



## Guideline Summary NGC-9168

### Guideline Title

**Guidelines for performing ultrasound guided vascular cannulation: recommendations of the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists.**

### Bibliographic Source(s)

Troianos CA, Hartman GS, Glas KE, Skubas NJ, Eberhardt RT, Walker JD, Reeves ST, Councils on Intraoperative Echocardiography and Vascular Ultrasound [trunc]. Guidelines for performing ultrasound guided vascular cannulation: recommendations of the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists. *J Am Soc Echocardiogr.* 2011 Dec;24(12):1291-318. [96 references] [PubMed](#)

### Guideline Status

This is the current release of the guideline.

### Scope

#### Disease/Condition(s)

Any disease or condition requiring vascular cannulation

#### Guideline Category

Management

Risk Assessment

#### Clinical Specialty

Anesthesiology

Cardiology

Critical Care

Emergency Medicine

Family Practice

Infectious Diseases

Internal Medicine

Nephrology

Pediatrics

Radiology

Surgery

Thoracic Surgery

#### Intended Users

Advanced Practice Nurses

Allied Health Personnel

Hospitals

Nurses

Physician Assistants

Physicians

## Guideline Objective(s)

- To provide comprehensive practice guidelines on the use of ultrasound for vascular cannulation
- To discuss the role of ultrasound for vascular cannulation of pediatric patients and the use of ultrasound to facilitate arterial cannulation and peripheral venous access

## Target Population

Adult and pediatric patients undergoing vascular cannulation

## Interventions and Practices Considered

1. Ultrasound-guided central venous access
  - Internal jugular vein cannulation
  - Subclavian vein cannulation
  - Femoral vein cannulation
2. Ultrasound orientation
  - Short axis (SAX)
  - Long axis (LAX)
  - Oblique orientation
3. Real-time versus static imaging
4. Ultrasound-guided cannulation of pediatric patients
5. Ultrasound-guided arterial cannulation (real-time ultrasound not recommended routinely for arterial cannulation in general)
6. Ultrasound-guided peripheral venous cannulation (not recommended routinely)
7. Vascular access confirmation
8. Training in cognitive and technical skills for ultrasound use

## Major Outcomes Considered

- Overall cannulation success rate
- First attempt success rate
- Number of failed catheter placements
- Time to successful cannulation
- Number of attempts to successful cannulation
- Complication rates
- Outcomes in relation to operator experience

## Methodology

### Methods Used to Collect/Select the Evidence

Searches of Electronic Databases

### Description of Methods Used to Collect/Select the Evidence

The writing committee conducted a comprehensive search of medical and scientific literature in the English language through the use of PubMed and MEDLINE. Original research studies relevant to ultrasound-guided vascular access published in peer-reviewed scientific journals from 1990 to 2011 were reviewed using the Medical Subject Headings terms "ultrasonography," "catheterization-central venous/adverse effects/methods," "catheterization-peripheral," "jugular veins," "subclavian vein," "femoral vein," "artery," "adult," "pediatric," "randomized controlled trials," and "meta-analysis."

### Number of Source Documents

Not stated

### Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

### Rating Scheme for the Strength of the Evidence

#### Categories of Support from Scientific Evidence

*Category A: Supportive Literature*

Randomized controlled trials report statistically significant ( $P < .01$ ) differences between clinical interventions for a specified clinical outcome.

Level 1: The literature contains multiple randomized controlled trials, and the aggregated findings are supported by meta-analysis.

analysis.

Level 2: The literature contains multiple randomized controlled trials, but there is an insufficient number of studies to conduct a viable meta-analysis for the purpose of these guidelines.

Level 3: The literature contains a single randomized controlled trial.

#### *Category B: Suggestive Literature*

Information from observational studies permits inference of beneficial or harmful relationships among clinical interventions and clinical outcomes.

Level 1: The literature contains observational comparisons (e.g., cohort and case-control research designs) of two or more clinical interventions or conditions and indicates statistically significant differences between clinical interventions for a specified clinical outcome.

Level 2: The literature contains noncomparative observational studies with associative (e.g., relative risk, correlation) or descriptive statistics.

Level 3: The literature contains case reports.

#### *Category C: Equivocal Literature*

The literature cannot determine whether there are beneficial or harmful relationships among clinical interventions and clinical outcomes.

Level 1: Meta-analysis did not find significant differences among groups or conditions.

Level 2: There is an insufficient number of studies to conduct meta-analysis, and 1) randomized controlled trials have not found significant differences among groups or conditions, or 2) randomized controlled trials report inconsistent findings.

Level 3: Observational studies report inconsistent findings or do not permit inference of beneficial or harmful relationships.

#### *Category D: Insufficient Evidence from Literature*

The lack of scientific evidence in the literature is described by the following conditions:

1. No identified studies address the specified relationships among interventions and outcomes.
2. The available literature cannot be used to assess the relationships among clinical interventions and clinical outcomes. The literature either does not meet the criteria for content as defined in the "focus" of the guidelines or does not permit a clear interpretation of findings because of methodologic concerns (e.g., confounding in study design or implementation).

Source: American Society of Anesthesiologists and Society of Cardiovascular Anesthesiologists Task Force on Transesophageal Echocardiography. Practice guidelines for perioperative transesophageal echocardiography. An updated report by the American Society of Anesthesiologists and the Society of Cardiovascular Anesthesiologists Task Force on Transesophageal Echocardiography. *Anesthesiology* 2010;112:1084-96.

## **Methods Used to Analyze the Evidence**

Review of Published Meta-Analyses

Systematic Review with Evidence Tables

## **Description of the Methods Used to Analyze the Evidence**

The committee reviewed the scientific evidence for the strength of the recommendation (i.e., risk/benefit ratio) as supportive evidence (category A), suggestive evidence (category B), equivocal evidence (category C), or insufficient evidence (category D). The weight or "level" of evidence was assigned within each category (see the "Rating Scheme for the Strength of the Evidence" field).

## **Methods Used to Formulate the Recommendations**

Not stated

## **Rating Scheme for the Strength of the Recommendations**

Not applicable

## **Cost Analysis**

A formal cost analysis was not performed and published cost analyses were not reviewed.

## **Method of Guideline Validation**

Peer Review

## **Description of Method of Guideline Validation**

The document was reviewed by 10 reviewers nominated by the American Society of Echocardiography (ASE) and the Society of Cardiovascular Anesthesiologists and approved for publication by the governing bodies of these organizations.

## **Recommendations**

### **Major Recommendations**

The definitions of categories of support from scientific evidence (**A-D**) and levels of evidence for each category (**1-3**) are provided at the end of the "Major Recommendations" field.

### **Internal Jugular (IJ) Vein Cannulation**

*It is recommended that properly trained clinicians use real-time ultrasound during IJ cannulation whenever possible to improve cannulation success and reduce the incidence of complications associated with the insertion of large-bore catheters. This recommendation is based on **category A, level 1 evidence**.*

The writing committee recognizes that static ultrasound (when not used in real time) is useful for the identification of vessel anatomy by skin-marking the optimal entry site for vascular access and for the identification of vessel thrombosis and is superior to a landmark-guided technique.

### **Subclavian (SC) Vein Cannulation**

Current literature does not support the routine use of ultrasound for uncomplicated patients undergoing SC vein cannulation. Individual operators should not attempt cannulation more than twice, as the incidence of complication, particularly pneumothorax, rises significantly with additional attempts. *High-risk patients may benefit from ultrasound screening of the SC vein before attempted cannulation to identify vessel location and patency and to specifically identify thrombus before attempted cannulation.* The recommendation for ultrasound guidance during SC vein cannulation is based on **category A** (supportive), **level 3 evidence**.

### **Femoral Vein (FV) Cannulation**

The scientific evidence for real-time ultrasound-guided FV cannulation is **category C, level 2**: equivocal with insufficient scientific evidence to support a recommendation for routine use. In addition, complications during FV cannulation are less severe than those that occur with SC and IJ vein cannulation. *It is therefore the recommendation of this writing committee that real-time ultrasound be used only for examining the FV to identify vessel overlap and patency when feasible.*

### **Pediatric Ultrasound Guidance**

*It is the recommendation of the writing committee that trained clinicians use real-time ultrasound during IJ cannulation whenever possible to improve cannulation success and reduce the incidence of complications associated with the insertion of large-bore catheters in pediatric patients.* This recommendation is based on **category A, level 1 supportive literature**. *It is also the recommendation of the council that trained clinicians use real-time ultrasound during FV cannulation whenever possible to improve cannulation success and reduce the incidence of complications associated with insertion of large-bore catheters in pediatric patients.* This is a **category C, level 2 recommendation**.

### **Ultrasound-guided Arterial Cannulation**

Although ultrasound may identify the presence, location, and patency of arteries suitable for cannulation or vascular access, *the council does not recommend routine real-time ultrasound use for arterial cannulation in general.* However, for radial artery cannulation, there is **category A, level 1 support** for the use of ultrasound to improve first-pass success (Shiloh et al., 2011).

Ultrasound is most effectively used as a rescue technique for arterial access and to identify the location and patency of suitable arteries for cannulation or procedural access. Long axis (LAX) imaging is particularly useful to identify vessel tortuosity, atheromatous plaques, and difficulties with catheter insertion.

### **Ultrasound-guided Peripheral Venous Cannulation**

Although ultrasound may identify the presence, location, and patency of peripheral veins, *the council does not recommend routine real-time ultrasound use for peripheral venous cannulation*, although there is **category B, level 2** (suggestive observational studies) **support** for the use of ultrasound for percutaneous intravenous central catheterization (PICC) insertion. Ultrasound is most effectively used to identify the location and patency of suitable veins for peripherally inserted central venous catheters.

### **Vascular Access Confirmation**

*The council recommends that real-time ultrasound be used for confirmation of successful vessel cannulation. It is vitally important for the guide wire to be visualized in the target vessel and that the adjacent structures be visualized to confirm the absence of the guide wire. Because there may be ambiguity of the guide wire tip with short axis (SAX) ultrasound imaging alone, manometry with a fluid-filled catheter through a flexible catheter in the vessel is recommended when LAX imaging is not used for confirmation of venous catheter placement* (Ezaru et al., 2009). When available, transesophageal echocardiographic or fluoroscopic imaging of the guide wire in the superior vena cava or inferior vena cava provides definitive confirmation of placement into the central venous system (see Figure 1 in the original guideline).

### **Training**

It is the recommendation of this council that individuals gain the requisite knowledge, develop the required dexterity, and perform 10 ultrasound-guided vascular access procedures under supervision to demonstrate competence to independently practice this technique.

### **Recommended Training Objectives for Ultrasound-guided Vascular Cannulation**

#### *Cognitive Skills*

1. Knowledge of the physical principles of ultrasound
2. Knowledge of the operation of the ultrasound equipment, including the controls that affect the imaging display
3. Knowledge of infection control standards for performing vascular access and sterile preparation of the ultrasound probe for real-time use
4. Knowledge of the surface anatomy specific to the access site and ultrasound anatomy that allows identification of the target vessel and structures that are to be avoided
5. Ability to recognize the location and patency of the target vessel
6. Ability to recognize atypical anatomy of vessel location and redirect the needle entry to minimize complications
7. Knowledge of the color Doppler and spectral Doppler flow patterns that identify arterial and venous flow

7. Knowledge of the color flow and spectral Doppler flow patterns that identify arterial and venous flow characteristics

#### *Technical Skills*

1. Ability to operate the ultrasound equipment and controls to produce quality information to identify the target vessel
2. Dexterity to coordinate needle guidance in the desired direction and depth on the basis of the imaging data
3. Use of needle guides for coordination of needle insertion with imaging data when operator dexterity is lacking or clinical conditions make dexterity coordination challenging
4. Ability to insert the catheter into the target vessel using ultrasound information
5. Ability to confirm catheter placement into the target vessel and the absence of the catheter in unintended vessels and structure

#### **Conclusions**

It is the recommendation of this council, on the basis of **level 1 scientific evidence**, that properly trained clinicians use real-time ultrasound during IJ cannulation whenever possible to improve cannulation success and reduce the incidence of complications associated with the insertion of large-bore catheters. Despite fewer scientific studies, the council also recommends the use of real-time ultrasound for the cannulation of the IJ and FV in pediatric patients. Complications during FV cannulation in adults are less severe than those that occur with SC and IJ vein cannulation, and therefore, ultrasound guidance is recommended only for identifying vessel overlap and patency when feasible for FV cannulation. Obese and coagulopathic patients should have ultrasound screening of the SC vein before attempted cannulation to identify vessel location and patency. If real-time ultrasound is not used as the initial technique for SC vein cannulation, it should be used as a rescue device. It is also an effective rescue device for arterial cannulation.

Proper training is necessary to realize the clinical outcomes supported by the literature, to gain an appreciation of the ultrasound anatomy, identify the optimal entry site and needle angle, and understand the limitations of the ultrasound-guided technique. Precannulation or static ultrasound with skin marking is useful for identifying vessel anatomy and thrombosis but may not improve cannulation success or reduce complications, as does real-time ultrasound needle guidance.

#### **Definitions:**

##### **Categories of Support from Scientific Evidence**

###### *Category A: Supportive Literature*

Randomized controlled trials report statistically significant ( $P < .01$ ) differences between clinical interventions for a specified clinical outcome.

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Level 3: The literature contains case reports.

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Level 2: There is an insufficient number of studies to conduct meta-analysis, and 1) randomized controlled trials have not found significant differences among groups or conditions, or 2) randomized controlled trials report inconsistent findings.

Level 3: Observational studies report inconsistent findings or do not permit inference of beneficial or harmful relationships.

###### *Category D: Insufficient Evidence from Literature*

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1. No identified studies address the specified relationships among interventions and outcomes.
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## Clinical Algorithm(s)

None provided

## Evidence Supporting the Recommendations

### References Supporting the Recommendations

Ezaru CS, Mangione MP, Oravitz TM, Ibinson JW, Bjerke RJ. Eliminating arterial injury during central venous catheterization using manometry. *Anesth Analg*. 2009 Jul;109(1):130-4. [PubMed](#) 

Shiloh AL, Savel RH, Paulin LM, Eisen LA. Ultrasound-guided catheterization of the radial artery: a systematic review and meta-analysis of randomized controlled trials. *Chest*. 2011 Mar;139(3):524-9. [PubMed](#) 

### Type of Evidence Supporting the Recommendations

The type of supporting evidence is identified and graded for most recommendations (see the "Major Recommendations" field).

Recommendations for the use of ultrasound were based on supportive literature (category A) with a level 1 weight of scientific evidence (multiple randomized controlled trials with the aggregated findings supported by meta-analysis).

## Benefits/Harms of Implementing the Guideline Recommendations

### Potential Benefits

Appropriate performance of ultrasound-guided vascular cannulation resulting in improved cannulation success and reduced incidence of complications

### Potential Harms

- Improper use or inadequate training in the use of ultrasound for vascular cannulation may not reduce the incidence of complications associated with placement of intravascular catheters.
- Central venous catheter mechanical complications include arterial puncture, hematoma, hemothorax, pneumothorax, arterial-venous fistula, venous air embolism, nerve injury, thoracic duct injury (left side only), intraluminal dissection, and puncture of the aorta.
- The most common complications of internal jugular (IJ) vein cannulation are arterial puncture and hematoma.
- The most common complication of subclavian (SC) vein cannulation is pneumothorax.
- The femoral approach is associated with complications, including bleeding and vascular injury, such as pseudoaneurysms, arteriovenous fistulas and retroperitoneal bleeding.
- Femoral access has the highest incidence of infection and thrombosis at 19.8% and 21.5%, respectively.
- The application of the ultrasound probe may compress venous structures in hypovolemic adult patients and pediatric population.
- The complications arising from the incorrect cannulation of an artery with a large bore catheter intended for an adjacent vein have significant morbidity and mortality. This is particularly true for unintentional carotid artery (CA) cannulation during IJ vein cannulation attempts but also holds true for unintentional arterial puncture at other sites.
- Common femoral vein and common femoral artery vessel overlap in pediatric patients may increase the risk for complications and is not predictable with surface landmarks alone.
- Another frequent problem encountered in neonates is the high incidence of venous and arterial thrombosis when multiple cardiac catheterization procedures have been performed.

## Qualifying Statements

### Qualifying Statements

This report is made available by the American Society of Echocardiography (ASE) as a courtesy reference source for its members. This report contains recommendations only and should not be used as the sole basis to make medical practice decisions or for disciplinary action against any employee. The statements and recommendations contained in this report are based primarily on the opinions of experts, rather than on scientifically verified data. The ASE makes no express or implied warranties regarding the completeness or accuracy of the information in this report, including the warranty of merchantability or fitness for a particular purpose. In no event shall the ASE be liable to you, your patients, or any other third parties for any decision made or action taken by you or such other parties in reliance on this information. Further, the use of this information does not constitute the offering of medical advice by the ASE or create any physician-patient relationship between the ASE and your patients or anyone else.

## Implementation of the Guideline

### Description of Implementation Strategy

An implementation strategy was not provided.

## Institute of Medicine (IOM) National Healthcare Quality Report Categories

### IOM Care Need


Getting Better  
Living with Illness

### IOM Domain

Effectiveness  
Safety

## Identifying Information and Availability

### Bibliographic Source(s)

Troianos CA, Hartman GS, Glas KE, Skubas NJ, Eberhardt RT, Walker JD, Reeves ST, Councils on Intraoperative Echocardiography and Vascular Ultrasound [trunc]. Guidelines for performing ultrasound guided vascular cannulation: recommendations of the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists. *J Am Soc Echocardiogr.* 2011 Dec;24(12):1291-318. [96 references] [PubMed](#) 

### Adaptation

Not applicable: The guideline was not adapted from another source.

### Date Released

2011 Dec

### Guideline Developer(s)

American Society of Echocardiography - Professional Association  
Society of Cardiovascular Anesthesiologists - Medical Specialty Society

### Source(s) of Funding

American Society of Echocardiography

### Guideline Committee

Councils on Intraoperative Echocardiography and Vascular Ultrasound of the American Society of Echocardiography

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### Financial Disclosures/Conflicts of Interest

The authors reported no actual or potential conflicts of interest in relation to this document.

### Guideline Status

This is the current release of the guideline.

### Guideline Availability

Electronic copies: Available in Portable Document Format (PDF) from the [American Society of Echocardiography Web site](#) 

### Availability of Companion Documents

None available

#### **Patient Resources**

None available

#### **NGC Status**

This NGC summary was completed by ECRI Institute on August 24, 2012. The information was verified by the guideline developer on September 27, 2012.

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