

**Evidence Profile**

**Recommendation Question 6: Should use of visualization technologies (e.g., ultrasound, vein finders) for the insertion of peripheral VAD be recommended?**

**Recommendation 6.1: The guideline panel recommends that health providers use ultrasound-guided technique for the insertion of peripheral arterial catheters.**

**Population:** Nurses and the interprofessional team

**Intervention:** use of visualization technology (e.g. ultrasound, vein finders) for the insertion of peripheral VADs

**Comparison:** Standard practice

**Outcomes:** Success rate on first attempt/number of failed attempts, patient satisfaction (not reported on in this body of literature), complications (i.e. phlebitis, infiltration, extravasation, infection, bleeding, embolism)

**Setting:** All practice settings where patients with vascular access devices are cared for (e.g., primary care, long-term care, acute care, community care)

**Bibliography:** 9271, 208, 123, 173, 191, 7384

Quality assessment							Summary of Findings		No. of Participants		Reported Effects/Outcomes	Certainty	Reference
No of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Country	Intervention	Intervention	Control			
<b>Success rate on first attempt</b> (defined as: successful arterial catheterization on the first attempt, and time to successful catheterization)													
1 <sup>a</sup>	Systematic review of RCTs	Not serious <sup>b</sup>	Not serious	Not serious	Not serious	Not detected	9271: Multiple: Israel, Germany, USA, France, Japan, Switzerland, Denmark, Canada, China, Thailand, Oman, Korea	9271: Ultrasound-guided technique for radial artery catheterization in adults and pediatric populations. Short axis out of plane and long axis in-plane techniques were used, a variety of different ultrasound devices were used, and providers had varying levels of experience.	9271: n total = 19 RCTs, 3220 participants  n adult studies = 14 studies, 2824 participants  n pediatric studies = 5 studies, 399 participants	9271: not specified	The review reported increased first attempt success rate of arterial catheter insertion with US guidance compared to palpation or traditional methods. Five additional RCTs identified supported these findings.  9271: Ultrasound guided techniques were associated with higher incidence of first attempt success than traditional palpation techniques (RR, 1.39; 95% CI, 1.21–1.59).  The pooled weighted mean	⊕⊕⊕⊕ HIGH	9271: Zhao et al. (2021)

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No of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Country	Intervention	Intervention	Control			
							<p><u>208</u>:China</p> <p><u>208</u>: All of the arterial cannulation procedures were performed by the same anesthesiologist who was skilled in 2 methods of ultrasound-guided and traditional palpation techniques using a 24-G catheter. In the ultrasound group, the arterial puncture was guided by high-frequency ultrasound and was performed using the short-axis, out-of-plane technique. In the palpation group, the location of the radial artery was determined by external landmarks and palpation of the pulse.</p>	<p><u>208</u>: n=30</p> <p>First attempt success rate: 12 (40%)</p> <p>Total success rate: 29 (96.7%)</p>	<p><u>208</u>: n=30</p> <p>First attempt success rate: 3 (10%)</p> <p>Total success rate: 18 (60%)</p>	<p>difference (WMD) indicated that the ultrasound guided technique for radial arterial catheterization was associated with fewer mean attempts to success (WMD, -0.80; 95% CI, -1.35 to -0.25).</p> <p><u>208</u>: The first-attempt success rate in the US group was significantly higher than that in the palpation group (relative risk, 4.0; 95% CI, 1.3–12.8). Similarly, the total success rate in the US group was significantly higher than that in the palpation group (relative risk, 1.61; 95% CI, 1.19–2.17).</p>		<p><u>208</u>: Liu et al. (2019)</p>	
							<p><u>123</u>: USA</p> <p><u>123</u>: A postgraduate year 1 novice emergency medicine intern placed the radial artery catheter using a wide-band 4–12 MHz linear array transducer using the out-of-plane technique traditionally taught by our emergency ultrasound faculty. Patients randomized to the control group received the landmark</p>	<p><u>123</u>: n=20</p> <p>First-pass success: 75%</p> <p>Overall success:</p>	<p><u>123</u>: n=20</p> <p>First-pass success: 0%</p> <p>Overall</p>	<p><u>123</u>: Results were positive favouring the US group for radial artery catheterization for both first pass success and overall success.</p>		<p><u>123</u>: Gibbons (2020)</p>	

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							<p><u>173</u>: China</p> <p>technique for radial artery catheterization.</p> <p><u>173</u>: Patients in the intervention group received the modified long-axis in-plane US technique for radial artery catheterization. Patients in the control group received manual palpation - the operator palpated the radial artery pulse with the left index and middle fingers. The strongest pulse point was identified as the puncture point. All radial artery cannulations were performed before or after induction of general anesthesia according to anesthesiologist's preference. The specified technique was then used to place the radial artery catheter using a 20-gauge intravenous catheter.</p>	<p>100%</p> <p><u>173</u>: n=143</p> <p>Success rates on the first attempt: 91.6% (131/143)</p> <p>Success rate on total attempts: 97.9% (140/143)</p>	<p>success: 15%</p> <p><u>173</u>: n=142</p> <p>Success rates on the first attempt: 57.7% (82/142)</p> <p>Success rate on total attempts: 84.5% (120/142)</p>	<p><u>173</u>: Results were positive favouring the US group for success rates on first attempt (95% CI (4-15.7), OR 7.9) and total attempts (95% CI (2.5-29.2) OR 8.5).</p>		<p><u>173</u>: Wang et al. (2020)</p>	
							<p><u>191</u>: USA</p> <p><u>191</u>: Adult patients in the emergency department were prepped for an arterial line in the standard sterile fashion with patient supine, wrist extended and hand fixed with adhesive tape. Patients received either US-guided technique or traditional palpation technique.</p>	<p><u>191</u>: n=30</p> <p>Success: Yes 29 (96.7%), No 1 (3.3%)</p> <p>Total attempts, mean (SD): 1.3 (0.596)</p>	<p><u>191</u>: n=30</p> <p>Success: Yes 14 (46.7%), No 16 (53.3%)</p> <p>Total attempts, mean (SD): 2.0 (0.928)</p>	<p><u>191</u>: Results were positive, favouring the US group. For every 100 people who receive US-guided technique, 50 more people will have a successful attempt (ranges from 19 more to 96 more).</p> <p><u>7384</u>: The first-attempt success rate in the US group was significantly higher than that in the palpation group. There was no significant difference in the total success rate between the US group and the</p>		<p><u>191</u>: Wilson et al. (2020)</p>	
							<p><u>7384</u>: China</p> <p><u>7384</u>: In the ultrasonography group, the operator performed the cannulation using the technique introduced by Kiberenge et al. - the dynamic needle tip positioning (DNTP) technique. A short axis out-of-plane view of the radial artery was obtained using the ultrasonography machine with a high-frequency probe. The ultrasonography machine was prepared, and the depth was set at 1.8-2.2 cm by a technician before the patient was sent to the pre-anesthesia room. The</p>	<p><u>7384</u>: n=30</p> <p>First attempt success rate: 29 (96.6%)</p> <p>Total success rate: 30 (100%)</p>	<p><u>7384</u>: n=30</p> <p>First attempt success rate: 22 (73.3%)</p> <p>Total success rate: 28</p>	<p><u>7384</u>: Yu et al. (2019)</p>			

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No of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Country	Intervention	Intervention	Control			
								left hand was chosen unless the surgeon or attending anesthesiologist requested use of the right hand. In the palpation group, the operator chose the puncture site by palpating the radial artery. The needle and catheter were advanced toward the radial artery until a flash-back of blood was observed. The catheter was inserted using the Seldinger technique.		(93.3%)	palpation group, though it still trended towards favouring the US group. For every 100 people who receive US-guided technique, 23 more people will have a successful first attempt (ranges from 4 more to 47 more).		
<b>Complications</b> (assessed as rate/incidence of complications overall, or rate/incidence of hematoma, infection, or thrombosis)													
1 <sup>c</sup>	Systematic review of RCTs	Not serious <sup>d</sup>	Not serious	Not serious	Serious <sup>e</sup>	None	<u>9271</u> : Multiple: Israel, Germany, USA, France, Japan, Switzerland, Denmark, Canada, China, Thailand, Oman, Korea	<u>9271</u> : Ultrasound-guided technique for radial artery catheterization in adults and pediatric populations. Short axis out of plane and long axis in-plane techniques were used, a variety of different ultrasound devices were used, and providers had varying levels of experience.	<u>9271</u> : n= 8 trials that examined hematoma, 6 adult studies (999 participants), 2 pediatric studies (143 participants)  Hematoma: n=	<u>9271</u> : Hematoma: n= 125/550 (22.7%)	The systematic review reported fewer complications when using US guidance for arterial catheter insertion compared to palpation or traditional methods. Additional RCTs included supported these findings.  <u>9271</u> : Ultrasound-guided technique was associated with a lower risk of hematoma than the traditional palpation techniques for radial arterial catheterization (RR, 0.40; 95% CI, 0.22–0.72).	⊕⊕⊕○ MODERATE	<u>9271</u> : Zhao et al. (2021)

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							<p><u>208</u>: China</p> <p><u>123</u>: USA</p> <p><u>173</u>: China</p>	<p><b>Additional RCTs included:</b></p> <p><u>208</u>: All of the arterial cannulation procedures were performed by the same anesthesiologist who was skilled in 2 methods of ultrasound-guided and traditional palpation techniques using a 24-G catheter. In the ultrasound group, the arterial puncture was guided by high-frequency ultrasound and was performed using the short-axis, out-of-plane technique. In the palpation group, the location of the radial artery was determined by external landmarks and palpation of the pulse.</p> <p><u>123</u>: A postgraduate year 1 novice emergency medicine intern placed the radial artery catheter using a wide-band 4–12 MHz linear array transducer using the out-of-plane technique traditionally taught by our emergency ultrasound faculty. Patients randomized to the control group received the landmark technique for radial artery catheterization.</p> <p><u>173</u>: Patients in the intervention group received the modified long-axis in-plane US technique for radial artery catheterization. Patients in the control group received manual palpation - the operator palpated the radial artery pulse with the left index and middle fingers. The strongest pulse point was identified as the puncture point. All radial artery</p>	<p>61/592 (10.3%)</p> <p><u>208</u>: n=30 insertions Hematoma: 1 (3.3%) Thrombosis: 0</p> <p><u>123</u>: n= 20 patients Complications: 0 (0%)</p> <p><u>173</u>: n=143 patients Incidence of hematoma: 2.8%</p>	<p><u>208</u>: n=30 insertions Hematoma: 8 (26.7%) Thrombosis: 0</p> <p><u>123</u>: n=20 patients Complications: 1 (5%)</p> <p><u>173</u>: 142 Incidence of hematoma: 19.7%</p>	<p><u>208</u>: Results were positive, favouring the US group for incidences of hematoma (relative risk, 0.13; 95% CI, 0.02–0.94). There were no incidences of thrombosis in either group.</p> <p><u>123</u>: There were no significant differences in complications between the groups.</p> <p><u>173</u>: Results were positive, favouring the US group for incidences of hematoma (odds ratio [OR], 8.54, 95% CI, 2.9 to 25.0).</p>		<p><u>208</u>: Liu et al. (2019)</p> <p><u>123</u>: Gibbons (2020)</p> <p><u>173</u>: Wang et al. (2020)</p>

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							<p><u>191</u>:USA</p> <p><u>7384</u>: China</p>	<p>cannulations were performed before or after induction of general anesthesia according to anesthesiologist's preference. The specified technique was then used to place the radial artery catheter using a 20-gauge intravenous catheter.</p> <p><u>191</u>: Adult patients in the emergency department were prepped for an arterial line in the standard sterile fashion with patient supine, wrist extended and hand fixed with adhesive tape. Patients received either US-guided technique or traditional palpation technique.</p> <p><u>7384</u>: In the ultrasonography group, the operator performed the cannulation using the technique introduced by Kiberenge et al. – the dynamic needle tip positioning (DNTP) technique. A short axis out-of-plane view of the radial artery was obtained using the ultrasonography machine with a high-frequency probe. The ultrasonography machine was prepared, and the depth was set at 1.8–2.2 cm by a technician before the patient was sent to the pre-anesthesia room. The left hand was chosen unless the surgeon or attending anesthesiologist requested use of the right hand. In the palpation group, the operator chose the puncture site by palpating the radial artery. The needle and catheter were advanced toward the radial artery until a flash-back</p>	<p><u>191</u>: n=30 patients</p> <p>Complications: Yes 6 (20.0%) No 24 (80.0%)</p> <p>Complication type: Hematoma 5 (16.7%) Laceration 0 (0.0%) Occlusion 1 (3.3%)</p> <p><u>7384</u>: n=30 patients</p> <p>Hematoma: 0</p> <p>Infection: 0</p>	<p><u>191</u>: n=30 patients</p> <p>Complications: Yes 11 (36.7%) No 19 (63.3%)</p> <p>Complication type: Hematoma 9 (30.0%) Laceration 0 (0.0%) Occlusion 2 (6.7%)</p> <p><u>7384</u>: n=30 patients</p> <p>Hematoma: 2 (0.07%)</p> <p>Infection: 0</p>	<p><u>191</u>: Results were positive favouring the US group, with fewer incidences of complications. For every 100 people who receive the intervention, 17 less people will have complications (ranges from 29 less to 10 more).</p> <p><u>7384</u>: Results did not demonstrate any differences in complications between groups; there was a slight trend favouring US group for incidence of hematoma.</p>		<p><u>191</u>: Wilson et al. (2020)</p> <p><u>7384</u>: Yu et al. (2019)</p>

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No of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Country	Intervention	Intervention	Control			
								of blood was observed. The catheter was inserted using the Seldinger technique.					
Outcome: Patient satisfaction (Not reported in the evidence)													
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**Explanations**

RR = relative risk

OR = odds ratio

CI = confidence interval

US = ultrasound

RCT = randomized controlled trial

ROB = risk of bias

<sup>a</sup> One systematic review included a total of 19 RCTs that examined the outcome of success rate. Five additional RCTs published after the systematic reviews or not included in the reviews were also included. The findings of the RCTs supported those of the systematic reviews and were not GRADED separately.

<sup>b</sup> The included systematic review assessed ROB of the included studies using the Jadad score. The study quality was high for a Jadad score of 4 in 8 studies, moderate score of 3 in 7 studies, and low score of 2 in 4 studies. The primary reason for concern was lack of blinding, which is difficult to achieve with ultrasound intervention. We downgraded by 0.5.

<sup>c</sup> One systematic review included a total of 8 RCTs that examined the outcome of complications. Five additional RCTs published after the systematic reviews or not included in the reviews were also included. The findings of the RCTs supported those of the systematic reviews and were not GRADED separately.

<sup>d</sup> The included systematic review assessed ROB of the included studies using the Jadad score. Review authors classified 4 studies as low ROB (score of 4), 3 studies as moderate ROB (score of 3), and 1 study as high ROB (score of 2). The primary reason for concern was lack of blinding, which is difficult to achieve with ultrasound intervention. We downgraded by 0.5.

<sup>e</sup> There were less than 300 events in the included systematic reviews, but with narrow confidence intervals. We downgraded by 0.5.