

Algorithms, Tools, Technology and Artificial Intelligence for Peripheral Intravenous Catheter Vein Selection for Prolonged Dwell

Michael D. Liddelow^{1,2*}, Du Huynh¹, Nikhilesh Bappoo^{2,3,4}, Peter J. Carr^{2,5,6,7}, Mark Reynolds¹

1.School of Physics, Mathematics & Computing, The University of Western Australia

2.VeinTech Pty Ltd, Western Australia

3.UWA Medical School, The University of Western Australia, Perth, Australia

4.UWA Centre for Medical Research (affiliated with the Harry Perkins Institute of Medical Research), Perth, Australia

5.School of Nursing and Midwifery, University of Galway, Ireland

6.Alliance for Vascular Access Teaching and Research Group, School of Nursing and Midwifery, Griffith University, Nathan, Australia

7.School of Allied Health, The University of Western Australia, Perth, Australia

* michael.liddelow@research.uwa.edu.au



Background

Peripheral intravenous catheter (PIVC) insertion is among the most common invasive procedures in healthcare.^[1] Despite its ubiquity, 35–40% of adults require multiple insertion attempts,^[2] and nearly half of all PIVCs fail before completing their intended dwell time.^[3,4] Patients with difficult intravenous access (DIVA), (related to obesity, dark skin tones, chronic illness, or advanced age) represent up to 50% of hospitalised patients.^[5–8] With rising obesity rates,^[9] and an ageing population, this burden is expected to grow.

Objectives

To map clinical adoption of Algorithms, Tools, Technology & Artificial Intelligence (ATTAs) for PIVC vein selection supporting prolonged dwell.

- 1.What ATTAs exist to support PIVC vein selection for prolonged dwell?
- 2.How are competency and sustainability of ATTAs defined, measured, and assessed?
- 3.What evidence exists regarding clinical adoption of these aids in practice?

Methods

Conducted per JBI scoping review guidelines^[10] with PRISMA-ScR. Reporting via the PAGER framework.^[12] Screening through Covidence.^[11]

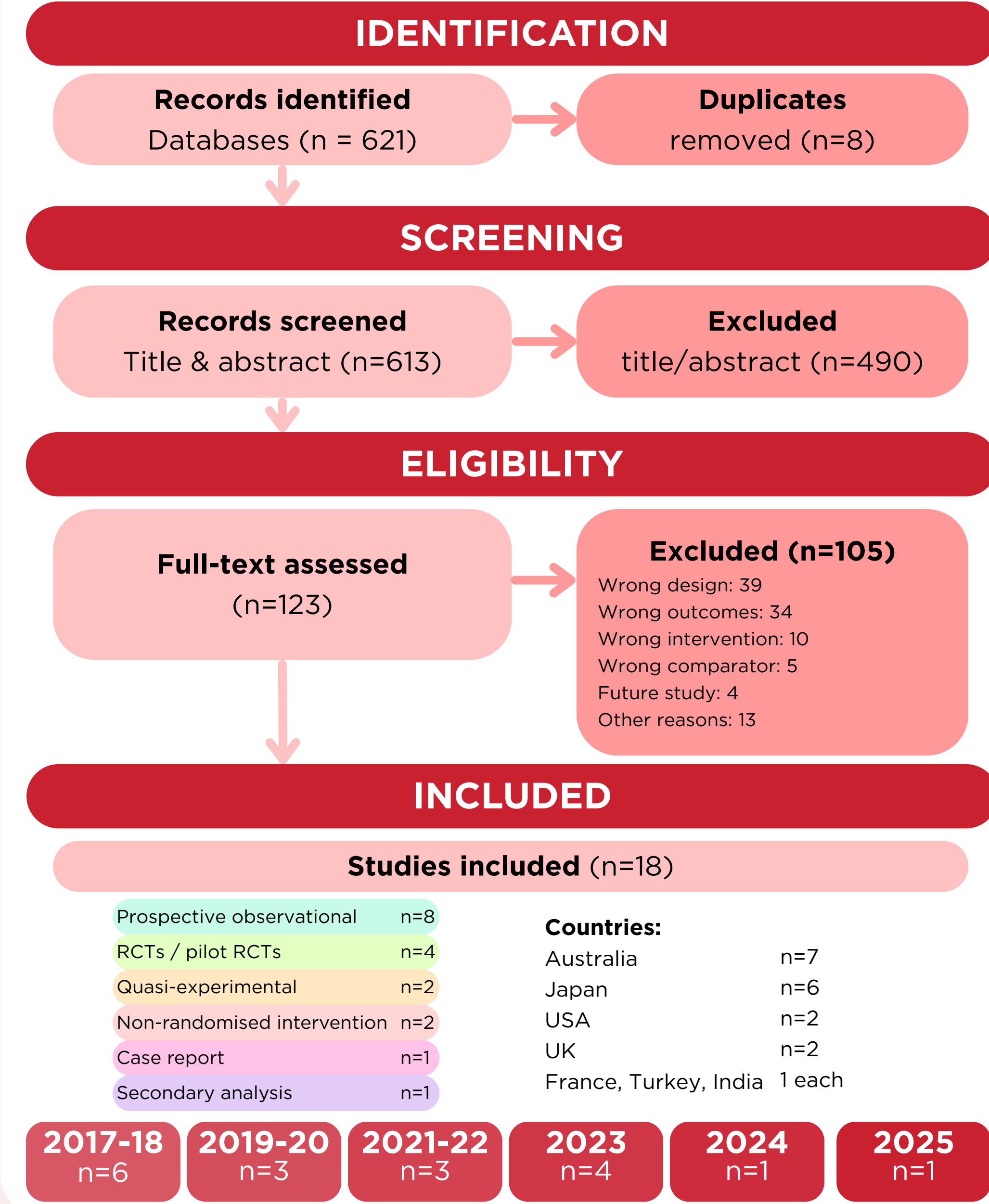
CINAHL MEDLINE Google Scholar
Health Source: Nursing

Period: 2017–2025 | Search: Oct 2025 | Excluded: paediatric, CVC-only, insertion-success-only studies

Competing Interests & Support

Supported by the Australian Government – Department of Education, National Industry PhD Program, Round 4 (Project ID 41640). MDL & NB are employees at VeinTech Pty Ltd; NB holds equity; MDL and PJC hold share options. VeinTech is developing an ultrasound-based PIVC assistance device.

Selection of Studies



Pager Framework Summary

PATTERNS

- Visualisation (US, NIR) and standardisation (algorithms, VAS teams) dominate the evidence.
- No AI or Machine Learning (ML) studies.
- Technologies focus on insertion.

References

- 1.Hoskins MJ et al. (2023) *Medicine* (Baltimore)
- 2.Keogh S & Mathew S (2019) *Aust Comm Safety Qual Health Care*
- 3.Carr PJ et al. (2018) *Cochrane Database Syst Rev* 2018
- 4.Druegeon B et al. (2024) *Antimicrob Resist Infect Control*
- 5.Nafiu OO et al. (2010) *Paediatr Anaesth*
- 6.Fields JM et al. (2014) *J Vasc Access*

- 7.Aulagnier J et al. (2014) *Acad Emerg Med*
- 8.Schults JA et al. (2022) *PLOS ONE*
- 9.AIHW (2024) *Overweight and Obesity*
- 10.Peters MDJ et al. (2020) *JBI Evid Synth*
- 11.Babineau J (2014) *J Can Health Libr Assoc*
- 12.Bradbury-Jones C et al. (2022) *Int J Soc Res Methodol*

GAPS

- No AI/ML for vessel selection.
- Visualisation ≠ optimal selection.^[25]
- CVR metric inconclusive.^[14]
- No predictive tool integrates vessel characteristics.

- 13.Bahl A et al. (2024) *PLOS ONE*
- 14.Leroux S et al. (2023) *J Emerg Med*
- 15.Lissy Ben B et al. (2024) *J Pharm Bioallied Sci*
- 16.Smith E & Irimia V (2023) *Br J Nurs*
- 17.Marsh N et al. (2018) *Trials* 19(1):596
- 18.Marsh N et al. (2023) *J Clin Nurs*

EVIDENCE FOR PRACTICE

- Use US-guided long PIVCs for DIVA.^[21,20]
- Implement I-DECIDED®.^[21]
- Choose negative-pressure needle-less connectors.^[18]

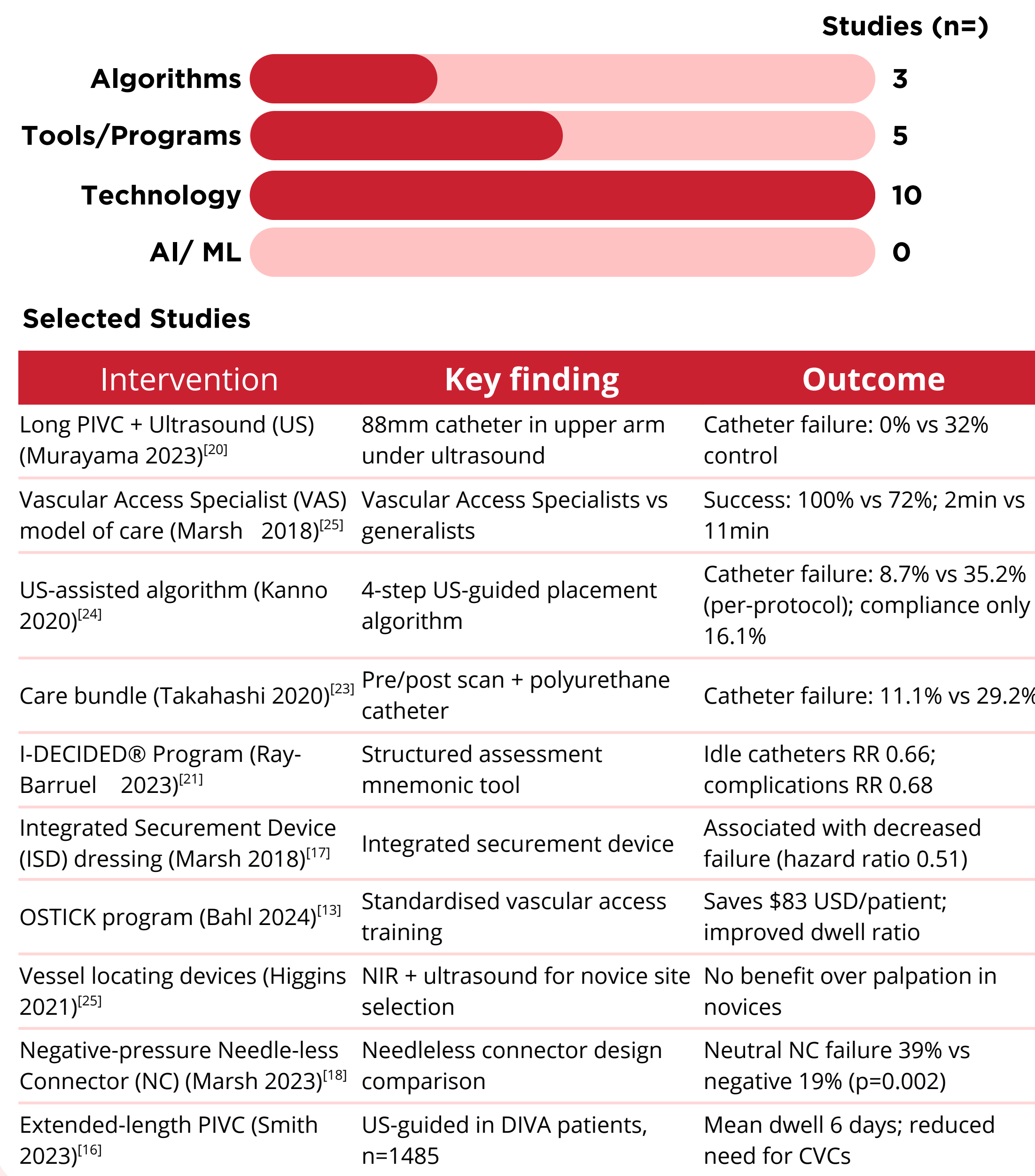
- 19.Marsh N et al. (2018) *Trials* 19(1):564
- 20.Murayama R et al. (2023) *Drug Discov Ther*
- 21.Ray-Barruel G et al. (2023) *Int J Nurs Stud*
- 22.Erdoğan BC & Baykara ZG (2025) *Aust J Adv Nurs*
- 23.Kanno C et al. (2020) *Drug Discov Ther*
- 24.Takahashi T et al. (2020) *Sci Rep*

RESearch RECOMMENDATIONS

- Definitive multicentre RCTs for ISDs^[17] and VAS models.^[19]
- Develop predictive AI with anatomical + patient data.^[23,25]
- Gaze/motion analysis for skill assessment.^[26]

- 19.Higgins N et al. (2021) *J Clin Nurs*
- 19.Parker S et al. (2024) *Vasc Access J Can Vasc Access Assoc*

Results - ATTA Categories



Competency & Retention

Nine studies used validated scales or checklists. Key metrics included:

Knowledge Transfer

PIVC Care Algorithm: scores went from 9 to 21, which was maintained at 2 months^[22]

Procedural Performance

VAS: 100% success, 2 min vs generalist 72%, 11 min^[19]

Compliance/ Documentation

Documentation: 11% → 85% after retraining^[15]
I-DECIDED®: 9.8% → 59%^[21]

Simulation Training

Workbooks, online, simulation, OSCE competency assessment^[23]

Adoption Barriers

Peripheral Despite proven efficacy in specific contexts, real-world adoption remains consistently limited for generalist staff:

- Time pressure in routine clinical care^[23]
- Cognitive load of image interpretation and probe manipulation^[23]
- Insufficient sustainability post-study
 - Only 1 of 3 hospitals sustained I-DECIDED®^[21]

Key Trade-off: US-algorithm reduced catheter failure from 35.2% → 8.7%, but overall compliance was only 16.1%, rendering no overall benefit^[23]



Conclusion

This scoping review aimed to map ATTAs for PIVC vessel selection. Studies highlight simple teaching interventions that incorporate technology with mixed modality learning that blends hands on practice, simulation and digital resources, can support learners and contribute to improved patient outcomes. However, the literature also highlights the need for standardised reporting of training methods, the use of validated assessment tools and further investigation into how these skills are adopted in clinical settings and maintained over time. Current, ATTAs, focus on standardising insertion steps or post-insertion management rather than predicting the ideal vein before insertion. Because vessel selection is critical for long dwell times, the absence of predictive support represents a significant and largely unexplored opportunity in PIVC technology.