

Adherence to peripheral venous catheters' guidelines by emergency nurses: A systematic review

Joana Teixeira^{a,b,c,d,*} , Celeste Bastos^c, Maria do Rosário Pinto^{b,d}

^a School of Medicine and Biomedical Sciences (ICBAS) – Porto University (UP), Porto, Portugal

^b Health Sciences Research Unit: Nursing (UICISA: E), Nursing School of Coimbra (ESENFC), Portugal

^c CINTESIS@RISE, Nursing School of Porto (ESEP), Porto, Portugal

^d The Nursing Research, Innovation and Development Centre of Lisbon (CIDNUR), Nursing School of Lisbon, Portugal

ARTICLE INFO

Keywords:

Catheterization, Peripheral
Catheter-related infections
Guideline adherence
Nursing Care
Systematic Review

ABSTRACT

Background: Peripheral intravenous catheters are widely used in emergency departments for intravenous treatment. However, peripheral intravenous catheter practices supported by the latest evidence remain suboptimal, negatively affecting patient outcomes.

Objective: To identify the determinants influencing adherence to peripheral intravenous catheter guidelines in the emergency department (the insertion technique, maintenance protocols, and timely removal) and to analyse strategies for improving adherence.

Methods: A systematic review was conducted from August to September 2025, in the Cochrane Central Register of Controlled Trials, CINAHL Complete, MEDLINE Complete databases (via EBSCOhost), and SCOPUS and included eligible papers published from 2018, according to eligibility criteria: studies involving emergency department nurses or clinicians, focusing on peripheral intravenous catheter adherence determinants and related strategies. This approach followed the methodological guidelines of the Joanna Briggs Institute and the PRISMA Statement reporting guidelines for Systematic Reviews.

Results: The six studies included in this review identified individual, organisational, and clinical decision-making determinants that influence emergency nurses' adherence to peripheral intravenous catheter infection prevention guidelines, including limited knowledge, training gaps, lack of institutional support, and inconsistent practices. Effective strategies included ongoing education, ultrasound-guided training, the involvement of vascular access teams, and quality improvement approaches like the Plan-Do-Study-Act cycle.

Conclusions: This review identified key determinants and strategies that influence and enhance emergency nurses' adherence to infection prevention guidelines for peripheral intravenous catheter care. The importance of integrating technical training with supportive environments and effective clinical leadership is emphasised throughout multimodal intervention programs. Future interventions should prioritise team empowerment, alignment with institutional goals, and promoting nurses' motivation and self-efficacy, ideally through participatory approaches.

Registration: PROSPERO Registration ID CRD42024506801, registered 03/09/2024.

* Correspondence author at. Rua do Rio Tâmega 103, 2785-270 São Domingos de Rana.

E-mail address: joanamf@hotmail.com (J. Teixeira).

@JmftJoana (J. Teixeira)

What is already known

- Peripheral intravenous catheters are commonly used in emergency departments
- Although guidelines for peripheral intravenous catheter management exist, their implementation is often inconsistent

What this paper adds

- Determinants that influence adherence to peripheral intravenous catheter guidelines include outdated knowledge, disbelief in evidence, unclear responsibilities, usual practices, and insufficient training
- Strategies to promote adherence to the guidelines. Key strategies include technical training, supportive environments, strong clinical leadership, enhancing team engagement, and optimising patient outcomes.

1. Background

Peripheral intravenous catheters are commonly used devices in emergency departments (Capdevila et al., 2016; Gunasegaran et al., 2018; Zingg et al., 2023) for life-saving intravenous therapy or diagnostic testing (Thomas et al., 2020), ensuring timely and appropriate care (Decker et al., 2016). Their clinical significance lies in their capacity to provide immediate therapeutic interventions that can be lifesaving in acute and critical scenarios, where delays in vascular access are associated with increased morbidity and mortality (Ray-Barruel et al., 2020). However, catheter insertion is typically a painful and stressful procedure that often involves multiple insertion attempts, resulting in complications that affect patient outcomes (Alexandrou et al., 2018). One of the most significant complications associated with this medical device is the risk of infection, specifically peripheral intravenous catheter-associated infections, which are recognised as healthcare-associated infections (Alexandrou et al., 2018; Simonetti et al., 2019).

However, preventing these infections remains a significant challenge for emergency care nurses. Acutely ill patients who are admitted to the emergency department not only have the potential to spread communicable infectious diseases to healthcare personnel and other patients but are also vulnerable to acquiring new infections associated with the care they receive (Liang et al., 2014). Additionally, there is evidence of non-standardised practice among professionals, with significant deviations from recent evidence, such as that issued by the Centers for Disease Control and Prevention (2024); Nickel et al. (2024); World Health Organization (2024), with negative consequences for infection prevention and control and patient safety (Simonetti et al., 2019; Thomas, Cabilan and Johnston, 2020; Zingg et al., 2023). One of these deviations is the placement of catheters without adhering to evidence-based criteria (Lim et al., 2020).

In a study of 224 patients (Thomas, Cabilan and Johnston, 2020), 71 % received at least one PIVC, with between 34 % and 40 % of these devices remaining unused. Furthermore, documentation was inadequate, with 29 % of insertions not recorded. These findings highlight the importance of adhering to recommendations on clinically indicated insertion, device selection, and accurate documentation in the emergency department, underscoring the need for targeted interventions to promote safer and more appropriate practice. Recent research on peripheral intravenous catheter-associated infections also reports that they can be prevented through standardised, evidence-based practices outlined in guidelines for caregivers to follow (Zingg et al., 2023). The findings raise the question of why, despite available guidelines, their implementation does not consistently achieve effective results. Working in this subject, Fischer and his team (Fischer et al., 2016) conducted a scoping review on barriers and strategies in guideline implementation, concluding that guideline implementation and adherence do not occur immediately but may take several years to be fully completed. Adherence is a self-initiated action of following directions without deviations. It is related to a set of actions or behaviours, namely preventive behaviours, divided into compliance and initiative or participation. It is multifactorial and can be influenced by several determinants (Lecours and Therriault, 2016; International Council of Nurses, 2019).

Bandura's Social Cognitive Theory (Bandura, 2001) explores some of those determinants. Considering this theory, observational learning, reciprocal determinism, and self-efficacy are key determinants that interact dynamically, emphasising the reciprocal relationship between personal, behavioural, and environmental influences.

Aligned with Bandura's Social Cognitive Theory Kilinc, Yildiz and Harmanci (2018) argued that indirect learning occurs through observing other people's behaviours. As a result, observers can weaken previously acquired negative knowledge, acquire new beliefs and values, and learn to use the environment based on the model. The Learning process involves four basic processes: *attention*, *retention*, *motivation*, and *production*. In *attention* process, the observer pay *attention* to the behaviors and activities that will be modeled and perceiving them correctly; these can be influenced by the individual's interest, preparation, needs, and goals, affective ability, previous experiences, and the functionality of the modeled behavior; b) in *retention*, the model needs to be remembered, converting the observed information into stored information; c) in *motivation*, individuals who make observations learn the model's behavior and display similar behaviors, reinforcing their behaviors, converting learning into performance; d) in *production*, behaviors are practiced; self-efficacy plays an important role in transforming individuals' behaviors into performance.

Aiming for behavioural change and its transformation into performance, understanding the dimension of the phenomenon under study, emergency nurses' implementation of infection prevention guidelines for peripheral intravenous catheters could be improved.

Thus, it is crucial to identify evidence on the determinants influencing nurses’ adherence to peripheral intravenous guidelines during the insertion, maintenance, and removal of peripheral intravenous catheters, as well as strategies to promote it. The results obtained will be discussed based on Bandura’s theory (Bandura, 1998, 2001; Kilinc, Yildiz and Harmanci, 2018).

2. Methods

This systematic review adheres to the methodological guidelines and quality assessment for Systematic Reviews of the Joanna Briggs Institute (Aromataris et al., 2024). It complies with the PRISMA Statement reporting guidelines for Systematic Reviews (Page et al., 2021).

The research question was delineated using the PIC(O) mnemonic (Booth et al., 2019; Aromataris et al., 2024), where P stands for Population, I for Intervention/Phenomenon of interest and O for Outcome: *What are the determinants and strategies related to insertion and maintenance of peripheral intravenous catheter (I) that impact adherence to guidelines for infection prevention and control (O) by emergency nurses (P)?*

2.1. Information sources and search strategy

Initially, a first search was done to identify the specific terms to construct the search strategy. Secondly, all identified keywords and index terms were combined using the Boolean operators “OR” and “AND” to achieve the best search strategy for each database. The search was initially conducted from March to May 2024, and updated in August and September 2025, in the Cochrane Central Register of Controlled Trials, CINAHL Complete, MEDLINE Complete databases (via EBSCOhost), and SCOPUS (abstract, title and keywords only), using the following search strategy, adapted for each database: (((“nurs*” OR “clinician*”) AND ((MM “Emergency Service, Hospital+”) OR (MM “Emergency Service+”) OR “emergency department” OR “emergency room” OR “emergency”))) AND (((“intervent*” OR “strateg*” OR “program”)) AND ((MM “Catheterization, Peripheral+”) OR “peripheral vascular catheter” OR “short-term peripheral venous catheters” OR “peripheral vascular access” OR “peripheral venous catheter” OR “peripheral intravenous catheter”))) AND (((“good practices*” OR practice* OR “best practice*” OR attitude” OR (MM “Attitude+”) OR (MM “Guideline Adherence”) OR “adherence”)) AND ((“infection” OR (MM “Catheter-Related Infections”) OR (MM “Infection Control+”) OR “infection prevention” OR “infection” OR “control” OR “prevention” OR (MM “Phlebitis+”) OR “phlebitis” OR “peripheral line-associated infections” OR “catheter-related bloodstream infections”)))).

2.2. Eligibility criteria

To extract and select the final studies, eligibility criteria were defined to respond effectively to the research question (Table 1). This review included primary quantitative and qualitative studies published from 2018 onwards, focusing on nurses or clinicians involved in inserting and maintaining peripheral intravenous catheters in adult emergency departments. The aim was to explore impact factors, strategies, and interventions influencing adherence, nurses’ satisfaction, behaviour change, and perspectives on infection prevention and control. Studies were excluded if they involved nurses outside the emergency department (e.g., wards), addressed other types of infections or non-infectious complications, described interventions beyond nurses’ scope of practice, or review articles. No language restrictions were applied.

The search was limited to studies published from 2018 onward to capture the most current evidence and clinical practices related to PIVC management. This decision was made to ensure that the review reflects recent developments and aligns with contemporary standards of care, while also taking into account that a similar review had been carried out in 2016 (Fischer et al., 2016).

Table 1
Eligibility Criteria.

	Inclusion criteria	Exclusion criteria
Population	Nurses in adults ED or moments where ED nurses are involved (e.g., PIVC insertion). We decide to include the “clinician” term, because there are different realities between countries about this topic (e.g., in England the insertion of PIVC is a clinician’ responsibility but in Portugal this is a nurses’ intervention) and we want all the evidence available.	Nurses in other hospital contexts or out of hospital (e.g., medical ward).
Intervention/ Phenomenon of Interest	Impact factors and strategies/interventions for nurses, related to the insertion and maintenance of peripheral intravenous catheters.	Studies involving interventions pertaining to other infections and interventions that nurses are unable to perform or oversee independently or in a multidisciplinary way, were excluded.
Outcomes	Primary outcome: Adherence; Secondary outcomes: nurses’ satisfaction, and nurses’ factors that impact change behaviour; nurses’ perspective about this phenomenon and PIVC infection prevention and control (e.g., incidence of PIVC infection, incidence of phlebitis, as an inflammatory process)	Prevention and control of other types of infections or peripheral catheter-related non-infectious complications.
Context	Emergency department	All other in-hospital settings.
Language	There were no limitations on written language.	
Date	The most recent evidence available (since 2018).	Studies prior to 2018.
Study Type	Primary studies (quantitative and qualitative).	Review articles.

2.3. Selection and data collection process

Two reviewers independently analysed the results, following the PRISMA guidelines for reporting systematic reviews (Page et al., 2021) using Rayyan software® (Ouzzani et al., 2016). The process began by removing duplicate entries. Subsequently, the reviewers begin by evaluating the study type and removing those that do not comply with the inclusion criteria. After that, we examined the target population, the intervention/phenomenon of interest, and outcomes, beginning with reading the titles and abstracts of each study obtained. Articles that successfully fulfilled eligibility criteria underwent a comprehensive full-text review. The librarian played a crucial role in getting the full text of the articles that were not fully accessible. Two reviewers (JT and MRP) discussed disagreements with the third reviewer (CB) as necessary to reach consensus.

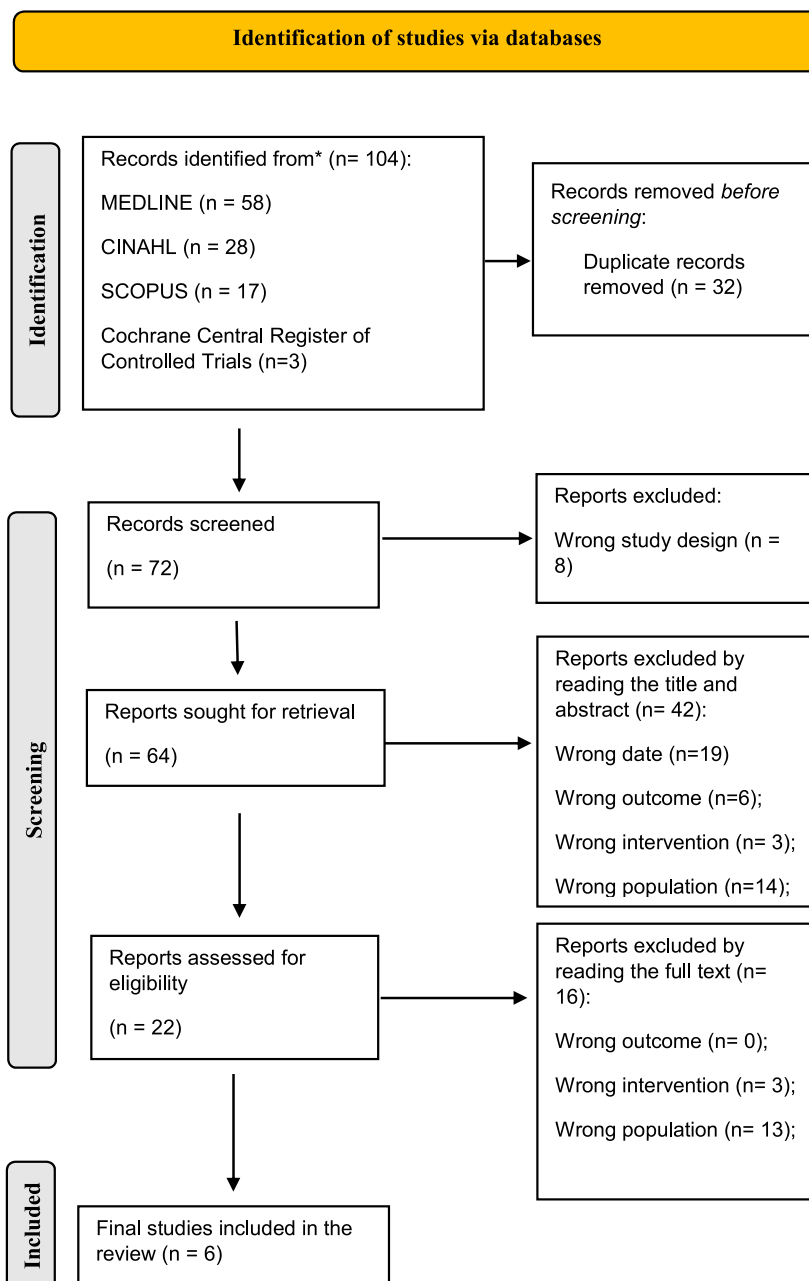


Fig. 1. PRISMA Flow Diagram (Page et al., 2021).

2.4. Quality appraisal and synthesis methods

To assess the level of agreement between the first two reviewers (JT and MRP), Cohen's Kappa (κ) was calculated (Landis and Koch, 1977). Based on the classification counts (nAA = 9, nAB = 2, nBA = 2, nBB = 101), the resulting κ value was 0.80, indicating substantial agreement between reviewers (Landis and Koch, 1977).

The data extraction process can be seen in the PRISMA Flow Diagram (Page et al., 2021). The final documents were analysed for quality, using the Joanna Briggs Institute's critical appraisal tools (Aromataris et al., 2024). Tables were created to summarise each article's qualitative and quantitative data, including the following information: author, year of publication and country, study methodology, participants, aim, intervention, outcomes, results/implications for practice, and quality assessment.

3. Results

3.1. Study selection

Six final articles were included based on the eligibility criteria (Fig. 1).

3.2. Study characteristics

The six final studies were developed in America (three) and in Australia (three). All were published after 2020, involving 832 participants (nurses and clinicians) and 11431 observational moments. The remaining data are presented in a tabular format (Tables 2 and 3).

3.3. Result of quality appraisal

The final articles have an average methodological quality of 87,50 % (Table 4), indicating a high methodological rigour level according to The Joanna Briggs Institute critical appraisal guidelines.

3.4. Results of individual studies

In line with the review's objective and primary outcome, the results address the determinants and strategies for improving adherence to existing guidelines and evidence-based practice.

Barriers or determinants to guideline adherence can be organised into broader thematic domains. At the *individual level*, disbelief in research evidence, lack of knowledge and experience, and inhibition due to habitual practice are frequently reported, with limited confidence during multiple attempts further constraining adherence in the high-pressure and high-risk emergency department environment (Xu et al., 2023). This was further supported by a recent qualitative study, which found that most clinicians were unaware of the national peripheral intravenous catheter clinical care standard and faced difficulties engaging with its complex content. Adherence was further hindered by a combination of factors, including the high-pressure environment of the emergency department, lack of training, insufficient feedback mechanisms, and poor standardisation across practice settings (Xu et al., 2024). Emotional and motivational determinants, such as fear of being judged or reluctance to challenge unsafe practices, also limited adherence. Key facilitators included recognition of suboptimal practice, a strong belief in the value of patient engagement, and clinicians' motivation to improve their care.

At the *organisational level*, inadequate training, lack of clarity of responsibility, and insufficient institutional commitment are consistently highlighted as determinants of non-adherence (Xu et al., 2023). Xu et al. (2024) also revealed system-level challenges, including the high turnover of junior staff, inconsistency in training and credentialing across health services, and limited access to necessary resources such as ultrasound devices or trained personnel. These factors undermine not only safe clinical practice but also long-term implementation of standards.

Finally, *clinical decision-making factors* such as catheter size selection, choice of puncture site, and documentation practices have also been identified as key influences on adherence to infection prevention and control guidelines (Mielke et al., 2023; Xu et al., 2023, 2025). Another common issue was the limited involvement of patients, which is an essential component of safe, evidence-based care, particularly in discussions of risks and benefits (2.9 %) and education on self-care (1.4 %), which were largely absent (Xu et al., 2025).

These findings highlight a persistent evidence-practice gap and underscore the urgent need for multifaceted, targeted strategies to address this gap. These should prioritise clinician training, simplified and accessible guidance, strong clinical leadership, and the integration of patient partnership and decision-support tools to improve adherence to standards and ultimately enhance patient outcomes (Xu et al., 2025).

Studies consistently demonstrate the effectiveness of intervention programs that combine cognitive and instrumental strategies to improve adherence to guideline-based clinical practices (Bell and Spencer, 2021; Campos et al., 2023; Mielke et al., 2023; Xu et al., 2023). Quantitative evidence further supports these findings. For instance, Bell and Spencer (2021) reported improved adherence scores following the implementation of specialised vascular access teams and an educational program (average 5.59 before vs. 6.16 after intervention). Campos et al. (2023) demonstrated that ultrasound-guided peripheral intravenous catheter training significantly reduced failure rates, which had previously ranged from 33 % to 69 %. Likewise, the "Operation STICK" program in the emergency department (Mielke et al., 2023) led to notable improvements, including a reduction in the overall number of peripheral intravenous

Table 2
Final Results.

title	Author Year, Location	Aim	Participants	Study Type	Strategies, Interventions	Outcomes	Key findings	Implications for future research
Implementing an emergency department vascular access team: A quality review of training, competency, and outcomes.	Bell & Spencer (2021) USA	Examine the process and outcomes of successful implementation of an emergency department vascular access specialist team (EVAST)	Five nurses, (3351 moments)	Analytical cross-sectional study	Implementation of specialty vascular access teams throughout all hospitals through a collaborative educational program.	Number of devices placed, failure rate; first-time success; breakdown of device placements per month; anatomic location and laterality; catheter size; compliance; success rates; placements outside of the ED and inside; device-related complications; clinician collaboration; work satisfaction; compliance.	A Plan-Do-Study-Act quality improvement cycle was employed to evaluate and guide the implementation process and to drive clinician education and competency. There is a clear need to implement a specialised vascular access team throughout all hospitals. Dedicated personnel trained dramatically improves patient outcomes and reduces device-related complications, highlighting improved efficiencies and greater clinician collaboration. All team members are alerted to newly trained clinicians and encouraged to provide mentorship, coaching, and feedback. In addition, individual reports enable EVAST team leaders and clinicians to monitor professional development and growth. This feedback is provided using reports from the collective data pool for each team member. The reports demonstrate good data management and collation to improve clinical practices.	Further investigation is required to understand the clinical and financial impact of dedicated vascular access teams on more extensive healthcare facilities.
Factors impacting emergency department clinicians' peripheral intravenous catheter practice: A qualitative analysis.	Xu et al. (2023) Australia	Explore attitudes and experiences of ED clinicians around PIVC insertion and care processes.	433 survey responses (271 nurses)	Qualitative study	Survey enabled an exploration of clinicians' knowledge, attitudes and adherence to the Australian PIVC Standard.	Routine PIVC insertion; patient participation; catheter size and site choice; managing difficult intravenous access; insertion site preparation; documentation; adherence.	Barriers to adherence are identified: perceptions of a lack of feasibility of the standard in an ED setting, disbelief in research evidence, experiences of ambiguous responsibilities, inhibition by habitual practices,	Future development of clinical standards needs to consider and adopt new strategies to promote the engagement of key partners. It will increase the likelihood of creating evidence and recommendations (continued on next page)

Table 2 (continued)

title	Author Year, Location	Aim	Participants	Study Type	Strategies, Interventions	Outcomes	Key findings	Implications for future research
							insufficient training, lack of recognition of good PIVC care and poor engagement. Lack of knowledge and experience of the standard is a critical factor that impacts adherence, as highlighted in other studies; education organizational priorities may also influence clinicians' attitudes and perceptions that the quality indicators in the standard are neither feasible nor highly relevant in the ED environment; clinicians reported lack of sufficient time, space and resources, disbelief in research evidence, practices based on 'habit', multiple attempts without confidence, high-pressure, and high-risk nature of the ED environment. Sustainable behaviour changes demands awareness, time, and acceptance from ED clinicians and a sustainable plan to address individual knowledge, attitudes, and practice issues. To achieve effective adoption and persistent adherence to PIVC guideline recommendations, individual-based implementation strategies may need to be developed and enacted by healthcare services to ensure the quality of PIVC care. Clinicians must learn to adjust their practice to	that are more widely accepted by clinicians and lead to successful knowledge translation. Researchers should understand what needs to change for the behaviour in the ED context and have completed a behavioural diagnosis before developing the change strategies and interventions. This could be completed using an implementation science framework.

(continued on next page)

Table 2 (continued)

title	Author Year, Location	Aim	Participants	Study Type	Strategies, Interventions	Outcomes	Key findings	Implications for future research
Foundation for implementing a comprehensive vascular access excellence initiative organization-wide to improve vascular access device insertion and standardize care: best practice for an acute care hospital.	Campos et al. (2023) USA	Evaluate the effectiveness of a training program for identifying DIVA patients and PIVC ultrasound-guided (USG) insertion. The study also considers some factors that impact adherence to this program and patient outcomes.	92 nurses	Analytical cross-sectional study	Ultrasound-guided peripheral intravenous catheter insertion training program	Number of attempts; type of device placed; the use of ultrasound; dwell time of PIVC; complications; ultrasound-guided peripheral intravenous catheter insertions by shift; difficult intravenous access patients; rates of bloodstream infections; length of stay in the hospital; number of calls for advanced-skilled nurse assistance for difficult intravenous access patients; average number of days under IV therapy; nurse confidence assessments pre- and post-course.	adhere to the best research evidence instead of routinely using time Criticality as an excuse for non-adherence behaviour. To ensure changes occur, interventions focused on addressing clinicians' readiness to change, promoting the recognition of the need to make changes and introducing intentional pause and rethink processes to assist the transition from the old practice to the new practice could become more widely adopted. The journey created engagement and empowerment of the nurses to design processes to improve patient care and outcomes. The nursing staff, with support from infection prevention and clinical leaders, conducted product trials and reviewed good practices in this area. Further education was provided to reinforce the importance of vein assessment and early identification of DIVA patients for appropriate escalation to an advanced skilled nurse.	The initiatives were implemented at a single public-district acute care hospital, limiting generalizability. Patient satisfaction was not formally measured and would be beneficial to evaluate as part of the ongoing vascular access excellence initiative. This study was done during the COVID-19 pandemic. Thus, the results of the program were not consistently tracked over time. Longitudinal data collection would be necessary to definitively capture the actual outcomes of the initiatives implemented, using more key performance indicators.
Bridging the Gap in Traditional PIVC Placement: An Evaluation of	Mielke et al. (2023) USA	Evaluate a vascular access training program (Operation STICK) in the ED.	6512 PIVCs ED (4884 in control group, while 1628 were in the	Quasi-experimental study	The <i>Operation STICK</i> (OSTICK) program is a comprehensive training initiative in the	Primary outcomes: functionality of the PIVC; dwell time to hospital length of stay;	The study evaluated the impact of the OSTICK training program on PIVC placement in the ED,	The quasi-experimental study has several limitations, including the lack of randomization (continued on next page)

Table 2 (continued)

title	Author Year, Location	Aim	Participants	Study Type	Strategies, Interventions	Outcomes	Key findings	Implications for future research
Operation STICK Vascular Access Outcomes			intervention group)		emergency department designed to improve peripheral intravenous placement skills. It includes three key components: self-paced online modules with interactive videos and quizzes, hands-on simulation training with advanced visualization technologies, and supervised one-on-one practice on real patients. The program emphasizes patient- centred care and includes a vein assessment scoring system to guide clinicians in choosing between traditional and ultrasound-guided techniques, ensuring they are well-prepared to tailor their approach to each patient's needs.	the secondary outcome was adherence to best practices in the site; device selection; the number of attempts; vascular access score only for the intervention group.	analyzing 6512 cases (25 % performed by OSTICK- trained clinicians). OSTICK-trained staff achieved significantly higher first-stick success (91.3 %) and fewer attempts, with more forearm placements and longer catheter dwell times. Linear regression showed a significant association between OSTICK training and increased dwell time, also influenced by patient age and gender. The program promotes thorough vascular assessment over the standard two-attempt rule, reducing complications and costs. Despite most staff receiving ≤ 5 h of training, OSTICK offers standardized, effective education that improves vascular access outcomes.	(partially addressed through propensity score matching), incomplete data (especially missing removal assessments for over half the patients) and the absence of individual inserter data, which may have influenced results despite broad staff participation. A novel metric (catheter dwell time relative to hospital stay) was used to compensate for data gaps. Additionally, limited pre-OSTICK data restricted direct comparisons. Future research should aim to validate the OSTICK model in other clinical settings.
Peripheral intravenous catheter clinical care standard adherence in emergency departments: A qualitative study underpinned by the behaviour change wheel	Xu et al. (2024) Australia	To explore the barriers and facilitators influencing emergency department clinicians' adherence to the Australian PIVC Clinical Care Standard, using the Behaviour Change Wheel (BCW).	25 doctors and nurses from two metropolitan EDs	Qualitative descriptive study	Semi-structured interviews guided by the BCW framework (COM-B and TDF); deductive and inductive analysis; identification of behaviour-informed interventions	Identified 9 subthemes mapped to barriers and facilitators; multiple implementation opportunities proposed	Barriers: busy ED environment, lack of training, insufficient feedback mechanisms, poor standardization. Facilitators: recognition of suboptimal practice, belief in patient engagement, motivation to improve.	Future studies should explore rural and remote EDs; use co-design approaches with clinicians and patients; apply implementation science frameworks to develop tailored interventions.
Peripheral Intravenous Catheter Care at Australian Emergency Departments: A Cross-Sectional Observational Study	Xu et al. (2025) Australia	To investigate emergency department clinicians' adherence to the Australian PIVC Clinical Care Standard via prospective audit.	277 clinicians (nurses and doctors) across 3 emergency departments; 1568 episodes of care (insertion, maintenance, and removal).	Cross-sectional observational study	Bedside observations and electronic chart audits aligned with 9/ 10 PIVC Clinical Care Standard indicators.	Low adherence in key areas: patient engagement (1.4 % received education), poor documentation, frequent use of antecubital fossa, high rate of idle catheters (41.8 %).	Suboptimal PIVC care remains prevalent despite the existence of clinical guidelines. Common issues include idle insertions, limited patient involvement, inadequate hand hygiene after procedures, and failure to	Highlights the need for implementation strategies, training, and consideration of vascular access specialist roles; future studies should include rural EDs and examine patient

(continued on next page)

Table 2 (continued)

title	Author Year, Location	Aim	Participants	Study Type	Strategies, Interventions	Outcomes	Key findings	Implications for future research
							allow antiseptics to dry before insertion. These findings underscore the need to implement targeted strategies, particularly focused on clinician training and actively informing and partnering with patients throughout the PIVC care process.	engagement in decision-making.

Table 3
Quantitative data.

Autor/Year	Sample	Intervention/Phenomenom of Interest	Outcomes	Pre-intervention/G control	After-intervention/G intervention	IC
(Bell and Spencer, 2021)	$n = 3351$	Implementation of speciality vascular access teams and an educational program.	Adherence	Average 5.59	Average 6,16	
(Campos et al., 2023)	92 nurses completed the USGPiVC insertion training	Ultrasound-guided peripheral intravenous catheter insertion training: a program training for nurses	Complications	33 %–69 % failure rates	Lowered significantly	
(Mielke et al., 2023)	6512 PIVCs in ED (4884 in the control group; 1628 in the intervention group)	The "Operation STICK" (OSTICK) program in the Emergency Department is a comprehensive training curriculum for Peripheral Intravenous Catheter (PIVC) placement.	Total PIVCs; PIVCs placed by ED technicians 20-gauge PIVCs in admitted patients	4884 57,70 % 80,30 %	1628 68,10 % 87,60 %	95 %
(Xu et al., 2025)	277 clinicians (nurses and doctors);1568 episodes of care		Adherence in key areas: patient engagement documentation, use of antecubital fossa, rate of idle catheters, self-education. patient engagement	10,1 %	Not available	Not available
			documentation	(e.g., 9,3 % for PIVC removal; 29,8 % for PIVC-related Complications)	Not available	Not available
			use of antecubital fossa	82,1 %	Not available	Not available
			rate of idle catheters	41,4 %	Not available	Not available

Table 4
Quality Assessment.

	1	2	3	4	5	6	7	8	
Analytical cross-sectional studies									
(Campos et al., 2023)	Y	Y	Y	Y	Y	N	Y	Y	87,50 %
(Bell and Spencer, 2021)	Y	Y	Y	Y	N	N	Y	N	62,50 %
(Xu et al., 2025)	Y	Y	Y	Y	N	N	Y	Y	62,50 %
Quasi-experimental studies	1	2	3	4	5	6	7	8	9
(Mielke et al., 2023)	Y	Y	Y	Y	Y	Y	Y	Y	Y
Qualitative study	1	2	3	4	5	6	7	8	9
(Xu et al., 2023)	Y	Y	Y	Y	Y	Y	Y	Y	Y
(Xu et al., 2024)	N	Y	Y	Y	Y	Y	Y	Y	Y
Methodological quality average									
									83,75 %

catheters placed (4884 vs. 1628), an increase in technician-performed insertions (57.7 % vs. 68.1 %), and higher rates of appropriate 20-gauge PIVC use in admitted patients (80.3 % vs. 87.6 %).

Beyond quantitative outcomes, qualitative findings highlight additional facilitators of adherence. The involvement of specialised vascular access teams has been shown to support consistent evidence-based practice and enhance patient outcomes (Bell and Spencer, 2021; Campos et al., 2023). Moreover, engaging key stakeholders in the development of clinical standards increases nurses' acceptance of evidence and recommendations, promoting successful knowledge translation (Xu et al., 2023). Importantly, effective implementation requires an understanding of behavioural determinants in the emergency department context and the use of structured change strategies guided by implementation science frameworks (Xu et al., 2023).

Several strategies stand out as particularly impactful. Ongoing education and training, including advanced techniques such as ultrasound-guided insertions, equip nurses with the skills needed to improve practice (Bell and Spencer, 2021; Campos et al., 2023; Mielke et al., 2023; Xu et al., 2023). Quality improvement methodologies, such as the Plan-Do-Study-Act (PDSA) cycle, have also proven effective in guiding the structured introduction of vascular access teams (Bell and Spencer, 2021).

Although the limited number and heterogeneity of studies preclude a formal statistical synthesis, the consistent improvements from pre- to post-intervention across these programs indicate a clear positive trend. Taken together, these findings underscore the importance of an integrated qualitative and quantitative perspective in identifying determinants of adherence and reinforcing the role of multifaceted strategies in enhancing emergency nurses' adherence to infection prevention and control guidelines for peripheral intravenous catheters.

4. Discussion

The present study identified multiple determinants of adherence to guidelines for vascular access procedures in emergency departments, including barriers such as disbelief in evidence, unclear responsibilities, habitual practice, inadequate training, the high-pressure environment of the emergency department and lack of organisational commitment (Xu et al., 2023, 2024).

Furthermore, the theoretical framework of Bandura's social cognitive theory (Bandura, 1986, 2001) is pertinent to understanding these determinants, which are considered challenges. This theory explains behaviour through reciprocal determinism between the person, their behaviour, and the environment, highlighting the importance of self-efficacy. This reciprocity allows the person to be an agent of their own learning, influencing and being influenced by their environment.

Aligning with this, a person's belief in their own ability to learn or perform a behaviour (self-efficacy) is crucial (Bandura, 1998). One way of reinforcing the perception of self-efficacy is through vicarious learning provided by social models (Bandura, 1998). The educational strategies mentioned in our findings are close to the vicarious learning presented by Bandura since they include training skills, facilitating the learning process by modelling and are opportunities to strengthen professionals' confidence in their ability to exhibit the desired behaviour, which means adherence to the recommendations on the insertion and maintenance of the peripheral intravenous catheter.

For example, the study by Mielke et al. (2023) included several interactive educational strategies, one of which was simulation, where the trainee received individualised guidance and supervision from a more experienced professional.

In the study by Campos et al. (2023), after an initial theoretical phase, the trainees carried out the insertion of peripheral intravenous catheters under the supervision of a clinical tutor.

Following Bandura's perspective (Bandura, 1986), simulation enables vicarious learning through the observation of a model that displays behaviour that the trainee can imitate, repeat and integrate into a controlled environment.

In both simulated training and supervised clinical practice, the trainee has the opportunity to receive feedback on the particularities of the replicated behaviour, to correct and improve their performance. These strategies also promote self-efficacy and self-confidence, essential elements for maintaining adherence to the guidelines.

Environmental and systemic factors also contribute to variance in adherence. Ara et al. (2019) reinforce that available resources could impact nurses' adherence to peripheral intravenous catheter guidelines. The evidence also suggests the need for educational programs, focused on promoting the engagement and empowerment of staff teams and adapting practices to the complex and dynamic environment of the emergency department (Bell and Spencer, 2021; Campos et al., 2023; Mielke et al., 2023; Xu et al., 2023). This perspective is corroborated by other authors (Ara et al., 2019; Hontoria-Alcoceba et al., 2023), which reinforces the use of peripheral intravenous catheter care bundles and decision-making algorithms to improve adherence.

An appropriate implementation science framework should underpin interventions to optimise initial and sustainable practice improvement (Fakih et al., 2013; Thomas, Cabilan and Johnston, 2020). Aligned with this, a holistic approach, compiling decision-making (Ray-Barruel and Rickard, 2018; Ray-Barruel et al., 2020; Silva et al., 2024), education, organisational policies, and promotional strategies has demonstrated moderate success in culture change and sustainability, a challenge in healthcare practice, around the world.

Despite the results obtained focusing only on developed countries, there are some similarities between high-, middle-, and low-income countries (Santos-Costa et al., 2022; Pestana-Santos et al., 2025; Xu et al., 2025).

For instance, one study developed in sub-Saharan Africa highlights significant pedagogical and curricular challenges, related to education and the disconnection between theoretical knowledge and practical application, which hinders effective training, the lack of standardised infection prevention and control protocols, and the need for greater collaboration between educators and clinical instructors (Pestana-Santos et al., 2025). On the other hand, some studies highlight the underuse of reflective practice curricula (García-Mayor et al., 2021) and the existing inequities revealed through audits (Blanco-Mavillard et al., 2022; Santos-Costa et al., 2022; Hu et al., 2025; Xu et al., 2025).

The main difference lies in the availability of resources, which is lower in low-income countries (Ray-Barruel and Rickard, 2018; Pestana-Santos et al., 2025).

For high-, middle-, and low-income countries, the economic impact of non-adherence to peripheral intravenous catheter guidelines is considerable (Zingg et al., 2023). The authors emphasise that bloodstream infections related to peripheral intravenous catheters are costly adverse events with an incidence of approximately 0.5–0.7 per 1000 catheter-days. These infections are associated with high morbidity and a 30-day mortality rate of 11–13.2 %, rising to 27–35.8 % in cases caused by *Staphylococcus aureus*. Beyond mortality, such complications can lead to severe sequelae, including endocarditis, and necessitate prolonged hospital stays, intensive antimicrobial therapy, and complex follow-up care, all of which significantly increase healthcare expenditure. In addition, the widespread practice of inserting peripheral intravenous catheters without a clinical indication further exacerbates costs by generating unnecessary use of materials and staff time, while simultaneously exposing patients to avoidable risks. However, the removal is also important, as the duration of peripheral intravenous catheters increases the risk of catheter colonisation (Teixeira et al., 2025). Together, these findings underscore that strict adherence to evidence-based guidelines has substantial cost-saving potential.

Holistic strategies that integrate organisational policies, decision-making tools, and team empowerment show promise for sustainable change. Care bundles, decision-making algorithms, and audit feedback mechanisms are examples of such integrated approaches (Ara et al., 2019; Ray-Barruel et al., 2020; Hontoria-Alcoceba et al., 2023; Silva et al., 2024). However, their implementation requires a systemic perspective, supported by implementation science frameworks, to guide change processes effectively and sustainably (Fakih et al., 2013; Thomas, Cabilan and Johnston, 2020).

The Plan-Do-Study-Act (PDSA) cycle, widely recognised in quality improvement processes, as seen in the study of Bell and Spencer (2021), was used to evaluate and guide the implementation process and to enhance the education and competence of professionals. Its cyclical and iterative nature aligns closely with action research methodologies, where planning, implementation, evaluation and reflection are key elements (Gary Kuhne and Quigley, 1997).

In action research, the *planning phase* involves defining the problem, specifying the intervention, and determining measures (steps one to three in Kuhne & Quigley's framework). This parallels the “Plan” stage of the Plan-Do-Study-Act cycle, where strategies are designed to address barriers, such as uncertainty in decision-making or a lack of confidence. The *action phase* of action research (step

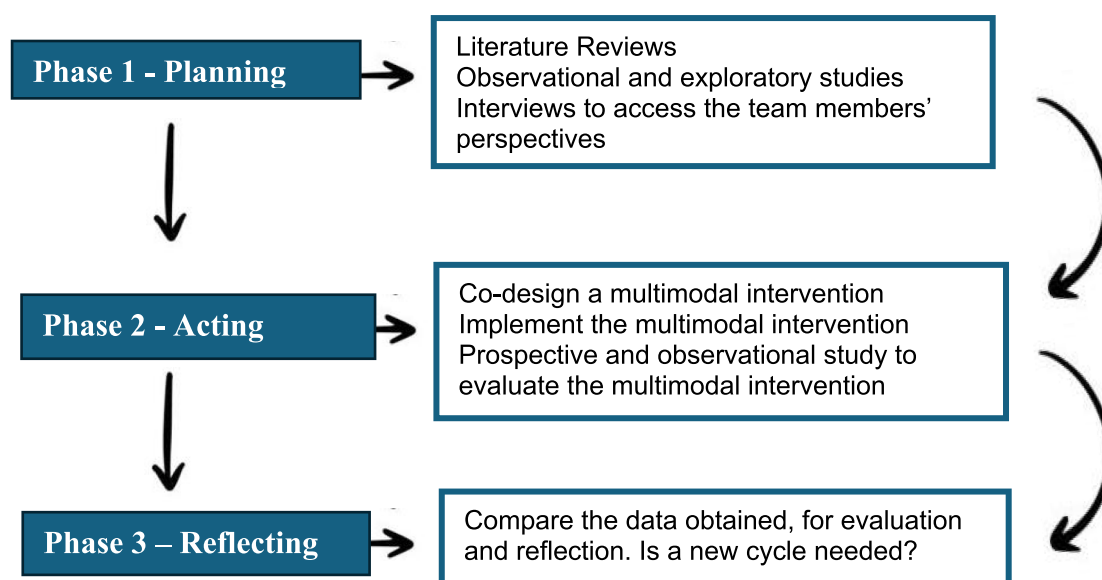


Fig. 2. Implementation plan for a multimodal intervention to improve care for people with PIVC.

four) corresponds to the “Do” stage of Plan-Do-Study-Act, where the intervention is implemented and closely observed, for example, through pilot testing decision aids or supervised insertion practices. The *reflection phase* includes evaluation and reflection (steps five and six), which align with the “Study” and “Act” phases of the Plan-Do-Study-Act cycle, involving a systematic analysis of outcomes, assessment against predefined criteria, and iterative refinement of practice.

Operationalising these methodologies in the emergency department will allow interventions to be directly linked to key determinants in that context.

As an example, we proposed the following longitudinal implementation and evaluation plan (Fig. 2), which applies an action research methodology (Gary Kuhne and Quigley, 1997) to enhance care for patients requiring a peripheral intravenous catheter.

The process would begin with the planning phase, aimed at understanding individual, organisational, and clinical decision-making determinants that influence adherence to evidence-based guidelines. The action phase would follow this, centred on the co-creation of a multimodal intervention (potentially involving on-the-job training, clinical simulation, and peer learning), developed in close collaboration with the emergency department team. Finally, the reflection phase would involve re-evaluation of adherence indicators (e.g., site selection, idle PIVCs, hand hygiene) through the observation of clinical practices, complemented by nurses’ feedback and iterative adjustments, to support the sustained implementation of best practices.

5. Limitations

The lack of articles on the emergency department justifies the few results obtained in this review, reinforcing the importance of future research in this area.

Another limitation is that the studies included come from only two countries, which may restrict the generalisation of the results, given that professional practices and care contexts can vary significantly between different geographical and cultural realities. However, this limitation did not result from predefined selection criteria, but rather from the set of studies obtained that met the established eligibility criteria.

We also recognise that, although the research question focuses explicitly on nursing practices, this care may also be performed by other clinicians, depending on the professional regulations of each country. Consequently, studies involving both nurses and clinicians were included. The results were interpreted from the perspective of nursing practice, in accordance with the regulatory frameworks applicable in the authors’ country. Nonetheless, it is recommended that each reader interpret these findings within the context of their own professional regulations. However, multidisciplinary collaboration is necessary to achieve effective and sustainable improvements in this area of care, as guidelines for inserting and maintaining peripheral intravenous catheters are the same, regardless of who provides the care.

Another limitation is the lack of quantitative data and their heterogeneity, which may interfere with the analyses due to the limited number of results obtained.

6. Conclusions

This review identified multiple determinants and strategies that influence emergency nurses’ adherence to infection prevention and control guidelines for the insertion and maintenance of peripheral intravenous catheters. At the individual level, barriers include limited knowledge, lack of confidence, habitual practice, and emotional factors such as fear of judgment or reluctance to challenge unsafe practices. Organisational determinants such as inadequate training, unclear responsibilities, insufficient institutional support, and limited access to resources further hinder adherence. Additionally, gaps in clinical decision-making, such as inappropriate catheter selection, inadequate documentation, and low patient engagement, contribute to suboptimal practice. Despite these challenges, several strategies have been shown to improve adherence, including structured education and training, the implementation of specialised vascular access teams, the use of behaviour-informed frameworks, and quality improvement methodologies such as the PDSA cycle. Programs like Operation STICK demonstrate the value of integrated, multifaceted interventions that address both cognitive and practical skill gaps. Ultimately, improving adherence requires not only equipping nurses with technical skills but also fostering supportive environments, clinical leadership, and patient-centred care models. These findings underscore the importance of targeted, system-level efforts to close the evidence-practice gap in emergency departments and enhance the quality and safety of vascular access care.

Programs should emphasise the team’s empowerment and engagement with organisational objectives that promote infection control and patient safety. More studies should be conducted in this context, particularly in relation to decision-making, to promote nurses’ motivation and perceptions of self-efficacy. This could be done through an action research methodology, which presupposes the team’s involvement in all its phases.

Funding

This work is funded by National Funds through the FCT - Foundation for Science and Technology, I.P., within the scope of the projects UIDB/00742/2020 and UIDP/00742/2020.

CRediT authorship contribution statement

Joana Teixeira: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project

administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Celeste Bastos:** Writing – review & editing, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Maria do Rosário Pinto:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Methodology, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

The authors would like to thank the Documentation Centres for their library support in locating articles.

References

- Alexandrou, E., et al., 2018. Use of short peripheral intravenous catheters: characteristics, management, and outcomes worldwide. *J. Hosp. Med.* 13 (5). <https://doi.org/10.12788/jhm.3039>. Available at.
- Ara, L., et al., 2019. Transferring knowledge into practice: a multi-modal, multi-centre intervention for enhancing nurses' infection control competency in Bangladesh. *J. Hospital Infect.* 102 (2), 234–240. <https://doi.org/10.1016/j.jhin.2018.07.042>. Available at.
- Edited by Aromataris, E., et al., 2024. In: Aromataris, Edoardo, et al. (Eds.), *JBIM Manual for Evidence Synthesis*. JBI. <https://doi.org/10.46658/JBIMES-24-01>. Edited by Available at.
- Bandura, A., 1986. *Social Foundations of Thought and action: A social Cognitive Theory*. Prentice Hall, Englewood cliffs, NJ.
- Bandura, A., 1998. Health promotion from the perspective of social cognitive theory. *Psychol. Health* 13 (4), 623–649. <https://doi.org/10.1080/08870449808407422>. Available at.
- Bandura, A., 2001. *Social Cognitive Theory: an agentic perspective*. *Annu. Rev. Psychol.* 52, 1–26.
- Bell, J., Spencer, T., 2021. Implementing an emergency department vascular access team: a quality review of training, competency, and outcomes. *J. Vasc. Access.* 22 (1), 81–89. <https://doi.org/10.1177/1129729820924554>. Available at.
- Blanco-Mavillard, I., et al., 2022. What fuels suboptimal care of peripheral intravenous catheter-related infections in hospitals? A qualitative study of decision-making among Spanish nurses. *Antimicrob. Resist. Infect. Control* 11 (1), 105. <https://doi.org/10.1186/s13756-022-01144-5>. Available at.
- Booth, A., et al., 2019. Formulating questions to explore complex interventions within qualitative evidence synthesis. *BMJ Glob. Health* 4 (Suppl 1), e001107. <https://doi.org/10.1136/bmjgh-2018-001107>. Available at.
- Campos, C., et al., 2023. Foundation for implementing a comprehensive vascular access excellence initiative organization-wide to improve vascular access device insertion and standardize care: best practice for an acute care hospital. *British J. Nurs.* 32 (19), S26–S37. <https://doi.org/10.12968/bjon.2023.32.19.S26>. Available at.
- Capdevila, J.A., et al., 2016. 2016 Expert consensus document on prevention, diagnosis and treatment of short-term peripheral venous catheter-related infections in adults. *Cirugía Cardiovasc.* 23 (4), 192–198. <https://doi.org/10.1016/j.circv.2016.06.001>. Available at.
- Centers for Disease Control and Prevention, 2024. Intravascular catheter-related infection (BSI) Prevention Guidelines | summary of recommendations | infection control. Available at <https://www.cdc.gov/infection-control/hcp/intravascular-catheter-related-infection/index.html>.
- Decker, K., et al., 2016. Peripheral intravenous catheter insertion in the Emergency Department. *Australas. Emerg. Nurs. J.* 19 (3), 138–142. <https://doi.org/10.1016/j.aenj.2015.12.003>. Available at.
- Fakih, M.G., et al., 2013. Peripheral venous catheter care in the emergency department: education and feedback lead to marked improvements. *Am. J. Infect. Control* 41 (6), 531–536. <https://doi.org/10.1016/j.ajic.2012.07.010>. Available at.
- Fischer, F., et al., 2016. Barriers and strategies in guideline implementation—A scoping review. *Healthcare* 4 (3), 36. <https://doi.org/10.3390/healthcare4030036>. Available at.
- García-Mayor, S., et al., 2021. Nursing students' perceptions on the use of clinical simulation in psychiatric and mental health nursing by means of objective structured clinical examination (OSCE). *Nurse Educ. Today* 100, 104866. <https://doi.org/10.1016/j.nedt.2021.104866>. Available at.
- Gary, Kuhne, Quigley, A., 1997. *Understanding and using Actio research in practice settings*. NEW DIRECTIONS FOR ADULT AND CONTINUING EDUCATION. Jossey-Bass Publishers.
- Gunasegaran, N., et al., 2018. A randomized controlled study to evaluate the effectiveness of 2 treatment methods in reducing incidence of short peripheral catheter-related phlebitis. *J. Infusion Nurs.* 41 (2), 131–137. <https://doi.org/10.1097/NAN.0000000000000271>. Available at.
- Hontoria-Alcoceba, R., et al., 2023. Implementation of evidence-based practice in peripheral intravenous catheter care. *J. Nurs. Care Qual.* 38 (3), 226–233. <https://doi.org/10.1097/NCQ.0000000000000688>. Available at.
- Hu, A., et al., 2025. Impact of a WeChat-based intervention on nurses knowledge and practice in peripheral venous catheter insertion. *Sci. Rep.* 15 (1), 18242. <https://doi.org/10.1038/s41598-025-03430-9>. Available at.
- International Council of Nurses, 2019. CIPE- Classificação Internacional para a Prática de Enfermagem. Available at <https://www.icn.ch/icnp-browser>.
- Kiling, G., Yildiz, E., Harmanci, P., 2018. Bandura's social learning and role model theory in nursing education. In: Alexandrova, E., Shapekova, N. (Eds.), *Health Sciences Research in a Globalizing World*. St. Kliment Ohridski University Press, pp. 132–140. Available at <https://www.researchgate.net/publication/329885408>.
- Landis, J.R., Koch, G.G., 1977. The measurement of Observer agreement for categorical data. *Biometrics* 33 (1), 159. <https://doi.org/10.2307/2529310>. Available at.
- Lecours, A., Theriault, P.-Y., 2016. French transcultural validation of the Compliance with Safety Behavior Scale. *Work* 55 (4), 805–815. <https://doi.org/10.3233/WOR-162445>. Available at.
- Liang, S.Y., et al., 2014. Infection prevention in the Emergency department. *Ann. Emerg. Med.* 64 (3), 299–313. <https://doi.org/10.1016/j.annemergmed.2014.02.024>. Available at.
- Lim, Z.J., et al., 2020. Evaluating the sustained effectiveness of a multimodal intervention aimed at influencing PIVC insertion practices in the emergency department. *Emerg. Med. J.* 37 (7), 444–449. <https://doi.org/10.1136/emered-2019-208852>. Available at.
- Mielke, N., et al., 2023. Bridging the gap in traditional PIVC placement: an evaluation of Operation STICK Vascular access outcomes. *Ther. Clin. Risk. Manage* 19, 937–948. <https://doi.org/10.2147/TCRM.S435628>. Available at.
- Nickel, B., et al., 2024. *Infusion Therapy Standards of Practice*, 9th edition. *J. Infusion Nurs.* 47 (1S), S1–S285. <https://doi.org/10.1097/NAN.0000000000000532>. Available at.
- Ouzzani, M. et al. (2016) 'Rayyan—A web and mobile app for systematic reviews', *Systematic Reviews*, 5(1), p. 210. Available at: <https://doi.org/10.1186/s13643-016-0384-4>.
- Page, M., et al., 2021. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* n71. <https://doi.org/10.1136/bmj.n71>. Available at.
- Pestana-Santos, M., et al., 2025. Exploring nurse educators' experiences and perceptions of healthcare-associated infection prevention and control in two countries of sub-Saharan Africa: an exploratory qualitative study. *Nurse Educ. Today*, 106856. <https://doi.org/10.1016/j.nedt.2025.106856>. Available at.

- Ray-Barruel, G., et al., 2020. The I-DECIDED clinical decision-making tool for peripheral intravenous catheter assessment and safe removal: a clinimetric evaluation. *BMJ Open*. 10 (1), e035239. <https://doi.org/10.1136/bmjopen-2019-035239>. Available at.
- Ray-Barruel, G., Rickard, C.M., 2018. Helping nurses help PIVCs: decision aids for daily assessment and maintenance. *British J. Nurs.* 27 (8), S12–S18. <https://doi.org/10.12968/bjon.2018.27.8.S12>. Available at.
- Santos-Costa, P., et al., 2022. Nurses' Practices in the peripheral intravenous catheterization of adult oncology patients: a mix-method study. *J. Pers. Med.* 12 (2), 151. <https://doi.org/10.3390/jpm12020151>. Available at.
- Silva, T.L., et al., 2024. I-decided®-Brazil: cross-cultural adaptation of an assessment and decision-making tool for peripheral intravenous catheter. *Texto Contexto - Enfermagem* 33. <https://doi.org/10.1590/1980-265x-tce-2023-0279en>. Available at.
- Simonetti, V., et al., 2019. Assessing nursing students' knowledge of evidence-based guidelines on the management of peripheral venous catheters: a multicentre cross-sectional study. *Nurse Educ. Today* 73, 77–82. <https://doi.org/10.1016/j.nedt.2018.11.023>. Available at.
- Teixeira, J., et al., 2025. Current approaches on nurse-performed interventions to prevent healthcare-acquired infections: an umbrella review. *Microorganisms*. 13 (2), 463. <https://doi.org/10.3390/microorganisms13020463>. Available at.
- Thomas, C., Cabilan, C.J., Johnston, A.N.B., 2020. Peripheral intravenous cannula insertion and use in a tertiary hospital emergency department: a cross-sectional study. *Australas. Emerg. Care* 23 (3), 166–172. <https://doi.org/10.1016/j.auec.2020.02.001>. Available at.
- World Health Organization, 2024. Guidelines for the prevention of bloodstream iGuidelines for the prevention of bloodstream infections and other infections associated with the use of intravascular catheters. Part I: peripheral catheters. Available at <https://iris.who.int/bitstream/handle/10665/376722/9789240093829-eng.pdf?sequence=1&isAllowed=y>.
- Xu, H., et al., 2023. Factors impacting emergency department clinicians' peripheral intravenous catheter practice: a qualitative analysis. *Int. Emerg. Nurs.* 71, 101366. <https://doi.org/10.1016/j.ienj.2023.101366>. Available at.
- Xu, H., et al., 2024. Peripheral intravenous catheter clinical care standard adherence in emergency departments: a qualitative study underpinned by the behaviour change wheel. *Empir. Res. Qualitat.* 1–15. <https://doi.org/10.1111/jan.16409>. Available at.
- Xu, H.(Grace), et al., 2025. Peripheral intravenous catheter care at Australian Emergency departments: a cross-sectional observational study. *J. Adv. Nurs.* [Preprint]. <https://doi.org/10.1111/jan.16810>. Available at.
- Zingg, W., et al., 2023. Best practice in the use of peripheral venous catheters: a scoping review and expert consensus. *Infect. Prev. Pract.* 5 (2), 100271. <https://doi.org/10.1016/j.infpip.2023.100271>. Available at.