



# **Protocols for Standard Radiological Practice – Good Practice Guidelines as defined by SI 478 2002**

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**Submitted to Council by:  
Medical Ionising Radiation Committee on 7 October 2004**

**Adopted by Council on 9 November 2004**

## **Radiation Protection Sub-Committee : re Good Practice Guidelines**

**S.I. 478 of 2002, Article 11.2 states:**

**‘Written protocols for every type of standard radiological practice shall be established by the Medical or Dental Councils in respect of each type of equipment’.**

### **INTRODUCTION**

#### **Council Directive 97/43/Euratom of June 1997**

*Article 6.1 Written protocols for every type of standard radiological practice shall be established for each equipment.*

#### **The Ionising Radiation (Medical Exposure) Regulations 2000**

The Ionising Radiation (Medical Exposure) Regulations 2000 (together with notes on good practice) implement for Great Britain the majority of the provisions of Council Directive 97/43/Euratom of 30 June 1997 (the “Medical Exposures Directive”). The guidelines for Article 6.1 read:

*6.1. The protocols required under this regulation should not be confused with employer’s procedures required by regulation 4(1). Protocols cannot be absolute or totally comprehensive as it is not possible to produce detailed and rigid protocols for every examination. However, they should be specific to each examination and machine as appropriate, e.g. in diagnostic practice, for a particular x-ray room, x-ray exposure factors for a specific examination (PA chest: 120kV 2mAs). They must be written down and their status clear. Protocols should allow latitude for professional judgment but where the latitude provided is exceeded and exposure factors varied, it would be advisable to record the changes made. Where, on commissioning, exposure values are programmed via the console into the x-ray generator, it is recommended that a record of the values be kept in the department together with any changes to these values, whether for individual patients, or as a result of agreed protocol changes.*

#### **Protocols for standard radiological practice**

Details of sources for protocols for five types of standard radiological practice (namely Radiography, Fluoroscopy, Computed Tomography, Nuclear Medicine, and Interventional Radiology) are summarised in the following pages.

Where available, a European source is quoted. Otherwise, a North American source is used.

## RADIOGRAPHY

### SOURCES:

**‘European Guidelines on Quality Criteria for Diagnostic Radiographic Images’  
Report EUR 16260, 1996, European Commission**

*This document may be downloaded in from the following internet address:*

<ftp://ftp.cordis.lu/pub/fp5-euratom/docs/eur16260.pdf>

### **Content :**

Outlines the general principles associated with good imaging performance – image annotation, quality control of x-ray imaging equipment, patient positioning, x-ray beam limitation, protective shielding, radiographic exposure conditions, screen film system, film blackening, radiographic exposures per examination, film processing, image viewing conditions and reject analysis.

Gives guidelines on diagnostic requirements, criteria for radiation dose to patient, and example of good radiographic technique for a limited number of radiographic examinations:

- Chest - *see sample on page 3*
- Skull
- Lumbar spine
- Pelvis
- Intravenous urogram
- Breast

**‘European Guidelines on Quality Criteria for Diagnostic Radiographic Images in Paediatrics’**

**Report EUR 16261, 1996, European Commission**

*This document may be downloaded in from the following internet address:*

<ftp://ftp.cordis.lu/pub/fp5-euratom/docs/eur16261.pdf>

**Content:** Similar format to ‘European Guidelines on Quality Criteria for Diagnostic Radiographic Images’ (Report EUR 16260, 1996, European Commission), but deals with the general principles associated with good imaging performance in more detail.

Gives guidelines on diagnostic requirements, criteria for radiation dose to patient, and example of good radiographic technique for the following paediatric radiographic examinations:

- Chest
- Skull
- Pelvis
- Full spine
- Segmental spine
- Intravenous urogram
- Abdomen
- Urinary tract – including intravenous urography, and micturating cystourethrography

sample - **EUROPEAN COMMISSION GUIDELINES FOR PA CHEST RADIOGRAPH**  
From *'European Guidelines on Quality Criteria for Diagnostic Radiographic Images'*

## **1. DIAGNOSTIC REQUIREMENTS**

### **1.1 Image criteria**

- 1.1.1. Performed at full inspiration (as assessed by the position of the ribs above the diaphragm - either 6 anteriorly or 10 posteriorly) and with suspended respiration
- 1.1.2. Symmetrical reproduction of the thorax as shown by central position of the spinous process between the medial ends of the clavicles
- 1.1.3. Medial border of the scapulae to be outside the lung fields
- 1.1.4. Reproduction of the whole rib cage above the diaphragm
- 1.1.5. Visually sharp reproduction of the vascular pattern in the whole lung, particularly the peripheral vessels
- 1.1.6. Visually sharp reproduction of:
  - (a) the trachea and proximal bronchi,
  - (b) the borders of the heart and aorta,
  - (c) the diaphragm and lateral costo-phrenic angles
- 1.1.7. Visualization of the retrocardiac lung and the mediastinum
- 1.1.8. Visualization of the spine through the heart shadow

### **1.2. Important image details**

- 1.2.1. Small round details in the whole lung, including the retrocardiac areas:
  - high contrast: 0.7 mm diameter
  - low contrast: 2 mm diameter
- 1.2.2. Linear and reticular details out to the lung periphery:
  - high contrast: 0.3 mm in width,
  - low contrast: 2 mm in width

## **2. CRITERIA FOR RADIATION DOSE TO PATIENT**

Entrance surface dose for a standard-sized patient: 0.3 mGy

## **3. EXAMPLE OF GOOD RADIOGRAPHIC TECHNIQUE**

- |                                  |   |
|----------------------------------|---|
| 3.1. Radiographic device:        | vertical stand with stationary or moving grid |
| 3.2. Nominal focal spot value:   | $\leq 1.3$                                    |
| 3.3. Total filtration:           | $\geq 3.0$ mm Al equivalent                   |
| 3.4. Anti-scatter grid:          | $r = 10; 40/\text{cm}$                        |
| 3.5. Screen film system:         | nominal speed class 400                       |
| 3.6. FFD:                        | 180 (140-200) cm                              |
| 3.7. Radiographic voltage:       | 125 kV  |
| 3.8. Automatic exposure control: | chamber selected - right lateral              |
| 3.9. Exposure time:              | $< 20$ ms                                     |
| 3.10. Protective shielding:      | standard protection                           |

# FLUOROSCOPY

## SOURCE:

### ACR Practice Guidelines

These guidelines may be accessed on the American College of Radiology website ([www.acr.org](http://www.acr.org)), click on Publications/Products – Standards and Guidelines; no membership or password required)

**Content:** A series of documents designed to assist practitioners in providing appropriate radiological care for patients. The documents cover the following topics for each fluoroscopic examination : indications; qualifications of personnel; specifications of examination (including quality control, patient preparation, examination preliminaries, and examination technique); and equipment specifications. The following documents pertain to fluoroscopy examinations. *See extract on page 5.*

#### Neuroradiology / Head and Neck

ACR Practice Guideline for the Performance of Myelography and Cisternography

#### Cardiovascular

ACR Practice Guideline for the Performance of Diagnostic Infusion Venography

#### Abdomen / Gastrointestinal

ACR Practice Guideline for the Performance of Esophagrams and Upper Gastrointestinal Examinations in Adults

ACR Practice Guideline for the Performance of the Modified Barium Swallow in Adults

ACR Practice Guideline for the Performance of a Per Oral Barium Small Bowel Examination in Adults

ACR Practice Guideline for the Performance of an Enteroclysis Examination in Adults

ACR Practice Guideline for the Performance of a Barium Enema Examination in Adults

ACR Practice Guideline for the Performance of Pediatric Contrast Examination of the Upper Gastrointestinal Tract

ACR Practice Guideline for the Performance of Pediatric Contrast Examination of the Small Bowel

ACR Practice Guideline for the Performance of Pediatric Contrast Enema Examinations

#### Genitourinary

ACR Practice Guideline for the Performance of Hysterosalpingography

ACR Practice Guideline for the Performance of Adult Cystography and Urethrography

ACR Practice Guideline for the Performance of Voiding Cystourethrography in Children

*extract from* **ACR GUIDELINE FOR BARIUM ENEMA IN ADULTS**

**B. Colon Preparation**

The preparation should consist of any effective combination of dietary restriction, hydration, osmotic laxatives, contact laxatives, and cleansing enemas. These preparations are done with the intent of achieving a colon that is free of fecal material (except for minor mobile debris) and excess fluid or achieving a result as close to this ideal as possible. In appropriate clinical situations, preparation may be limited or omitted.

**C. Examination Preliminaries**

1. An appropriate medical history should be available.
2. The barium enema tip should be inserted by a physician or a trained assistant (technologist, nurse, or physician assistant). A retention cuff may be used. It should be inflated carefully in accordance with the manufacturer's guidelines. A physician should be in the fluoroscopic area during cuff inflation.
3. Medications may be administered to facilitate patient examination.

**D. Examination Technique**

The following examination descriptions may be modified by the physician to produce examinations of equal or better quality. The physician should modify any or all parts of the examination as warranted by clinical circumstances and the condition of the patient.

**1. Single-contrast examination**

- a. A sufficient volume of an appropriate low density (i.e., 15%-25% weight/volume) barium suspension should be administered rectally to provide colonic distention.
- b. Kilovoltage of 100 kVp or greater should be used (depending on patient size) during filming.
- c. Manual or mechanical compression of all accessible segments of the colon during fluoroscopy.
- d. Spot radiographs should demonstrate all fluoroscopically identified suspicious findings as well as those segments of the colon in profile that may not routinely be demonstrated on overhead projections.
- e. Overhead radiographs, if obtained, should include frontal and oblique views of the entire filled colon, an angled-beam view of the sigmoid colon, and a lateral view of the rectum.
- f. Postevacuation radiographs may be helpful.
- g. The quality controls specific to this study are:
  - i. Each accessible segment of the colon is seen with compression during fluoroscopy.
  - ii. Each segment of the entire colon is seen without overlap, if possible.
  - iii. Radiographic technique should attempt to penetrate all segments of the colon.

**2. Double –contrast examination**

- a. High-density (80% weight/volume or greater) barium suspension commercially prepared specifically for this examination is used.
- b. Kilovoltage of 90 kVp or greater, depending on the patient's size, is used.
- c. Barium suspension and air are introduced under fluoroscopic control to achieve adequate coating and distension of the entire colon.
- d. The colon should be examined fluoroscopically during the course of the examination.
- e. Radiographs should be taken to attempt to demonstrate all segments of the colon in double contrast. Suggested views include the following:
  - i. Spot radiographs of the rectum, sigmoid colon, flexures, and cecum in double contrast.
  - ii. Large format radiographs, including prone and supine views of the entire colon, an angled-beam view of the sigmoid colon, and a lateral view of the rectum.
  - iii. Both lateral decubitus views of the entire colon using a horizontal beam (a wedge filter is recommended).
- f. The quality controls specific to the double contrast study are:
  - i. Adequate barium coating of the entire colon has been achieved.
  - ii. The colon is well distended with air.
  - iii. Each segment of the colon is seen in double contrast on at least two radiographs taken in different positions, whenever possible.

## COMPUTED TOMOGRAPHY

### SOURCE:

**‘European Guidelines on Quality Criteria for Computed Tomography’  
Report EUR 16262, 1996, European Commission**

*This document may be downloaded in from the following internet address:*

<http://www.dr.dk/guidelines/ct/quality/index.htm>

**Content:** Similar format to ‘European Guidelines on Quality Criteria for Diagnostic Radiographic Images’, but includes detailed protocols (*see sample on page 7*) for the following CT examinations:

<b>Cranium</b>	<b>Chest</b>
Brain	Chest, general
Skull base	Chest, mediastinal vessels
	Chest, high resolution computed tomography
<b>Face and Neck</b>	
Face and sinuses	<b>Abdomen and Pelvis</b>
Petrous bone	Abdomen, general
Orbits	Liver and spleen
Sella and hypophysis	Kidneys
Salivary glands	Pancreas
Pharynx	Adrenal glands
Larynx	Pelvis, general
Face and sinuses	
	<b>Bones and Joints</b>
<b>Spine</b>	Osseous pelvis
Vertebral and paravertebral structures	Osseous shoulder
Lumbar spine	
Spinal cord	

**sample - EUROPEAN COMMISSION GUIDELINES FOR CT BRAIN**  
*from 'European Guidelines on Quality Criteria for Computed Tomography'*

**Preparatory steps:**

- Indications: traumatic lesions, and suspected or known focal or diffuse structural disease of the brain when MRI is contraindicated or not available
- Advisable preliminary investigations: clinical neurological examination; MRI is often an alternative examination without exposure to ionising radiation
- Patient preparation: information about the procedure; restraint from food, but not fluid, is recommended, if intravenous contrast media are to be given
- Scan projection radiograph: lateral from skull base to vertex; in patients with multiple injuries from cervical vertebra to vertex

**1. DIAGNOSTIC REQUIREMENTS**

**Image criteria:**

**1.1 Visualization of**

- 1.1.1 Whole cerebrum
- 1.1.2 Whole cerebellum
- 1.1.3 Whole skull base
- 1.1.4 Vessels after intravenous contrast media

**1.2 Critical reproduction**

- 1.2.1 Visually sharp reproduction of the border between white and grey matter
- 1.2.2 Visually sharp reproduction of the basal ganglia
- 1.2.3 Visually sharp reproduction of the ventricular system
- 1.2.4 Visually sharp reproduction of the cerebrospinal fluid space around the mesencephalon
- 1.2.5 Visually sharp reproduction of the cerebrospinal fluid space over the brain
- 1.2.6 Visually sharp reproduction of the great vessels and the choroid plexuses after intravenous contrast media

**2. CRITERIA FOR RADIATION DOSE TO THE PATIENT**

- 2.1 CTDI<sub>w</sub> : routine head: 60 mGy
- 2.2 DLP : routine head: 1050 mGy cm

**3. EXAMPLES OF GOOD IMAGING TECHNIQUE**

- 3.1 Patient position : supine
- 3.2 Volume of investigation : from foramen magnum to the skull vertex
- 3.3 Nominal slice thickness : 2-5 mm in posterior fossa; 5-10 mm in hemispheres
- 3.4 Inter-slice distance/pitch : contiguous or a pitch = 1.0
- 3.5 FOV : head dimension (about 24 cm)
- 3.6 Gantry tilt : 10-12° above the orbito-meatal (OM) line to reduce exposure of the eye lenses
- 3.7 X-ray tube voltage (kV) : standard
- 3.8 Tube current and : should be as low as consistent with exposure time product (mAs) required image quality
- 3.9 Reconstruction algorithm : soft tissue
- 3.10 Window width : 0-90 HU (supratentorial brain)  
140-160 HU (brain in posterior fossa)  
2000-3000 HU (bones)
- 3.11 Window level : 40-45 HU (supratentorial brain)  
30-40 HU (brain in posterior fossa)  
200-400 HU (bones)

**4. CLINICAL CONDITIONS WITH IMPACT ON GOOD IMAGING PERFORMANCE**

- 4.1 Motion - movement artefact deteriorates image quality (prevented by head fixation or sedation of non-cooperative patients)
- 4.2 Intravenous contrast media - useful to identify vascular structures, enhancing lesions and alterations of blood-brain barrier
- 4.3 Problems and pitfalls - calcifications versus *contrast enhancement*
- 4.4 Modification to technique - interpetrous beam hardening artefacts  
subtle irregularity can be checked with slices in the area of suspected pathology, before considering contrast administration

## NUCLEAR MEDICINE

### SOURCES:

#### **British Nuclear Medicine Society – Clinical Procedure Guidelines**

*These guidelines may be downloaded from the British Nuclear Medicine Society website ([www.bnms.org.uk](http://www.bnms.org.uk)); click on 'Quality Assurance', then 'Clinical Procedure Guidelines'; no membership or password required).*

**Content:** A series of quality guidelines which address the key aspects of procedures that affect the quality of the result. The guidelines cover the following topics for each nuclear medicine examination: purpose, common indications, procedure, radiopharmaceutical, image acquisition, data analysis, and interpretation. The following nuclear medicine examinations are included. *See extract on page 9.*

#### NUCLEAR MEDICINE

Dynamic renal radionuclide studies

Renal cortical Scintigraphy (DMSA)

Thyroid imaging

Bone imaging for metastases

Lung VQ imaging for diagnosis of pulmonary embolism

Hepatobiliary scintigraphy

Myocardial perfusion imaging

#### **European Association of Nuclear Medicine – Paediatric Nuclear Medicine Guidelines and Radionuclide Therapy Guidelines**

*These guidelines may be downloaded from the European Association of Nuclear Medicine website ([www.eanm.org](http://www.eanm.org)); click on 'Scientific Information', then 'Guidelines'; no membership or password required).*

Paediatric Nuclear Medicine Guidelines include:

- Bone Scintigraphy
- DMSA Scintigraphy,
- Glomerular Filtration Rate determination,
- Indirect Radionuclide Cystography,
- Standard and Diuretic Renogram,
- Direct Radionuclide Cystography,
- Radioiodinated MIBG Scintigraphy

Radionuclide Therapy guidelines include Therapy with Iodine-131, Iodine-131-meta Iodo Benzylguanidine Therapy, and Treatment of Refractory Metastatic Bone Pain.

## *extract from* **BNMS GUIDELINE FOR ISOTOPE BONE SCAN**

### **1. Purpose**

The purpose of this guideline is to assist specialists in Nuclear Medicine and Radionuclide Radiology in recommending, performing, interpreting and reporting the results of bone scans. It should be read in conjunction with the generic guideline for the provision of radionuclide imaging services.

### **2. Background**

Bone scintigraphy is a sensitive imaging method for detecting (or excluding) and monitoring bone metastases in malignant disease and may detect metastases before they are apparent radiologically. Imaging is achieved using  $^{99m}\text{Tc}$ -labelled diphosphonates (e.g. MDP) which become incorporated into the hydroxyapatite crystal matrix as new bone is formed. Uptake in bone is dependent on local blood flow and the degree of osteoblastic activity.

### **3. Common Indications**

- 3.1 Staging of malignancies which are known to metastasise to bone – particularly prostate, lung and any other primary (e.g. breast) with local advanced disease at the time of presentation.
- 3.2 Investigation of bone pain in patients with known or suspected malignancy
- 3.3 Monitoring disease progression and response to chemo or radiotherapy (but see controversies below)

### **4. Procedure**

#### **4.1 Patient preparation**

- 4.1.1 Unless contra-indicated, the patient should be well hydrated and given instructions, both written and verbal, prior to imaging about the need to drink at least one litre of fluid between injection and imaging.
- 4.1.2 The patient should be encouraged to void frequently, particularly immediately prior to imaging; if a catheter is present, the bag should be emptied before imaging.
- 4.1.3 A clinical history including trauma, surgery, fractures, prostheses, bone or joint pains, primary malignancy, radiotherapy or limitation of limb movement should be obtained. In addition, a note should be made of urinary diversion in procedures that have been performed.

### **5. Radiopharmaceutical**

- 5.1  $^{99m}\text{Tc}$ -diphosphonates – 600MBq (DRL for adults) – scaled dose for paediatric patients (c.f. generic guidelines for children). Up to 800MBq may be given for SPECT studies.

### **6. Image Acquisition**

#### **6.1 Camera**

- 6.1.1 Either whole body scan (high data density) with scan speed 8-10 cm/min, or multiple overlapping spot images may be obtained. If spot views are chosen, the anterior and posterior pelvic images should be acquired first, in order to minimise bladder activity.
- 6.1.2 A collimator giving optimal resolution should be used.

#### **6.2 Views**

Images should be obtained no earlier than 2-3 hours after injection (depending on the specific agent used). A longer delay may be helpful in elderly patients with slower bone uptake.

Images should be marked to indicate left and right sides, and SPECT images should include indicators for ant/post and sup/inf.

Minimum technique should include anterior and posterior views of the axial skeleton and proximal limbs. Distal limbs should be included if clinically indicated.

If ant/post images are equivocal, additional spot views may be helpful (eg. Obliques of ribs, vertex views of skull).

Spot views with high data density (minimum 500k) may be helpful if whole-body images are equivocal.

SPECT imaging of relevant area may be obtained if planar images do not resolve the clinical problem.

Where bladder activity obscures pelvic structures, lateral or squat views may be obtained or a further post-void image undertaken. If the patient is unable to empty the bladder, masking the retained urinary activity with lead shielding will allow improved detail in the rest of the pelvis.

Infants and young children require specific technical variations – please refer to the EANM guideline for bone imaging in paediatrics, which is accessible through the BNMS web site.

### **7. Data Analysis**

For showing the overall distribution of activity in the skeleton in the output format, images may be normalised for counts across anterior and posterior views by scaling to a maximum count density in a normal area (lumbar spine if possible). Areas of low count density will also need to be scaled up in order to avoid losing low-grade abnormalities.

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## INTERVENTIONAL RADIOLOGY

### SOURCE:

#### **Society of Interventional Radiology Clinical Practice Guidelines**

*These guidelines may be accessed on the Society of Interventional Radiology website ([www.sirweb.org](http://www.sirweb.org), click on 'clinical practice'; no membership or password required)*

**Content:** Series of documents outlining indications, successful end-points, and suggested success rates and complication thresholds (*see extract on page 11*) for the following interventional radiology procedures :

Interventional Procedures
Percutaneous transluminal angioplasty
Drainage
Percutaneous biopsy
Central venous access
Percutaneous transcatheter embolisation
Percutaneous transhepatic cholangiography and biliary drainage
Percutaneous management of thrombosed or dysfunctional dialysis access
Diagnostic neuroangiography and other procedures
Transjugular intrahepatic portosystemic shunts
Percutaneous permanent inferior vena cava filter placement
Percutaneous nephrostomy
Diagnostic arteriography
Diagnostic infusion venography
Angiography, angioplasty, and stent placement in renal artery stenosis
Percutaneous vertebroplasty
Carotid artery angioplasty and stent placement

*extract from* **SCVIR GUIDELINES FOR CENTRAL VENOUS ACCESS**

## DEFINITIONS

Image-guided percutaneous central venous access is defined as the placement of a catheter with its tip in the caval atrial region utilizing the assistance of real-time imaging. The most commonly used imaging techniques during placement include fluoroscopy and ultrasonography.

Tunneled catheters are defined as catheters that travel through a subcutaneous tract prior to exiting the body through a small incision in the skin. Implanted 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, 9, 10, 15, 22, 26).

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.

While 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. Therefore, indicator thresholds may be used to assess the efficacy of ongoing quality improvement programs. For the purpose 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 for the placement of central venous access devices). 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.

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.

Table 3

### COMPLICATIONS OF CENTRAL VENOUS ACCESS

Complications are defined as early (occurring within 30 days of placement) or late (occurring after 30 days). 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 when compared to blind or external landmark techniques (7, 27, 31, 34, 38, 43).

Complications (major and minor) occur in approximately 7% of patients when image guidance is used (7, 11, 14, 18, 20, 31, 37, 39). Published complication rates and suggested thresholds are listed in Table 3.

The overall procedure threshold for major complications resulting from image-guided central venous access including the subclavian, jugular and peripheral approaches is 3%.

Complication Rates and Suggested Thresholds for Central Venous Access

Specific Major Complications for Image-guided Central Venous Access	Rate (%)	Suggested Threshold (%)
Subclavian and jugular approaches		
Pneumothorax	1-2	3
Hemothorax	1	2
Hematoma	1	2
Perforation	0.5-1	2
Air embolism	1	2
Wound dehiscence	1	2
Procedure-induced sepsis	1	2
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

\* The literature is difficult to define, and most complications are thought not to be major complications.