 85063 PVCs (range, 0–2.2%) compared to approximately 0.04% of 616 405 PVCs in 3 Australian studies in which the number of PVCs was estimated.

There was no difference in dwell time of those with and without a PVCR-BSI in a survey of surgical patients with a PVC. One study noted the mean PVC dwell time in PVCR-BSI cases was 3.9 days (±2.1 days). Two additional studies found that 54% and 60% of PVCR-BSIs occurred in catheters in situ >3 days. One study found that 1, 32, and 31 PVCR-BSIs occurred when dwell times were 1 day, 2–4 days, and >4 days, respectively. Another study noted that of 17 PVCR-BSIs with known duration of catheterization, 2 involved PVCs in situ 1–2 days and 15 cases involved PVCs in situ 3 or more days. A study found that 30 of 45 PVCR-BSI cases (67%) involved PVCs with a dwell time of 4 or more days. Last, PVC dwell time >3 days was independently associated with the pooled risk of local site infection, phlebitis, and CR-BSI (adjusted OR, 188; 95% CI, 23–1169), and this was associated with the risk of PVCR-BSI (adjusted OR, 324; 95% CI, 21–1139). |
Source of funding	Not reported
Additional comments	No assessment or discussion of study type or quality
Quality appraisal (AMSTAR)	
1. 'A priori' design	☐Can't answer
2. Duplicate study selection and data extraction	☐No
3. Comprehensive literature search	☐No

4. Status of publication (i.e. grey literature) used as inclusion criterion	☐No
5. List of studies (included and excluded) provided	☐No
6. Characteristics of the included studies provided	☐No
7. Scientific quality of the included studies assessed and documented	☐No
8. Scientific quality of the included studies used appropriately	☐No
9. Appropriate methods used to combine the findings of studies?	☐No
10. Likelihood of publication bias assessed	☐No
11. Conflict of interest stated	☐Yes

Data extraction	
Bibliographic reference	Morrison K, Holt KE. The Effectiveness of Clinically Indicated Replacement of Peripheral Intravenous Catheters: An Evidence Review With Implications for Clinical Practice. Worldviews Evid Based Nurs. 2015;12(4):187-98.
Study type	Systematic review
Number of included trials	4 RCTs, and 2 meta-analyses reviewing a total of 13 research studies
Search strategy	Searched PubMed, ClinicalKey, ProQuest nursing and allied health, Ovid Medline, Ovid Healthstar, Journals@Ovid Full Text, and Cochrane. Search range 2009–2014. Search terms were phlebitis AND catheter-related bloodstream infection AND peripheral IV catheters OR peripheral IV device AND clinically indicated replacement.
Number of participants	4 RCTs with a total of 4,960 participants. Meta-analysis 1: 8,779 device days. Meta-analysis 2: 4,895 ppts.
Population	Adult patient requiring a peripheral vascular catheter
Intervention	Replacing the catheter only when clinically indicated
Comparison	Replacing the catheter every 72–96 hr
Relevant outcome measures	Occurrence of phlebitis and infection
Study designs	RCTs, meta-analyses
Outcomes	Four level II randomized controlled trials with no less than 155 subjects, and two level I meta-analyses reviewing a total of 13 research studies indicated that the replacement of peripheral intravenous catheters only when clinically indicated does not increase patient risk of phlebitis or infection when compared to the current practice of routine replacement between 72 and 96 hr in the adult patient population.
Source of funding	Not reported
Quality appraisal (AMSTAR)	
1. 'A priori' design	☐Can't answer
2. Duplicate study selection and data extraction	☐Yes
3. Comprehensive literature search	☐No
4. Status of publication (i.e. grey literature) used as inclusion criterion	☐No
5. List of studies (included and excluded) provided	☐No
6. Characteristics of the included studies provided	☐Yes
7. Scientific quality of the included studies assessed and documented	☐Yes
8. Scientific quality of the included studies used appropriately	☐Yes
9. Appropriate methods used to combine the findings of studies?	☐Yes
10. Likelihood of publication bias assessed	☐Yes
11. Conflict of interest stated	☐No

Data extraction	
Bibliographic reference	Webster J, Osborne S, Rickard CM, Marsh N. Clinically-indicated replacement versus routine replacement of peripheral venous catheters. Cochrane Database Syst Rev. 2019;1:CD007798.
Study type	Systematic (Cochrane) review and meta-analysis
Number of included trials	9 included studies
Search strategy	Searched the Cochrane Vascular Specialised Register, CENTRAL, MEDLINE, Embase and CINAHL and World Health Organization International Clinical Trials Registry Platform and ClinicalTrials.gov trials registers to 18 April 2018. Undertook reference checking, and contacted researchers and manufacturers.
Number of participants	7412 participants
Population	Any patient requiring a PIVC to be in situ for at least three days for the administration of intermittent or continuous therapy (this may include patients in hospitals, nursing homes, or in community settings). Excluded participants receiving parenteral fluids.
Intervention	Changing catheters every 72 to 96 hours (routine change). Included short PIVC made from any type of material (for example metal, plastic); non-coated or coated with any type of product (for example antibiotic, anticoagulant); or covered by any type of dressing (for example gauze, clear, occlusive). Included any duration of time before routine replacement. Excluded midline catheters and long peripheral catheters.
Comparison	Changing the catheter only if there were complications or therapy was complete.
Relevant outcome measures	*Primary outcomes* • Catheter-related blood stream infection (CRBSI, defined as a positive blood culture from a peripheral vein; clinical signs of infection; no other apparent source for the bloodstream infection except the IV catheter; and colonised IV catheter tip culture with the same organism as identified in the blood) • Thrombophlebitis (using any definition identified by the trial author) • All-cause bloodstream infection (BSI, defined as any positive blood culture drawn from a peripheral vein while an IV catheter is in situ or for 48 hours after removal) • Cost (in terms of materials and labour associated with IV catheter-related insertion) *Secondary outcomes* • Local infection (using any definition identified by the trial author)
Study designs	RCTs
Outcomes	No clear difference in the incidence of CRBSI between clinically indicated (1/3590) and routine change (2/3733) groups (risk ratio (RR) 0.61, 95% confidence interval (CI) 0.08 to 4.68), low-certainty evidence (downgraded twice for serious imprecision). No clear difference in the incidence of thrombophlebitis whether catheters were changed according to clinical indication or routinely (RR 1.07, 95% CI 0.93 to 1.25; clinically indicated 317/3590; 3-day change 307/3733, moderate-certainty evidence, downgraded once for serious risk of bias). The result was unaffected by whether the infusion was continuous or intermittent. Six trials provided thrombophlebitis rates by number of device days (32,709 device days). There is no clear difference between groups (RR 0.90, 95% CI 0.76 to 1.08; clinically indicated 248/17,251; 3-day change 236/15,458; moderate-certainty evidence, downgraded once for serious risk of bias). One trial (3283 participants), assessed all-cause blood stream infection (BSI). We found no clear difference in the all-cause BSI rate between the two groups (RR 0.47,

	95% CI 0.15 to 1.53; clinically indicated: 4/1593 (0.02%); routine change 9/1690 (0.05%); moderate-certainty evidence, downgraded one level for serious imprecision).
	Three trials (4244 participants), investigated costs; clinically indicated removal probably reduces device-related costs by approximately AUD 7.00 compared with routine removal (MD −6.96, 95% CI −9.05 to −4.86; moderate-certainty evidence, downgraded once for serious risk of bias).
	Four studies (4606 participants), reported local infection rates. It is uncertain if there are differences between groups (RR 4.96, 95% CI 0.24 to 102.98; clinically indicated 2/2260 (0.09%); routine replacement 0/2346 (0.0%); very low-certainty evidence, downgraded one level for serious risk of bias and two levels for very serious imprecision).
Source of funding	Chief Scientist Office, Scottish Government Health Directorates, The Scottish Government, UK.
Additional comments	Supersedes previous review also identified in this search (published 2015) – included two additional studies compared with previous review.
Quality appraisal (AMSTAR)	

1. 'A priori' design	☐Yes
2. Duplicate study selection and data extraction	☐Yes
3. Comprehensive literature search	☐Yes
4. Status of publication (i.e. grey literature) used as inclusion criterion	☐No
5. List of studies (included and excluded) provided	☐Yes
6. Characteristics of the included studies provided	☐Yes
7. Scientific quality of the included studies assessed and documented	☐Yes
8. Scientific quality of the included studies used appropriately	☐Yes
9. Appropriate methods used to combine the findings of studies?	☐Yes
10. Likelihood of publication bias assessed	☐Yes
11. Conflict of interest stated	☐Yes

Data extraction	
Bibliographic reference	You T, Jiang J, Chen J, Xu W, Xiang L, Jiao Y. Necessity of heparin for maintaining peripheral venous catheters: A systematic review and meta-analysis. Experimental and Therapeutic Medicine. 2017;14(2):1675-84.
Study type	Systematic review and meta-analysis
Number of included trials	32 studies, of which 22 reported phlebitis as an outcome and were included in meta-analysis. Of these 13 reported results for intermittent flushing and 9 evaluated heparin for continuous infusion.
Search strategy	A comprehensive literature search up to February 2016 was performed using PubMed, Embase, Web of Science and Cochrane Central Register of Controlled Trials without language limitation. Manual searching was also used to identify eligible studies from key journals, major conference abstracts, original articles and reference lists. The following Medical Subject Headings and free text words were used: 'Heparin', 'placebo', 'control' and 'peripheral'.
Number of participants	Study size ranged from 16 patients/16 catheters to 451 patients/1,257 catheters
Population	Subjects with peripheral venous catheters
Intervention	Heparin added to intravenous fluid
Comparison	No heparin added to the similar fluid
Relevant outcome measures	Phlebitis
Study designs	RCTs
Outcomes	The risk of phlebitis was significantly decreased by both continuous infusion (RR, 0.66; 95% CI, 0.58-0.75; P<0.01) and intermittent flushing (RR, 0.70; 95% CI, 0.56-0.86; P<0.01) of heparin in peripheral venous catheters. The overall effect of heparin on reducing phlebitis was also statistically significant (RR, 0.67; 95% CI, 0.60-0.75; P<0.001).
Source of funding	Not reported

Quality appraisal (AMSTAR)	
1. 'A priori' design	☐Can't answer
2. Duplicate study selection and data extraction	☐Yes
3. Comprehensive literature search	☐Yes
4. Status of publication (i.e. grey literature) used as inclusion criterion	☐No
5. List of studies (included and excluded) provided	☐No
6. Characteristics of the included studies provided	☐Yes
7. Scientific quality of the included studies assessed and documented	☐Yes
8. Scientific quality of the included studies used appropriately	☐Yes
9. Appropriate methods used to combine the findings of studies?	☐Yes
10. Likelihood of publication bias assessed	☐Yes
11. Conflict of interest stated	☐No

Data extraction	
Bibliographic reference	Zheng GH, Yang L, Chen HY, Chu JF, Mei L. Aloe vera for prevention and treatment of infusion phlebitis. Cochrane Database Syst Rev. 2014(6):CD009162.
Study type	Systematic (Cochrane) review
Number of included trials	43 trials (35 RCTs and eight qRCTs): 22 trials involved in prevention of phlebitis, and 21 trials involved in the treatment of phlebitis.
Search strategy	February 2014 searched the Cochrane Specialised Register and the Cochrane Central Register of Controlled Trials. The Specialised Register is constructed from weekly electronic searches of MEDLINE, EMBASE, CINAHL, AMED, and through handsearching relevant journals. In addition, searched MEDLINE, EMBASE and Allied and Complementary Medicine (AMED). The following trial databases were searched World Health Organization International Clinical Trials Registry Platform; ClinicalTrials.gov; Current Controlled Trials. The review authors searched the following Chinese databases: Chinese BioMedical Database; Traditional Chinese Medical Database System; China National Knowledge Infrastructure; Chinese VIP Information; Chinese Medical Current Contents; Chinese Academic Conference Papers Database and Chinese Dissertation Database; China Medical Academic Conference; WangFang database. We searched the bibliographies of all relevant publications for further studies and contacted authors and experts in the field of surgical nursing for any information about unpublished studies.
Number of participants	7465 participants, 5546 participants for phlebitis prevention and 1919 for treatment.
Population	Participants, who suffered from phlebitis of a peripheral limb vein that was associated with the presence of an intravenous access device, or who were at risk of developing phlebitis because of insertion of an intravenous access device.
Intervention	Topical external application of any type of Aloe vera (fresh Aloe vera slice or fresh Aloe vera juice) or aloe-derived products, or Aloe vera plus non-Aloe vera treatments, at the site of punctured skin
Comparison	No treatment, routine treatment or the same non-Aloe vera treatment at the same site
Relevant outcome measures	*Primary outcomes* 1. The incidence of phlebitis (for preventive effect) as assessed by the total incidence of phlebitis. Incidence of third degree and second degree phlebitis. 2. The rate of resolution of phlebitis (for treatment effect) as assessed by the total improvement rate of phlebitis. Recovery rate and marked improvement rate.
Study designs	RCTs and quasi-RCTs.
Outcomes	The effects of external application of fresh Aloe vera on preventing total incidence of phlebitis varied across the studies and we did not combine the data. Aloe vera reduced the occurrence of third degree phlebitis (RR 0.06, 95% CI 0.03 to 0.11, P < 0.00001) and second degree phlebitis (RR 0.18, 95% CI 0.10 to 0.31, P < 0.00001) compared with no treatment. Compared with external application of 75% alcohol, or 33% MgSO4 alone, Aloe vera reduced the total incidence of phlebitis (RR 0.02, 95% CI 0.00 to 0.28, P = 0.004 and RR 0.43, 95% CI 0.24 to 0.78, P = 0.005 respectively) but there was no clear evidence of an effect when compared with 50% or 75% MgSO4 (total incidence of phlebitis RR 0.41, 95% CI 0.16 to 1.07, P = 0.07 and RR 1.10 95% CI 0.54 to 2.25, P = 0.79 respectively; third degree phlebitis (RR 0.28, 95% CI 0.07 to 1.02, P = 0.051 and RR 1.19, 95% CI 0.08 to 18.73, P = 0.9 respectively; second degree phlebitis RR

	0.68, 95% CI 0.21 to 2.23, P = 0.53 compared to 75% MgSO4) except for a reduction in second degree phlebitis when Aloe vera was compared with 50% MgSO4 (RR 0.26, 95% CI 0.14 to 0.50, P < 0.0001).
	For the treatment of phlebitis, Aloe vera was more effective than 33% or 50% MgSO4 in terms of both any improvement (RR 1.16, 95% CI 1.09 to 1.24, P < 0.0001 and RR 1.22, 95% CI 1.16 to 1.28, P < 0.0001 respectively) and marked improvement of phlebitis (RR 1.97, 95% CI 1.44 to 2.70, P < 0.001 and RR 1.56, 95% CI 1.29 to 1.87, P = 0.0002 respectively). Compared with 50%MgSO4, Aloe vera also improved recovery rates from phlebitis (RR 1.42, 95% CI 1.24 to 1.61, P < 0.0001). Compared with routine treatments such as external application of hirudoid, sulphonic acid mucopolysaccharide and dexamethasone used alone, addition of Aloe vera improved recovery from phlebitis (RR 1.75, 95% CI 1.24 to 2.46, P = 0.001) and had a positive effect on overall improvement (marked improvement RR 1.26, 95% CI 1.09 to 1.47, P = 0.0003; any improvement RR 1.23, 95% CI 1.13 to 1.35, P < 0.0001). Aloe vera, either alone or in combination with routine treatment, was more effective than routine treatment alone for improving the symptoms of phlebitis including shortening the time of elimination of red swelling symptoms, time of pain relief at the location of the infusion vein and time of resolution of phlebitis.
Source of funding	Chief Scientist Office, Scottish Government Health Directorates, The Scottish Government, UK.

Quality appraisal (AMSTAR)	
1. 'A priori' design	☐Yes
2. Duplicate study selection and data extraction	☐Yes
3. Comprehensive literature search	☐Yes
4. Status of publication (i.e. grey literature) used as inclusion criterion	☐No
5. List of studies (included and excluded) provided	☐Yes
6. Characteristics of the included studies provided	☐Yes
7. Scientific quality of the included studies assessed and documented	☐Yes
8. Scientific quality of the included studies used appropriately	☐Yes
9. Appropriate methods used to combine the findings of studies?	☐Yes
10. Likelihood of publication bias assessed	☐Yes
11. Conflict of interest stated	☐Yes

Data extraction	
Bibliographic reference	Xu HG, Ray-Barruel G, Cooke M, Rickard C. Can the implementation of a PIVC bundle reduce bloodstream infection? A systematic review. Infection, Disease and Health. 2018;23 (Supplement 1):S4.
Study type	*Conference abstract only* Systematic review
Number of included trials	8 studies (4 interrupted time-series, 4 controlled before-after)
Search strategy	We searched electronic databases Pubmed, CINAHL, EMBASE, Medline, Cochrane CENTRAL, ISI Web of Science, trial registries and grey literature for eligible studies published in English from 1 January 2000 until 31 March 2018. Search terms included: peripheral intravenous catheter/cannula, insertion, maintenance, bundle, bloodstream infection (BSI).
Number of participants	Not reported
Population	General hospital population
Intervention	PIVC insertion or maintenance care bundles with two or more components. Various strategies were used in insertion bundles (up to 9 components) and maintenance bundles (up to 12 components).
Comparison	Not reported
Relevant outcome measures	Bloodstream infection (BSI).
Study designs	Interrupted time-series, controlled before-after **No RCTs identified/included – ineligible**
Outcomes	Two studies reported reduction in BSI rates with chlorhexidine gluconate skin prep and integrated closed catheter system.
Source of funding	Not reported
Quality appraisal (AMSTAR)	
1. 'A priori' design	☐Can't answer
2. Duplicate study selection and data extraction	☐Can't answer
3. Comprehensive literature search	☐Can't answer
4. Status of publication (i.e. grey literature) used as inclusion criterion	☐Can't answer
5. List of studies (included and excluded) provided	☐No
6. Characteristics of the included studies provided	☐No
7. Scientific quality of the included studies assessed and documented	☐Yes
8. Scientific quality of the included studies used appropriately	☐Can't answer
9. Appropriate methods used to combine the findings of studies?	☐Can't answer
10. Likelihood of publication bias assessed	☐Can't answer
11. Conflict of interest stated	☐No

Data extraction	
Bibliographic reference	Chang WP, Peng YX. Occurrence of Phlebitis: A Systematic Review and Meta-analysis. Nursing research. 2018;67(3):252-60.
Study type	Systematic review and meta-analysis
Number of included trials	17 studies, of which 14 contained complete data for meta-analysis.
Search strategy	We searched for literature published between 2006 and 2017 in the Cumulative Index to Nursing and Allied Health Literature (CINAHL), PubMed, ProQuest, and Cochrane Library databases.
Number of participants	N=4,343 patients and 5,846 PVCs.
Population	Patients aged 18 or older
Intervention	PVC gauge: ≤20 gauge, Insertion site: antecubital fossa, Duration of catheterization: >96 hours
Comparison	PVC gauge: >20 gauge, Insertion site: other locations, Duration of catheterization: ≤96 hours
Relevant outcome measures	Occurrence of phlebitis in patients with catheter implantation
Study designs	No restriction **No RCTs identified/included - ineligible**
Outcomes	Catheters of 20 gauge or smaller vs. those larger than 20 gauge (12 studies, 4,532 catheters): risk ratio (RR) of 0.88 (95% confidence interval [0.67, 1.17], p = .380), indicating no statistically significant difference in the occurrence of phlebitis between catheters of the aforementioned gauges. Catheters inserted in the antecubital fossa and those inserted in other locations on the upper limbs (7 studies, 3,589 catheters): RR of 1.05 (95% confidence interval [0.82, 1.34], p = .696), indicating no statistically significant difference in the occurrence of phlebitis between catheters inserted in the aforementioned locations. Catheters inserted for more than 96 hours and those inserted for 96 hours or less (5 studies, 3,335 catheters): RR of 1.13 (95% confidence interval [0.49, 2.61], p = .779), indicating no statistically significant difference in the occurrence of phlebitis between catheters inserted for the aforementioned durations.
Source of funding	Taipei Medical University Shuang Ho Hospital, Ministry of Health and Welfare

Quality appraisal (AMSTAR)	
1. 'A priori' design	☐Can't answer
2. Duplicate study selection and data extraction	☐Can't answer
3. Comprehensive literature search	☐No
4. Status of publication (i.e. grey literature) used as inclusion criterion	☐No
5. List of studies (included and excluded) provided	☐No
6. Characteristics of the included studies provided	☐Yes

7. Scientific quality of the included studies assessed and documented	☐Yes
8. Scientific quality of the included studies used appropriately	☐Yes
9. Appropriate methods used to combine the findings of studies?	☐Yes
10. Likelihood of publication bias assessed	☐Yes
11. Conflict of interest stated	☐Yes

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