Technoleg Iechyd Cymru
Health Technology Wales

Topic Exploration Report [1]

Topic explorations are designed to provide a high-level briefing on new topics submitted for consideration by Health Technology Wales. The main objectives of this report are to:

- Determine the quantity of evidence available for a technology of interest.
- Identify any gaps in the evidence.
- Inform decisions on topics that warrant fuller assessment by Health Technology Wales (HTW).

Topic exploration report number	TER539
Topic	Long length peripheral intravenous catheters for patients with difficult intravenous access
Summary of findings	Insertion of peripheral intravenous catheters (PIVCs) is the most common invasive procedure in acute healthcare. Around a third of adults have difficult venous access (DVA) and undergo repeated attempts at cannulation. Long peripheral catheters (LPCs) of 6 cm to 15 cm may reduce failed insertions and last longer than standard PIVCs of < 6 cm. We identified two relevant systematic reviews, one scoping review and six primary studies, in children and adults. Catheters from 4 cm up to 18 cm were identified as LPCs, although in some studies catheters of 8 cm to 10 cm were instead identified as midline catheters (MCs). Overall, the systematic reviews concluded that LPCs were safe and reliable but differences in classification and measurements made comparisons across studies challenging. Applying a definition for LPCs of 6 cm to 15 cm, seven randomised controlled trials (RCTs) were identified comparing LPCs with standard PIVCs, six of these RCTs were included in the reviews. There was evidence that LPCs showed improvement in dwell-time and failure rates over standard PIVCs. There was evidence from a non-randomised study that complications were greater with 6.4 cm LPCs than 12 cm LPCs and one systematic review reported higher rates of minor complications and catheter failure for LPCs compared to MCs. Five non-comparative primary studies found LPCs to be feasible for use in practice. One USA based cost-effectiveness study reported that LPCs did not increase direct costs compared with standard PIVCs and were a potentially cost-effective method for reducing complications in patients with DVA. There is some evidence from RCTs that LPCs of between 6.4 cm to 15 cm may improve dwell-time and failure rates. It is uncertain as to whether longer LPCs or MCs show improved outcomes over shorter LPCs.

[1] Cyfieithu dogfennau HTW wedi'u cyhoeddi o'r Saesneg i'r Gymraeg
Translation of published technical HTW documents from English into Welsh

Introduction and aims

Around 90% of hospitalised patients require a peripheral IV catheter (PIVC). In general, standard PIVCs are 3 cm to 6 cm in length. They are most commonly inserted in the back of the hand or the veins on the anterior of the elbow joint (the antecubital fossa) and end well before reaching the armpit (the axilla). They are typically only reliable for three to five days. It is estimated that 30% of adults who need a PIVC have difficult venous access (DVA). The definition of DVA can be imprecise, although usually defined as experiencing multiple (two or more) failed insertion attempts, having no visible or palpable veins, or a documented history of DVA. Failed insertions are painful for the patient, increase infection risk and can lead to delays in treatment. DVA often requires ultrasound-guided access to deeper veins and can mean that patients may be referred to the vascular access team for a midline catheter (MC) or a peripherally inserted central catheter (PICC line). A MC is usually defined as being 15 cm to 25 cm in length, is inserted in or above the antecubital fossa, and extends into the axilla or further. MCs are short-term devices, like PIVCs, although they tend to have longer viability time. PICC lines are longer again and terminate in the superior vena cava above the heart and are viable for several months.

PIVCs of 6 cm to 15 cm in length have been classified as long peripheral catheters (LPCs) and are inserted in the forearm, antecubital fossa or upper arm and end before reaching the axilla. LPCs are also used as short-term devices. Use of LPCs in people with DVA is proposed to improve success rates at first insertion and the potential longer viability time reduces the need for repeated canulation and breaks in treatment in comparison with standard PIVCs. In addition, the length allows at least two thirds of the catheter to reside in the vein, which reduces the risk of dislodgement. Introcan Safety® Deep Access, identified by the topic proposer, is an example of this technology. Introcan Safety® Deep Access is a 6.4 cm long catheter which is designed to facilitate ultrasound guided access to deeper veins. The catheter is inserted via a catheter over-needle technique using ultrasound by health care professionals trained in ultrasound-guided vascular access device placement. It is a Class IIa medical device and has a CE mark.

Health Technology Wales researchers searched for evidence on the clinical and cost-effectiveness of LPCs for patients with DVA in comparison with standard PIVCs.

Evidence overview

We identified two relevant systematic reviews, one scoping review and six primary studies, not included in the reviews, one of which reported economic outcomes. We did not identify any relevant health technology assessments.

Systematic reviews

Fabiani et al. (2024) conducted a systematic review exploring complications relating to ultrasound positioned LPCs and MCs, where LPCs were 6 cm to 15 cm and MCs > 15 cm. This review was conducted due to concerns that catheters were misclassified in previous studies due to poor labelling. In addition, there were concerns that different methods were used to report catheter-related complications. Quantitative primary studies in adults were included if the length of the catheter was clear, catheters were positioned with ultrasound-guidance and at least one complication was documented. Studies assessed as being at high risk of bias, based on predefined criteria, were excluded. Searches were conducted up to November 2023. Fourteen studies were identified. The authors reported that seven studies misclassified LPCs as MCs. After studies had been reclassified, nine had been conducted with LPCs of between 8 cm to 15 cm, three of these were randomised controlled trials (RCTs), the remainder were

Evidence overview

retrospective cohort studies. One of the RCTs was a comparison between LPC of 10 cm and MC of 20 cm, and two included comparisons between LPC (8 cm to 10 cm) and standard PIVC. For all studies involving LPCs the cumulative incidence of bloodstream infections was 0.4/1000 catheter-days; symptomatic catheter-related thrombosis was 1.8/1000 catheter-days. For MCs cumulative bloodstream infection was 0.3/1000 catheter days and catheter-related thrombosis was 0.9/1000 catheter days. Minor complications and catheter failure were found to be higher for LPCs. The authors concluded that misclassification existed in published studies and that there were differences between studies in the diagnosis and reporting of complications, making comparisons difficult.

Burek et al. (2022) conducted a scoping review aiming to explore the use of LPCs in children, including both LPCs and MCs. Primary studies of any design, published after 2000 were included. Searches were conducted up to February 2022. Twenty-one studies were identified. Two studies were RCTs, 11 were retrospective cohort and eight were prospective cohort studies. Fifteen studies reported catheter length (range 4 cm to 15 cm) and the reviewers noted that the terminology used to describe the catheters varied. Only four studies, including one of the RCTs, were identified that compared LPCs with standard PIVCs. Five studies compared LPCs with PICC lines. For all included studies the median dwell-time ranged from 5 to 14 days, with rate of completion of therapy from 20% to 86%. The most common complications were dislodgement, blockage, and infiltration (0% to 31%). The reviewers concluded that LPCs show promise in certain paediatric populations but also report variation between studies in quality, measurement tools and reported outcomes.

Qin et al. (2021) conducted a systematic review of the use of LPCs in adults and children. Primary studies of any design describing use of LPCs of 6 cm to 15 cm inserted using the direct Seldinger method were included. The direct Seldinger method is a different technique than catheter-over-wire insertion and requires additional steps. Searches were conducted up to September 2019. Sixteen studies were identified: four RCTs, nine prospective cohorts and three retrospective reviews. Five studies were in paediatric populations, all of these were also included in Burek et al. (2022) but there was no overlap in studies in adults with Fabiani et al. (2024). Most studies were undertaken in acute settings. The most common LPC was 8 cm long. Nine studies recruited patients with DVA and 11 used ultrasound-guidance for positioning. All the RCTs were in adults, three compared LPCs of 6 cm or 12 cm with standard PIVC, and one with PICC line insertion. The median procedure time ranged from 8.0 to 16.8 minutes, with reported success rates from 86% to 100%. Median dwell-time ranged from 1.1 to 9 days. Catheter failure was reported for 4.3% to 52.5% of LPCs, most commonly due to leakage, infiltration, and dislodgement. It was reported from the RCTs that LPCs showed improvement over standard PIVCs for dwell-time and failure rates. The review authors concluded that LPCs were safe and reliable in children and adults and may provide advantages over standard PIVCs.

Primary evidence

Bahl et al. (2020) conducted an RCT in 257 adults with DVA in a tertiary care hospital in the USA. Participants were randomised to receive an LPC of 6.4 cm (n=131) or a standard PIVC of 4.8 cm (n=126). Catheter survival time was reported to be 44 hours (95% confidence interval [CI], 2 to 218 hours) longer in the LPC group. There was no difference reported for first attempt success rates, number of attempts and length of time of procedure. Authors concluded that use of LPCs had improved catheter survival time.

Pavelkova et al. (2022) conducted a non-randomised study comparing frequency of complications for LPCs of 12 cm (n=93) vs 6.4 cm (n=55). Median dwell-time was reported as 8 days for the 6.4 cm vs 9 days for the 12 cm LPC. Complications were greater in the 6.4 cm group (38/1000 catheter days vs 17/1000 catheter days, p-0.004). Complications were not

associated with age, gender, number of insertions or selected veins. For the 6.4 cm LPC, complications were associated with ability to complete activities of daily living, as measured by the Barthel Index scale.

Giardina et al. (2022) reported on a single-arm prospective cohort study in 55 children with cystic fibrosis (median age 6.75 years) examining feasibility of ultrasound-guided placement of LPCs. Participants underwent a total of 122 catheter insertions, guided by ultrasound, over a 60-month period. In 86% of cases insertion was successful first time, treatment was completed in 88% of insertions, with 9% of catheters being removed for occlusion or dislodgement. Two major insertion related complications were reported. Authors concluded that ultrasound-guided insertion of LPCs is a safe method. However, whilst the study reported that LPCs were used, in 23.9% of insertions catheters of 4 cm length were used. There were no comparisons with standard PIVCs reported.

Godfrey & Gallipoli (2024) reported on a quality improvement project where ultrasound-guided placement of LPCs were implemented in patients with DVA at Mid and South Essex NHS Foundation Trust. Registered nurses underwent a training programme consisting of workshops and practice of ultrasound-guidance cannulation techniques. Data were collected from 386 patients from March 2021 to March 2023. In 95% of cases, insertion was successful first time and treatment was completed in 83.6% of cases. Equipment cost per insertion were reported as £18.44. When compared to MC insertion, costs were estimated as being £89.22 lower per insertion and a reduction in clinical waste was reported.

Smith & Irimia (2023) reported on an audit examining the introduction of LPCs at a 750-bed tertiary hospital (Aintree Hospital, Liverpool Hospitals NHS Foundation Trust). Data were collected between 2019 to 2022 with DVA patients referred to the vascular access team for LPC insertion with ultrasound guidance. 1,485 insertions were recorded, mean dwell-time was 6 days, 91% of insertions were successful first time and treatment completion rates were 75% for inpatients and 78% for outpatients. The authors report that the data supported the use of LPCs in patients with DVA and consequently new referral pathways had been developed. However, it is not clear as to whether all the insertions were with LPCs, since two devices were introduced at the same time, one 6.4 cm and one 5.0 cm. There were no comparisons with standard PIVCs reported.

Patel et al. (2019) conducted a retrospective study in a tertiary care hospital in Chicago. reviewing major complications when LPCs of 8 cm to 10 cm long were used by the vascular access team. Data were collected between October 2015 to June 2017, during which period 539 insertions were performed. LPCs were reported as being placed due to difficult access and a need for long-term antibiotics. Deep vein thrombosis rates and catheter related infections were low (<2%). There were no comparisons with standard PIVCs reported.

Economic evidence

Bahl et al. (2023) reported a secondary analysis of Bahl et al. (2020) (see above) assessing cost-effectiveness of LPC vs standard PIVC. The average direct catheter-related cost of treatment favoured the LPC group compared to standard PIVC ($400 vs $521, mean difference -$121 [95% bootstrapped CI, -$461 to $225]). The estimated incremental cost-effectiveness ratio (ICER) for LPC vs PIVC was -$1123 [95% bootstrapped CI -$8652 to $5964]) per complication avoided. It was reported that the absolute difference in complications avoided was 16.8%, favouring LPC. The authors concluded that LPCs did not increase direct costs and were a potentially cost-effective method for reducing complications in patients with DVA when using ultrasound guidance for insertion. However, this study was conducted in the USA and is therefore only partially applicable.

Evidence overview

Ongoing studies

One ongoing RCT was identified (NCT05884294) comparing a LPC of 6.4 cm with one of 10 cm. The study is being conducted in Brazil and aims to recruit 102 hospitalised participants with DVA. Primary outcome is the number of days of vascular access without complications, up to 30 days, end of treatment or withdrawal. Secondary outcomes are resource use, and an economic analysis is planned. The study aims to complete in December 2024. (Rabelo da Silva 2023)

Areas of uncertainty

- Variation in the classification of catheters as being standard, long or midline.
- Comparative efficacy and cost-effectiveness of MCs and LPCs of different lengths.
- Whether efficacy varies by patient population.
- Measurement of complications.
- Whether there is variation in the definition for difficult intravenous access across studies.
- Patient reported outcomes (e.g., pain) for LPCs vs standard PIVCs.
- Cost effectiveness of LPCs vs standard PIVCs in the UK.

Literature search results

Health technology assessments and guidance

None identified

Evidence reviews and economic evaluations

Fabiani A, Aversana N, Santoro M, et al. (2024). Complications associated to midline- and long peripheral catheters in adults. Systematic review of literature and proposal for a standardized model for data collection. Thromb Res. 236: 117-26. doi: http://doi.org/10.1016/j.thromres.2024.02.022

Burek AG, Liljestrom T, Dundon M, et al. (2022). Long peripheral catheters in children: A scoping review. J Hosp Med. 17(12): 1000-9. doi: http://doi.org/10.1002/jhm.12968

Qin KR, Ensor N, Barnes R, et al. (2021). Long peripheral catheters for intravenous access in adults and children: a systematic review of the literature. J Vasc Access. 22(5): 767-77. doi: https://dx.doi.org/10.1177/1129729820927272

Individual studies

Bahl A, Hijazi M, Chen NW, et al. (2020). Ultralong Versus Standard Long Peripheral Intravenous Catheters: A Randomized Controlled Trial of Ultrasonographically Guided Catheter Survival. Ann Emerg Med. 76(2): 134-42. doi: 10.1016/j.annemergmed.2019.11.013

Bahl A, Johnson S, Hijazi M, et al. (2023). Cost effectiveness of ultrasound-guided long peripheral catheters in difficult vascular access patients. J Vasc Access. 11297298231154297. doi: http://doi.org/10.1177/11297298231154297

Burek AG, Liljestrom T, Dundon M, et al. (2022). Long peripheral catheters in children: A scoping review. J Hosp Med. 17(12): 1000-9. doi: http://doi.org/10.1002/jhm.12968

Fabiani A, Aversana N, Santoro M, et al. (2024). Complications associated to midline- and long peripheral catheters in adults. Systematic review of literature and proposal for a standardized model for data collection. Thromb Res. 236: 117-26. doi: http://doi.org/10.1016/j.thromres.2024.02.022

Giardina M, Barillà D, Crimi C, et al. (2022). Ultrasound-guided placement of long peripheral cannula in children with cystic fibrosis. Pediatr Pulmonol. 57(9): 2060-6. doi: http://doi.org/10.1002/ppul.25978
Godfrey J, Gallipoli L. (2024). Introducing an ultrasound-guided longer length peripheral IV catheter for patients with difficult venous access. Br J Nurs. 33(7): S4-s8. doi: http://doi.org/10.12968/bjon.2024.33.7.S4
Patel SA, Araujo T, Rodriguez LP, et al. (2019). Long Peripheral Catheters: A Retrospective Review of Major Complications. J Hosp Med. 14(12): 758-60. doi: http://doi.org/10.12788/jhm.3313
Pavelkova K, Lisova K, Blahova P, et al. (2022). Comparison of 12-cm versus 6-cm long peripheral catheters in patients with difficult intravenous access (DIVA). J Vasc Access. 23(1): 94-7. doi: http://doi.org/10.1177/1129729820983151
Qin KR, Ensor N, Barnes R, et al. (2021). Long peripheral catheters for intravenous access in adults and children: a systematic review of the literature. J Vasc Access. 22(5): 767-77. doi: https://dx.doi.org/10.1177/1129729820927272
Rabelo da Silva E. (2023). Midline Catheter Versus Long Peripheral Intravenous Catheter in Hospitalized Adult Patients [NCT05884294]. https://clinicaltrials.gov/show/NCT05884294.
Smith E, Irimia V. (2023). Evaluation of extended-length cannula inserted using ultrasound guidance in patients with difficult IV access. Br J Nurs. 32(14): S14-s20. doi: http://doi.org/10.12968/bjon.2023.32.14.S14

Ongoing research
Rabelo da Silva E. (2023). Midline Catheter Versus Long Peripheral Intravenous Catheter in Hospitalized Adult Patients [NCT05884294]. https://clinicaltrials.gov/show/NCT05884294.

Date of search	March 2023
Concepts used	Introcan Safety Deep Access; Long peripheral catheter; Peripheral intravenous catheters; Ultrasound-guided IV cannulation

Proposed research question and evidence selection criteria (if selected)

Proposed Research question	**What is the clinical and cost-effectiveness of longer peripheral intravenous catheters (6 cm to 15 cm in length) compared to standard peripheral intravenous catheters for patients with difficult venous access.**

	Inclusion criteria	Exclusion criteria
Population	People with difficult venous access	
Intervention	Peripheral intravenous catheters of 6 cm to 15 cm long	
Comparison/ Comparators	Standard (<6 cm) peripheral intravenous catheters	
Outcome measures	Catheter dwell-time Number of insertion attempts Procedure time	

	Inclusion criteria	Exclusion criteria
	Catheter-related complications Health related QoL Resource use Economic outcomes	

Proposed speciality	Blood and immune system