








REVIEW ARTICLE

Review article: Peripheral intravenous catheter insertion in adult patients with difficult intravenous access: A systematic review of assessment instruments, clinical practice guidelines and escalation pathways

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Abstract

The optimal approach for peripheral intravenous catheter (PIVC) insertion in adult hospitalised patients with difficult intravenous access (DIVA) is unknown. The present study aimed to critically appraise the quality of (i) assessment instruments and (ii) clinical practice guidelines (CPGs) or escalation pathways for identifying and managing patients with DIVA. Cochrane Central Register of Controlled Trials, EBSCO MEDLINE, EMBASE (OVID) and EBSCO CINAHL databases were searched on 22 March 2021. Studies describing a

DIVA assessment measure, CPG or escalation pathway for PIVC insertion in adults (≥ 18 years of age) were included. Data were extracted using a standardised data extraction form including study design, type of resource and reported clinical outcomes. Quality of DIVA assessment instruments were reviewed using the COnsensus-based Standards for the selection of health Measurement Instruments checklist. Methodological quality of CPGs and escalation pathways was assessed using the Appraisal of Guidelines for Research and Evaluation-II (AGREE-II) instrument. Overall, 24 DIVA resources

Key findings

- Early identification of DIVA patients and improved first-time insertion success requires adoption of assessment instruments, CPGs and escalation pathways.
- A variety of decision support documents exist, with consensus that ultrasound-guided PIVC insertion should be used for DIVA.

comprising 16 DIVA assessment instruments and nine CPGs or escalation pathways (including one combined assessment instrument and escalation pathway) were identified. Instruments commonly focused on vein visibility and palpability as indicators of DIVA. CPGs and escalation pathways unanimously recommended use of vessel visualisation technology for patients with or suspected of DIVA. Methodological quality of the resources was mixed. Consensus and standardisation of resources to identify DIVA and recommendations for managing patients with DIVA is limited. Adopting consistent, evidence-based CPGs, escalation pathways or DIVA assessment instruments may significantly improve clinical outcomes.

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Introduction

Peripheral intravenous catheter (PIVC) insertion is the most common invasive clinical procedure for adult hospital patients. More than 50% of all hospitalised patients receive a PIVC to administer fluids and parenteral medications.¹ Despite their ubiquity, PIVC insertion can be challenging, even for experienced practitioners. Across all hospital settings, between 35% and 40% of first-attempt PIVC insertions fail, resulting in repeated painful insertion attempts and significant treatment delays.^{2–5} Ensuring first-time PIVC insertion success is crucial for preventing avoidable patient harm and wasting of healthcare resources, particularly in the ED where PIVCs are the device of choice for emergent access to treatment but where first-time insertion failure ranges between 14% and 27%.^{2,4–8}

Approximately, 30% of adults who receive a PIVC experience difficult intravenous access (DIVA), typically defined as two or more failed insertion attempts.⁹ DIVA is characterised by non-visible and/or non-palpable veins, often necessitating the use of technological aids to assist the successful insertion of vascular access devices.^{4,10,11} Increased risk of DIVA is associated with age, chronic and complex disease, a history of intravenous drug-use, body mass index and chemotherapy treatment.^{4,12} Patients with DIVA may undergo repeated, failed insertion attempts, increasing their risk of adverse events associated with vessel damage and venous depletion.^{13,14} In addition, every time a PIVC fails and a new one is required the protective barrier of the skin is breached increasing the risk of infection.¹⁵ A large proportion of patients describe repeated insertion attempts as moderately to extremely painful.² Failed PIVC insertion can result in lengthy treatment delays, missed medication administration, or escalation to a more invasive device (e.g. central venous catheter).^{12,16} Multiple failed attempts are also associated with escalating healthcare expenditure,⁶ with

one study reporting a sevenfold increase in costs following multiple failed insertion attempts compared to a single insertion attempt.¹⁷

Prospective identification of patients with DIVA using vessel assessment instruments, combined with the use of high-quality clinical guidelines or escalation pathways is recommended to maximise first-time insertion success and prevent PIVC insertion failure.⁹ In recent years, the use of ultrasound-guided (USG) PIVC insertion in the ED has become increasingly available for increasing first-time insertion success in patients with difficult or impossible intravenous access.¹⁸ In the Australian context, repeat traditional insertion is still the default following insertion failure,^{19,20} and identification and management of patients with DIVA remains complex and multifactorial.

Despite growing recognition of the importance of patients with DIVA, the scope of DIVA assessment instruments, clinical practice guidelines (CPGs) and escalation pathways, to guide clinical practice, particularly when providing emergency care, is currently not known. In addition, there is little appraisal of the quality of these resources to determine their appropriateness for use in routine clinical practice. Therefore, the objectives of this review are to identify and evaluate the quality of (i) assessment tools for identifying adult patients with DIVA and (ii) CPGs or escalation pathways for managing adult patients with DIVA who require a PIVC.

Methods

Review framework

A systematic review of assessment tools, CPGs or escalation pathways that aid the identification and management of DIVA patients was conducted in line with the Cochrane review methodology²¹ and reported according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement.²² The review was prospectively registered with PROSPERO (CRD42020173987).

Eligibility criteria

Included studies described an assessment instrument,²³ CPG²⁴ or

escalation pathway¹⁰ for the insertion of a PIVC in adults (≥ 18 years of age) with DIVA. We included escalation pathways to describe all resources available to clinicians inserting PIVCs in adults with DIVA. Because of the paucity of research, studies were not limited to ED populations. Studies, guidelines, or escalation pathways that only included patient populations < 18 years, non-human participants, or published language other than English were excluded.

Search strategy and study selection

A comprehensive search was undertaken on 7 May 2020 and rerun on 22 March 2021 (see Table S1 for search strategy). The databases Cochrane Central Register of Controlled Trials (CENTRAL), EBSCO MEDLINE, EBSCO CINAHL, EMBASE (OVID) and PubMed were searched using controlled vocabulary and text words related to PIVC insertion in patients with DIVA. Hand searches of bibliographies of retrieved publications for further relevant studies were also undertaken. Study authors did not need to be contacted as inclusion eligibility and data were extractable from the published reports.

Outcome measures

The primary outcomes were (i) a description of the available DIVA assessment instruments, CPGs and escalation pathways; (ii) the psychometric quality of assessment instruments, measured using the Consensus-based Standards for the selection of health Measurement Instruments (COSMIN) checklist;²⁵ and (iii) methodological quality of available CPGs and escalation pathways, measured according to the Appraisal of Guidelines for Research and Evaluation-II (AGREE-II) instrument criteria.²⁶

Data extraction and risk of bias

All references were screened and managed in Covidence systematic review software (Veritas Health Innovation, Melbourne, Australia). Two

study authors (RSP, ES) completed the data extraction form and risk of bias assessment independently, and discrepancies were resolved by discussion and consensus. Where required, consultation with a third, independent review author (JAS) was undertaken to resolve any disagreements. Data were extracted using a standardised data extraction form, created prior to the literature search and included study origin, tool, CPG or pathway, setting for psychometric testing and participants. For DIVA tools, relevant domains of the COSMIN checklist were evaluated using a 4-point rating scale (inadequate, doubtful, adequate and very good), for each relevant domain, depending on the information reported by the study authors. For the CPGs or escalation pathways, each appraiser independently scored the six AGREE-II domains using the 7-point scale, with a score of 7 indicating that the quality of reporting was exceptional. Domain scores were calculated by a summation of appraiser scores and by scaling the total as a percentage of the maximum possible score for that domain.

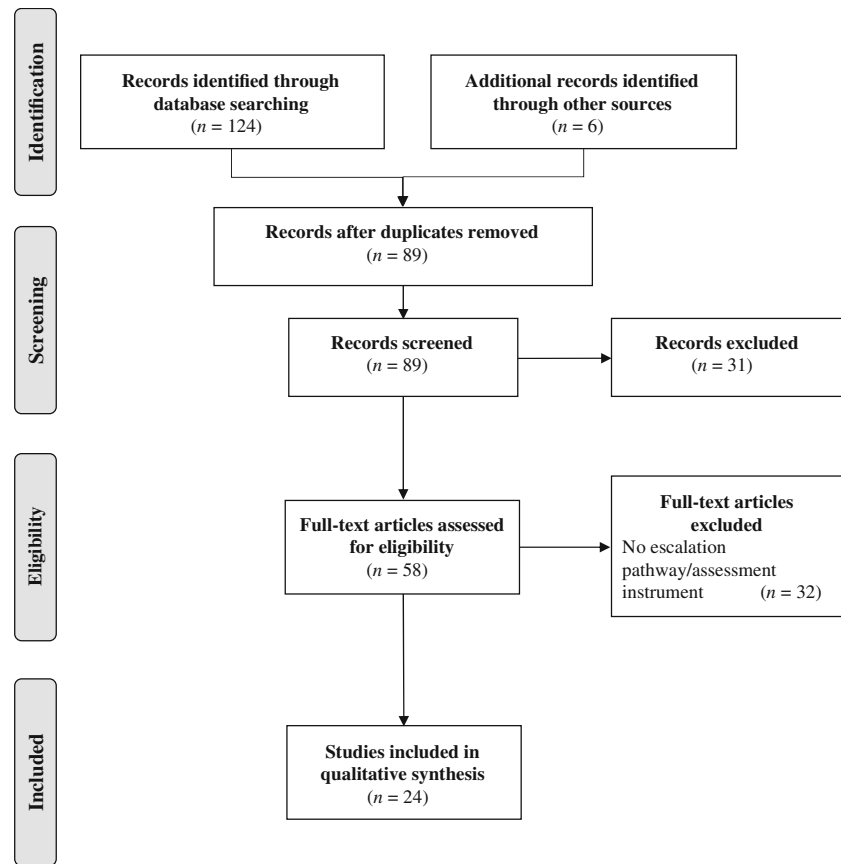


Figure 1. Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) flow diagram for included studies.

Synthesis

For each DIVA assessment tool identified, study design, DIVA indicators, psychometric properties, and the lowest COSMIN item ranking are presented. Scaled domain percentages and overall assessments, along with a synthesis of key recommendations and considerations, for each CPG and escalation pathway each are reported.

Results

Overall, 124 records were identified through database searching and an additional six records identified through other sources (Fig. 1).

Characteristics of included studies

We included 24 studies comprising 16 DIVA assessment tools and nine CPGs or escalation pathways (one study¹¹ included both an escalation pathway and assessment instrument). Most studies were from the USA (37.5%),^{23,27–34} then Italy

(12.5%),^{35–37} UK (12.5%),^{11,38,39} Australia (8.3%),^{10,40} France (8.3%),^{4,5} Spain (8.3%),^{41,42} the Netherlands (8.3%)^{13,43} and Germany (4.2%).⁴⁴ Overall, 29.2% of study populations included emergency patients,^{4,28–30,32,39,42} with the remainder including all hospitalised adult patients (37.5%),^{10,11,23,27,31,33,34,36,43} or oncology (8.3%),^{37,41} surgical (8.3%),^{13,35} prehospital emergency care (8.3%)^{5,44} and anaesthetic and critical care (4.2%)³⁸ patients. Two studies did not specify the population.^{39,40}

DIVA assessment instruments

We identified 16 DIVA assessment instruments, described in Table S2. Instruments included peripheral venous grading systems,^{4,5,11,40,41} single-item difficulty of access rating scales^{28,30} and 3-item,⁴² 4-item,⁴⁴ 5-item,^{13,43} 6-item,^{23,28} 7-item,³⁹

8-item^{29,35} and 10-item³⁷ risk factor checklists. Study designs included discussion papers,¹¹ pilot validation studies,³⁷ prospective cohort and observational studies^{13,23,35,40,41,43} and a mixed-methods study.³⁹ DIVA instruments were most commonly developed and evaluated in emergency settings ($n = 7$).^{4,5,28–30,35,42,44} Most commonly, instruments included vein visibility (88%) and palpability (69%) as key indicators for identifying DIVA. Vein visibility was quantified as ‘not visible’,^{13,29,35,43} ‘few visible’,^{23,44} visible ‘with tourniquet’,^{37,39} ‘vein easily seen’,³⁰ or in degrees of visibility.^{4,11,40,42} Similarly, palpability was quantified as ‘not palpable’,^{13,29,35,43} ‘few palpable’,^{23,44} palpable ‘with tourniquet’^{37,39} or as degrees of palpability.^{4,11,40,42} Other common indicators included known history of DIVA (38%), vein diameter (38%),

TABLE 1. Indicators of difficult intravenous access used by 16 assessment instruments

Item	<i>n</i>	%
Vein not visible (\pm tourniquet) ^{5,6,12,22,28,34,36,38,39,41–43}	13	88.0
Vein not palpable (\pm tourniquet) ^{5,6,12,22,28,34,36,38,39,42,43}	12	69.0
History of difficult cannulation ^{12,28,34,42–44}	6	38.0
Largest vein diameter <3 mm, small calibre veins ^{12,22,36,39,41,43}	6	38.0
Vascular depletion (history of chemotherapy, drug abuse, previous venepuncture) ^{22,34,36,38,39}	5	31.0
Limited number of available veins (e.g. because of hemiplegia, spasticity, radical mastectomy, arteriovenous fistula) ^{6,22,34,36,38}	5	31.0
Health conditions/treatments affecting vein/tissue health (e.g. neurovascular disease, coagulative disorder, taking anticoagulants/antiplatelets, chronic conditions, renal failure, diabetes, systemic lupus erythematosus, oedema, cachexia, radiotherapy to upper limb[s]) ^{22,27,28,34,38}	5	31.0
Obesity/overweight (BMI >25) ^{27,28,34,38}	4	25.0
Vein characteristics (e.g. rolling or winding, sclerotic, mobile, torturous veins, phlebitis) ^{22,34,36,38}	4	25.0
Skin appearance (e.g. dark, thick or fragile skin/poor skin integrity) ^{28,34,38,39}	4	25.0
Degree of inserter skill required for insertion, perceived difficulty of access ^{29,40}	2	12.5
Emergency surgery indication ¹²	1	6.3
Frequent hospitalisations ²⁸	1	6.3
Treatment \geq 6 months ³⁶	1	6.3
Dark/insufficient ambient lighting ⁴⁴	1	6.3
Risk of extravasation ⁴¹	1	6.3
Other patient characteristics (e.g. needle phobia, confusion) ³⁸	1	6.3

BMI, body mass index.

vascular depletion (31%), number of available veins (31%) and health conditions that affected vein or tissue condition (31%; Table 1).

Clinical efficacy of assessment instruments

Overall, six studies reported the clinical efficacy of identifying DIVA or insertion failure (Table S2). The Adult-Difficult Venous Catheterization (A-DICAVE) scale correlated with a clinicians' ratings of "difficulty" (correlation co-efficient [r] = 0.82) and the actual number of

insertion attempts required (r = 0.50) and could accurately discriminate between patients who required >2 attempts *versus* 1–2 attempts.⁴² Similarly, scores on the DIVA Clinical Predictor Tool correlated with number of insertion attempts (r = 0.32).²³ Four studies examined the accuracy of their instruments in identifying patients at high risk of DIVA.^{13,35,43,44} The enhanced adult DIVA (EA-DIVA) score (area under the curve [AUC] = 0.94), the adult DIVA (A-DIVA) scale (AUC = 0.89) and the modified A-DIVA scale

(AUC = 0.97) all accurately identified patients at high risk of DIVA, with good sensitivity and specificity (Table S2).^{13,35,43} The pre-hospital intravenous access assessment was also able to predict successful first-attempt insertion (AUC = 0.78) and >2 min to cannulation (AUC = 0.81), although this finding should be interpreted with caution as the authors used the same sample for both developing and testing the accuracy of the model.⁴⁴

Quality of DIVA assessment instruments

The psychometric quality of the DIVA instruments is summarised in Table 2. The majority included sufficient information to evaluate the COSMIN reliability, measurement error and criterion validity domains.²⁵ Of the seven studies which reported reliability, four^{13,37,42,43} were rated as 'adequate'.²⁵ Similarly, two out of four studies provided 'adequate' information related to measurement error.^{39,40} Criterion validity was reported in eight studies, with four meeting the 'very good' threshold.^{13,35,42,43} Overall, the EA-DIVA,³⁵ the A-DIVA scale,⁴³ the modified A-DIVA scale¹³ and the A-DICAVE⁴² provided promising psychometric properties.²⁵

CPG and escalation pathway recommendations

The review identified six CPGs pertaining to DIVA and three escalation pathways. All CPGs unanimously recommended the use of vessel visualisation in DIVA patients (see Table S3 for a summary).^{27,32–34,36,38} Each escalation pathway included vessel visualisation technology, recommending its use where DIVA was determined^{10,11} or after failed insertion attempts.³¹ Hallam *et al.*¹¹ and Sou *et al.*¹⁰ suggested the use of infrared or USG technology to aid device insertion, whereas Duran-Gehring *et al.* recommended escalating to USG after review by the treating physician and alternative insertion site considered.³¹ Only one escalation pathway provided a specific recommendation that clinicians evaluate the appropriateness of a PIVC insertion, with

TABLE 2. COSMIN ratings for DIVA assessment instruments

Instrument	COSMIN		
	Reliability	Measurement error	Criterion validity
A-DICAVE scale ⁴²	Adequate	NR	Very good
A-DIVA scale ¹²	NR	NR	Very good
Adult Venous Assessment Tool ³⁸	Inadequate	Adequate	NR
Clinical Evaluation of Peripheral Vein Accessibility ⁶	Adequate	NR	Inadequate
Difficulty of Attempting IV Placement ²⁷	NR	NR	NR
Difficult IV Access Criteria ²⁸	NR	NR	NR
Difficulty of Attempting IV Placement ²⁹	NR	NR	NR
DIVA Clinical Predictor Tool ²²	NR	NR	Inadequate
DIVA-CP ³⁶	Adequate	Inadequate	NR
EA-DIVA scale ³⁴	NR	NR	Very good
Modified A-DIVA scale ⁴³	Adequate	NR	Very good
Peripheral IV Access Questionnaire ⁴⁰	NR	NR	NR
Peripheral Vein Assessment Tool ⁵	NR	NR	NR
Prehospital IV Access Assessment ⁴⁴	NR	NR	Inadequate
Vein Assessment Tool ³⁹	Inadequate	Adequate	NR
Venous International Assessment ⁴¹	Doubtful	Inadequate	Inadequate

A-DICAVE, Adult-Difficult Venous Catheterization; A-DIVA, adult difficult intravenous access; COSMIN, COnsensus-based Standards for the selection of health Measurement Instruments; DIVA, difficult intravenous access; EA-DIVA, enhanced adult difficult intravenous access; IV, intravenous; NR, not reported.

guidance for instead choosing a mid-line, peripherally inserted central catheter or tunnelled central venous catheter.¹⁰ Overall, each escalation pathway recommended vessel visualisation technologies only when used by trained practitioners.^{10,11,31}

Clinical efficacy of CPGs and escalation pathways

No included CPG explored the utility or feasibility of implementing their guidance in clinical practice. Only the escalation pathway developed by Sou and colleagues evaluated clinical outcomes, reporting a 93% success rate, and a significant reduction in median unsuccessful insertion attempts (pre = 2 [2, 4], post = 1 [1], $P < 0.001$) and patient-reported pain (pre = 7 [5, 9], post = 2 [1, 3], $P < 0.001$) after implementation.¹⁰

Methodological quality of CPGs and escalation pathways

Table 3 presents the scaled domain percentages according to the AGREE-II criteria for each CPG and escalation pathway. Overall, ratings for scope, purpose, clarity and presentation were high for most. Stakeholder involvement was mixed; generally relevant professional groups were involved, however, input from patients was infrequently sought, with overall ratings especially low for the escalation pathways. Similarly, while rigour of development for CPGs was high in the majority, this information was infrequently or poorly detailed for each escalation pathway. Details regarding editorial independence were often poorly described, and no CPG or escalation pathway provided information for applicability. Overall, two CPGs^{27,33} and two escalation pathways^{10,11}

scored highly (≥ 5) on the AGREE-II criteria.²⁶

Discussion

This systematic review of resources to guide difficult PIVC insertion found variable identification and escalation practices with minimal focus on their implementation. Of the 16 DIVA assessment instruments and nine CPGs or escalation pathways, reported evidence describing the clinical efficacy in routine clinical practice and the quality of these instruments or guidelines was mixed. This paradigm, combined with a lack of recognition of the harmful sequelae of failed PIVC insertion attempts, has resulted in little change in PIVC insertion success rates over time.⁹

Primarily, DIVA assessment instruments relied on vein visibility

TABLE 3. AGREE-II scaled scores for clinical practice guidelines and escalation pathways

Author (year)	Scaled total scores (%)					
	Scope and purpose	Stakeholder involvement	Rigour of development	Clarity of presentation	Applicability	Editorial independence
Bodenham <i>et al.</i> (2016) ³⁸	78	50	11	83	17	33
Chopra <i>et al.</i> (2015) ²⁷	100	100	78	100	42	67
Duran-Gehring <i>et al.</i> (2016) ³¹	100	44	19	92	0	0
Franco-Sadud <i>et al.</i> (2019) ³⁴	97	72	75	100	44	92
Gorski <i>et al.</i> (2021) ³³	100	78	86	100	13	96
Hallam <i>et al.</i> (2016) ¹¹	81	50	41	96	11	100
Lamperti <i>et al.</i> (2012) ³⁶	69	56	55	81	21	38
Sou <i>et al.</i> (2017) ¹⁰	100	56	11	92	4	100
Valdez <i>et al.</i> (2015) ³²	56	50	64	94	0	0

AGREE-II, Appraisal of Guidelines for Research and Evaluation-II.

and palpability as key indicators.^{4,11,13,23,29,35,37,39–44} The conceptualisation of these was heterogeneous, and few studies adequately evaluated the reliability and validity of quantifying these indicators.^{37,42,43} The EA-DIVA,³⁵ A-DIVA and modified A-DIVA scales^{13,43} demonstrated promising psychometric properties, particularly for their accuracy in identifying DIVA patients.²⁵ In addition, the A-DICAVE reported promising clinical efficacy, with moderate to high correlations between total score and clinicians' perceived 'difficulty', the number of insertion attempts and prediction of need for >2 *versus* 1–2 attempts.⁴² With the exception of reliability, there was a lack of high-quality assessment for most psychometric properties. For all instruments, further psychometric testing in inpatient settings is therefore needed to recommend their routine use.

Even in the ED – where PIVC use is ubiquitous and staff have greater training, escalation to senior staff is more accessible and USG intravenous access is more readily available – clinical guidelines around PIVC insertion decisions to aid emergency clinicians are critical for ensuring high-quality care.^{9,19} High-quality CPGs and escalation pathways are

available and early identification of DIVA is recommended.^{10,11,27,34} Assessment of vein quality was not always well quantified, however, and there was no clear threshold for escalation,³² nor consistent, comprehensive guidelines or pathways for management.¹¹ Guidance regarding the maximum number of attempts generally recommended escalation following ≤ 2 –3 total attempts at PIVC placement,^{10,31} and was broadly consistent with the recent Infusion Nursing Society (INS) Guidelines (≤ 2 attempts prior to escalation).³³ Similarly, specific recommendations regarding inserter skill focused on escalating to an 'experienced' practitioner where DIVA was suspected.^{11,33} Only the INS Guidelines provided a clear standard for practitioner competency (Standard 5, *Competency and Competency Assessment*),³³ however it was acknowledged that agreement in defining an 'experienced' clinician was an ongoing challenge.²¹

Most CPGs and escalation pathways advocated for the use of USG PIVC insertion in DIVA patients.^{10,11,27,32–34,36,38} This reflects the emerging trend of using this technology when inserting PIVCs in patients with DIVA,¹⁰ and is consistent with research demonstrating that ultrasound

technology improves first attempt insertion success.⁴⁵ However, these recommendations have resource implications and assume that hospitals have access to personnel (i.e. highly skilled, accredited inserters), education (including ongoing skills maintenance) and equipment (i.e. ultrasound devices). Research also highlights that clinician 'gestalt' (i.e. factors that a highly experienced clinician may intuit to recognise a potentially difficult PIVC insertion), can accurately complement decision-making regarding escalation to a more experienced clinician or to USG technology.⁴⁶ This further underscores the necessity of clinical expertise for both insertion success and need to escalate.

All CPGs and escalation pathways had room for improvement, according to AGREE-II criteria.²⁶ Although Chopra *et al.*²⁷ included consumer panellists, and Gorski *et al.*³³ included empirical literature examining consumer experiences in the development of their guidelines, there was an overall lack of involvement of individuals who had experienced difficult PIVC insertion during development. Information regarding the applicability of guidelines in clinical practice was also lacking,

which has significant implications for successful implementation and evaluation in routine clinical practice.

Patients with DIVA often undergo repeated, failed insertion attempts,¹³ increasing their risk of post-insertion complications.¹⁴ Preliminary evidence suggests that DIVA assessment instruments, guidelines and pathways can enhance clinical outcomes by increasing insertion success and reducing post-insertion complications.^{10,31,42} Although general and ED-specific resources are available to support PIVC insertion in the context of difficult access, it is unclear how these assessment instruments, guidelines, and pathways enhance clinical outcomes and prevent insertion-related adverse events. Specifically, no guideline or pathway provided information about utility (only one study reported clinically relevant outcomes),¹⁰ acceptability to clinicians and consumers in the clinical context, or an evaluation of implementation methods.

Patient experiences of DIVA continue to be a neglected topic within this area. Recognising patient preferences is important, especially as a large proportion of patients describe repeated PIVC insertion attempts as moderately to extremely painful.² Some DIVA instruments involved patient assessment of face validity, however, most resources failed to include patients and caregiver preferences in their development, with the Michigan Appropriateness Guide for Intravenous Catheters the only resource to involve a consumer representative during development.²⁷

PIVC use is pervasive in all hospital settings and particularly in the ED.⁴ PIVCs are routinely inserted by novice to expert inserters⁴⁶ without a clear model of care, resulting in inconsistent delivery of best care to patients at greatest risk of insertion failure.⁷ This is combined with an alarming number of idle or “just in case” PIVCs,^{47–49} raising the question: Are we causing more harm than good, especially in patients with DIVA?^{50,51} More broadly, a crucial step in preventing complications associated with DIVA may instead be to first consider if

PIVC access is even the most appropriate mode of treatment delivery.¹¹ Although DIVA prediction instruments and pragmatic insertion decision-making algorithms are necessary, literature pertaining to the decision to use a PIVC and the appropriateness of alternative routes in different settings remains a knowledge gap. Clearer direction from CPGs on who needs a PIVC in the first place is critical.

This systematic review is not without limitations. We used a broad search strategy that encompassed numerous databases and grey literature, as well as hand-searching of reference lists. Although we expanded our search to include escalation pathways in addition to CPGs, it is possible some relevant studies were missed because of variations in terminology or because of excluding papers not in English. The expanded scope of the present study to include studies outside of the emergency setting also impacts the specificity of current findings for use in the ED. The lack of discussion within CPGs regarding implementation, or evaluation of escalation pathways and DIVA assessment instruments in clinical practice, limits the scope of this review to explore or meta-analyse their use and efficacy in clinical practice. Consequently, this reduces the generalisability and utility in improving first attempt insertion success in patients with DIVA in practice.⁹ A key strength of the review was the rigorous methodology.

Conclusions

There is limited international consensus and standardisation of resources to identify and manage patients with or at-risk of difficult PIVC insertion, however, the adoption of CPGs, escalation pathways or DIVA assessment instruments for patients with DIVA may improve clinical outcomes. Combined, the included resources demonstrated consensus of recommended use of USG PIVC insertion in patients with DIVA. Future research should evaluate the impact of implementing DIVA resources in clinical practice to improve patient care.

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Competing interests

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Data availability statement

The data that support the findings of the present study are available from the corresponding author upon reasonable request.

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Supporting information

Additional supporting information may be found in the online version of this article at the publisher's web site:

Table S1. Summary of search terms used for the electronic database search.

Table S2. Assessment tools summary information.

Table S3. Clinical practice guidelines and escalation pathways summary information.