

# Quality Improvement Guidelines for Central Venous Access



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J Vasc Interv Radiol 2010; 21:976–981

## PREAMBLE

THE membership of the Society of Interventional Radiology (SIR) Standards of Practice Committee represents experts in a broad spectrum of interventional procedures from both the private and academic sectors of medicine. Generally Standards of Practice Committee members dedicate the vast majority of their professional time to performing interventional procedures; as such they represent a valid broad expert constituency of the subject matter under consideration for standards production.

Technical documents specifying the exact consensus and literature review methodologies as well as the institu-

tional affiliations and professional credentials of the authors of this document are available upon request from SIR, 3975 Fair Ridge Dr., Suite 400 North, Fairfax, VA 22033.

## METHODOLOGY

SIR produces its Standards of Practice documents using the following process. Standards documents of relevance and timeliness are conceptualized by the Standards of Practice Committee members. A recognized expert is identified to serve as the principal author for the standard. Additional authors may be assigned dependent upon the magnitude of the project.

An in-depth literature search is performed using electronic medical literature databases. Then a critical review of peer-reviewed articles is performed with regards to the study methodology, results, and conclusions. The qualitative weight of these articles is assembled into an evidence table, which is used to write the document such that it contains evidence-based data with respect to content, rates, and thresholds.

When the evidence of literature is weak, conflicting, or contradictory, consensus for the parameter is reached by a minimum of 12 Standards of Practice Committee members using a Modified Delphi Consensus Method (Appendix A). For purposes of these documents, consensus is defined as 80% Delphi participant agreement on a value or parameter.

The draft document is critically reviewed by the Revisions Subcommittee members of the Standards of Practice Committee, either by telephone conference calling or face-to-face meeting. The

finalized draft from the Committee is sent to the SIR membership for further input/criticism during a 30-day comment period. These comments are discussed by the Subcommittee, and appropriate revisions made to create the finished standards document. Prior to its publication the document is endorsed by the SIR Executive Council.

## INTRODUCTION

This guideline was revised from a quality improvement document initially developed by SIR for central venous access (1).

These guidelines are written to be used in quality improvement programs to assess central venous access procedures. The most important processes of care are (i) patient selection, (ii) performing the procedure, and (iii) monitoring the patient. The outcome measures or indicators for these processes are indications, success rates, and complication rates. Outcome measures are assigned threshold levels.

## DEFINITIONS

Image-guided percutaneous central venous access is defined as the placement of a catheter with its tip in the cavoatrial region or right atrium with the assistance of real-time imaging. The cavoatrial junction has been defined as two vertebral body units below the carina (2). The most commonly used imaging techniques during placement are fluoroscopy and ultrasonography (US).

Tunneled catheters are defined as catheters that travel through a subcutaneous tract before exiting the body through a small incision in the skin. Im-

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M.J.W. has research funded by Siemens Medical Solutions (Erlangen, Germany). None of the other authors have identified a conflict of interest.

This article first appeared in J Vasc Interv Radiol 1997; 8:475–479; 2003; 14:S231–S235.

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DOI: 10.1016/j.jvir.2010.03.006

planted ports are similar to tunneled catheters. However, they do not exit the skin, but terminate with a device buried in the subcutaneous tissues. The catheter exit or implanted port site can be located in several different locations but is usually placed over the torso/neck or peripherally. However, other alternative access routes have been described (3–8).

Successful placement is defined as follows: introduction of a catheter into the venous system with the tip in the desired location and the catheter functions for its intended use (eg, can be used to deliver medications or for dialysis). Functional success is the most important component of this definition.

Complications can be stratified on the basis of outcome. Major complications result in admission to a hospital for therapy (for outpatient procedures), an unplanned increase in the level of care, prolonged hospitalization, permanent adverse sequelae, or death. Minor complications result in no sequelae; they may require nominal therapy or a short hospital stay for observation (generally overnight; see Appendix B; 9,10). The complication rates and thresholds described here refer to major complications unless otherwise specified.

**INDICATIONS FOR CENTRAL VENOUS ACCESS**

Indications for central venous access are listed in **Table 1** (11). An example of a diagnostic indication for central venous access would include central venous pressure monitoring. The threshold for these indications is 95%. When fewer than 95% of procedures are for these indications, the department will review the process of patient selection.

The decision to place a central venous access device should be made after considering the risks and benefits to each patient. Coagulopathy and sepsis may be relative contraindications to immediate implantation of long-term central venous access devices. Appropriate effort should be made to correct or improve a patient’s coagulopathy before placement of a central venous catheter. Other factors that may also increase complications include venous stenosis, acute thrombosis, and local skin infection at the insertion site. In patients in whom these findings or abnormalities cannot be corrected, the procedure may still be indicated if the risk/benefit ratio

**Table 1**  
**Indications for Central Venous Access**

<b>Therapeutic Indications</b>
Administration of chemotherapy
Administration of total parenteral nutrition
Administration of blood products
Administration of intravenous medications
Intravenous fluid administration
Performance of plasmapheresis
Performance of hemodialysis
<b>Diagnostic Indications</b>
To establish or confirm a diagnosis
To establish a prognosis
To monitor response to treatment
For repeated blood sampling

is lower than those of the alternative methods of diagnosis or treatment.

**QUALITY IMPROVEMENT**

Although practicing physicians should strive to achieve perfect outcomes (eg, 100% success, 0% complications), in practice all physicians will fall short of this ideal to a variable extent. Thus, indicator thresholds may be used to assess the efficacy of ongoing quality improvement programs. For the purposes of these guidelines, a threshold is a specific level of an indicator that should prompt a review. “Procedure thresholds” or “overall thresholds” reference a group of indicators for a procedure (eg, major complications). Individual complications may also be associated with complication-specific thresholds. When measures such as indications or success rates fall below a minimum threshold or when complication rates exceed a maximum threshold, a review should be performed to determine causes and to implement changes, if necessary. For example, if the incidence of catheter-related infection is one measure of the quality of central venous access, then values in excess of the defined threshold should trigger a review of policies and procedures within the department to determine the causes and to implement changes to reduce the incidence of the complication. Thresholds may vary from those listed here; for example, patient referral patterns and selection factors may dictate a different threshold value for a particular indicator at a particular institution. Thus, setting universal thresholds is very diffi-

cult and each department is urged to alter the thresholds as needed to higher or lower values to meet its own quality improvement program needs.

Participation by the radiologist in patient follow-up is an integral part of central venous access and will increase the success rate of the procedure. Close follow-up with monitoring and management of patients who have undergone central venous access is appropriate for the radiologist.

**SUCCESS RATES OF CENTRAL VENOUS ACCESS**

Success rates for central venous access are listed in **Table 2** (4–8, 12–72), along with recommended threshold values. Ultrasound-guided access confers higher initial venous cannulation success (68,71).

**COMPLICATIONS OF CENTRAL VENOUS ACCESS**

Complications of central venous access are defined as early (occurring within 30 days of placement) or late (occurring after 30 days). The overall procedure threshold for major complications resulting from image-guided central venous access including the subclavian, jugular, and peripheral approaches is 3%.

Early complications can be subdivided into procedurally related, defined as those that occur at the time or within 24 hours of the intervention; and those occurring beyond that period. Complications that occur at the time of the procedure usually consist of injury to the surrounding vital structures or malpositioning of the catheter tip. The incidence of early complications is lower with image-guided techniques compared with blind or external landmark techniques (17,32,36,39,43,48,63,64,68,69,72–75).

Complications (major and minor) occur in approximately 7% of patients when image guidance is used (17,19,22,25,27,36,42,44,63,64,68,69,72–74,77). Published complication rates and suggested thresholds are listed in **Table 3** (63,69,73,75–79). Published rates for individual types of complications are highly dependent on patient selection and are based on series comprising several hundred patients, which is a volume larger than most individual practitioners are likely to treat. For example, higher rates of infection may be seen

**Table 2**  
Success Rates (4–8,12–72)

Procedure	Reported Rate (%)	Threshold (%)
Internal jugular approach (7,14,32–40,64,65,67,68,70–72)	96	95
Subclavian vein approach		
Catheter (7,16,18,19,22–24,26,29,33,36–38,41–49)	95	90
Infusion port (7,23,25,29,50)	95	90
PICCs (7,12,17,27,29,30,51–56,69)	96	90
Peripherally implanted ports (5,13,15,20–22,28–30,53,57–63)	96	90
Translumbar approach (4,6,8,66)	96	90

Note.—Success rates and thresholds listed are for the adult population and could be expected to be lower in a pediatric population. PICC = peripherally inserted central catheter.

**Table 3**  
Complication Rates and Suggested Thresholds for Central Venous Access (63,69,73,75–79)

Major Complication for Image-guided Central Venous Access	Rate (%)	Suggested Threshold (%)
Subclavian and jugular approaches		
Pneumothorax	1–3	4†
Hemothorax	1	2
Hematoma	1–3	4‡
Perforation	0.5–1	2
Air embolism	1	2
Wound dehiscence	1	2
Procedure-induced sepsis	1–3	4§
Thrombosis*	4	8
Peripheral placement PICC and peripheral ports		
Pneumothorax/hemothorax	0	0
Hematoma	1	2
Wound dehiscence	1	2
Phlebitis*	4	8
Arterial injury	0.5	1
Thrombosis*	3	6
Procedure-induced sepsis	1	2

Note.—PICC = peripherally inserted central catheters.

\* The literature is limited with respect to the number of studies that address these issues. The overall thrombosis/phlebitis rate ranges from 0.8% to 4.7% with the majority considered a minor complication (69,76,77,79).

† See Damascelli et al (73), Funaki et al (63), and Biffi et al (78).

‡ See Teichgraber et al (75).

§ See Funaki et al (63) and Beheshti et al (77).

in predominantly immunocompromised populations (65,70,79) or in patients receiving total parenteral nutrition (76).

### CENTRAL VENOUS DEVICE-SPECIFIC VARIABLES

#### Peripherally Inserted Central Catheters

Valved peripherally inserted central catheters and ports are associated with lower incidences of infectious complica-

tions and occlusions. In addition, proximal valve placement (as opposed to distal valve placement) is associated with even further diminished infectious and occlusive complications compared with the distal valve versions (11,80).

#### Tunneled Catheters

Permanent hemodialysis catheters are more reliable (ie, improved catheter blood flow) than temporary hemodialysis catheters (81). Standard dual-

tip hemodialysis catheters have better outcomes than split-tip hemodialysis catheters, although split-tip hemodialysis catheters are associated with lower incidences of complications. Standard dual-tip and split-tip catheters exceed Dialysis Outcomes Quality Initiative standards (82–84).

Published rates for individual types of complications are highly dependent on patient selection and are based on series comprising several hundred patients, which is a larger volume than most individual practitioners are likely to treat. Generally the complication-specific thresholds should be set higher than the complication-specific reported rates listed here. It is also recognized that a single complication can cause a rate to cross above a complication-specific threshold when the complication occurs within a small patient series (eg, early in a quality improvement program). In this situation, an overall procedural threshold is more appropriate for use in a quality improvement program. In **Tables 2 and 3**, all values are supported by the weight of literature evidence and panel consensus.

**Acknowledgments:** Sean R. Dariushnia, MD, authored the first draft of this document and served as topic leader during the subsequent revisions of the draft. Sanjoy Kundu, MD, FRCPC, is chair of the SIR Standards of Practice Committee and Michael Wallace, MD, is the chair of the SIR Revisions Subcommittee. John F. Cardella, MD, is Councilor of the SIR Standards Division. All other authors are listed alphabetically. Other members of the Standards of Practice Committee and SIR who participated in the development of this revised clinical practice guideline are (listed alphabetically): John F. Angle, MD, Daniel B. Brown, MD, Horacio R. D'Agostino, MD, Sanjeeva P. Kalva, MD, Arshad Ahmed Khan, MD, Cindy Kaiser Saiter, NP, Marc S. Schwartzberg, MD, Samir S. Shah, MD, LeAnn Stokes, MD, Aradhana Venkatesan, MD, Darryl A. Zuckerman, MD.

### APPENDIX A: SIR STANDARDS OF PRACTICE COMMITTEE CLASSIFICATION OF COMPLICATIONS BY OUTCOME

#### Minor Complications

- A. No therapy, no consequence.
- B. Nominal therapy, no consequence; includes overnight admission for observation only.

## Major Complications

- C. Require therapy, minor hospitalization (<48 hours).
- D. Require major therapy, unplanned increase in level of care, prolonged hospitalization (>48 hours).
- E. Permanent adverse sequelae.
- F. Death.

## APPENDIX B: CONSENSUS METHODOLOGY

Reported complication-specific rates in some cases reflect the aggregate of major and minor complications. Thresholds are derived from critical evaluation of the literature, evaluation of empirical data from Standards of Practice Committee members' practices, and, when available, the SIR HI-IQ System national database.

Consensus on statements in this document was obtained utilizing a modified Delphi technique (1,2).

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### SIR DISCLAIMER

The clinical practice guidelines of the Society of Interventional Radiology attempt to define practice principles that generally should assist in producing high quality medical care. These guidelines are voluntary and are not rules. A physician may deviate from these guidelines, as necessitated by the individual patient and available resources. These practice guidelines should not be deemed inclusive of all proper methods of care or exclusive of other methods of care that are reasonably directed towards the same result. Other sources of information may be used in conjunction with these principles to produce a process leading to high quality medical care. The ultimate judgment regarding the conduct of any specific procedure or course of management must be made by the physician, who should consider all circumstances relevant to the individual clinical situation. Adherence to the SIR Quality Improvement Program will not assure a successful outcome in every situation. It is prudent to document the rationale for any deviation from the suggested practice guidelines in the department policies and procedure manual or in the patient's medical record.