Inclusion Criteria
- 0-17 years of age

Exclusion Criteria
- None

Background
This summary includes research-based articles that describe risk factors (age, weight and/or size of vessel and venous access type, catheter size) for central venous catheter complications (infection, line malfunction, thrombosis, vessel stenosis, vessel occlusion) and research-based articles that describe ultrasound and landmark technique in catheter placement.

Critically Analyze the Evidence
The GRADE criteria were used to evaluate the quality of evidence presented in research articles reviewed during the development of this guideline. The table below defines how the quality of evidence is rated and how a strong versus a weak recommendation is established.

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Type of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong</td>
<td>Desirable effects clearly outweigh undesirable effects or vice versa</td>
</tr>
<tr>
<td>Weak</td>
<td>Desirable effects closely balanced with undesirable effects</td>
</tr>
<tr>
<td>Quality</td>
<td>Type of Evidence</td>
</tr>
<tr>
<td>High</td>
<td>Consistent evidence from well-performed RCTs or exceptionally strong evidence from unbiased observational studies</td>
</tr>
<tr>
<td>Moderate</td>
<td>Evidence from RCTs with important limitations (e.g., inconsistent results, methodological flaws, indirect evidence, or imprecise results) or unusually strong evidence from unbiased observational studies</td>
</tr>
<tr>
<td>Low</td>
<td>Evidence for at least 1 critical outcome from observational studies, from RCTs with serious flaws or indirect evidence</td>
</tr>
<tr>
<td>Very Low</td>
<td>Evidence for at least 1 critical outcome from unsystematic clinical observations or very indirect evidence</td>
</tr>
</tbody>
</table>

PICO Question 1: In children requiring central venous access, are there criteria for age, weight, and/or size of vessel with regards to venous access type (PICC vs. TCVC vs. Port) and catheter size that will lessen chance of complication occurrence (e.g., infections, line malfunction, thrombosis, vessel stenosis, vessel occlusion)?

Recommendation(s):
Strong recommendation with low quality evidence that in children <1 year of age or <10 kilograms receiving a CVC via subclavian or internal jugular vein, a catheter <6F should be used. (1-6)
Strong recommendation with low quality evidence that CVC tips need to be placed centrally. (1-6)
Strong recommendation with moderate quality evidence that ports should not be placed in the lateral inframammary position and tunneled central venous catheters should be placed in the internal jugular vein over the subclavian vein. (14)

A review of the literature yielded 1 retrospective cohort study regarding age/weight and CVC complications. (2) Janik (2004) included children less than the age of 5 who underwent subclavian or internal jugular CVC placement. (2) Age, height, weight, primary disease, access site, type of CVC, and complications were noted. In children less than the age of 1 year or weighing less than 10 kilograms, with CVC placed in subclavian or internal jugular vein, less than a 6F catheter should be used. (2) Larger catheter size was a risk factor for complications after controlling for confounders.

A review of the literature yielded 3 retrospective cohort studies regarding tip location and CVC complications. (3,4,6) Jumani (2013) reviewed 2500 PICCs in their study regarding complication risk factors and concluded that a non-central tip location (midline and midclavicular) had a higher incidence of complication than centrally placed tips (43.8% vs. 16.2%, p <0.001). (3) Non-central tip placement was associated with noninfectious complications regardless of dwell time. Jain (2013) reviewed tip location in the neonate cohort and concluded similar findings, that non-central tip placement is associated with mechanical and infiltration complications (47% vs. 29%, p = 0.001). (16)
A review of the literature yielded 1 randomized controlled trial and 1 retrospective cohort study regarding vessel selection and CVC complications. (1,5) CVCs were randomized to either the subclavian or internal jugular vein group. Long-term complications did not differ between groups. A statistical difference was detected in overall complications between the subclavian and internal jugular group (48% vs. 23%, p = 0.02). (5)

No relevant articles in the literature in the last 10 years were found regarding optimal size of vessel to size of catheter.

**PICO Question 2:** In children, does ultrasound during catheter placement (compared to ultrasound guidance) decrease incidence of complications (infections, line malfunction, thrombosis, vessel stenosis, vessel occlusion)?

**Recommendation(s):**
- Weak recommendation with moderate quality evidence that ultrasound decreases the incidence of complications in catheters placed in the femoral vein. (2,7-14)
- Strong recommendation with moderate quality evidence that ultrasound decreases incidence of complications in catheters placed in the internal jugular vein. (2,7-14)
- Weak recommendation with moderate quality evidence that ultrasound decreases incidence of complications in catheters placed in the subclavian vein. (2,7-14)

A review of the literature yielded 3 randomized controlled trials and 1 retrospective cohort study regarding ultrasound versus landmark technique for catheter placement in the femoral vein. (7-10) All of the studies demonstrated no difference in successful cannulation rate between the ultrasound-guided group and the landmark group; successful cannulation was high in both groups. (7-9) The 3 randomized controlled trials did not report any differences in complications; the occurrence of complications was low and the studies were not powered to detect complications. (7-9) A retrospective cohort study conducted by Froehlich, et al., stated that the number of complications (venous punctures) was lower in the ultrasound group (8.5% vs. 19.4%, p = 0.03). Median number of cannulation attempts were fewer with ultrasound than landmark (3 vs. 1, p = 0.001). (10)

A review of the literature yielded 3 randomized controlled trials and 1 retrospective cohort study regarding ultrasound versus landmark technique for catheter placement in the internal jugular vein. (11-14) All articles demonstrated that ultrasound-guided catheter placement reduced the number of cannulation attempts in patients. Chuan (2005) demonstrated that the complication rate was lower for patients receiving an ultrasound-guided catheter compared to the landmark techniques (3.1% vs. 26.7%, p = 0.025). (11) The number of cannulation attempts was also lower in the ultrasound group than the landmark group (1.5 attempts vs. 2.5 attempts, p = 0.001). (11)

A review of the literature yielded 1 randomized controlled trial regarding ultrasound versus landmark technique for catheter placement in the subclavian vein. Bruzoni (2012) demonstrated that the ultrasound-guided technique has a higher success at first attempt compared to the landmark techniques in the subclavian vein (65% vs. 45%, p = 0.021). (13) Successful cannulation after 3 attempts was achieved at a rate of 95% with the use of ultrasound compared to 74% with the use of landmark (p = 0.0001). (13) Fewer complications were detected in the ultrasound group compared to the landmark group when placing catheters in the subclavian vein.

**Critical Points of Evidence**

**Evidence Supports**
- In children <1 year of age or <10 kilograms receiving a CVC via subclavian or internal jugular vein, a catheter <6F should be used. (14) – Strong recommendation, low quality evidence.
- CVC tips should be placed centrally. (14) – Strong recommendation, low quality evidence
- Ultrasound decreases the incidence of complications in catheters placed in the femoral or subclavian vein. (2,7-14) – Weak recommendation, moderate quality evidence
- Ultrasound decreases incidence of complications in catheters placed in the internal jugular vein. (2,7-14) – Strong recommendation, moderate quality evidence

**Evidence Against**
- Ports should not be placed in lateral inframammary position. Tunneled central venous catheters should be placed in the internal jugular vein over the subclavian vein. (14) – Strong recommendation, moderate quality evidence

**Evidence Lacking/Inconclusive**
- There is no evidence in the pediatric literature that suggests an optimal size of vessel to size of catheter ratio.

*NOTE: The references cited represent the entire body of evidence reviewed to make each recommendation.*
References


Clinical Standards Preparation

This clinical standard was prepared by the Evidence-Based Outcomes Center (EBOC) team in collaboration with content experts at Texas Children’s Hospital. Development of this clinical standard supports the TCH Quality and Patient Safety Program initiative to promote clinical standards and outcomes that build a culture of quality and safety within the organization.

EBP Course Participants and EBOC Support
Shireen Hayatghaibi, MPH, Radiology
Daniel Ashton, MD, Radiology
Christine Procido, MPH, Evidence-Based Practice Specialist
Charles Macias, MD, MPH, Medical Director

Additional EBOC Support
Tom Burke, Research Assistant
Karen Gibbs, MSN/MPH, RN, Evidence-Based Practice Specialist
Andrea Jackson, MBA, RN, Evidence-Based Practice Specialist
Betsy Lewis, MSN, RN, CNL, Evidence-Based Practice Specialist
Jennifer Loveless, MPH, Evidence-Based Practice Specialist
Sheesha Porter, MS, RN, Evidence-Based Practice Specialist
Anne Dykes, MSN, RN, Assistant Director

Development Process

This clinical standard was developed using the process outlined in the EBOC Manual. The literature appraisal documents the following steps:

1. Review Preparation
   - PICO questions established
   - Evidence search confirmed with content experts
2. Review of Existing External Guidelines
   - N/A
3. Literature Review of Relevant Evidence
   - Searched: PubMed
4. Critically Analyze the Evidence
   - 6 randomized controlled trials, 21 nonrandomized studies
5. Summarize the Evidence
   - Materials used in the development of the clinical standard, literature appraisal, and any order sets are maintained in a Central Venous Catheter evidence-based review manual within EBOC.

Evaluating the Quality of the Evidence

Published clinical guidelines were evaluated for this review using the AGREE II criteria. The summary of these guidelines are included in the literature appraisal. AGREE II criteria evaluate the following categories:

- Guideline Scope and Purpose
- Stakeholder Involvement
- Rigor of Development
- Clarity and Presentation
- Applicability
- Editorial Independence

Using 4-point Likert scale, the higher the score, the more comprehensive the guideline.

This clinical standard specifically summarizes the evidence in support of or against specific interventions and identifies where evidence is lacking/inconclusive. The following categories describe how research findings provide support for treatment interventions:

- "Evidence Supports" provides evidence to support an intervention
- "Evidence Against" provides evidence against an intervention

Recommendations

Practice recommendations were directed by the existing evidence and consensus amongst the content experts. Patient and family preferences were included when possible. The Content Expert Team and EBOC team remain aware of controversies in Central Venous Catheter Standardization in children. Evidence is lacking, options in care are provided in the clinical standard and the accompanying order sets (if applicable).

Approval Process

Clinical standards are reviewed and approved by hospital committees as deemed appropriate for its intended use. Clinical standards are reviewed as necessary within EBOC at Texas Children’s Hospital. Content Expert Teams are involved with every review and update.

Disclaimer

Practice recommendations are based upon the evidence available at the time the clinical standard was developed. Clinical standards (guidelines, summaries, or pathways) do not set out the standard of care and are not intended to be used to dictate a course of care. Each physician/practitioner must use his or her independent judgment in the management of any specific patient and is responsible, in consultation with the patient and/or the patient’s family, to make the ultimate judgment regarding care.

Version History

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<th>Date</th>
<th>Action</th>
<th>Comments</th>
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<tbody>
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<td>Fall 2015</td>
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