

## Supplement 4. Detailed guideline results

### 1. Which central vein should be selected as the CVC site to reduce cannulation-related complications in ICU patients?

#### Results

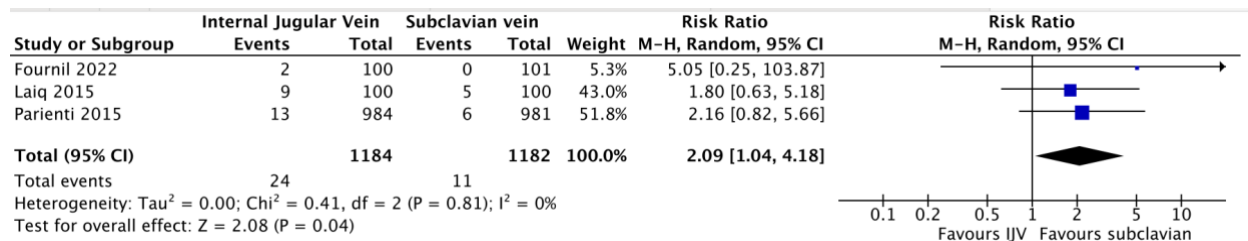
A total of **9 RCTs** were identified, of which 3 were identified through the post-2022 update. Of these 9 studies, 2 analysed more than two insertion sites. In total, **8 studies** compared the internal jugular vein with the subclavian/axillary vein, **2 studies** compared the subclavian/axillary vein with the femoral vein, and **1 study** compared the internal jugular vein with the femoral vein.

#### Risk of bias (RoB-2)

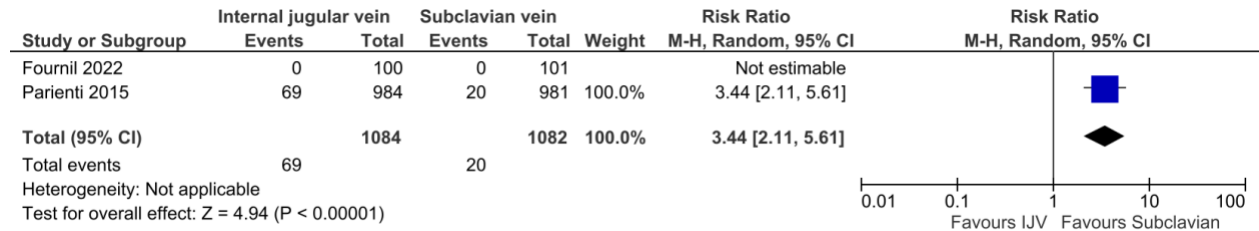
Note that none of the included studies were blinded.

	Randomization: Infection	Randomization: Mechanical complications	Randomization: Thrombotic events	Intended interventions: Infection	Intended interventions: mechanical complications	Intended interventions: thrombotic events	Missing outcome: Infection	Missing outcome: mechanical complications	Missing outcome: thrombotic events	Outcome measurement: Infection	Outcome measurement: mechanical complications	Outcome measurement: thrombotic events	Selection of reported result: Infection	Selection of reported result: mechanical complications	Selection of reported result: thrombotic events	Overall: thrombotic events	Overall: Infection	Overall: mechanical complications
Czarnik 2023	+	+	NA	+	+	+	NA	+	NA	NA	+	NA	NA	NA	NA	NA	NA	+
Fournil 2022	+	+	+	+	+	+	-	+	+	+	+	-	+	+	+	-	-	+
Gülmen 2010	NA	+	NA	NA	+	NA	+	NA	NA	+	NA	NA	+	NA	NA	NA	NA	-
Kocum 2011	NA	+	NA	NA	+	NA	+	NA	NA	+	+	NA	+	NA	NA	NA	NA	+
Laiq 2015	+	+	NA	+	+	NA	+	+	NA	+	+	+	+	+	NA	NA	-	-
Merrer 2001	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	-	+	+
Parianti 2015	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	-	+	+
Shin 2019	NA	+	NA	NA	+	NA	+	NA	NA	+	+	+	+	+	NA	NA	NA	+
Trabelsi 2022	NA	+	NA	NA	+	NA	+	NA	NA	+	+	+	+	+	NA	NA	NA	+

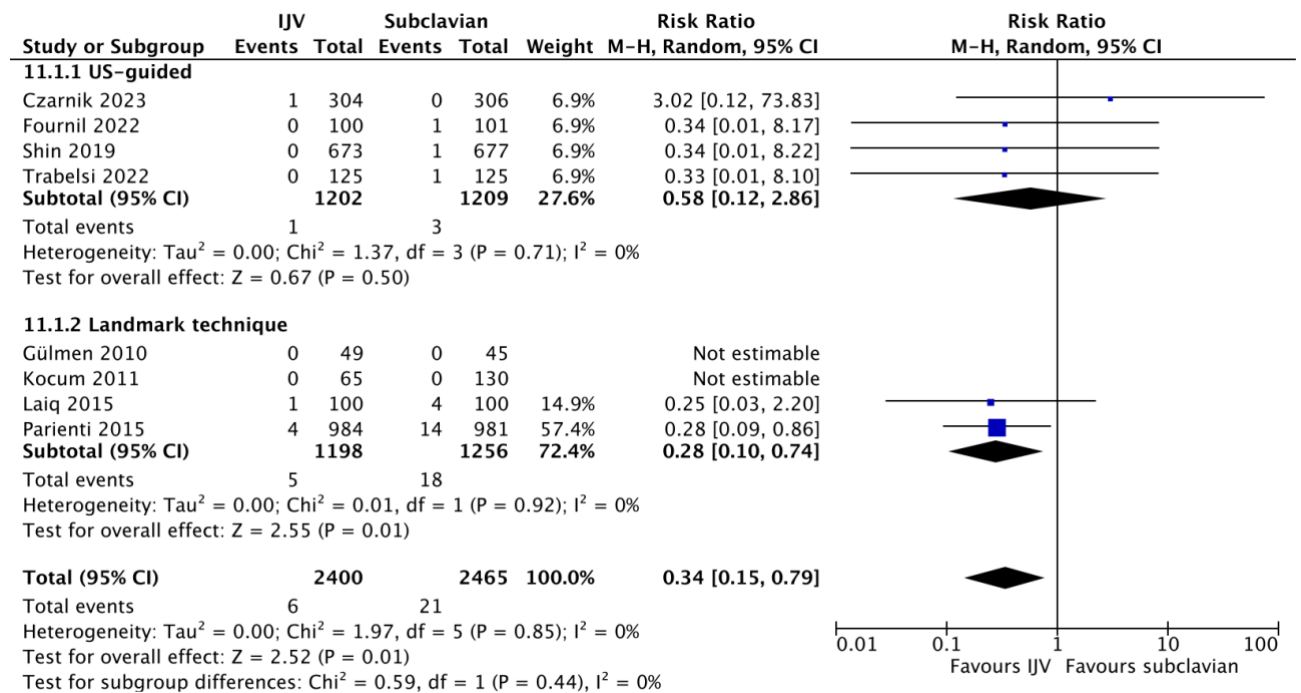
## Catheter-related infection



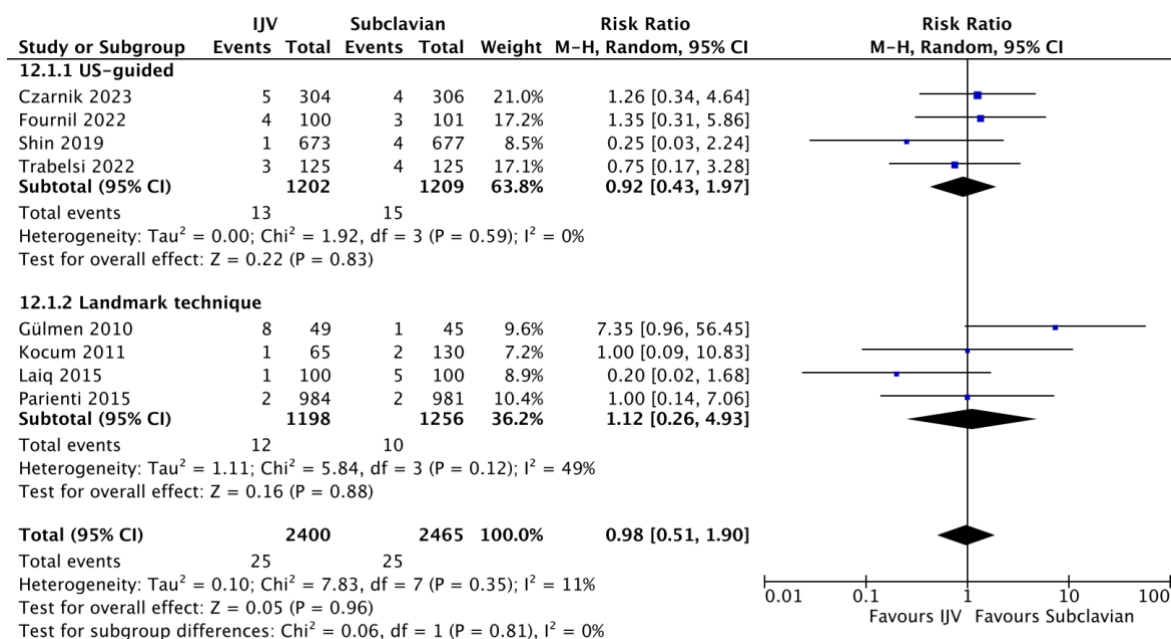
## Thromboembolic complications



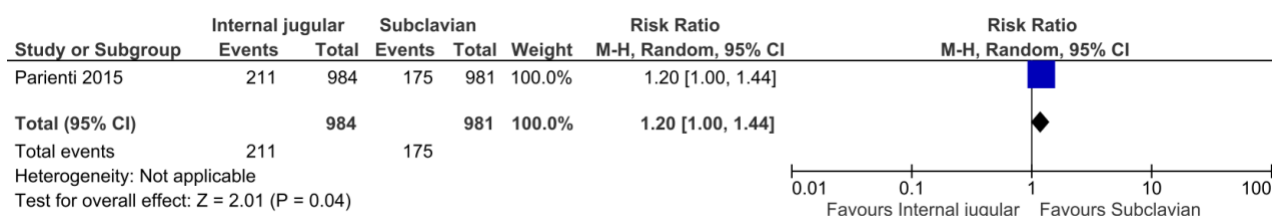
## Pneumothorax









## Arterial puncture



## Mortality



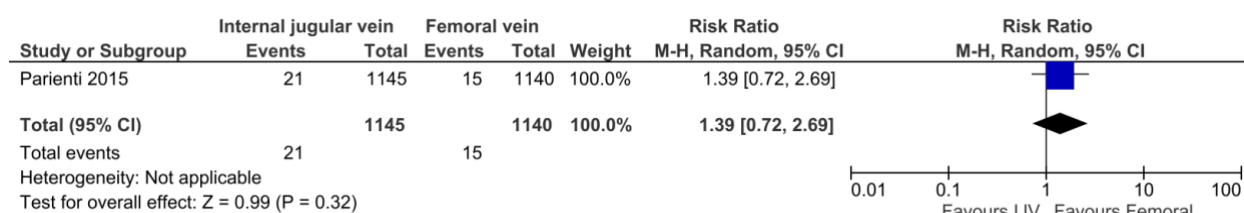
**Certainty of evidence (GRADE):**

Certainty assessment							№ of patients		Effect		Certainty
Outcome	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Internal jugular vein	Subclavian vein	Relative (95% CI)	Absolute (95% CI)	
Catheter-related infection	randomised trials	not serious	not serious	not serious <sup>a</sup>	serious <sup>b</sup>	none	24/1184 (2.0%)	11/1182 (0.9%)	<b>RR 2.09</b> (1.04 to 4.18)	<b>10 more per 1000</b> (from 0 fewer to 30 more)	 Moderate <sup>a,b</sup>
Thrombotic events	randomised trials	serious <sup>c</sup>	serious <sup>d</sup>	serious <sup>c</sup>	serious <sup>b</sup>	none	69/1084 (6.4%)	20/1082 (1.8%)	<b>RR 3.44</b> (2.11 to 5.61)	<b>45 more per 1000</b> (from 21 more to 85 more)	 Very low <sup>b,c,d,e</sup>
Pneumothorax: both ultrasound and landmark technique	randomised trials	serious <sup>f</sup>	very serious <sup>h</sup>	not serious	serious <sup>i</sup>	none	6/2400 (0.3%)	21/2465 (0.9%)	<b>RR 0.34</b> (0.15 to 0.79)	<b>6 fewer per 1000</b> (from 7 fewer to 2 fewer)	 Very low <sup>f,h,i</sup>
Pneumothorax: ultrasound	randomised trials	not serious	not serious	not serious	serious <sup>j</sup>	none	1/1202 (0.1%)	3/1209 (0.2%)	<b>RR 0.58</b> (0.12 to 2.86)	<b>1 fewer per 1000</b> (from 2 fewer to 5 more)	 Moderate <sup>j</sup>
Arterial puncture	randomised trials	serious <sup>f</sup>	very serious <sup>h</sup>	not serious	not serious <sup>g</sup>	none	25/2400 (1.0%)	25/2465 (1.0%)	<b>RR 0.98</b> (0.51 to 1.90)	<b>0 fewer per 1000</b> (from 5 fewer to 9 more)	 Very low <sup>f,g,h</sup>
Mortality	randomised trials	very serious <sup>k</sup>	not serious	not serious	serious <sup>l</sup>	none	211/984 (21.4%)	175/981 (17.8%)	<b>RR 1.20</b> (1.00 to 1.44)	<b>36 more per 1000</b> (from 0 fewer to 78 more)	 Very low <sup>k,l</sup>

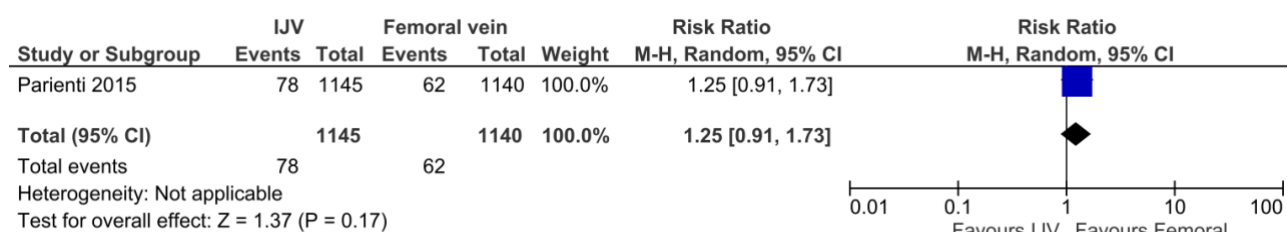
**Footnotes to the above table:** a. Most studies involve ICU patients. b. Wide 95% CIs and OIS criteria (RRR 50%) not met. c. Studies often did not include data on asymptomatic thrombosis. d. Two studies: one shows a very large effect favouring the subclavian vein, the other (of lower quality) favours neither vein. The absence of large pooled data on thrombotic events suggests downgrading the certainty of evidence. e. Fournil's study considered only symptomatic thrombosis. f. Several studies received "some concerns" in the final risk-of-bias rating. In addition, the largest trial — Parienti et al. — used ultrasound to substantially different extents between the venous sites. g. Despite wide 95% CIs, the absolute event rates are very similar — they likely do not differ in reality. h. Use of two different methods — ultrasound and landmark technique. i. Absolute differences in event rates may indicate an effect. j. High probability that the optimal sample size was not achieved given such a low complication rate. k. Mortality was not a study endpoint; follow-up duration is difficult to assess. l. Wide 95% CIs spanning both no effect and a clinically important effect.

~ INTERNAL JUGULAR VEIN VERSUS FEMORAL VEIN ~

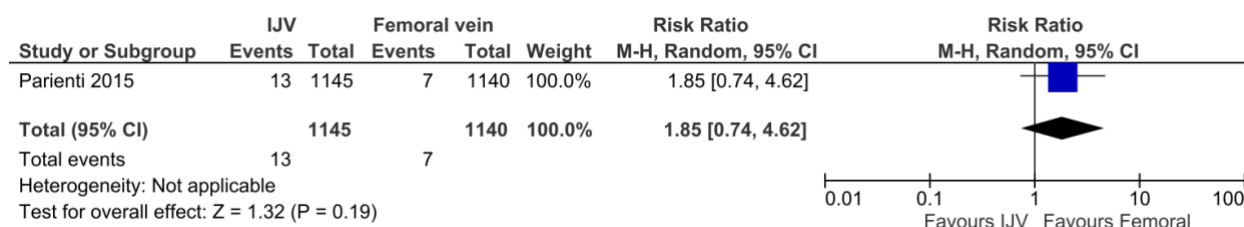
## Catheter-related infection



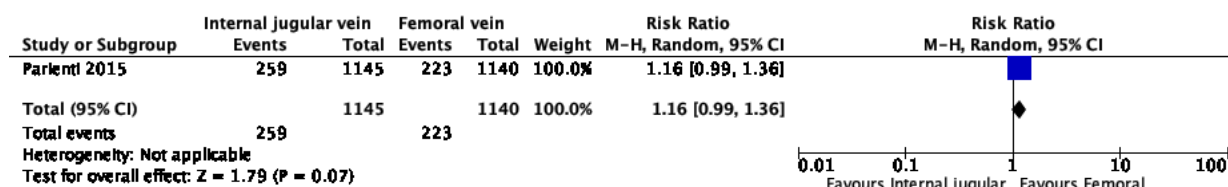
## Thromboembolic complications



## Composite mechanical complications (pneumothorax, arterial puncture, haematoma)



## Mortality



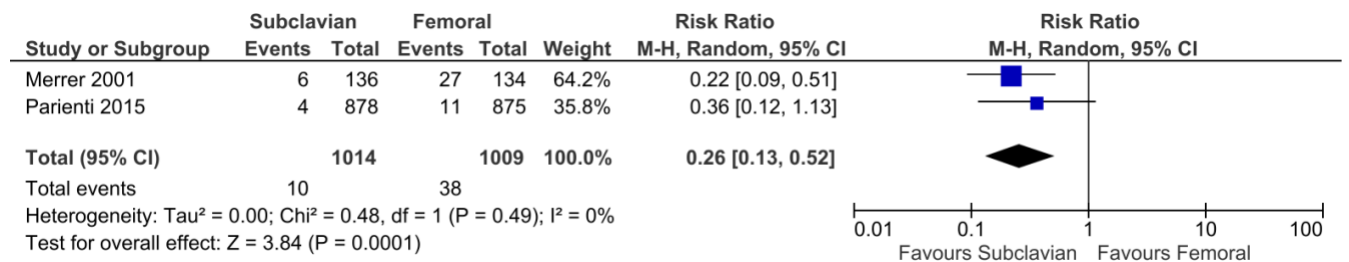
Certainty of evidence (GRADE)

Certainty assessment							N <sup>o</sup> of patients		Effect		Certainty
Outcome	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Internal jugular vein	Femoral vein	Relative (95% CI)	Absolute (95% CI)	
Catheter-related infection	randomised trials	serious	not serious <sup>a</sup>	not serious	very serious <sup>b</sup>	none	21/1145 (1.8%)	15/1140 (1.3%)	<b>RR 1.39</b> (0.72 to 2.69)	<b>5 more per 1000</b> (from 4 fewer to 22 more)	⊕○○○ ○ Very low <sup>a,b</sup>
Thrombotic events	randomised trials	serious <sup>c</sup>	not serious	not serious	very serious <sup>b</sup>	none	78/1145 (6.8%)	62/1140 (5.4%)	<b>RR 1.25</b> (0.91 to 1.73)	<b>14 more per 1000</b> (from 5 fewer to 40 more)	⊕○○○ ○ Very low <sup>b,c</sup>
Composite mechanical complications	randomised trials	serious <sup>a</sup>	not serious	not serious	very serious <sup>b</sup>	none	13/1145 (1.1%)	7/1140 (0.6%)	<b>RR 1.85</b> (0.74 to 4.62)	<b>5 more per 1000</b> (from 2 fewer to 22 more)	⊕○○○ ○ Very low <sup>a,b</sup>
Mortality	randomised trials	very serious <sup>d</sup>	not serious	not serious	serious <sup>b</sup>	none	259/1145 (22.6%)	223/1140 (19.6%)	<b>RR 1.16</b> (0.99 to 1.36)	<b>31 more per 1000</b> (from 2 fewer to 70 more)	⊕○○○ ○ Very low <sup>b,d</sup>

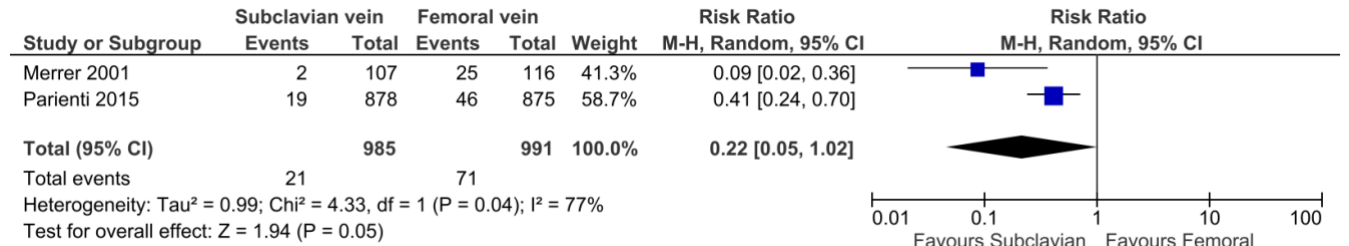
**Footnotes to the above table:** a. Differing rates of ultrasound and landmark-technique use between the venous sites. b. Wide 95% CIs plus only one study, so the risk of point-estimate imprecision is high. c. Substantial missing data on detection of thromboembolic events. d. Differing use of ultrasound and landmark technique between venous sites. In addition, mortality was not a study endpoint.

~ SUBCLAVIAN/AXILLARY VEIN VERSUS FEMORAL VEIN ~

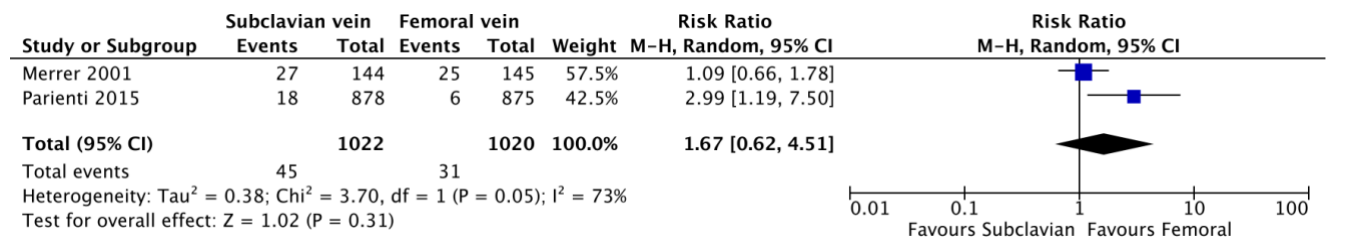
## Catheter-related infection



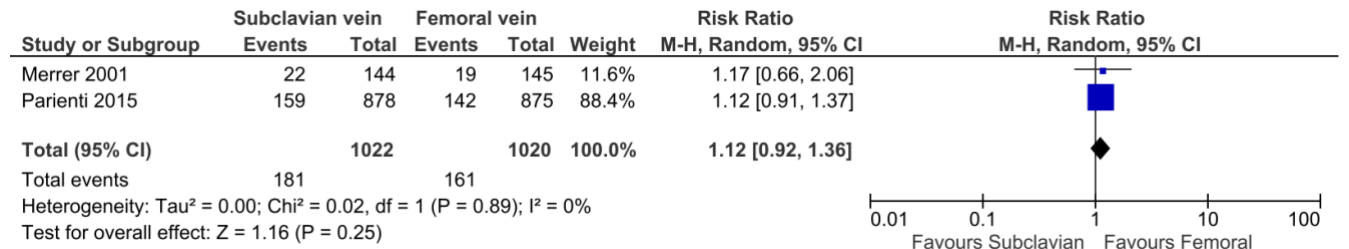
## Thromboembolic complications







## Composite mechanical complications (pneumothorax, arterial puncture, haematoma)



## Mortality



## Certainty of evidence (GRADE)

Certainty assessment							N <sub>e</sub> of patients		Effect		Certainty
N <sub>e</sub> of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Subclavian vein	Femoral vein	Relative (95% CI)	Absolute (95% CI)	
Catheter-related infection	randomised trials	serious <sup>a</sup>	not serious	not serious	serious <sup>b</sup>	none	10/1014 (1.0%)	38/1009 (3.8%)	RR 0.26 (0.13 to 0.52)	28 fewer per 1000 (from 33 fewer to 18 fewer)	 Low <sup>a,b</sup>
Thrombotic events	randomised trials	serious <sup>c</sup>	not serious	not serious	serious <sup>d</sup>	none	21/985 (2.1%)	71/991 (7.2%)	RR 0.22 (0.05 to 1.02)	56 fewer per 1000 (from 68 fewer to 1 more)	 Low <sup>c,d</sup>
Composite mechanical complications	randomised trials	serious <sup>a</sup>	serious <sup>e</sup>	not serious	serious <sup>b,d</sup>	none	45/1022 (4.4%)	31/1020 (3.0%)	RR 1.67 (0.62 to 4.51)	20 more per 1000 (from 12 fewer to 107 more)	 Very low <sup>a,b,d,e</sup>
Mortality	randomised trials	very serious <sup>a</sup>	not serious	not serious	serious <sup>b,f</sup>	none	181/1022 (17.7%)	161/1020 (15.8%)	RR 1.12 (0.92 to 1.36)	19 more per 1000 (from 13 fewer to 57 more)	 Very low <sup>a,b,f</sup>

**Footnotes to the above table:** a. Substantial difference in ultrasound vs landmark-technique use between the venous sites. b. Optimal information size (RRR 20/30/50%) not met. c. Missing data on asymptomatic thromboembolic events. d. 95% CIs spanning both an effect and no effect. e. I<sup>2</sup> = 78%. In addition, minimal overlap between the studies' 95% CIs. f. Wide 95% CIs.

## 1. Evidence-to-decision pathway (GRADE) — common to all three meta-analyses

Problem		
Is the problem a priority?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> No</li> <li><input type="radio"/> Probably no</li> <li><input type="radio"/> Probably yes</li> <li><input checked="" type="radio"/> Yes</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>The choice of central venous catheter (CVC) insertion site is one of the key aspects of the procedure, because the site selected can substantially influence the rates of thromboembolic complications, infections, and mechanical complications.</p>	
Desirable Effects		
How substantial are the desirable anticipated effects?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Trivial</li> <li><input type="radio"/> Small</li> <li><input type="radio"/> Moderate</li> <li><input type="radio"/> Large</li> <li><input checked="" type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p><b><u>Internal jugular vein (vs subclavian vein)</u></b></p> <p><b>A) Infection</b></p> <p>RR 2.09 (95% CI 1.04 to 4.18) — large effect</p> <p><b>B) Thromboembolic events</b></p> <p>RR 3.44 (95% CI 2.11 to 5.61) — large effect</p> <p><b><u>Internal jugular vein (vs femoral vein):</u></b></p> <p><b>A) Infection:</b> RR 1.39 (95% CI 0.72 to 2.69) — a statistically non-significant, trivial effect.</p> <p><b>B) Thromboembolic events:</b> RR 1.25 (95% CI 0.91 to 1.73) — a statistically non-significant, trivial effect.</p> <p><b>C) Mechanical complications:</b> RR 1.85 (95% CI 0.74 to 4.62) not statistically significant, trivial effect.</p> <p>No outcome was statistically significantly associated with either access site.</p> <p>It is worth noting, however, that for all outcomes — infection, thromboembolic events, and mechanical complications — the 95% confidence intervals are shifted toward favouring the femoral vein.</p> <p><b><u>Subclavian/axillary vein (vs femoral vein):</u></b></p> <p><b>A) Infection:</b> RR 0.26 (95% CI 0.13 to 0.52) — large effect.</p> <p><b>B) Thromboembolic events:</b> RR 0.22 (95% CI 0.05 to 1.02) — borderline statistical significance, moderate effect</p> <p>The panel concluded that, for the abovementioned critical outcomes, the pooled effect is moderate.</p>	<p><b><u>Internal jugular vein vs subclavian vein:</u></b></p> <p>The subclavian vein may be associated with lower rates of thromboembolic complications (very low certainty of evidence) and infections (moderate certainty of evidence).</p> <p><b><u>Internal jugular vein vs femoral vein:</u></b></p> <p>The comparison of these two access sites is based on a single randomised trial (Parietti et al., 2015, NEJM).</p> <p>It should be noted that femoral vein cannulation carries no risk of pneumothorax.</p>

Undesirable Effects		
How substantial are the undesirable anticipated effects?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Trivial</li> <li>○ Small</li> <li>○ Moderate</li> <li>○ Large</li> <li>● Varies</li> <li>○ Don't know</li> </ul>	<p><b><u>Internal jugular vein (vs subclavian/axillary vein):</u></b></p> <p><b>A) Pneumothorax — landmark technique</b> RR 0.28 (95% CI 0.10 to 0.74) — large effect</p> <p><b>B) Pneumothorax — ultrasound</b> RR 0.58 (95% CI 0.12 to 2.86) — not statistically significant, with a small 95% CI shift favouring the internal jugular vein. Trivial effect.</p> <p><b>C) Arterial puncture — landmark technique</b> RR 1.12 (95% CI 0.26 to 4.93) not statistically significant, trivial effect.</p> <p><b>D) Arterial puncture — ultrasound</b> RR 0.92 (95% CI 0.43 to 1.97) not statistically significant, trivial effect</p> <p><b><u>Internal jugular vein (vs femoral vein):</u></b> No clearly harmful effects of any particular access site were observed.</p> <p><b><u>Subclavian/axillary vein (vs femoral vein):</u></b></p> <p><b>A) Mechanical complications:</b> RR 1.67 (95% CI 0.62 to 4.51) not statistically significant, trivial effect.</p>	<p><b><u>Internal jugular vein vs subclavian/axillary vein</u></b></p> <p>The subclavian/axillary vein may carry a higher risk of pneumothorax when the landmark technique is used. With ultrasound-guided cannulation, no significant association with insertion site was observed (although the very low pneumothorax rate in this subgroup must be taken into account).</p> <p><b><u>Subclavian/axillary vein vs femoral vein:</u></b></p> <p>Note that the subclavian/axillary route carries a risk of pneumothorax, whereas the femoral route does not.</p>
Certainty of evidence		
What is the overall certainty of the evidence of effects?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Very low</li> <li>● Low</li> <li>○ Moderate</li> <li>○ High</li> <li>○ No included studies</li> </ul>	<p><b><u>Internal jugular vein (vs subclavian/axillary vein):</u></b></p> <p>Certainty of evidence for the most important outcomes (i.e. complications) is as follows:</p> <p><b>A) Infection</b> — moderate certainty of evidence</p> <p><b>B) Thromboembolic complications</b> — very low certainty of evidence</p> <p><b>C) Pneumothorax</b> — landmark technique — low certainty of evidence</p> <p><b>D) Pneumothorax</b> — ultrasound — moderate certainty of evidence</p> <p><b>E) Arterial puncture</b> — landmark technique — low certainty of evidence</p> <p><b>F) Arterial puncture</b> — ultrasound — moderate certainty of evidence</p> <p>The panel concluded that the overall certainty of evidence for the abovementioned outcomes is low.</p> <p><b><u>Internal jugular vein (vs femoral vein):</u></b></p>	

	<p>All outcomes were rated as having "very low" certainty of evidence. This is because only one randomised trial was included (in which ultrasound was used to differing extents during cannulation). In addition, wide 95% confidence intervals were observed, which reduce confidence in the precision of the effect estimate.</p> <p><b><u>Subclavian/axillary vein (vs femoral vein):</u></b></p> <p><b>A) Infection:</b> low certainty of evidence</p> <p><b>B) Thromboembolic events:</b> low certainty of evidence</p> <p><b>C) Mechanical complications:</b> very low certainty of evidence</p> <p>The panel concluded that the overall certainty of evidence is "low".</p>	
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**Values**  
Is there important uncertainty about or variability in how much people value the main outcomes?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Important uncertainty or variability</li> <li>○ Possibly important uncertainty or variability</li> <li>● Probably no important uncertainty or variability</li> <li>○ No important uncertainty or variability</li> </ul>	<p>The panel identified infection, pneumothorax, and thrombosis as the most important outcomes.</p>	

**Balance of effects**  
Does the balance between desirable and undesirable effects favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Favors the comparison</li> <li>○ Probably favors the comparison</li> <li>○ Does not favor either the intervention or the comparison</li> <li>● Probably favors the intervention</li> <li>○ Favors the intervention</li> <li>○ Varies</li> <li>○ Don't know</li> </ul> <p><b>The intervention here refers to the subclavian vein</b></p>	<p><b><u>Internal jugular vein vs subclavian/axillary vein:</u></b></p> <p>The balance of benefits and harms between the subclavian/axillary vein and the internal jugular vein probably favours the subclavian vein. Of the three critical outcomes — infections, thromboembolic complications, and mechanical complications — the subclavian site is associated with lower risks of infection and thrombosis. In addition, ultrasound guidance appears to substantially reduce mechanical complications such as pneumothorax and inadvertent arterial puncture, lowering the weight of these events in the site-selection decision</p> <p><b><u>Internal jugular vein vs femoral vein:</u></b></p> <p>Based on the abovementioned results, it is not possible to determine unequivocally which access site (between internal jugular and femoral) is preferred for reducing complications. Nonetheless, the direction of the 95% CIs should be considered when weighing a potential preference for the femoral over the internal jugular vein.</p> <p><b><u>Subclavian/axillary vein vs femoral vein:</u></b></p> <p>The axillary/subclavian route is supported by a strong and clear protective effect on infection risk, as well as a probable reduction in</p>	

	<p>thromboembolic events. For mechanical complications such as pneumothorax and inadvertent arterial puncture, no statistically significant differences between the compared sites were found.</p> <p>In light of these data, the Expert Panel concluded that, considering the critical outcomes, the axillary/subclavian route should probably be regarded as preferred.</p>	
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**Resources required**

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Large costs</li> <li>○ Moderate costs</li> <li>○ Negligible costs and savings</li> <li>○ Moderate savings</li> <li>○ Large savings</li> <li>○ Varies</li> <li>● Don't know</li> </ul>	No data on resource requirements as a function of CVC insertion site.	<p>It is possible that the subclavian/axillary route, given its greater technical difficulty (especially under ultrasound guidance), will require greater educational and training investment</p> <p>For the choice between the internal jugular and femoral veins, there is no evidence that either route differentially affects resource use.</p>

**Certainty of evidence of required resources**  
 What is the certainty of the evidence of resource requirements (costs)?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Very low</li> <li>○ Low</li> <li>○ Moderate</li> <li>○ High</li> <li>● No included studies</li> </ul>	No data on resource requirements as a function of CVC insertion site.	

Cost effectiveness Does the cost-effectiveness of the intervention favor the intervention or the comparison?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Favors the comparison</li> <li><input type="radio"/> Probably favors the comparison</li> <li><input type="radio"/> Does not favor either the intervention or the comparison</li> <li><input type="radio"/> Probably favors the intervention</li> <li><input type="radio"/> Favors the intervention</li> <li><input type="radio"/> Varies</li> <li><input checked="" type="radio"/> No included studies</li> </ul>	No data on cost-effectiveness as a function of CVC insertion site.	It is plausible that the subclavian/axillary route, by reducing infection and thromboembolic risk, may be associated with greater cost-effectiveness, primarily through lower costs of treating these complications. However, the potentially higher risk of pneumothorax when the landmark technique is used may also generate additional treatment costs.
Equity What would be the impact on health equity?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Reduced</li> <li><input type="radio"/> Probably reduced</li> <li><input type="radio"/> Probably no impact</li> <li><input checked="" type="radio"/> Probably increased</li> <li><input type="radio"/> Increased</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul> <p><b>When the subclavian vein is used</b></p>	No data on the impact on health equity as a function of CVC insertion site.	<p><b>Subclavian/axillary vein vs other veins:</b></p> <p>The main beneficiaries of subclavian/axillary access appear to be patients with head injuries (lower thrombosis risk), immunocompromised patients (lower infection risk), patients with extensive burns (easier vascular access), and patients with neck injuries, in whom other sites may be inaccessible or carry greater risk.</p>
Acceptability Is the intervention acceptable to key interest-holders?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> No</li> <li><input type="radio"/> Probably no</li> <li><input checked="" type="radio"/> Probably yes</li> <li><input type="radio"/> Yes</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul> <p><b>When the subclavian vein is used</b></p>	No data on acceptability as a function of CVC insertion site.	Choosing the subclavian/axillary vein may be less acceptable to clinicians who prefer the internal jugular vein (technically easier to cannulate).

Feasibility Is the intervention feasible to implement?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<input type="radio"/> No <input type="radio"/> Probably no <input checked="" type="radio"/> Probably yes <input type="radio"/> Yes <input type="radio"/> Varies <input type="radio"/> Don't know  <b>When the subclavian vein is used</b>	No data on feasibility of implementation as a function of CVC insertion site.	A preference for the subclavian vein may face implementation barriers in the ICU for the following reasons: 1) operator skills; 2) familiarity with ultrasound techniques; 3) personal beliefs.

**2. Should ultrasound be used during CVC placement compared with the landmark technique in ICU patients? — INTERNAL JUGULAR VEIN**

## Results

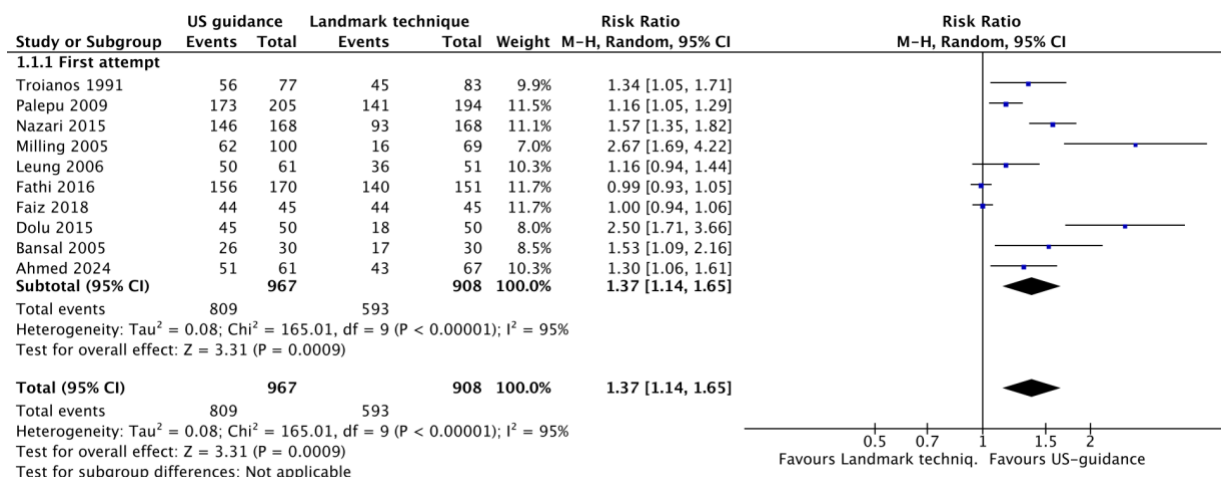
A total of **22 RCTs were identified**, of which 7 were identified through the post-2015 update. Of the 22 publications, 20 studies used real-time ultrasound guidance, while the remaining 2 used pre-procedural ultrasound assistance (US-assistance).

### Risk of bias (RoB-2)

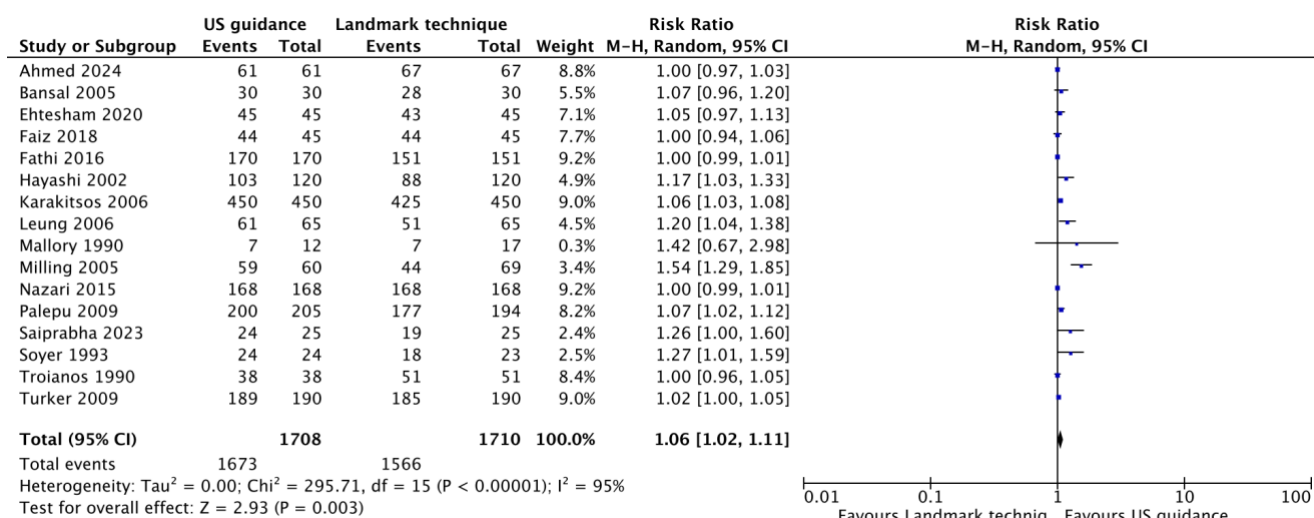
Note that none of the included studies were blinded. The studies included in the 2015 Cochrane review were collectively rated as having "serious" risk of bias (assessed with the RoB-1 tool). For the update with 7 new studies, the GR working group used the RoB-2 tool (below).

	Randomization	Intended intervention	Missing data	Outcome measurement	Selective reporting	Overall
Ahmed 2024	●	+	+	+	●	●
Dolu 2015	●	+	+	+	+	●
Ehtesham 2020	+	+	+	●	+	●
Faiz 2018	●	●	●	+	●	●
Fathi 2016	●	+	+	●	+	●
Nazari 2015	●	+	+	●	●	●
Saiprabha 2023	●	●	+	●	+	●

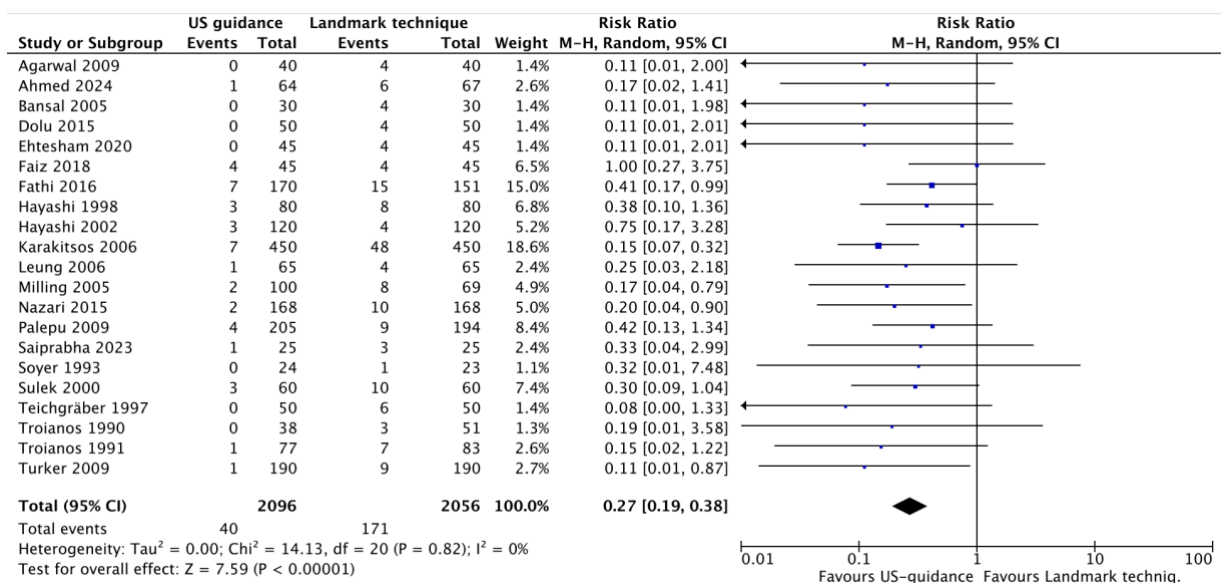
### First-attempt success



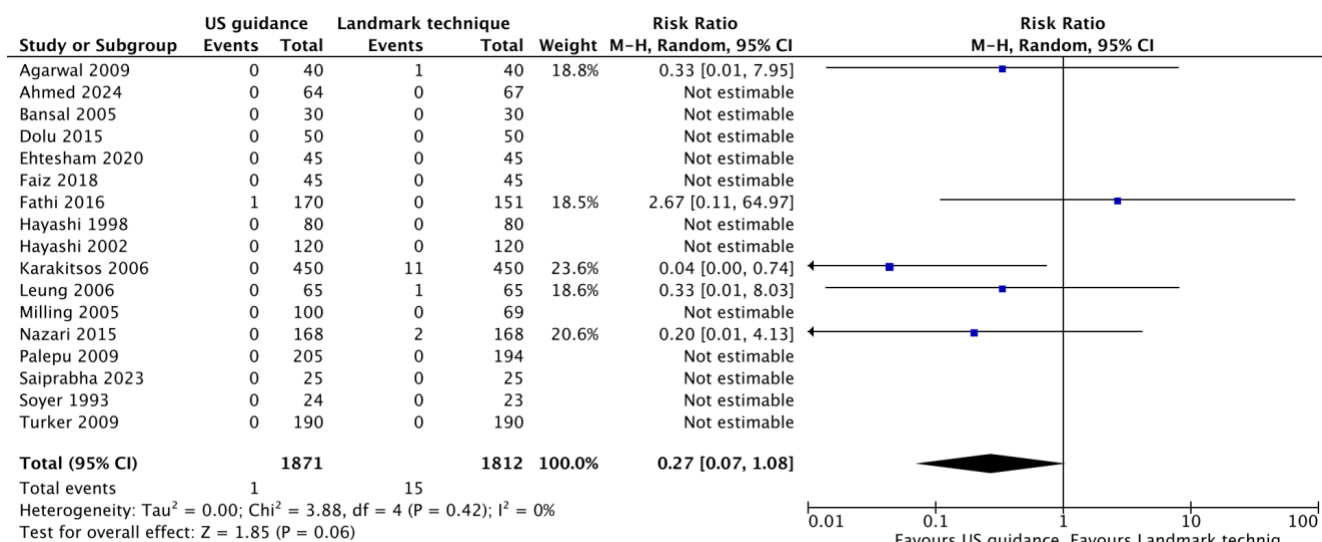
## Overall cannulation success



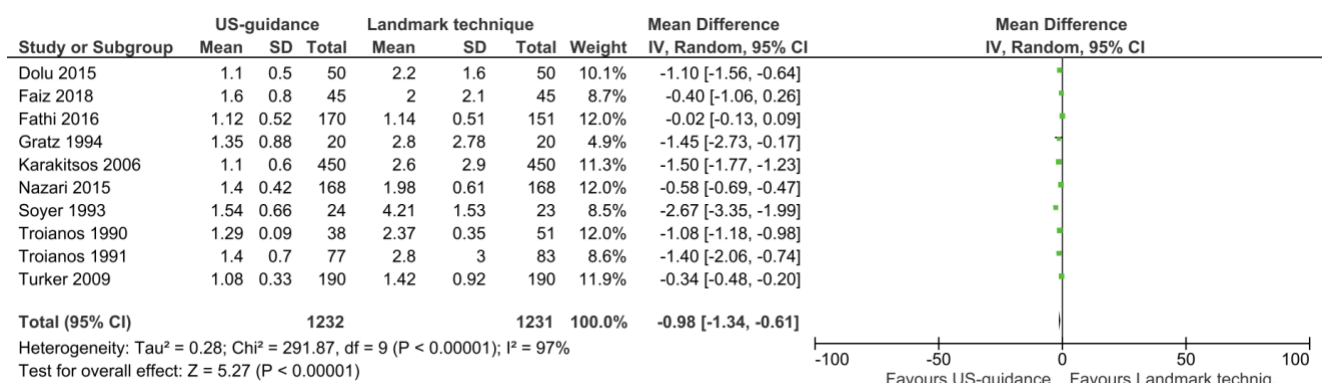
## Arterial puncture



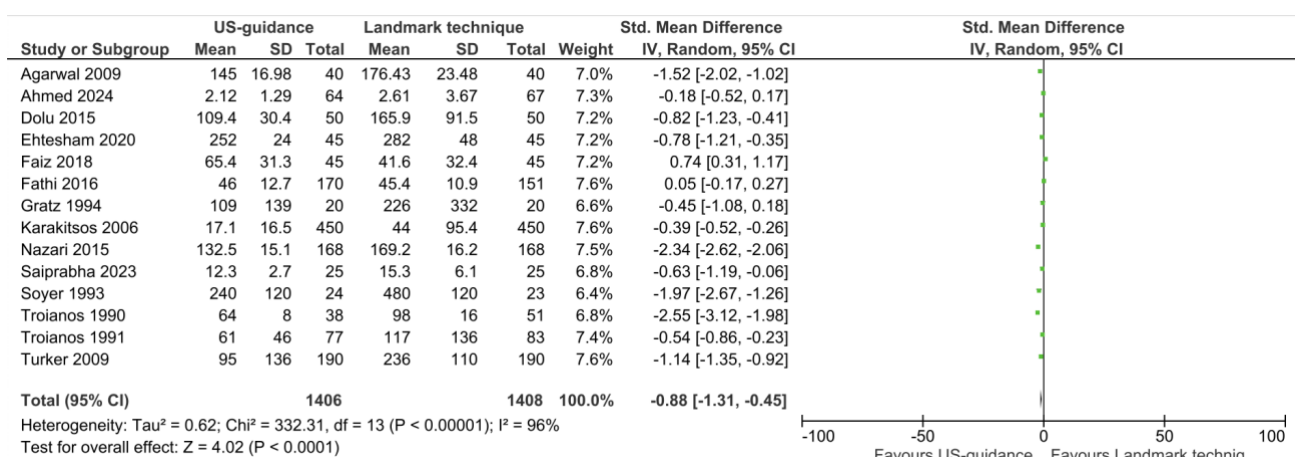
## Pneumothorax









## Number of cannulation attempts



## Cannulation time



## Certainty of evidence (GRADE)

Certainty assessment							N <sub>o</sub> of patients		Effect		Certainty
Outcome	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Ultrasound guidance	Anatomical landmark technique	Relative (95% CI)	Absolute (95% CI)	
First-attempt success	randomised trials	serious <sup>a</sup>	not serious <sup>b</sup>	not serious	not serious	publication bias strongly suspected <sup>e</sup>	809/967 (83.7%)	593/908 (65.3%)	<b>RR 1.37</b> (1.14 to 1.65)	<b>242 more per 1000</b> (from 91 more to 425 more)	 Low <sup>a,b,c</sup>
Carotid artery puncture	randomised trials	serious <sup>a</sup>	not serious	not serious	not serious	publication bias strongly suspected strong association <sup>d</sup>	40/2096 (1.9%)	171/2056 (8.3%)	<b>RR 0.27</b> (0.19 to 0.38)	<b>61 fewer per 1000</b> (from 67 fewer to 52 fewer)	 Moderate <sup>a,d</sup>
Pneumothorax	randomised trials	serious <sup>a</sup>	not serious	not serious	serious <sup>c</sup>	none	1/1871 (0.1%)	15/1812 (0.8%)	<b>RR 0.27</b> (0.07 to 1.08)	<b>6 fewer per 1000</b> (from 8 fewer to 1 more)	 Low <sup>a,c</sup>
Number of cannulation attempts	randomised trials	serious <sup>a</sup>	not serious	not serious	not serious	none	1232	1231	-	<b>MD 0.98 attempts fewer</b> (1.34 fewer to 0.61 fewer)	 Moderate <sup>a</sup>
Time to access	randomised trials	serious <sup>a</sup>	not serious	not serious	not serious	none	0	0	-	<b>SMD 0.88 SD lower</b> (1.31 lower to 0.45 lower)	 Moderate <sup>a</sup>
Overall cannulation success	randomised trials	serious <sup>a</sup>	serious <sup>f</sup>	not serious	not serious	publication bias strongly suspected <sup>e</sup>	1673/1708 (98.0%)	1566/1710 (91.6%)	<b>RR 1.06</b> (1.02 to 1.11)	<b>55 more per 1000</b> (from 18 more to 101 more)	 Very low <sup>a,c,f</sup>

**Footnotes:** a. The primary limitation of the studies is the impossibility of blinding. b. Although  $I^2$  is  $>90\%$ , most publications show a consistent direction of effect with substantial overlap among the 95% CIs. c. The funnel plot revealed publication asymmetry. d. Very strong effect of ultrasound on reducing arterial puncture events. e. The estimated effect spans both benefit and harm; we regard this as a source of clear systematic error. However, the clear signal in the absolute effect (0.8% vs 0.1%) is worth noting. f.  $I^2 = 95\%$ .

## Evidence-to-decision pathway (GRADE)

Problem		
Is the problem a priority?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> No</li> <li><input type="radio"/> Probably no</li> <li><input type="radio"/> Probably yes</li> <li><input checked="" type="radio"/> Yes</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>The internal jugular vein is the most commonly used central venous access site.</p> <p>Ultrasound use has been the subject of a large number of randomised trials, indicating a high priority for this question.</p> <p>Cannulation of this vein is associated with a relatively high complication rate, particularly puncture of the common carotid artery.</p>	
Desirable Effects		
How substantial are the desirable anticipated effects?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Trivial</li> <li><input type="radio"/> Small</li> <li><input type="radio"/> Moderate</li> <li><input checked="" type="radio"/> Large</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>— Common carotid artery puncture is clearly less frequent with ultrasound (RR 0.27; 95% CI 0.19 to 0.38) — moderate certainty of evidence</p> <p>— Pneumothorax is probably less frequent with ultrasound (RR 0.27; 95% CI 0.07 to 1.08) — low certainty of evidence</p> <p>— Both overall success and first-attempt success are significantly higher with ultrasound (RR 1.37; 95% CI 1.14 to 1.65 and RR 1.06; 95% CI 1.02 to 1.11) — low and very low certainty of evidence</p> <p>— Time to access is shorter with ultrasound (MD 0.98)</p> <p>— Number of cannulation attempts is lower with ultrasound (SMD 0.88)</p>	
Undesirable Effects		
How substantial are the undesirable anticipated effects?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input checked="" type="radio"/> Trivial</li> <li><input type="radio"/> Small</li> <li><input type="radio"/> Moderate</li> <li><input type="radio"/> Large</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>The analyses identified no outcome suggesting that ultrasound might not be preferred over the landmark technique.</p>	

## Certainty of evidence

What is the overall certainty of the evidence of effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Very low</li> <li><input checked="" type="radio"/> Low</li> <li><input type="radio"/> Moderate</li> <li><input type="radio"/> High</li> <li><input type="radio"/> No included studies</li> </ul>	<p>Certainty of evidence ranged from very low to moderate. From a procedural-safety perspective, the certainty of evidence for common carotid artery puncture is moderate.</p>	

## Values

Is there important uncertainty about or variability in how much people value the main outcomes?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Important uncertainty or variability</li> <li><input type="radio"/> Possibly important uncertainty or variability</li> <li><input checked="" type="radio"/> Probably no important uncertainty or variability</li> <li><input type="radio"/> No important uncertainty or variability</li> </ul>	<p>The panel identified pneumothorax, arterial puncture, and the number of cannulation attempts as the most important outcomes.</p>	

## Balance of effects

Does the balance between desirable and undesirable effects favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Favors the comparison</li> <li><input type="radio"/> Probably favors the comparison</li> <li><input type="radio"/> Does not favor either the intervention or the comparison</li> <li><input type="radio"/> Probably favors the intervention</li> <li><input checked="" type="radio"/> Favors the intervention</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>No outcome favoured the landmark technique. All outcomes clearly favour ultrasound. The balance of benefits and harms therefore clearly favours ultrasound.</p>	

Resources required		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Large costs</li> <li>○ Moderate costs</li> <li>● Negligible costs and savings</li> <li>○ Moderate savings</li> <li>○ Large savings</li> <li>○ Varies</li> <li>○ Don't know</li> </ul>	None of the included studies addressed resources associated with internal jugular vein cannulation. In Poland, an ultrasound device is part of the standard equipment of intensive care units (Ministry of Health Regulation, 2022). Under current conditions, the use of ultrasound for internal jugular vein cannulation therefore probably does not generate additional procedure-related costs.	
Certainty of evidence of required resources		
What is the certainty of the evidence of resource requirements (costs)?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Very low</li> <li>○ Low</li> <li>○ Moderate</li> <li>○ High</li> <li>● No included studies</li> </ul>	None of the included studies performed a resource analysis for internal jugular vein cannulation.	
Cost effectiveness		
Does the cost-effectiveness of the intervention favor the intervention or the comparison?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Favors the comparison</li> <li>○ Probably favors the comparison</li> <li>○ Does not favor either the intervention or the comparison</li> <li>○ Probably favors the intervention</li> <li>○ Favors the intervention</li> <li>○ Varies</li> <li>● No included studies</li> </ul>	None of the included studies performed a cost-effectiveness analysis for internal jugular vein cannulation.	There is evidence that the more frequent complications associated with the landmark technique may require urgent interventions and thereby increase the cost of treating such patients (pneumothorax, haemothorax, and common carotid artery puncture — Karakitsos, Crit Care 2006).
Equity		
What would be the impact on health equity?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Reduced</li> <li>○ Probably reduced</li> </ul>	Given the lower rate of common carotid artery puncture with ultrasound, the populations most likely	

<ul style="list-style-type: none"> <li>○ Probably no impact</li> <li>● Probably increased</li> <li>○ Increased</li> <li>○ Varies</li> <li>○ Don't know</li> </ul>	to benefit from this method include conscious patients, patients with haemostatic disorders, patients with respiratory failure, patients with advanced atherosclerosis, and dialysis patients.	
<b>Acceptability</b> Is the intervention acceptable to key interest-holders?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ No</li> <li>○ Probably no</li> <li>● Probably yes</li> <li>○ Yes</li> <li>○ Varies</li> <li>○ Don't know</li> </ul>	Use of ultrasound instead of the landmark technique appears to be acceptable to patients (efficacy and safety of ultrasound), medical staff (ease of the procedure and its widespread availability), and healthcare administration (ultrasound is standard ICU equipment).	
<b>Feasibility</b> Is the intervention feasible to implement?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ No</li> <li>○ Probably no</li> <li>● Probably yes</li> <li>○ Yes</li> <li>○ Varies</li> <li>○ Don't know</li> </ul>	Yes — ultrasound-guided cannulation of the internal jugular vein is relatively easy to implement. First, an ultrasound device is part of the standard equipment of intensive care units. Second, the procedure has a steep learning curve, allowing rapid acquisition of the necessary skills. Third, the available evidence clearly indicates that ultrasound should be the preferred approach	

### 3. Should ultrasound be used during CVC placement compared with the landmark technique in ICU patients? — SUBCLAVIAN/AXILLARY VEIN

#### Results

A total of **5 RCTs** were identified, all of which were included in the meta-analysis by Zawadka et al.

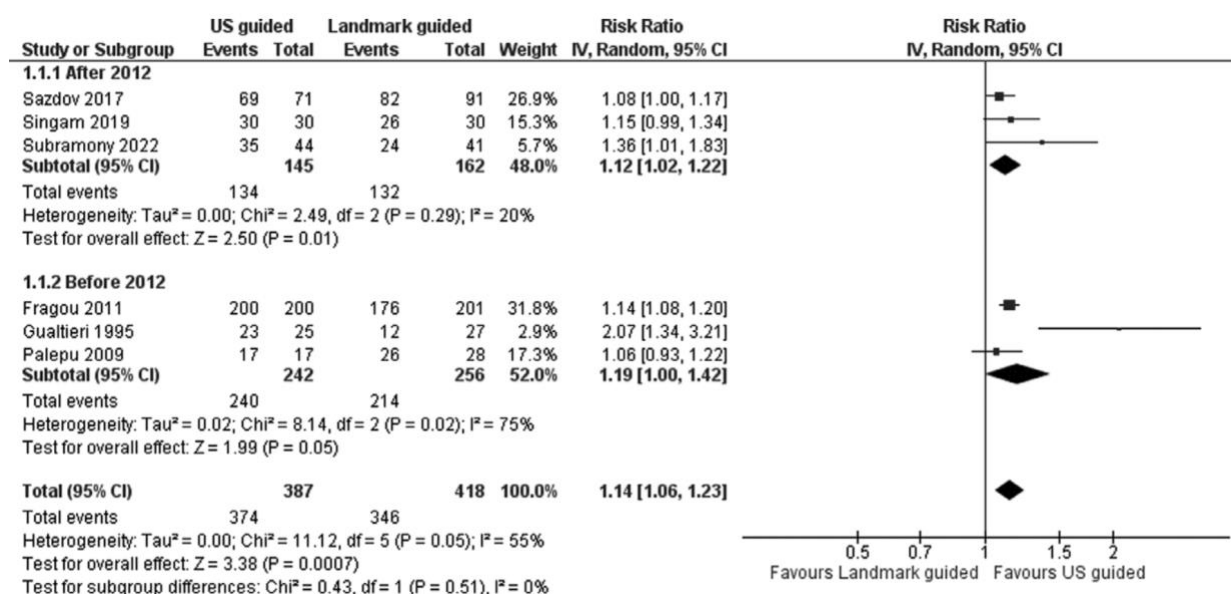
#### Risk of bias (RoB-2)

Note that none of the included studies were blinded. Most of the studies included in this meta-analysis were rated as having "low" risk of bias (see below).

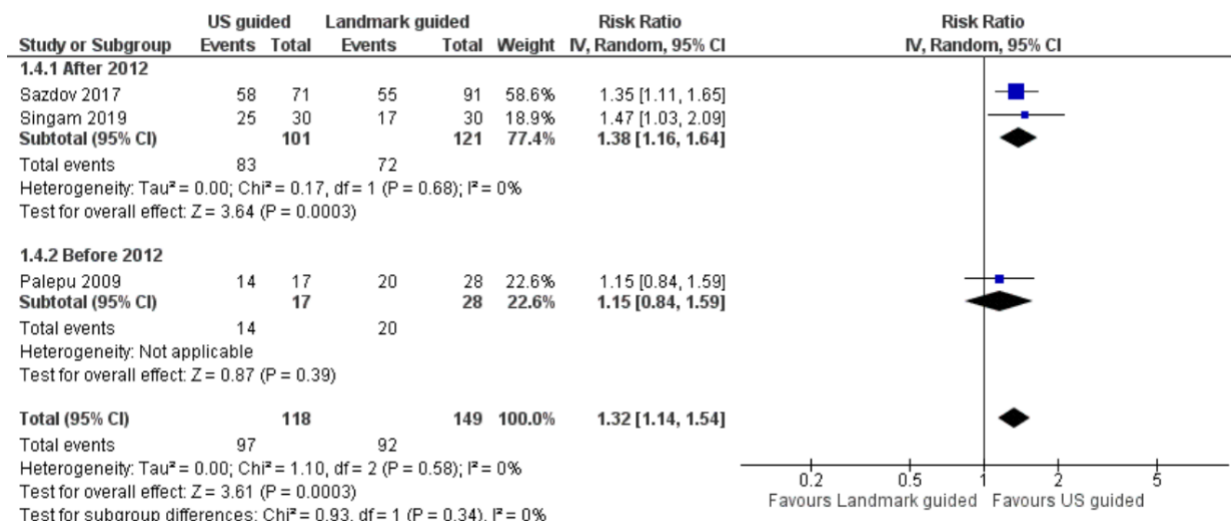
### Supplementary digital content 5. Risk of bias assessment

Study	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective outcome reporting	Overall
Subramony 2022	Low	Unclear/NR	Unclear	Unclear/NR	High	High	High
Singam 2019	Low	Unclear/NR	Unclear	Unclear/NR	Low	Low	Low
Sazdov 2017	Low	Unclear/NR	Unclear	Unclear/NR	Low	Low	Low
Fragou 2011	Low	Unclear/NR	Unclear	Unclear/NR	Low	Low	Low
Palepu 2009	Low	Unclear/NR	Unclear	Unclear/NR	Low	Low	Low
Gualtieri 1995	Low	Unclear/NR	Unclear	Unclear/NR	Low	Low	Low

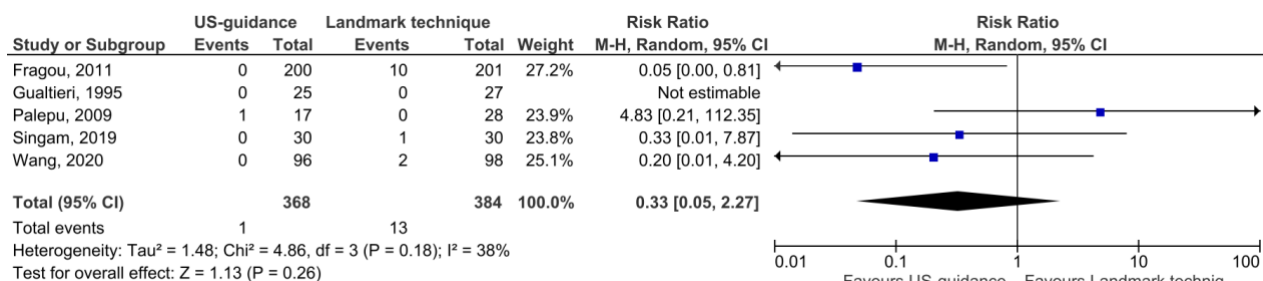
### Overall cannulation success



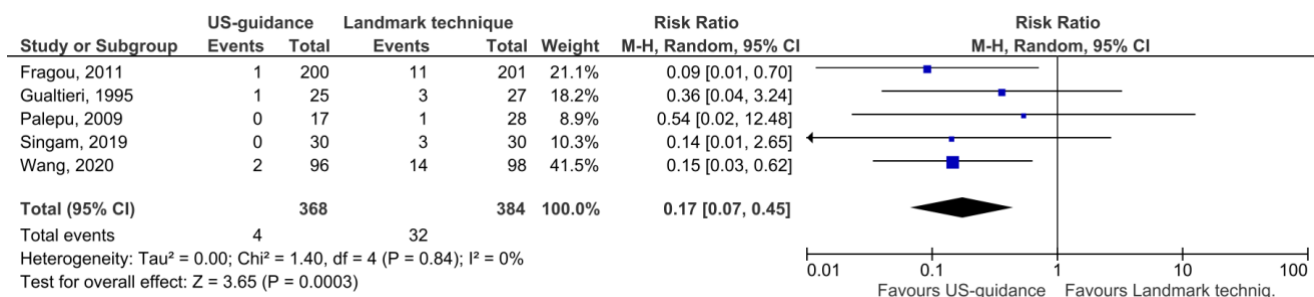
### First-attempt success



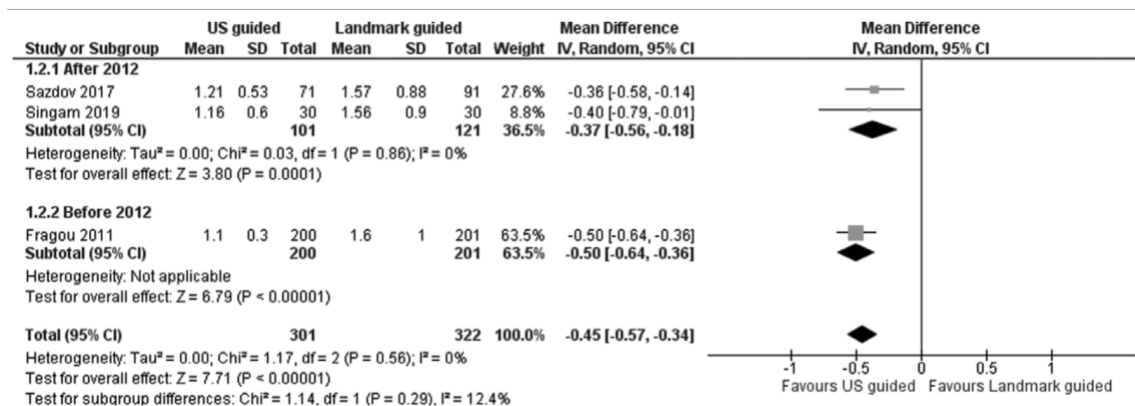
## Pneumothorax



## Arterial puncture



## Number of cannulation attempts



## Time to access

Time to access was statistically significantly shorter with ultrasound than with the landmark technique, by 10.14 seconds (17.34 to 2.94 seconds shorter). Note that this is a trivial effect.

### Certainty of evidence (GRADE)

Certainty assessment							N <sup>o</sup> of patients		Effect		Certainty
Outcome	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Ultrasound guidance	Anatomical landmark technique	Relative (95% CI)	Absolute (95% CI)	
Overall cannulation success	randomised trials	not serious	serious <sup>a</sup>	not serious <sup>b</sup>	not serious	none	374/387 (96.6%)	346/418 (82.8%)	<b>RR 1.14</b> (1.06 to 1.23)	<b>116 more per 1000</b> (from 50 more to 190 more)	⊕⊕⊕○ Moderate <sup>a,b</sup>
First-attempt success	randomised trials	not serious	not serious	not serious	not serious	none	97/118 (82.2%)	92/149 (61.7%)	<b>RR 1.32</b> (1.14 to 1.54)	<b>198 more per 1000</b> (from 86 more to 333 more)	⊕⊕⊕⊕ High <sup>f</sup>
Pneumothorax	randomised trials	not serious	not serious	serious <sup>b</sup>	serious <sup>d</sup>	none	1/368 (0.3%)	13/384 (3.4%)	<b>RR 0.33</b> (0.05 to 2.27)	<b>23 fewer per 1000</b> (from 32 fewer to 43 more)	⊕⊕⊕○ ○ Low <sup>b,d</sup>
Arterial puncture	randomised trials	not serious	not serious	serious <sup>b</sup>	serious <sup>c</sup>	strong association <sup>f</sup>	4/368 (1.1%)	32/384 (8.3%)	<b>RR 0.17</b> (0.07 to 0.45)	<b>69 fewer per 1000</b> (from 77 fewer to 46 fewer)	⊕⊕⊕○ Moderate <sup>b,c,e</sup>
Time to access	randomised trials	not serious	not serious	serious <sup>b</sup>	not serious	none	301	322	-	<b>MD 0.45 attempts lower</b> (0.57 lower to 0.34 lower)	⊕⊕⊕○ Moderate <sup>b</sup>
Number of attempts	randomised trials	not serious	very serious <sup>f</sup>	serious <sup>b</sup>	very serious <sup>g,h</sup>	none	301	322	-	<b>MD 10.14 seconds lower</b> (17.34 lower to 2.94 lower)	⊕○○○ ○ Very low <sup>b,f,g,h</sup>

**Footnotes:** a.  $I^2 = 55\%$ . b. The study populations differed in clinical variables and in use of mechanical ventilation. d. The low event rate of the outcome produces wide 95% CIs; at the same time, the signal in absolute percentages suggests an advantage of ultrasound. e. Large effect — up to 8-fold. f.  $I^2 = 77\%$ . g. Wide 95% CIs. h. Method of measuring time.

## Evidence-to-decision pathway (GRADE)

Problem		
Is the problem a priority?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> No</li> <li><input type="radio"/> Probably no</li> <li><input type="radio"/> Probably yes</li> <li><input checked="" type="radio"/> Yes</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>Cannulation of the subclavian/axillary vein may be associated with fewer complications than other central access sites. The question of how access to this vessel should be obtained therefore appears important.</p> <p>Ultrasound use during cannulation of this vein appears to have a significant and large protective effect against complications such as pneumothorax and subclavian/axillary artery puncture.</p>	
Desirable Effects		
How substantial are the desirable anticipated effects?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Trivial</li> <li><input type="radio"/> Small</li> <li><input type="radio"/> Moderate</li> <li><input checked="" type="radio"/> Large</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>The desirable effects of ultrasound use during axillary/subclavian vein cannulation are as follows:</p> <ul style="list-style-type: none"> <li>— Reduction in inadvertent subclavian/axillary artery puncture (RR 0.17; 95% CI 0.07 to 0.45) — moderate certainty of evidence</li> <li>— Successful cannulation (RR 1.14; 95% CI 1.06 to 1.23) — moderate certainty of evidence</li> <li>— First-attempt cannulation success (RR 1.32; 95% CI 1.14 to 1.54) — high certainty of evidence</li> <li>— Pneumothorax (RR 0.33; 95% CI 0.05 to 2.27) — low certainty of evidence — despite the lack of statistical significance, the absolute reduction in pneumothorax rate (0.3% vs 3.4%) is worth noting</li> </ul>	

## Undesirable Effects

How substantial are the undesirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>● Trivial</li> <li>○ Small</li> <li>○ Moderate</li> <li>○ Large</li> <li>○ Varies</li> <li>○ Don't know</li> </ul>	<p>No outcomes associated with harm from ultrasound use during subclavian/axillary vein cannulation were observed.</p>	<p>— Pneumothorax (RR 0.33; 95% CI 0.05 to 2.27) — low certainty of evidence — despite the lack of statistical significance, the absolute reduction in pneumothorax rate (0.3% vs 3.4%) is worth noting. Nonetheless, attention is drawn to the upper confidence limit, which could indicate harm from ultrasound. (1/368 [0.3%] vs 13/384 [3.4%])</p>

## Certainty of evidence

What is the overall certainty of the evidence of effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Very low</li> <li>● Low</li> <li>○ Moderate</li> <li>○ High</li> <li>○ No included studies</li> </ul>	<p>Overall, certainty of evidence ranged from very low to high. The most important outcomes (arterial puncture and pneumothorax) had moderate and low certainty of evidence, respectively.</p>	

## Values

Is there important uncertainty about or variability in how much people value the main outcomes?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Important uncertainty or variability</li> <li>○ Possibly important uncertainty or variability</li> <li>○ Probably no important uncertainty or variability</li> <li>● No important uncertainty or variability</li> </ul>	<p>The panel identified pneumothorax, arterial puncture, and the number of cannulation attempts as the most important outcomes.</p>	

## Balance of effects

Does the balance between desirable and undesirable effects favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Favors the comparison</li> <li><input type="radio"/> Probably favors the comparison</li> <li><input type="radio"/> Does not favor either the intervention or the comparison</li> <li><input type="radio"/> Probably favors the intervention</li> <li><input checked="" type="radio"/> Favors the intervention</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>The analysis identified no outcome whose effect estimate or confidence interval favoured the landmark technique over ultrasound.</p>	

## Resources required

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Large costs</li> <li><input type="radio"/> Moderate costs</li> <li><input checked="" type="radio"/> Negligible costs and savings</li> <li><input type="radio"/> Moderate savings</li> <li><input type="radio"/> Large savings</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>None of the included studies performed a resource analysis for axillary/subclavian vein cannulation. In Poland, an ultrasound device is part of the standard equipment of intensive care units (Ministry of Health Regulation, 2022). Under current conditions, ultrasound use for axillary/subclavian vein cannulation therefore probably does not generate additional procedure-related costs.</p>	

## Certainty of evidence of required resources

What is the certainty of the evidence of resource requirements (costs)?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Very low</li> <li><input type="radio"/> Low</li> <li><input type="radio"/> Moderate</li> <li><input type="radio"/> High</li> <li><input checked="" type="radio"/> No included studies</li> </ul>	<p>None of the included studies performed a resource analysis for axillary/subclavian vein cannulation.</p>	

## Cost effectiveness

Does the cost-effectiveness of the intervention favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Favors the comparison</li> <li><input type="radio"/> Probably favors the comparison</li> <li><input type="radio"/> Does not favor either the intervention or the comparison</li> <li><input type="radio"/> Probably favors the intervention</li> <li><input type="radio"/> Favors the intervention</li> <li><input type="radio"/> Varies</li> <li><input checked="" type="radio"/> No included studies</li> </ul>	<p>None of the included studies performed a resource analysis for axillary/subclavian vein cannulation.</p>	<p>There is evidence that more frequent complications associated with the landmark technique (subclavian/axillary artery puncture or pneumothorax) may require urgent interventions and thereby increase the cost of treatment.</p>

## Equity

What would be the impact on health equity?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Reduced</li> <li><input type="radio"/> Probably reduced</li> <li><input type="radio"/> Probably no impact</li> <li><input checked="" type="radio"/> Probably increased</li> <li><input type="radio"/> Increased</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>Given the lower rate of inadvertent subclavian/axillary artery puncture with ultrasound, particular benefits may accrue to selected patient groups — in particular conscious patients, patients with haemostatic disorders, patients with advanced atherosclerosis, and patients with chronic respiratory failure.</p>	

## Acceptability

Is the intervention acceptable to key interest-holders?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> No</li> <li><input type="radio"/> Probably no</li> <li><input type="radio"/> Probably yes</li> <li><input type="radio"/> Yes</li> <li><input checked="" type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>Ultrasound use is likely to be preferred by patients given the observed reduction in complications (including a lower risk of subclavian/axillary artery puncture and a probable reduction in pneumothorax risk) and the greater procedural efficacy (higher rate of successful cannulation and fewer attempts).</p> <p>Subclavian access using the landmark technique remains a widely used method of obtaining central venous access. It has a long tradition, is well established in clinical practice, and is often regarded as an effective emergency access route. Nonetheless, its use appears to be gradually declining, particularly in light of the growing body of evidence indicating the superiority of ultrasound-assisted techniques.</p> <p>Ultrasound use is also likely to be acceptable to hospital administration, because ultrasound devices are standard ICU equipment and the expected</p>	

	reduction in complications may translate into lower treatment costs.	
<b>Feasibility</b> Is the intervention feasible to implement?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<input type="radio"/> No <input type="radio"/> Probably no <input checked="" type="radio"/> Probably yes <input type="radio"/> Yes <input type="radio"/> Varies <input type="radio"/> Don't know	<p>Probably yes — ultrasound-guided axillary or subclavian vein cannulation should be feasible to implement, particularly because ultrasound devices are standard ICU equipment. In addition, the available evidence indicates that ultrasound should be the preferred approach.</p> <p>Potential implementation barriers include the greater technical difficulty of this approach (especially compared with internal jugular vein cannulation) and limited operator experience with the method, which may affect the pace of adoption.</p>	

#### **4. Should ultrasound be used during CVC placement compared with the landmark technique in ICU patients? — FEMORAL VEIN**

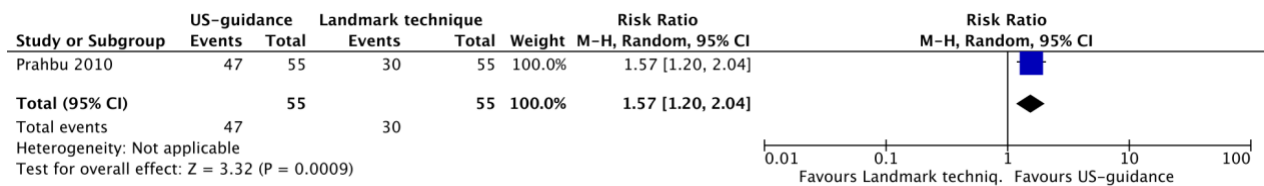
##### **Results**

Only 1 RCT (110 patients) was identified, a publication that was included in the Cochrane review.

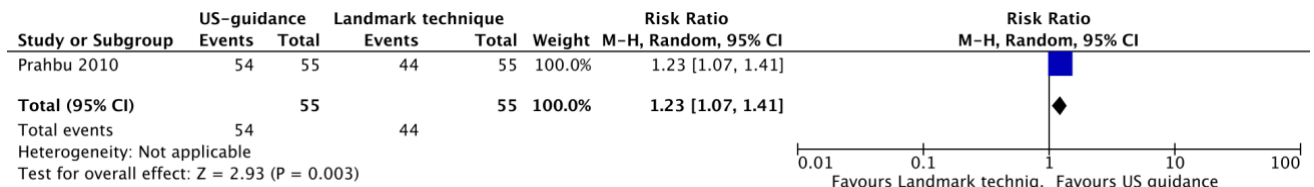
##### **Risk of bias (RoB-2)**

Note the absence of blinding in the included study. The study included in the 2015 Cochrane review was rated overall as having "serious" risk of bias (assessed with the RoB-1 tool).

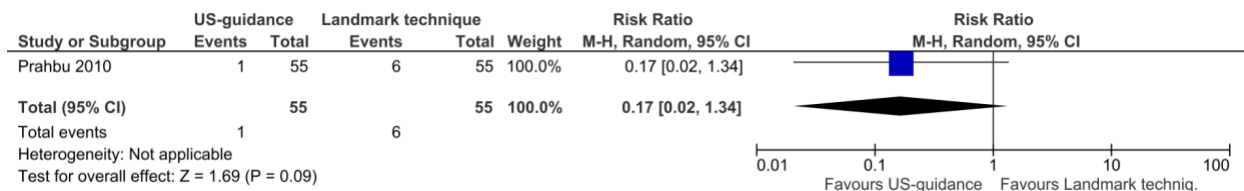
## First-attempt success



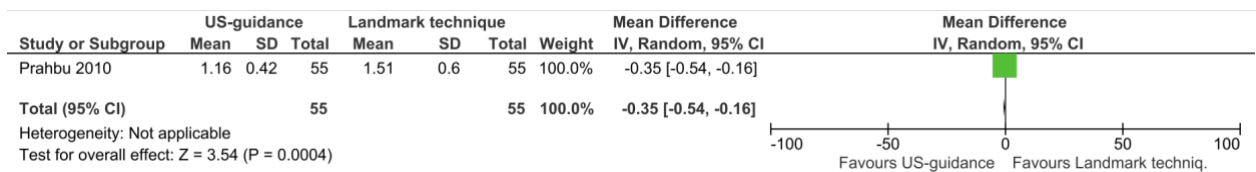
## Overall cannulation success



## Arterial puncture



## Number of cannulation attempts



## Certainty of evidence (GRADE)

Certainty assessment							№ of patients		Effect		Certainty
Outcome	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Ultrasound guidance	Anatomical landmark technique	Relative (95% CI)	Absolute (95% CI)	
First-attempt cannulation success	randomised trials	serious <sup>a</sup>	not serious <sup>b</sup>	not serious	very serious <sup>b</sup>	none	47/55 (85.5%)	30/55 (54.5%)	<b>RR 1.57</b> (1.20 to 2.04)	<b>311 more per 1000</b> (from 109 more to 567 more)	⊕○○○ ○ Very low <sup>a,b</sup>
Arterial puncture	randomised trials	serious <sup>a</sup>	not serious	not serious	very serious <sup>b</sup>	none	1/55 (1.8%)	6/55 (10.9%)	<b>RR 0.17</b> (0.02 to 1.34)	<b>91 fewer per 1000</b> (from 107 fewer to 37 more)	⊕○○○ ○ Very low <sup>a,b</sup>
Number of cannulation attempts	randomised trials	serious <sup>a</sup>	not serious	not serious	very serious <sup>b</sup>	none	55	55	-	<b>MD 0.35 attempts fewer</b> (0.54 fewer to 0.16 fewer)	⊕○○○ ○ Very low <sup>a,b</sup>
Overall cannulation success	randomised trials	serious <sup>a</sup>	not serious	not serious	very serious <sup>b</sup>	none	54/55 (98.2%)	44/55 (80.0%)	<b>RR 1.23</b> (1.07 to 1.41)	<b>184 more per 1000</b> (from 56 more to 328 more)	⊕○○○ ○ Very low <sup>a,b</sup>

**Footnotes:** a. The study has some limitations relating to the randomisation process and to missing data. b. This is the only study analysing the femoral vein. In addition, this study has a small sample size.

## Evidence-to-decision pathway (GRADE)

Problem		
Is the problem a priority?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> No</li> <li><input type="radio"/> Probably no</li> <li><input checked="" type="radio"/> Probably yes</li> <li><input type="radio"/> Yes</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>The use of techniques that minimise complications during invasive ICU procedures appears to be a priority, particularly because central venous cannulation is among the most frequently performed procedures. However, the femoral vein is not among the most commonly used access sites, which is also reflected in the small number of randomised trials available. Furthermore, one of the most serious complications of central venous cannulation — pneumothorax — is not associated with this access site. Nonetheless, the possibility of reducing the risk of haematomas and femoral artery puncture is likely to be the preferred option for patients.</p>	
Desirable Effects		
How substantial are the desirable anticipated effects?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Trivial</li> <li><input type="radio"/> Small</li> <li><input checked="" type="radio"/> Moderate</li> <li><input type="radio"/> Large</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>— Femoral artery puncture rates may be lower with ultrasound (RR 0.17; 95% CI 0.02 to 1.34) — very low certainty of evidence</p> <p>— First-attempt success may be higher with ultrasound (RR 1.57; 95% CI 1.20 to 2.04) — very low certainty of evidence</p> <p>— Overall cannulation success may be higher with ultrasound (RR 1.23; 95% CI 1.07 to 1.41) — very low certainty of evidence</p> <p>— Ultrasound use appears to reduce the total number of cannulation attempts (MD 0.35; 95% CI 0.54 to 0.16 fewer attempts)</p>	<p>Although the benefit of ultrasound for femoral artery puncture did not reach statistical significance, there is strong reason to believe that the true effect may be underestimated (underpowered).</p>
Undesirable Effects		
How substantial are the undesirable anticipated effects?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input checked="" type="radio"/> Trivial</li> <li><input type="radio"/> Small</li> <li><input type="radio"/> Moderate</li> <li><input type="radio"/> Large</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>The analyses identified no outcome suggesting that ultrasound might not be preferred over the landmark technique.</p>	

## Certainty of evidence

What is the overall certainty of the evidence of effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>● Very low</li> <li>○ Low</li> <li>○ Moderate</li> <li>○ High</li> <li>○ No included studies</li> </ul>	<p>All outcomes have very low certainty of evidence, owing to the small study population — only one study was included for this question.</p>	

## Values

Is there important uncertainty about or variability in how much people value the main outcomes?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Important uncertainty or variability</li> <li>● Possibly important uncertainty or variability</li> <li>○ Probably no important uncertainty or variability</li> <li>○ No important uncertainty or variability</li> </ul>	<p>The panel identified pneumothorax, arterial puncture, and the number of cannulation attempts as the most important outcomes.</p>	

## Balance of effects

Does the balance between desirable and undesirable effects favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Favors the comparison</li> <li>○ Probably favors the comparison</li> <li>○ Does not favor either the intervention or the comparison</li> <li>● Probably favors the intervention</li> <li>○ Favors the intervention</li> <li>○ Varies</li> <li>○ Don't know</li> </ul>	<p>No outcome favoured the landmark technique. All outcomes consistently favour ultrasound. The balance of effects therefore clearly favours ultrasound.</p>	

Resources required		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Large costs</li> <li>○ Moderate costs</li> <li>● Negligible costs and savings</li> <li>○ Moderate savings</li> <li>○ Large savings</li> <li>○ Varies</li> <li>○ Don't know</li> </ul>	<p>None of the included studies performed a resource analysis for femoral vein cannulation. In Poland, an ultrasound device is part of the standard equipment of intensive care units (Ministry of Health Regulation, 2022). Under current conditions, ultrasound use for femoral vein cannulation therefore probably does not generate additional procedure-related costs.</p>	
Certainty of evidence of required resources		
What is the certainty of the evidence of resource requirements (costs)?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Very low</li> <li>○ Low</li> <li>○ Moderate</li> <li>○ High</li> <li>● No included studies</li> </ul>	<p>None of the included studies performed a resource analysis for femoral vein cannulation.</p>	
Cost effectiveness		
Does the cost-effectiveness of the intervention favor the intervention or the comparison?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Favors the comparison</li> <li>○ Probably favors the comparison</li> <li>○ Does not favor either the intervention or the comparison</li> <li>○ Probably favors the intervention</li> <li>○ Favors the intervention</li> <li>○ Varies</li> <li>● No included studies</li> </ul>	<p>None of the included studies performed a cost-effectiveness analysis for femoral vein cannulation.</p>	<p>There is evidence that more frequent complications associated with the landmark technique may require urgent interventions and thereby increase the cost of treatment (femoral artery puncture).</p>
Equity		
What would be the impact on health equity?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Reduced</li> <li>○ Probably reduced</li> <li>○ Probably no impact</li> <li>● Probably increased</li> </ul>	<p>Given the lower rate of inadvertent femoral artery puncture with ultrasound, particular benefits may accrue to selected patient groups — in particular conscious patients, patients with haemostatic disorders, patients with advanced atherosclerosis, and chronic dialysis patients.</p>	

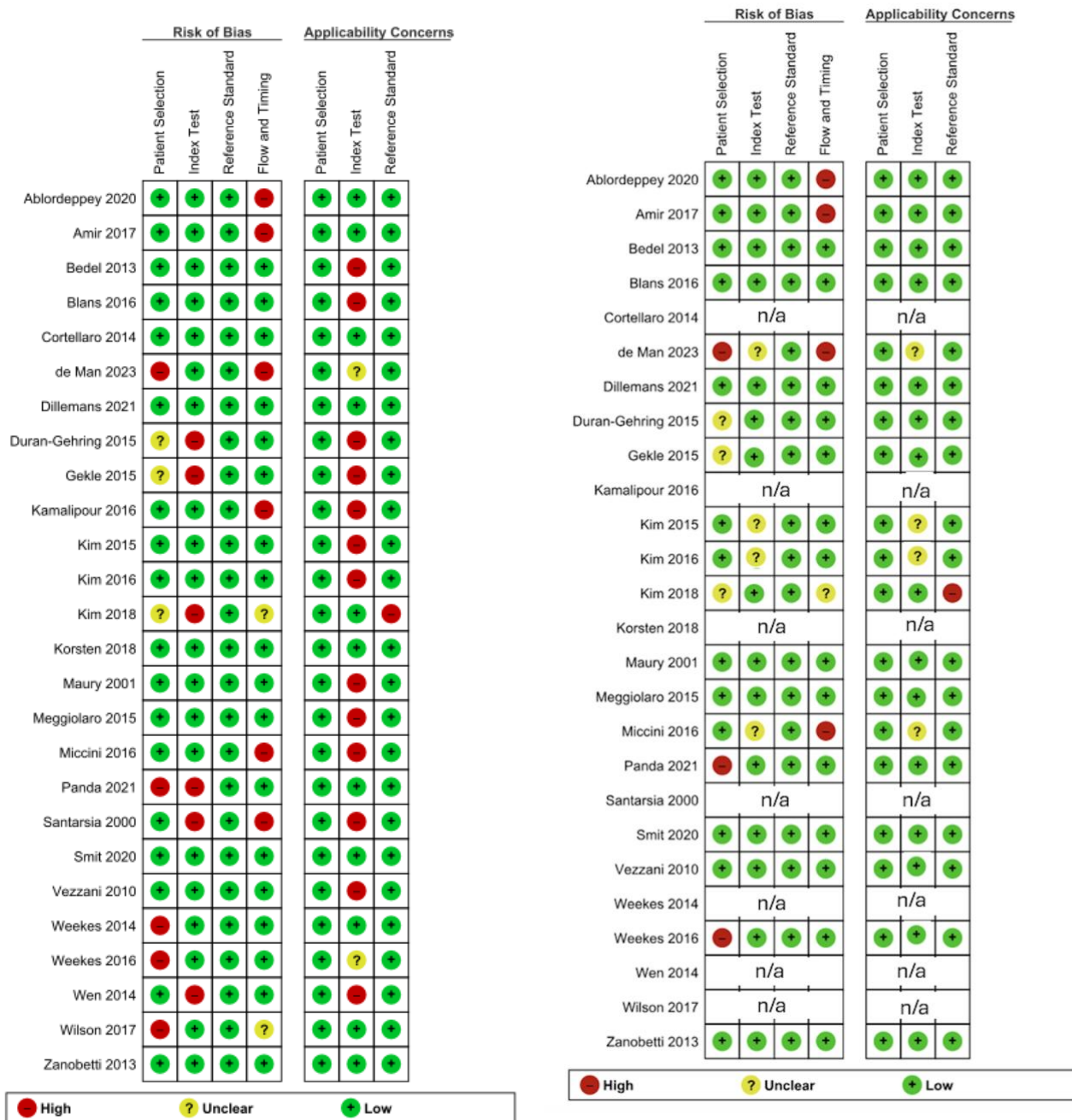
<input type="radio"/> Increased <input type="radio"/> Varies <input type="radio"/> Don't know		
<b>Acceptability</b> Is the intervention acceptable to key interest-holders?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<input type="radio"/> No <input type="radio"/> Probably no <input checked="" type="radio"/> Probably yes <input type="radio"/> Yes <input type="radio"/> Varies <input type="radio"/> Don't know	Use of ultrasound instead of the landmark technique appears to be acceptable to patients (efficacy and safety of ultrasound), medical staff (ease of the procedure and its widespread availability), and healthcare administration (ultrasound is standard ICU equipment).	
<b>Feasibility</b> Is the intervention feasible to implement?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<input type="radio"/> No <input type="radio"/> Probably no <input checked="" type="radio"/> Probably yes <input type="radio"/> Yes <input type="radio"/> Varies <input type="radio"/> Don't know	Yes — ultrasound-guided femoral vein cannulation is relatively easy to implement: 1) ultrasound is part of standard ICU equipment; 2) the procedure has a steep learning curve	

**5. Can ultrasound be used instead of routine post-insertion chest radiography for assessment after CVC placement in ICU patients?**

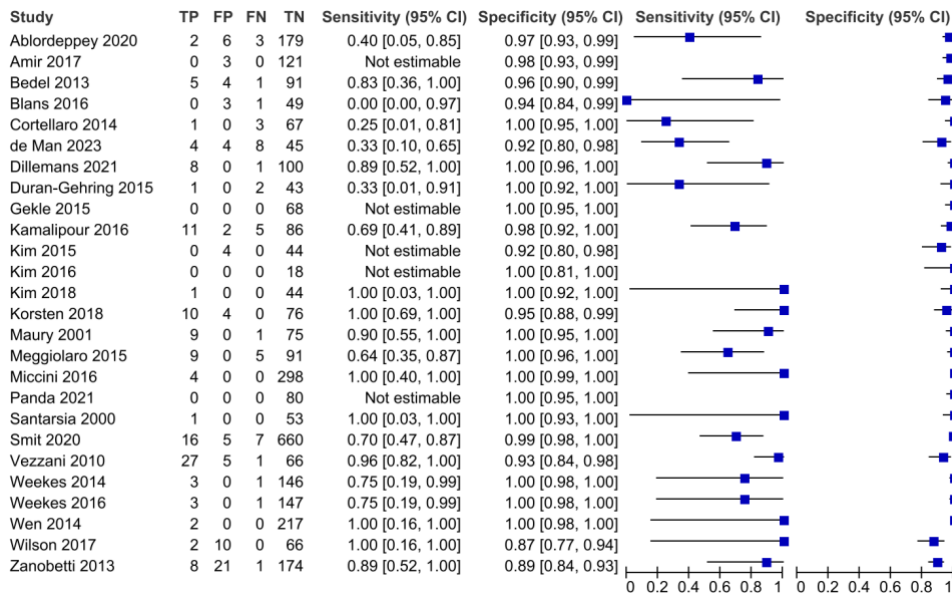
**Results**

A total of 26 observational studies were included for catheter malposition and 19 observational studies for pneumothorax detection. Of these, 9 studies were identified that had been published after the 2018 meta-analysis.

**Risk of bias (QUADAS-2) — left column: catheter malposition; right column: pneumothorax detection**



**Catheter misplacement**



Pooled sensitivity: 0.78 (95% CI 0.64 to 0.87); pooled specificity: 0.99 (95% CI 0.98 to 1.00);  $I^2=32.6\%$

**Rates of true-positive, true-negative, false-positive, and false-negative results, assuming a catheter-malposition prevalence of 5% (# in a cohort of 1000 patients)**

Prevalence: 5%    Sensitivity: 0.78    Specificity: 0.992

	Incorrect needle placement	Correct needle placement
Positive result	True positive: 39 (32–44)	False positive: 7 (2–23)
Negative result	False negative: 11 (6–18)	True negative: 943 (927–948)

Likelihood ratio<sup>+</sup> = 0.78/1-0.99=78

Pre-test odds = 0.05/0.95=0.05263

Post-test odds = 0.05263 x 78 = 4.106

Post-test probability = 4.106/1+4.106 = 0.8047

Post-test probability of disease following a positive test: approximately 80.5%

Likelihood ratio<sup>-</sup> = 1-0.78/0.99=0.222

Pre-test odds = 0.05/0.95=0.05263

Post-test odds = 0.05263 x 0.222 = 0.01169

Post-test probability = 0.01169/1+0.01169 = 0.01155

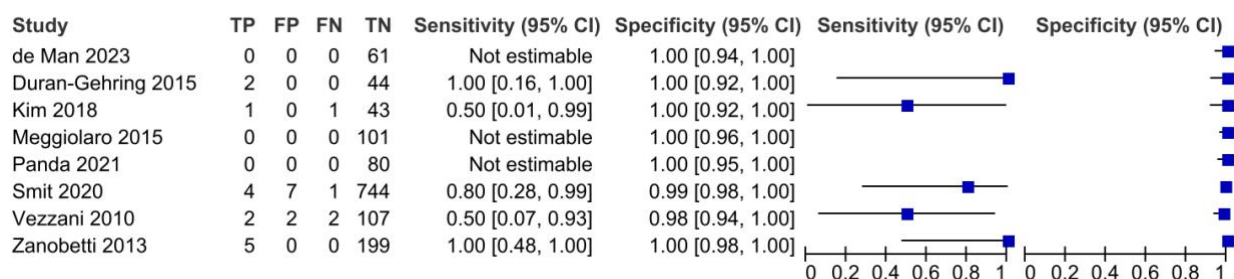
Post-test probability of disease following a negative test: approximately 1.16%

### Certainty of evidence (GRADE) — catheter malposition

Outcome	№ of studies (№ of patients)	Study design	Factors that may decrease certainty of evidence					Effect per 1000 patients tested			Test accuracy CoE	
			Risk of bias	Indirectness	Inconsistency	Imprecision	Publication bias	pre-test probability of 2.5%	pre-test probability of 5%	pre-test probability of 10%		
<b>True positives</b> (patients with catheter misplacement)	26 studies 168 patients	cohort & case-control type studies	not serious	serious <sup>a</sup>	very serious <sup>b,c</sup>	serious <sup>d</sup>	none	20 (16 to 22)	39 (32 to 44)	78 (64 to 87)	⊕○ ○○ Very low <sup>a,b,c,d</sup>	
<b>False negatives</b> (patients incorrectly classified as not having catheter misplacement)								5 (3 to 9)	11 (6 to 18)	22 (13 to 36)		
<b>True negatives</b> (patients without catheter misplacement)	26 studies 3343 patients	cohort & case-control type studies	not serious	serious <sup>a</sup>	very serious <sup>b,c</sup>	not serious	strong association	965 (956 to 975)	941 (931 to 950)	891 (882 to 900)		⊕⊕ ○○ Low <sup>a,b,c</sup>
<b>False positives</b> (patients incorrectly classified as having catheter misplacement)								10 (0 to 19)	9 (0 to 19)	9 (0 to 18)		

**Footnotes to the above table:** a. The effect of operator experience is difficult to estimate. b. The studies used different definitions of "catheter malposition". c. The studies used different ultrasound methods, including CEUS. d. Wide 95% CIs spanning both support for and against using ultrasound instead of chest radiography.

### Pneumothorax



Pooled sensitivity: 0.84 (95% CI 0.43 to 0.97); pooled specificity: 1.00 (95% CI 0.97 to 1.00); I<sup>2</sup>=0%

**Rates of true-positive, true-negative, false-positive, and false-negative results, assuming a pneumothorax prevalence of 1% (# in a cohort of 1000 patients)**

Prevalence: 1% Sensitivity: 0.84 Specificity: 1.00

	<b>Pneumothorax</b>	<b>No pneumothorax</b>
Positive result	True positive: 8 (4–11)	False positive: 2 (0–6)
Negative result	False negative: 4 (0–28)	True negative: 986 (962–990)

Likelihood ratio<sup>+</sup> = 0.84/0.01=84

Pre-test odds = 0.01/0.99=0.010101

Post-test odds = 0.010101 x 84 = 0.8484

Post-test probability = 0.8484/1+0.8484 = 0.4595

Post-test probability of disease following a positive test: approximately 46%

Likelihood ratio<sup>-</sup> = 1-0.84=0.1616

Pre-test odds = 0.01/0.99=0.010101

Post-test odds = 0.010101 x 0.1616 = 0.001634

Post-test probability = 0.001634/1+0.001634 = 0.00163

Post-test probability of disease following a negative test: approximately 0.16%

**Certainty of evidence (GRADE) — pneumothorax**

Outcome	№ of studies (№ of patients)	Study design	Factors that may decrease certainty of evidence					Effect per 1000 patients tested			Test accuracy CoE
			Risk of bias	Indirectness	Inconsistency	Imprecision	Publication bias	pre-test probability of 1%	pre-test probability of 2.5%	pre-test probability of 5%	
<b>True positives</b> (patients with pneumothorax)	8 studies 18 patients	cohort & case-control type studies	not serious	serious <sup>a</sup>	not serious	very serious <sup>b</sup>	none	8 (4 to 10)	21 (11 to 24)	42 (22 to 49)	⊕○ ○ ○ Very low <sup>a,b</sup>
<b>False negatives</b> (patients incorrectly classified as not)								2 (0 to 6)	4 (1 to 14)	8 (1 to 28)	

Outcome	№ of studies (№ of patients)	Study design	Factors that may decrease certainty of evidence					Effect per 1000 patients tested			Test accuracy CoE
			Risk of bias	Indirectness	Inconsistency	Imprecision	Publication bias	pre-test probability of 1%	pre-test probability of 2.5%	pre-test probability of 5%	
having pneumothorax)											
<b>True negatives</b> (patients without pneumothorax)	8 studies 1360 patients	cohort & case-control type studies	not serious	serious <sup>a</sup>	not serious	not serious	strong association	986 (962 to 990)	971 (948 to 975)	946 (923 to 950)	⊕⊕⊕ ⊕ High <sup>a</sup>
<b>False positives</b> (patients incorrectly classified as having pneumothorax)							4 (0 to 28)	4 (0 to 27)	4 (0 to 27)		

**Footnotes to the above table:** a. The effect of operator experience is difficult to estimate. b. The 95% CIs are very wide and span both support for ultrasound and against using it in place of chest radiography.

## Evidence-to-decision pathway

Problem Is the problem a priority?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<input type="radio"/> No <input type="radio"/> Probably no <input checked="" type="radio"/> Probably yes <input type="radio"/> Yes <input type="radio"/> Varies <input type="radio"/> Don't know	<p>Many studies have been conducted (26 for catheter malposition and 19 for pneumothorax detection) on the use of ultrasound as a routine diagnostic test after central catheter placement. The rate of catheter malposition is approximately 5% (1 in 20 cannulations) and the rate of pneumothorax approximately 1% (1 in 100 cannulations), so these complications represent a meaningful proportion of the thousands of central catheters placed in the ICU. The panel therefore concluded that the question of whether ultrasound should be preferred over routine chest radiography is probably a priority, since any recommendation could affect a large patient population. A move away from routine chest radiography could have a substantial impact on healthcare organisation, hospital finances, and the workload of medical staff.</p>	

## Test accuracy

How accurate is the test?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Very inaccurate</li> <li>○ Inaccurate</li> <li>● Accurate</li> <li>○ Very accurate</li> <li>○ Varies</li> <li>○ Don't know</li> </ul>	<p><b>A) Catheter malposition (both "CEUS" and "non-CEUS"):</b></p> <ul style="list-style-type: none"> <li>— Test sensitivity 0.78 (95% CI: 0.64 to 0.87);</li> <li>— Test specificity 0.99 (95% CI: 0.98 to 1.00);</li> </ul> <p>When ultrasound is used to rule out catheter malposition, the main concern is its relatively lower sensitivity than chest radiography (78%). The main problem with this test will therefore be a number of false-negative results. In addition, the rate of catheter malposition (with variability in how this is defined) is approximately 5% (1 in 20 cases). This means that with a positive test (e.g. catheter in the right atrium), the probability that the catheter is indeed malpositioned is approximately 80%. With a negative test (i.e. catheter in the correct position), the probability that the catheter is in fact malpositioned is only 1.15%. <b>In summary, ultrasound is a good method for ruling out catheter malposition.</b></p> <p>It is for the panel to decide whether the post-test probability (1.15% with a false-negative result) is low enough to abandon routine chest radiography.</p> <p><b>B) Pneumothorax ("lung sliding" + "lung point"):</b></p> <ul style="list-style-type: none"> <li>— Test sensitivity 0.84 (95% CI: 0.42 to 0.98);</li> <li>— Test specificity 0.99 (95% CI: 0.98 to 1.00);</li> </ul> <p>When ultrasound is used to rule out pneumothorax, the main concern is its relatively lower sensitivity than chest radiography (84%). The main problem with this test will therefore be a number of false-negative results. However, the low pneumothorax rate (1%) means that the negative likelihood ratio yields a post-test probability of 0.16%. This means that with a negative test ruling out pneumothorax, the probability that the patient actually had a pneumothorax is 0.16%. Considering the positive likelihood ratio — i.e. when pneumothorax is detected on ultrasound — the probability that the patient truly had a pneumothorax (post-test probability) is 46%, so definitive confirmation requires further diagnostic testing. <b>In summary, ultrasound is a very good method for ruling out pneumothorax after central venous cannulation.</b></p> <p>It is for the panel to decide whether the post-test probability (0.16% with a false-negative result) is low enough to abandon routine chest radiography. It should</p>	<p>There is variability in diagnostic algorithms. This is particularly important for ruling out catheter malposition. Different methods were used — for example, contrast assistance or scanning of various anatomical sites. It should also be noted that the analysis of catheter position did not address ultrasound "guidewire tracking". Incorporating this element might improve the sensitivity of ultrasound for assessing catheter position.</p> <p>For ruling out pneumothorax, the panel restricted analysis to studies using an algorithm that included assessment of lung sliding and detection of the lung point.</p> <p>In trauma patients, ultrasound shows very high diagnostic performance — according to the Cochrane review (Chan et al., 2020), ultrasound sensitivity was 91% (95% CI: 85–94%) and specificity 99% (95% CI: 97–100%), substantially exceeding the sensitivity of supine chest radiography (47%).</p>

	be noted that the post-test probability for pneumothorax diagnosis (46%) is too low to forgo additional diagnostic methods (including chest radiography).	
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## Desirable Effects

How substantial are the desirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Trivial</li> <li>○ Small</li> <li>○ Moderate</li> <li>○ Large</li> <li>○ Varies</li> <li>● Don't know</li> </ul>	<p>In general, there are no studies of differences in patient-important outcomes as a function of the diagnostic test used (ultrasound vs chest radiography). The available analyses allow only assessment of the time difference between performing ultrasound and chest radiography. Ultrasound allows approximately 8-fold faster exclusion of complications such as catheter malposition and pneumothorax. Ultrasound: 6 (4–11) min vs chest radiography: 45 (29–65) min.</p>	<p>All other potential effects — such as influence on therapeutic management, complications, and other outcomes — can only be inferred theoretically.</p> <ol style="list-style-type: none"> <li>1) Faster detection of complications will probably be associated with faster intervention</li> <li>2) Discontinuing routine chest radiography will reduce exposure to ionising radiation</li> <li>3) Ultrasound assessment, being repeatable, allows serial evaluation of the development and dynamics of a pneumothorax, which is more difficult with chest radiography.</li> </ol>

## Undesirable Effects

How substantial are the undesirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Trivial</li> <li>○ Small</li> <li>○ Moderate</li> <li>○ Large</li> <li>○ Varies</li> <li>● Don't know</li> </ul>	<p>No studies are available on differences in patient-important outcomes as a function of the diagnostic test used (ultrasound vs chest radiography). No potentially harmful effects of ultrasound were identified.</p>	<p>The potential harms of using ultrasound alone could relate to the risk of false-negative results — situations in which complications are not detected on ultrasound. This may lead to delayed diagnosis and, consequently, to adverse clinical outcomes such as delayed catheter repositioning or delayed treatment of pneumothorax.</p> <p>The timing of ultrasound after catheter placement may theoretically influence its sensitivity for detecting pneumothorax. If ultrasound is performed early, the pneumothorax may not yet have reached a detectable size and may be missed — unlike routine chest radiography performed later. It should be emphasised, however, that clinically</p>

		significant pneumothoraces usually produce symptoms that will most likely be noticed by medical staff regardless of the imaging modality used.
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**Certainty of the evidence of test accuracy**

What is the overall certainty of the evidence of test accuracy?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>● Very low</li> <li>○ Low</li> <li>○ Moderate</li> <li>○ High</li> <li>○ No included studies</li> </ul>	<p><b>A) Catheter malposition (both "CEUS" and "non-CEUS"):</b></p> <p>— Test sensitivity — very low certainty of evidence,            — Test specificity — low certainty of evidence.</p> <p>The most important factors that limited the certainty of evidence were: 1) the effect of operator experience on ultrasound performance is difficult to estimate; 2) substantial variability in ultrasound algorithms between studies (including use of contrast and assessment of different anatomical sites). In addition, wide 95% confidence intervals for sensitivity were observed, which further reduced the certainty of evidence.</p> <p><b>B) Pneumothorax ("lung sliding" + "lung point"):</b></p> <p>— Test sensitivity — very low certainty of evidence,            — Test specificity — high certainty of evidence.</p> <p>As with catheter position assessment, the effect of operator experience on the diagnostic performance of ultrasound is difficult to estimate. In addition, for sensitivity, very wide 95% confidence intervals were observed (0.43 to 0.97), which substantially reduces confidence in any specific sensitivity value.</p>	

**Certainty of the evidence of test's effects**

What is the overall certainty of the evidence for any critical or important direct benefits, adverse effects or burden of the test?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Very low</li> <li>○ Low</li> <li>○ Moderate</li> <li>○ High</li> <li>● No included studies</li> </ul>	<p>No studies are available on differences in patient-important outcomes as a function of the diagnostic test used (ultrasound vs chest radiography).</p>	

### Certainty of the evidence of management's effects

What is the overall certainty of the evidence of effects of the management that is guided by the test results?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<input type="radio"/> Very low <input type="radio"/> Low <input type="radio"/> Moderate <input type="radio"/> High <input checked="" type="radio"/> No included studies	No studies are available on interventions implemented after diagnostic testing.	

### Certainty of the evidence of test result/management

How certain is the link between test results and management decisions?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<input type="radio"/> Very low <input type="radio"/> Low <input type="radio"/> Moderate <input type="radio"/> High <input checked="" type="radio"/> No included studies	No studies are available on the influence of diagnostic testing on therapeutic decision-making.	

### Certainty of effects

What is the overall certainty of the evidence of effects of the test?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<input type="radio"/> Very low <input type="radio"/> Low <input type="radio"/> Moderate <input type="radio"/> High <input checked="" type="radio"/> No included studies	No studies are available on the effects of using ultrasound or chest radiography.	

### Values

Is there important uncertainty about or variability in how much people value the main outcomes?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<input type="radio"/> Important uncertainty or variability <input type="radio"/> Possibly important uncertainty or variability <input type="radio"/> Probably no important uncertainty or variability <input checked="" type="radio"/> No important uncertainty or variability	The panel unanimously identified pneumothorax as the most critical patient-important outcome. It should be noted, however, that the studies addressed diagnostic accuracy rather than impact on patient prognosis.	Based on the available data, the panel could assess only test accuracy; there is no evidence on how the diagnostic test influences subsequent management, complications, or other outcomes.

## Balance of effects

Does the balance between desirable and undesirable effects favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Favors the comparison</li> <li>○ Probably favors the comparison</li> <li>○ Does not favor either the intervention or the comparison</li> <li>● Probably favors the intervention</li> <li>○ Favors the intervention</li> <li>○ Varies</li> <li>○ Don't know</li> </ul>	<p><b>Efekty pozytywne:</b></p> <p>All other potential effects — such as influence on therapeutic management, complications, and other outcomes — can only be inferred theoretically.</p> <ol style="list-style-type: none"> <li>1) Faster detection of complications will probably be associated with faster intervention</li> <li>2) Discontinuing routine chest radiography will reduce exposure to ionising radiation</li> <li>3) Ultrasound assessment, being repeatable, allows serial evaluation of the development and dynamics of a pneumothorax, which is more difficult with chest radiography.</li> </ol> <p><b>Efekty negatywne:</b></p> <p>The potential harms attributable to ultrasound alone would relate to a number of false-negative cases — situations in which patients with a given complication are not detected by ultrasound. This could lead to delayed detection of these complications and to adverse treatment outcomes (e.g. delayed catheter repositioning or delayed pneumothorax management).</p> <p>Note — the interval between CVC placement and ultrasound may theoretically influence the sensitivity of ultrasound for detecting pneumothorax. If ultrasound is performed early, the pneumothorax may not yet have grown to a size detectable by routine chest radiography. However, clinically significant pneumothoraces will produce symptoms that will most likely draw the attention of medical staff regardless of the imaging modality used.</p> <hr/> <p>The panel concluded that ultrasound may be preferred over chest radiography, provided that:</p> <ol style="list-style-type: none"> <li>1) The operator is proficient in ultrasound;</li> <li>2) The reported test sensitivities are reliable;</li> <li>3) The panel regards pneumothorax as a more critical outcome than catheter malposition;</li> <li>4) The patient has good conditions for ultrasound assessment;</li> <li>5) There is consensus on the considerations made by the panel</li> </ol>	

Resources required		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Large costs</li> <li>○ Moderate costs</li> <li>○ Negligible costs and savings</li> <li>○ Moderate savings</li> <li>● Large savings</li> <li>○ Varies</li> <li>○ Don't know</li> </ul>	No data from the included studies.	Abandoning routine chest radiography will reduce the workload of staff (nurses, radiologists, radiology technicians, porters) and reduce the use of radiology equipment.
Certainty of evidence of required resources		
What is the certainty of the evidence of resource requirements (costs)?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Very low</li> <li>○ Low</li> <li>○ Moderate</li> <li>○ High</li> <li>● No included studies</li> </ul>	No data from the included studies.	
Cost effectiveness		
Does the cost-effectiveness of the intervention favor the intervention or the comparison?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Favors the comparison</li> <li>○ Probably favors the comparison</li> <li>○ Does not favor either the intervention or the comparison</li> <li>○ Probably favors the intervention</li> <li>○ Favors the intervention</li> <li>○ Varies</li> <li>● No included studies</li> </ul>		The panel considers that, where routine chest radiography is abandoned, healthcare systems will see financial benefits.

## Equity

What would be the impact on health equity?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<input type="radio"/> Reduced <input type="radio"/> Probably reduced <input checked="" type="radio"/> Probably no impact <input type="radio"/> Probably increased <input type="radio"/> Increased <input type="radio"/> Varies <input type="radio"/> Don't know	<p>No data. The panel did not identify any particular populations that would be specific beneficiaries of abandoning routine chest radiography.</p>	

## Acceptability

Is the intervention acceptable to key interest-holders?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<input type="radio"/> No <input type="radio"/> Probably no <input checked="" type="radio"/> Probably yes <input type="radio"/> Yes <input type="radio"/> Varies <input type="radio"/> Don't know	<p>Ultrasound is likely to be acceptable to the main interest groups:</p> <ol style="list-style-type: none"> <li>1) Patients — less exposure to ionising radiation and to additional procedures, with any associated stress.</li> <li>2) Hospital administration — lower costs</li> <li>3) Radiology staff and porters — reduced workload</li> <li>4) ICU physicians — the panel considers that ICU physicians may be the only group with less support for ultrasound, since performing ultrasound requires appropriate skills, partly entails performing an additional procedure, and carries greater responsibility.</li> </ol>	

## Feasibility

Is the intervention feasible to implement?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<input type="radio"/> No <input type="radio"/> Probably no <input checked="" type="radio"/> Probably yes <input type="radio"/> Yes <input type="radio"/> Varies <input type="radio"/> Don't know	<p>The panel concluded that routine introduction of ultrasound instead of chest radiography may be feasible, provided that ICU physicians have appropriate post-procedural ultrasound skills. The panel does not foresee feasibility problems from the perspective of radiology staff or hospital administration.</p>	

## **6. What is the role of positioning maneuvers during CVC placement in ICU patients? — Trendelenburg position for internal jugular vein cannulation**

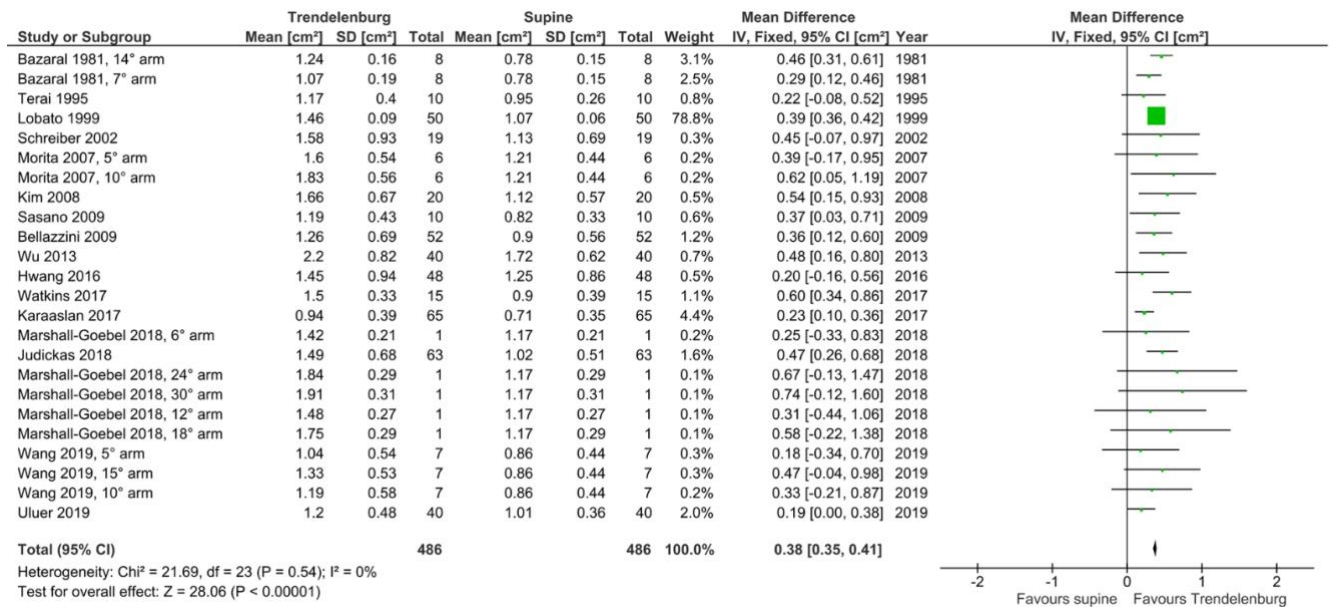
### **Results**

A total of 16 observational studies were included, in which ultrasound was used to assess anatomical conditions after Trendelenburg positioning. All included studies were part of the 2023 meta-analysis. The studies mainly concerned the right internal jugular vein.

### **Risk of bias**

Overall risk of bias was rated as high. The main problem was that some studies were not blinded to the operator — the operator knew the patient was in the Trendelenburg position, which creates a natural tendency to overestimate measurements. In addition, there is inherent *publication bias* — studies are most often published only when they demonstrate a significant effect of the maneuver.

### **Cross-sectional area of the internal jugular vein**



### Certainty of evidence (GRADE)

Certainty assessment							N <sup>o</sup> of patients		Effect		Certainty
Outcome	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	tredelenburg position	horizontal position	Relative (95% CI)	Absolute (95% CI)	
Cross-sectional area (CSA)	non-randomised studies	serious <sup>a</sup>	not serious	very serious <sup>b</sup>	not serious	none	486	486	-	MD 0.38 cm <sup>2</sup> higher (0.35 higher to 0.41 higher)	⊕○○○ Very low <sup>a,b</sup>

Footnotes to the above table: a. Studies with high risk of bias owing to lack of blinding in some studies. b. Vessel cross-sectional area is not a patient-important outcome.

### Evidence-to-decision pathway (GRADE)

Problem		
Is the problem a priority?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> No</li> <li><input type="radio"/> Probably no</li> <li><input checked="" type="radio"/> Probably yes</li> <li><input type="radio"/> Yes</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>Central venous cannulation is one of the most common procedures performed in intensive care patients. The most frequent complications of CVC placement are catheter malposition (approximately 5%) and pneumothorax (approximately 1%). The use of appropriate positioning maneuvers appears justified to increase the efficacy and safety of internal jugular vein cannulation.</p>	
Desirable Effects		
How substantial are the desirable anticipated effects?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Trivial</li> <li><input type="radio"/> Small</li> <li><input type="radio"/> Moderate</li> <li><input checked="" type="radio"/> Large</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>Cross-sectional area (CSA): MD 0.38 cm<sup>2</sup> greater (95% CI 0.35 to 0.41) in favour of Trendelenburg position — large effect.</p>	<p>An increase in the cross-sectional area of the internal jugular vein may improve cannulation conditions by enlarging the vessel cross-section, thereby increasing the probability of successful venous puncture. This may be particularly important in hypovolaemic patients.</p>
Undesirable Effects		
How substantial are the undesirable anticipated effects?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Trivial</li> <li><input type="radio"/> Small</li> <li><input type="radio"/> Moderate</li> <li><input type="radio"/> Large</li> <li><input type="radio"/> Varies</li> <li><input checked="" type="radio"/> Don't know</li> </ul>	<p>The analysis addressed only vessel cross-sectional area, not patient-important outcomes. Accordingly, no adverse effects of this method were detected.</p>	<p>Use of the Trendelenburg position may theoretically be associated with:</p> <ul style="list-style-type: none"> <li>— increased intracranial pressure</li> <li>— impaired ventilation, particularly in patients with respiratory failure</li> <li>— discomfort in conscious patients</li> <li>— potential increase in regurgitation risk</li> <li>— potential increase in intraocular pressure</li> </ul>

Certainty of evidence		
What is the overall certainty of the evidence of effects?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>● Very low</li> <li>○ Low</li> <li>○ Moderate</li> <li>○ High</li> <li>○ No included studies</li> </ul>	<p>Certainty of evidence was rated "very low" because of the absence of direct studies on the efficacy of central catheter placement.</p>	
Values		
Is there important uncertainty about or variability in how much people value the main outcomes?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Important uncertainty or variability</li> <li>○ Possibly important uncertainty or variability</li> <li>● Probably no important uncertainty or variability</li> <li>○ No important uncertainty or variability</li> </ul>	<p>The panel identified successful cannulation and pneumothorax detection as the most important outcomes. Vessel size was rated as a moderately important outcome.</p>	
Balance of effects		
Does the balance between desirable and undesirable effects favor the intervention or the comparison?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Favors the comparison</li> <li>○ Probably favors the comparison</li> <li>○ Does not favor either the intervention or the comparison</li> <li>● Probably favors the intervention</li> <li>○ Favors the intervention</li> <li>○ Varies</li> <li>○ Don't know</li> </ul>	<p>An increase in the cross-sectional area of the internal jugular vein may improve cannulation conditions and increase the probability of successful venous puncture. However, there are theoretical contraindications to this method (described above), so any panel recommendation will apply to selected cases.</p>	
Resources required		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Large costs</li> <li>○ Moderate costs</li> <li>● Negligible costs and savings</li> <li>○ Moderate savings</li> <li>○ Large savings</li> <li>○ Varies</li> <li>○ Don't know</li> </ul>	<p>No data on resources.</p>	<p>Effective and straightforward performance of the Trendelenburg maneuver requires a bed capable of this maneuver.</p>

## Certainty of evidence of required resources

What is the certainty of the evidence of resource requirements (costs)?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Very low</li> <li><input type="radio"/> Low</li> <li><input type="radio"/> Moderate</li> <li><input type="radio"/> High</li> <li><input checked="" type="radio"/> No included studies</li> </ul>	No data on resources.	

## Cost effectiveness

Does the cost-effectiveness of the intervention favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Favors the comparison</li> <li><input type="radio"/> Probably favors the comparison</li> <li><input type="radio"/> Does not favor either the intervention or the comparison</li> <li><input checked="" type="radio"/> Probably favors the intervention</li> <li><input type="radio"/> Favors the intervention</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> No included studies</li> </ul>	No data on cost analysis.	

## Equity

What would be the impact on health equity?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Reduced</li> <li><input type="radio"/> Probably reduced</li> <li><input type="radio"/> Probably no impact</li> <li><input type="radio"/> Probably increased</li> <li><input type="radio"/> Increased</li> <li><input checked="" type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	The main beneficiaries of this method are likely to be patients with a very small vessel cross-sectional area (e.g. hypovolaemic patients and those with very low central venous pressure). Conversely, patients with pulmonary or cerebral pathology may experience potential harm from the Trendelenburg maneuver.	

## Acceptability

Is the intervention acceptable to key stakeholders?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> No</li> <li><input type="radio"/> Probably no</li> <li><input checked="" type="radio"/> Probably yes</li> <li><input type="radio"/> Yes</li> <li><input type="radio"/> Varies</li> </ul>	The panel concluded that the procedure will probably be acceptable to all interest groups. However, in some conscious patients the Trendelenburg position may be associated with unpleasant subjective sensations and	

○ Don't know	discomfort, which may worsen cannulation conditions.	
<b>Feasibility</b> Is the intervention feasible to implement?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ○ Probably yes ● Yes ○ Varies ○ Don't know	The panel concluded that positioning the patient in Trendelenburg is cost-free and simple to perform, and therefore appears feasible.	

## 7. What is the role of positioning maneuvers during CVC placement in ICU patients? — Trendelenburg position for subclavian/axillary vein cannulation

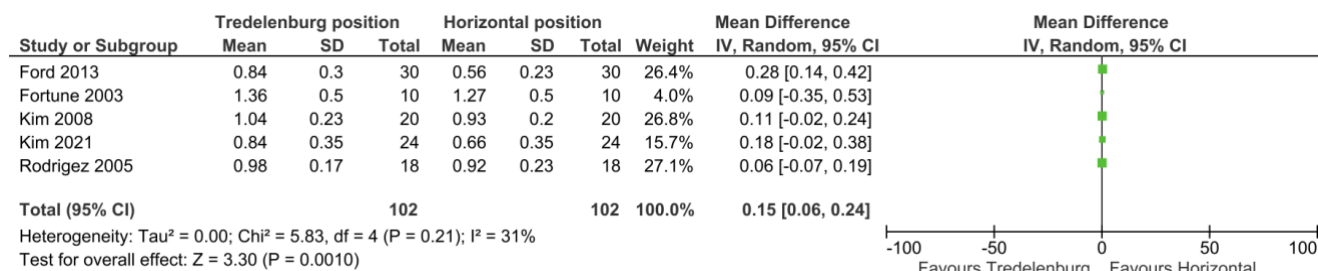
### Results

A total of 5 observational studies were included, in which ultrasound was used to assess anatomical conditions after Trendelenburg positioning. All included studies were identified through a literature review.

### Risk of bias

Risk of bias was rated as high. The main problem was that some studies were not blinded to the operator — the operator knew the patient was in the Trendelenburg position, which creates a natural tendency to overestimate measurements. In addition, there is inherent *publication bias* — studies are most often published only when they demonstrate a significant effect of the maneuver.

### Cross-sectional area of the subclavian/axillary vein



## Certainty of evidence (GRADE)

Certainty assessment							N <sup>o</sup> of patients		Effect		Certainty
Outcome	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Trendelenburg position	Horizontal position	Relative (95% CI)	Absolute (95% CI)	
Cross-sectional area (CSA)	non-randomised studies	serious <sup>a</sup>	not serious	very serious <sup>b</sup>	not serious	publication bias strongly suspected <sup>c</sup>	102	102	-	MD 0.15 cm <sup>2</sup> higher (0.06 higher to 0.24 higher)	⊕○○○ ○ Very low <sup>a,b,c</sup>

**Footnotes to the above table:** a. Studies with high risk of bias, mainly due to lack of investigator blinding. b. Vessel cross-sectional area is not a patient-important outcome. c. The nature of the studies strongly suggests probable publication bias.

## Evidence-to-decision pathway (GRADE)

Problem		
Is the problem a priority?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> No</li> <li><input type="radio"/> Probably no</li> <li><input checked="" type="radio"/> Probably yes</li> <li><input type="radio"/> Yes</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>Central venous cannulation is one of the most common procedures performed in intensive care patients. The most frequent complications of CVC placement are catheter malposition (approximately 5%) and pneumothorax (approximately 1%). The use of specific positioning maneuvers therefore appears justified to increase the efficacy and safety of axillary/subclavian vein cannulation.</p>	
Desirable Effects		
How substantial are the desirable anticipated effects?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Trivial</li> <li><input type="radio"/> Small</li> <li><input checked="" type="radio"/> Moderate</li> <li><input type="radio"/> Large</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>Cross-sectional area (CSA): MD 0.15 cm<sup>2</sup> greater (95% CI 0.06 to 0.24) in favour of Trendelenburg position — large effect.</p>	<p>An increase in the cross-sectional area of the axillary/subclavian vein may improve cannulation conditions by enlarging the vessel cross-section, thereby increasing the probability of successful venous</p>

		puncture. This may be particularly important in hypovolaemic patients.
<b>Undesirable Effects</b> How substantial are the undesirable anticipated effects?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<input type="radio"/> Trivial <input type="radio"/> Small <input type="radio"/> Moderate <input type="radio"/> Large <input type="radio"/> Varies <input checked="" type="radio"/> Don't know	The analysis addressed only vessel cross-sectional area, not patient-important outcomes. Accordingly, no adverse effects of this method were detected.	Use of the Trendelenburg position may theoretically be associated with: <ul style="list-style-type: none"> <li>— increased intracranial pressure</li> <li>— impaired ventilation, particularly in patients with respiratory failure</li> <li>— discomfort for patients associated with this position</li> <li>— potential increase in regurgitation risk</li> <li>— potential increase in intraocular pressure</li> </ul>
<b>Certainty of evidence</b> What is the overall certainty of the evidence of effects?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<input type="radio"/> Very low <input type="radio"/> Low <input type="radio"/> Moderate <input type="radio"/> High <input type="radio"/> No included studies	Certainty of evidence was rated "very low" because of the absence of direct studies on the efficacy of central catheter cannulation.	
<b>Values</b> Is there important uncertainty about or variability in how much people value the main outcomes?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<input type="radio"/> Important uncertainty or variability <input type="radio"/> Possibly important uncertainty or variability <input checked="" type="radio"/> Probably no important uncertainty or variability <input type="radio"/> No important uncertainty or variability	The panel identified successful cannulation and pneumothorax detection as the most important outcomes. Vessel size was rated as a moderately important outcome.	

## Balance of effects

Does the balance between desirable and undesirable effects favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Favors the comparison</li> <li><input type="radio"/> Probably favors the comparison</li> <li><input type="radio"/> Does not favor either the intervention or the comparison</li> <li><input checked="" type="radio"/> Probably favors the intervention</li> <li><input type="radio"/> Favors the intervention</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>An increase in the cross-sectional area of the subclavian/axillary vein may improve cannulation conditions and increase the probability of successful venous puncture. However, there are theoretical contraindications to this method (described above), so any panel recommendation will apply to selected cases.</p>	

## Resources required

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Large costs</li> <li><input type="radio"/> Moderate costs</li> <li><input checked="" type="radio"/> Negligible costs and savings</li> <li><input type="radio"/> Moderate savings</li> <li><input type="radio"/> Large savings</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>No data on resources.</p>	<p>Effective and straightforward performance of the Trendelenburg maneuver requires beds capable of this maneuver.</p>

## Certainty of evidence of required resources

What is the certainty of the evidence of resource requirements (costs)?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Very low</li> <li><input type="radio"/> Low</li> <li><input type="radio"/> Moderate</li> <li><input type="radio"/> High</li> <li><input checked="" type="radio"/> No included studies</li> </ul>	<p>No data on resources.</p>	

## Cost effectiveness

Does the cost-effectiveness of the intervention favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"><li><input type="radio"/> Favors the comparison</li><li><input type="radio"/> Probably favors the comparison</li><li><input type="radio"/> Does not favor either the intervention or the comparison</li><li><input type="radio"/> Probably favors the intervention</li><li><input type="radio"/> Favors the intervention</li><li><input type="radio"/> Varies</li><li><input checked="" type="radio"/> No included studies</li></ul>	No data on cost analysis.	

## Equity

What would be the impact on health equity?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"><li><input type="radio"/> Reduced</li><li><input type="radio"/> Probably reduced</li><li><input type="radio"/> Probably no impact</li><li><input type="radio"/> Probably increased</li><li><input type="radio"/> Increased</li><li><input checked="" type="radio"/> Varies</li><li><input type="radio"/> Don't know</li></ul>	The main beneficiaries of this method are likely to be patients with a very narrow vessel lumen — for example, hypovolaemic patients and those with very low central venous pressure. Conversely, patients with respiratory failure or signs of intracranial hypertension may experience potential harm from the Trendelenburg maneuver.	

## Acceptability

Is the intervention acceptable to key interest-holders?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"><li><input type="radio"/> No</li><li><input type="radio"/> Probably no</li><li><input checked="" type="radio"/> Probably yes</li><li><input type="radio"/> Yes</li><li><input type="radio"/> Varies</li><li><input type="radio"/> Don't know</li></ul>	The panel concluded that the procedure will probably be acceptable to all interest groups. However, in some conscious patients the Trendelenburg position may be associated with unpleasant subjective sensations and discomfort, which may worsen cannulation conditions.	

## Feasibility

Is the intervention feasible to implement?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"><li><input type="radio"/> No</li><li><input type="radio"/> Probably no</li><li><input type="radio"/> Probably yes</li><li><input checked="" type="radio"/> Yes</li><li><input type="radio"/> Varies</li></ul>	The panel concluded that this procedure is cost-free and simple to perform, and therefore appears feasible.	

○ Don't know		
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## 8. What is the role of positioning maneuvers during CVC placement in ICU patients? — reverse Trendelenburg position for femoral vein cannulation

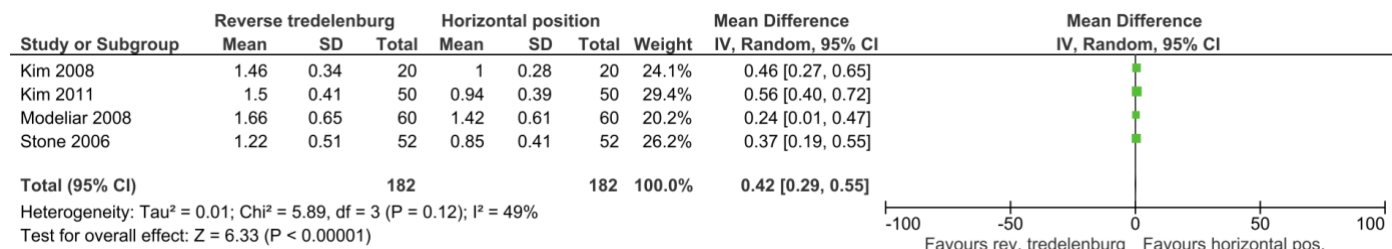
### Results

A total of 4 observational studies were included, in which ultrasound was used to assess anatomical conditions during reverse Trendelenburg positioning. All included studies were identified through a literature review.

### Risk of bias

Overall risk of bias was rated as high. The main problem was that some studies were not blinded to the operator — the operator knew the patient was in the reverse Trendelenburg position, which creates a natural tendency to overestimate measurements. In addition, there is inherent *publication bias* — studies are most often published only when they demonstrate a significant effect of the maneuver.

### Cross-sectional area of the femoral vein



### Certainty of evidence (GRADE)

Certainty assessment							N <sup>o</sup> of patients		Effect		Certainty
Outcome	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	reverse Trendelenburg position	horizontal position	Relative (95% CI)	Absolute (95% CI)	
Cross-sectional area (CSA)	non-randomised studies	serious <sup>a</sup>	not serious	very serious <sup>b</sup>	not serious	publication bias strongly suspected <sup>c</sup>	182	182	-	MD 0.42 cm <sup>2</sup> higher (0.29 higher to 0.55 higher)	⊕○○○ ○ Very low <sup>a,b,c</sup>

**Footnotes to the above table:** b. Vessel cross-sectional area is not a patient-important outcome. c. It seems likely that such publications would not have been published had they not demonstrated an effect.

## Evidence-to-decision pathway (GRADE)

Problem		
Is the problem a priority?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> No</li> <li><input type="radio"/> Probably no</li> <li><input checked="" type="radio"/> Probably yes</li> <li><input type="radio"/> Yes</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>Central venous cannulation is one of the most common procedures performed in intensive care patients. The most frequent complications of CVC placement are catheter malposition (approximately 5%) and pneumothorax (approximately 1%).</p> <p>The use of specific positioning maneuvers therefore appears justified to increase the efficacy and safety of femoral vein cannulation.</p>	
Desirable Effects		
How substantial are the desirable anticipated effects?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Trivial</li> <li><input type="radio"/> Small</li> <li><input type="radio"/> Moderate</li> <li><input checked="" type="radio"/> Large</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>Cross-sectional area (CSA): MD 0.42 cm<sup>2</sup> greater (95% CI 0.29 to 0.55) in favour of reverse Trendelenburg position — large effect.</p>	<p>An increase in the cross-sectional area of the femoral vein may improve cannulation conditions and increase the probability of successful venous puncture. This may be particularly important in hypovolaemic patients. In addition, in patients with raised intracranial pressure, the reverse Trendelenburg</p>

		position may further reduce intracranial pressure.
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**Undesirable Effects**  
How substantial are the undesirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Trivial</li> <li>○ Small</li> <li>○ Moderate</li> <li>○ Large</li> <li>○ Varies</li> <li>● Don't know</li> </ul>	<p>The analysis addressed only vessel cross-sectional area, not patient-important outcomes. Accordingly, no adverse effects of this method were detected.</p>	<p>Use of the reverse Trendelenburg position may theoretically be associated with:</p> <p>— haemodynamic deterioration related to a potential reduction in venous return</p>

**Certainty of evidence**  
What is the overall certainty of the evidence of effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>● Very low</li> <li>○ Low</li> <li>○ Moderate</li> <li>○ High</li> <li>○ No included studies</li> </ul>	<p>Certainty of evidence was rated "very low" because of the absence of direct studies on cannulation efficacy.</p>	

**Values**  
Is there important uncertainty about or variability in how much people value the main outcomes?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Important uncertainty or variability</li> <li>○ Possibly important uncertainty or variability</li> <li>● Probably no important uncertainty or variability</li> <li>○ No important uncertainty or variability</li> </ul>	<p>The panel identified successful cannulation and pneumothorax detection as the most important outcomes. Vessel size was rated as a moderately important outcome.</p>	

## Balance of effects

Does the balance between desirable and undesirable effects favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"><li><input type="radio"/> Favors the comparison</li><li><input type="radio"/> Probably favors the comparison</li><li><input type="radio"/> Does not favor either the intervention or the comparison</li><li><input checked="" type="radio"/> Probably favors the intervention</li><li><input type="radio"/> Favors the intervention</li><li><input type="radio"/> Varies</li><li><input type="radio"/> Don't know</li></ul>	An increase in the cross-sectional area of the femoral vein may improve cannulation conditions and increase the probability of successful venous puncture. However, there are theoretical contraindications to this method (described above), so any panel recommendation will apply to selected cases.	

## Resources required

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"><li><input type="radio"/> Large costs</li><li><input type="radio"/> Moderate costs</li><li><input checked="" type="radio"/> Negligible costs and savings</li><li><input type="radio"/> Moderate savings</li><li><input type="radio"/> Large savings</li><li><input type="radio"/> Varies</li><li><input type="radio"/> Don't know</li></ul>	No data on resources.	Effective and straightforward use of the reverse Trendelenburg position requires beds capable of this maneuver.

## Certainty of evidence of required resources

What is the certainty of the evidence of resource requirements (costs)?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"><li><input type="radio"/> Very low</li><li><input type="radio"/> Low</li><li><input type="radio"/> Moderate</li><li><input type="radio"/> High</li><li><input checked="" type="radio"/> No included studies</li></ul>		

## Cost effectiveness

Does the cost-effectiveness of the intervention favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"><li><input type="radio"/> Favors the comparison</li><li><input type="radio"/> Probably favors the comparison</li><li><input type="radio"/> Does not favor either the intervention or the comparison</li><li><input type="radio"/> Probably favors the intervention</li><li><input type="radio"/> Favors the intervention</li><li><input type="radio"/> Varies</li><li><input checked="" type="radio"/> No included studies</li></ul>	No data on cost analysis.	

## Equity

What would be the impact on health equity?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"><li><input type="radio"/> Reduced</li><li><input type="radio"/> Probably reduced</li><li><input type="radio"/> Probably no impact</li><li><input type="radio"/> Probably increased</li><li><input type="radio"/> Increased</li><li><input checked="" type="radio"/> Varies</li><li><input type="radio"/> Don't know</li></ul>	The main beneficiaries of this method are likely to be patients with a very small femoral vein cross-sectional area — for example, hypovolaemic patients or those with very low central venous pressure. Conversely, patients with severe cardiovascular failure may experience potential harm from the reverse Trendelenburg position.	

## Acceptability

Is the intervention acceptable to key stakeholders?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"><li><input type="radio"/> No</li><li><input type="radio"/> Probably no</li><li><input checked="" type="radio"/> Probably yes</li><li><input type="radio"/> Yes</li><li><input type="radio"/> Varies</li><li><input type="radio"/> Don't know</li></ul>	The panel concluded that the procedure will probably be acceptable to all interest groups.	

## Feasibility

Is the intervention feasible to implement?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"><li><input type="radio"/> No</li><li><input type="radio"/> Probably no</li><li><input type="radio"/> Probably yes</li><li><input checked="" type="radio"/> Yes</li><li><input type="radio"/> Varies</li><li><input type="radio"/> Don't know</li></ul>	The panel concluded that this procedure is cost-free and simple to perform, and therefore appears feasible.	

**9. What is the role of positioning maneuvers during CVC placement in ICU patients? — arm abduction during subclavian/axillary vein cannulation**

**Results**

A total of **5 randomised trials (4 using ultrasound and 1 using the landmark technique) were included**, which assessed the safety and efficacy of arm abduction (the so-called "stop sign"). Four observational studies assessing anatomical conditions during this maneuver were also included. All included studies were identified through a literature search.

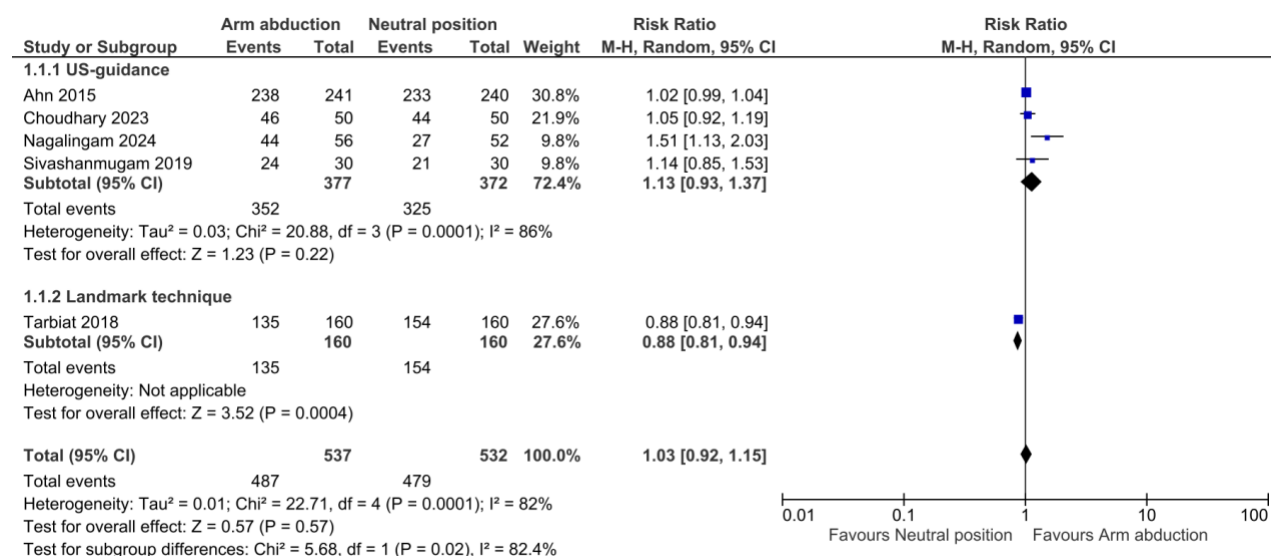
	Randomization	Intended intervention	Missing data	Outcome measurement	Selective reporting	Overall
Ahn 2015	+	+	+	+	+	+
Choudhary 2023	○	+	-	+	+	-
Nagalingam 2024	+	+	+	+	○	○
Sivashanmugam 2019	+	+	+	+	○	○
Tarbiat 2018	+	+	+	+	-	-

**Risk of bias (RoB-2) — randomised trials**

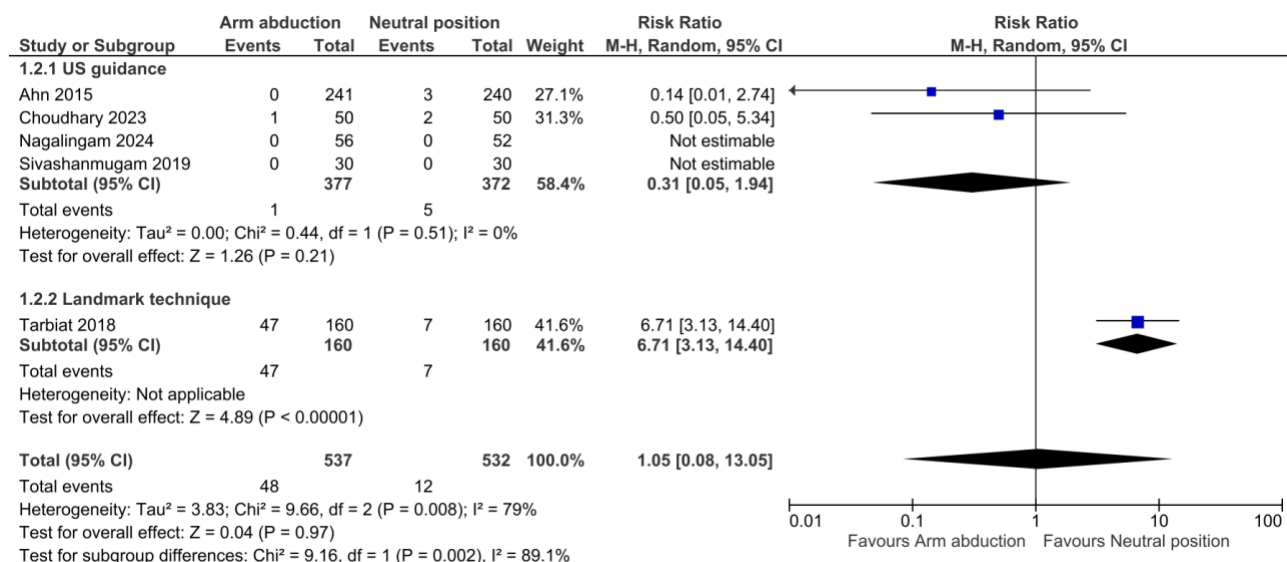
**Risk of bias — observational studies**

Overall risk of bias was rated as high. The main problem with the observational studies was that some were not blinded to the operator — the operator knew the patient's arm was abducted, which creates a natural tendency to overestimate measurements. In addition, there is inherent *publication bias* — studies are most often published only when they demonstrate a significant effect of the maneuver.

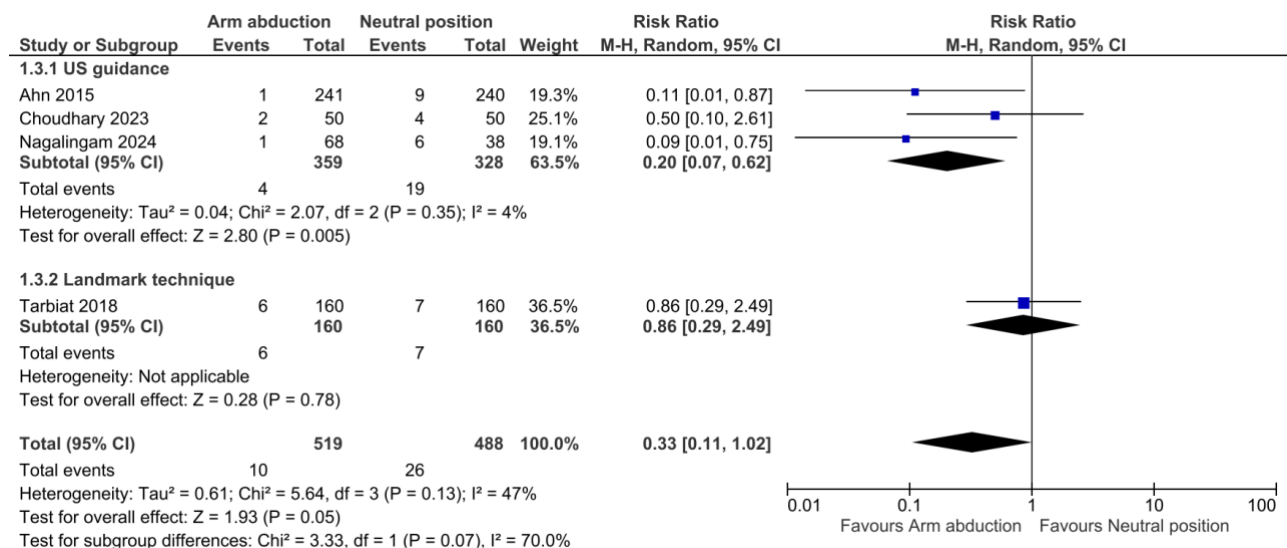
### Cannulation success — RCTs



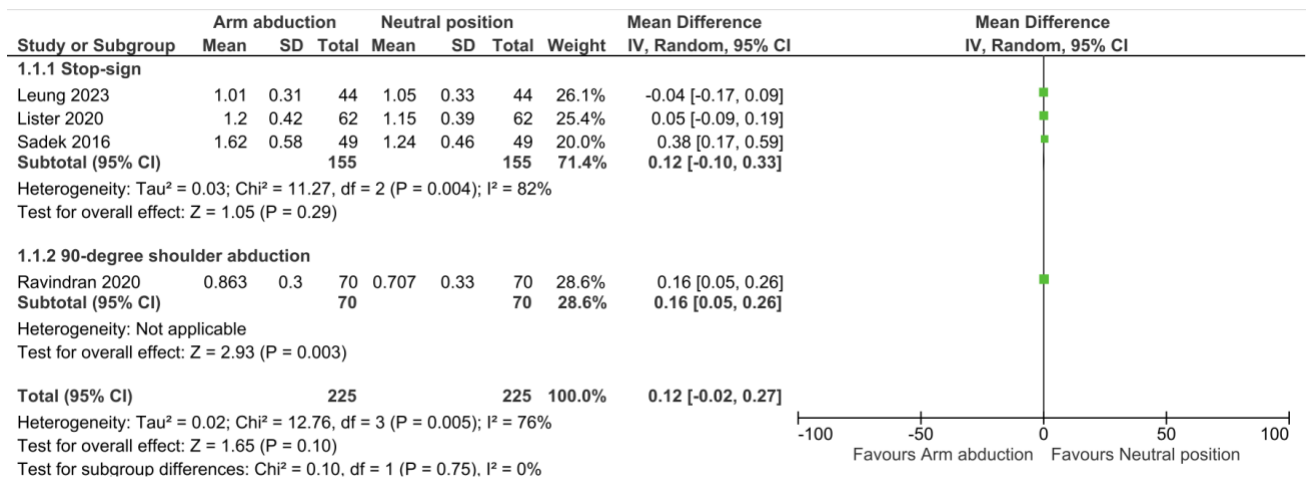
### Mechanical complications (arterial puncture, haematoma, pneumothorax) — RCTs



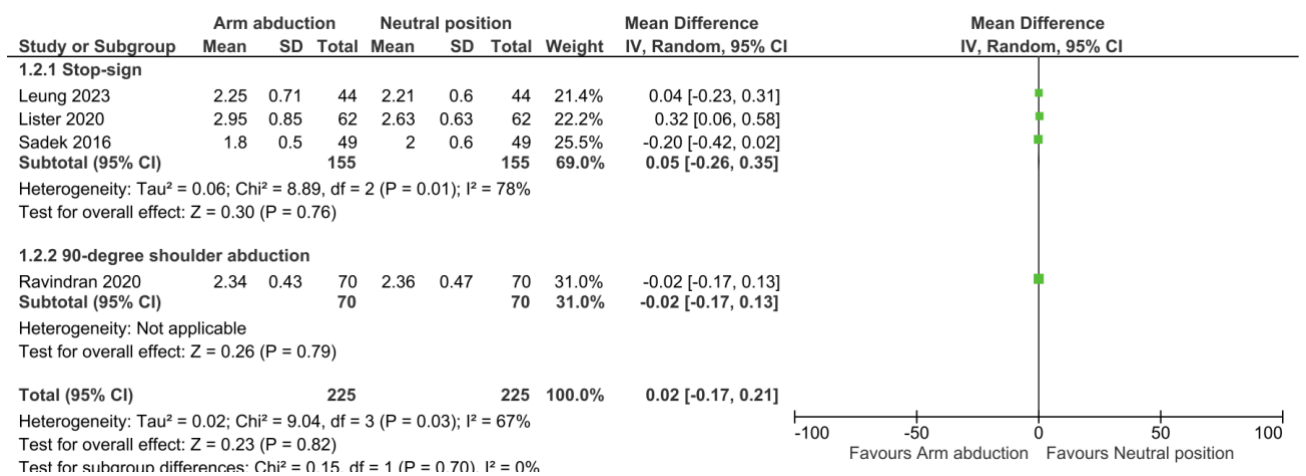
## Catheter malposition — RCTs



## Vessel cross-sectional area — observational studies








## Skin-to-vein distance — observational studies



## Certainty of evidence (GRADE)

Certainty assessment							№ of patients		Effect		Certainty
Outcome	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	arm abduction	neutral arm position	Relative (95% CI)	Absolute (95% CI)	
Success	randomised trials	serious <sup>b</sup>	serious <sup>c</sup>	not serious <sup>d</sup>	serious <sup>c</sup>	none	487/537 (90.7%)	479/532 (90.0%)	<b>RR 1.03</b> (0.92 to 1.15)	<b>27 more per 1000</b> (from 72 fewer to 135 more)	⊕○○○ Very low <sup>b,c,d,e</sup>
Complications (ultrasound)	randomised trials	serious <sup>b</sup>	not serious	not serious	serious <sup>a,c</sup>	none	1/377 (0.3%)	5/372 (1.3%)	<b>RR 0.31</b> (0.05 to 1.94)	<b>9 fewer per 1000</b> (from 13 fewer to 13 more)	⊕⊕○○ Low <sup>a,b,c</sup>

Certainty assessment							№ of patients		Effect		Certainty
Outcome	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	arm abduction	neutral arm position	Relative (95% CI)	Absolute (95% CI)	
Complications (anatomical landmark technique)	randomised trials	serious <sup>b</sup>	not serious	not serious	very serious <sup>c,f</sup>	none	47/160 (29.4%)	7/160 (4.4%)	RR 6.71 (3.13 to 14.40)	250 more per 1000 (from 93 more to 586 more)	 Very low <sup>b,c,f</sup>
Catheter misplacement (ultrasound)	randomised trials	serious <sup>b</sup>	not serious	not serious	not serious <sup>g</sup>	none	4/359 (1.1%)	19/328 (5.8%)	RR 0.20 (0.07 to 0.62)	46 fewer per 1000 (from 54 fewer to 22 fewer)	 Moderate <sup>b,g</sup>
Catheter misplacement (anatomical landmark technique)	randomised trials	serious <sup>b</sup>	not serious	not serious	serious <sup>f</sup>	none	6/160 (3.8%)	7/160 (4.4%)	RR 0.86 (0.29 to 2.49)	6 fewer per 1000 (from 31 fewer to 65 more)	 Low <sup>b,f</sup>
Cross-sectional area (CSA)	non-randomised studies	not serious	serious <sup>h</sup>	very serious <sup>i</sup>	serious <sup>c</sup>	none	225	225	-	MD 0.12 cm <sup>2</sup> more (0.02 fewer to 0.27 more)	 Very low <sup>c,hi</sup>
Skin-to-vein distance	non-randomised studies	not serious	serious <sup>j</sup>	very serious <sup>k</sup>	serious <sup>c</sup>	none	225	225	-	MD 0.02 cm more (0.17 fewer to 0.21 more)	 Very low <sup>c,j,k</sup>

**Footnotes to the table:** a. Small population. b. Publications with small patient groups. Pre-registered protocols are not available for some studies. c.  $I^2 = 82\%$ . d. 4 of 5 studies use first-attempt success, but it is worth considering whether this is a sufficient outcome for us. e. Wide 95% CIs. f. Only one study with a small patient group. g. Despite wide 95% CIs and a relatively low event rate of the outcome, the absolute event rates indicate a clear effect, so certainty was not downgraded for imprecision. h.  $I^2 = 76\%$ . i. Vessel cross-sectional area is not a patient-important outcome. j.  $I^2 \approx 67\%$ . k. Skin-to-vein distance is not a patient-important outcome.

## Evidence-to-decision pathway

Problem		
Is the problem a priority?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> No</li> <li><input type="radio"/> Probably no</li> <li><input checked="" type="radio"/> Probably yes</li> <li><input type="radio"/> Yes</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>Central venous cannulation is one of the most common procedures performed in intensive care patients. The most frequent complications of CVC placement are catheter malposition (approximately 5%) and pneumothorax (approximately 1%). The use of specific positioning maneuvers therefore appears justified to increase the efficacy and safety of axillary/subclavian vein cannulation.</p>	
Desirable Effects		
How substantial are the desirable anticipated effects?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Trivial</li> <li><input type="radio"/> Small</li> <li><input type="radio"/> Moderate</li> <li><input checked="" type="radio"/> Large</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p><b><u>Arm abduction (or the so-called "stop sign"):</u></b></p> <p><b>A) Catheter malposition:</b> RR 0.33 (0.11 to 1.02) — borderline statistical significance, moderate effect. With ultrasound, a significant effect was observed — RR 0.20 (95% CI 0.07 to 0.62) — large effect. With the landmark technique (1 RCT), no significant effect of arm abduction on catheter malposition was observed.</p>	<p><u>Clear</u> differences are seen between the landmark technique and ultrasound — with the landmark technique, arm abduction is not associated with a reduction in catheter malposition. With ultrasound, the effect is large and suggests that arm abduction is preferable.</p>
Undesirable Effects		
How substantial are the undesirable anticipated effects?		
JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Trivial</li> <li><input type="radio"/> Small</li> <li><input type="radio"/> Moderate</li> <li><input type="radio"/> Large</li> <li><input checked="" type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p><b><u>Arm abduction (or the so-called "stop sign"):</u></b></p> <p><b>A) Successful cannulation:</b> RR 1.03 (95% CI 0.92 to 1.15) — not statistically significant, trivial effect. With the landmark technique (1 RCT), lower success was observed with arm abduction — RR 0.88 (95% CI 0.81 to 0.94).</p> <p><b>B) Mechanical complications:</b> RR 1.05 (95% CI 0.08 to 13.05) — not statistically significant, trivial effect. With the landmark technique (1 RCT), a higher complication rate was observed with arm abduction — RR 6.71 (95% CI 3.13 to 14.40) — large effect. With ultrasound, no statistically significant effect</p>	<p><u>Clear</u> differences are seen between the landmark technique and ultrasound — with the landmark technique, arm abduction is associated with a large increase in the risk of mechanical complications (mainly pneumothorax). With ultrasound, the risk of mechanical complications becomes statistically non-significant.</p>

	<p>was observed — RR 0.31 (95% CI 0.05 to 1.94) — not significant, trivial effect.</p> <p><b>C) Vessel cross-sectional area (CSA):</b> MD 0.12 cm<sup>2</sup> (−0.02 to +0.27) — a statistically non-significant, trivial effect.</p> <p><b>D) Skin-to-vein distance:</b> MD 0.02 cm (−0.17 to +0.21) — a statistically non-significant, trivial effect.</p>	
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**Certainty of evidence**

What is the overall certainty of the evidence of effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Very low</li> <li>● Low</li> <li>○ Moderate</li> <li>○ High</li> <li>○ No included studies</li> </ul>	<p><b>A) Successful cannulation:</b> low certainty of evidence</p> <p><b>B) Mechanical complications: ultrasound</b> — low certainty of evidence; <b>Landmark technique</b> — very low certainty of evidence</p> <p><b>C) Catheter malposition: ultrasound</b> — moderate certainty of evidence; <b>Landmark technique</b> — very low certainty of evidence</p> <p><b>D) Vessel cross-sectional area (CSA)</b> — very low certainty of evidence</p> <p><b>E) Skin-to-vein distance</b> — very low certainty of evidence</p> <p>The panel concluded that the best evidence comes from ultrasound studies and that the most important outcomes are catheter malposition and mechanical complications. The overall certainty of evidence was therefore rated as "low".</p>	

**Values**

Is there important uncertainty about or variability in how much people value the main outcomes?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li>○ Important uncertainty or variability</li> <li>○ Possibly important uncertainty or variability</li> <li>● Probably no important uncertainty or variability</li> <li>○ No important uncertainty or variability</li> </ul>	<p>The panel identified successful cannulation and pneumothorax detection as the most important outcomes. Vessel size was rated as a moderately important outcome.</p>	

## Balance of effects

Does the balance between desirable and undesirable effects favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Favors the comparison</li> <li><input type="radio"/> Probably favors the comparison</li> <li><input type="radio"/> Does not favor either the intervention or the comparison</li> <li><input type="radio"/> Probably favors the intervention</li> <li><input type="radio"/> Favors the intervention</li> <li><input checked="" type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p><b>A) Ultrasound</b> — When ultrasound is used, arm abduction appears reasonable to reduce the risk of catheter malposition. In this setting the maneuver does not appear to carry an increased risk of complications. Arm abduction was not, however, observed to improve cannulation success.</p> <p><b>B) Landmark technique</b> — With the landmark technique, arm abduction appears to be associated with an increased rate of complications (mainly pneumothorax). With this method, arm abduction does not appear to confer any benefit.</p>	<p>The panel's decision should address ultrasound and the landmark technique separately.</p>

## Resources required

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Large costs</li> <li><input type="radio"/> Moderate costs</li> <li><input checked="" type="radio"/> Negligible costs and savings</li> <li><input type="radio"/> Moderate savings</li> <li><input type="radio"/> Large savings</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	<p>No data on resource use as a function of the intervention.</p>	<p>Arm abduction is not associated with increased resource use. It is a simple and inexpensive maneuver.</p>

## Certainty of evidence of required resources

What is the certainty of the evidence of resource requirements (costs)?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Very low</li> <li><input type="radio"/> Low</li> <li><input type="radio"/> Moderate</li> <li><input type="radio"/> High</li> <li><input checked="" type="radio"/> No included studies</li> </ul>	<p>No data on the certainty of evidence regarding resource use.</p>	

## Cost effectiveness

Does the cost-effectiveness of the intervention favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Favors the comparison</li> <li><input type="radio"/> Probably favors the comparison</li> <li><input checked="" type="radio"/> Does not favor either the intervention or the comparison</li> <li><input type="radio"/> Probably favors the intervention</li> <li><input type="radio"/> Favors the intervention</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> No included studies</li> </ul>	No data on the cost-effectiveness of arm abduction.	<p><b>A) Ultrasound:</b> The only potential cost-effectiveness gain from arm abduction would relate to reducing the need for catheter repositioning, and hence to reduced staff workload and lower costs.</p> <p><b>B) Landmark technique:</b> Using arm abduction with the landmark technique appears to increase the rate of mechanical complications and will therefore be associated with higher costs of treating these complications.</p>

## Equity

What would be the impact on health equity?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> Reduced</li> <li><input type="radio"/> Probably reduced</li> <li><input checked="" type="radio"/> Probably no impact</li> <li><input type="radio"/> Probably increased</li> <li><input type="radio"/> Increased</li> <li><input type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	No data on impact on health equity.	

## Acceptability

Is the intervention acceptable to key interest-holders?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> No</li> <li><input type="radio"/> Probably no</li> <li><input type="radio"/> Probably yes</li> <li><input type="radio"/> Yes</li> <li><input checked="" type="radio"/> Varies</li> <li><input type="radio"/> Don't know</li> </ul>	No data on the acceptability of the intervention.	<p><b>A) Ultrasound:</b> The method will probably be acceptable to all interest groups.</p> <p><b>B) Landmark technique:</b> Owing to the potential harm of the method when the landmark technique is used, arm abduction will be unacceptable to both patients and clinicians.</p>

## Feasibility

Is the intervention feasible to implement?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
<ul style="list-style-type: none"> <li><input type="radio"/> No</li> <li><input type="radio"/> Probably no</li> <li><input type="radio"/> Probably yes</li> </ul>	No data on the feasibility of the intervention.	<b>A) Ultrasound:</b> The method will be simple for medical staff to implement.

<ul style="list-style-type: none"><li>○ Yes</li><li>● <b>Varies</b></li><li>○ Don't know</li></ul>		<b>B) Landmark technique:</b> Owing to the potential harm of the method when the landmark technique is used, arm abduction will be unacceptable to both patients and clinicians.
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