# Radial & Femoral Artery Cannulation

## CLINICAL BEST PRACTICE GUIDELINE

College publications contain practice parameters and standards which should be considered by all Ontario Respiratory Therapists in the care of their clients and in the practice of the profession. College publications are developed in consultation with professional practice leaders and describe current professional expectations. It is important to note that these College publications may be used by the College or other bodies in determining whether appropriate standards of practice and professional responsibilities have been maintained.

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COLLEGE OF RESPIRATORY THERAPISTS OF ONTARIO

## Acknowledgements

This respiratory therapy clinical best practice guideline (CBPG) was developed by a working group of the CRTO's Registration Committee comprised of practicing Registered Respiratory Therapists.

A search for related articles was performed on PubMed, MD Consult, and CINAHL (Cumulative Index to Nursing & Allied Health Literature). Relevant electronic books on MD Consult, Post-graduate On-line, Science Direct, Google Books and Elsevier were reviewed. The following terms were used: radial artery, radial artery cannulation, femoral artery, femoral artery cannulation, arterial cannulation, peripheral artery cannulation, peripheral access, vascular access, modified Allen's test, Allen's test, pulse oximetry, local anaesthesia for arterial cannulation. A general search engine web search was conducted on "Google", using the same terms identified above. A structured website search was conducted on the Public Health Agency of Canada (PHAC), and the Centres for Disease Control and Prevention (CDC).

We have endeavoured to integrate individual experience and practice with the best available clinically relevant evidence from research and other sources in order to help our members make informed decisions about patient/client care. The weight of literature used to develop the document is supported with a graded level of evidence.

These guidelines are not meant to be applied in a "cookbook" fashion to replace individual expertise. Instead they are intended to act as a tool to facilitate certification program development, and to assist clinicians as they struggle to make the best decisions in order to provide the finest possible care for the patients/clients for whom they treat.

We encourage all CRTO members to incorporate learning activities related to certification programs into the CRTO's Quality Assurance (QA) professional portfolio.

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## INTRODUCTION

The *Regulated Health Professions Act (RHPA)* sets out the framework for the regulation of health professions in Ontario. The primary purpose for the regulation of the health profession is to protect the public by ensuring that practitioners meet minimum qualifications and standards of practice. In order to focus on the issue of public protection the RHPA identifies thirteen "controlled acts". These acts consist of a variety of activities that if performed incorrectly could result in serious harm to the public.

The *Respiratory Therapy Act (RTA)* authorizes Respiratory Therapists to perform four controlled acts. The *Prescribed Procedures O. Reg 596/94* outlines a mandatory safeguard to help protect the public from harm that might occur when advanced prescribed procedures such as arterial cannulation are performed. The College of Respiratory Therapists of Ontario (CRTO) adheres to this regulation, and requires that members performing these controlled acts undergo a certification program approved by the Registration Committee of the CRTO. Radial and femoral cannulation, are examples of advanced prescribed procedures below the dermis which carry a greater risk for the public and so necessitate that a CRTO approved certification program be in place prior to the procedure being performed on a patient/client. For more on legislation and policies please visit the CRTO's website: http//www.crto.on.ca/html/legpol.htm

This respiratory therapy clinical best practice guideline (CBPG) is **not** intended to replace any current certification programs that have been approved by the Registration Committee of the CRTO. The purpose of these evidence-based guidelines are to provide a consistent approach to the development of certification programs/ process which are required for the performance of prescribed procedures below the dermis under Ontario Regulation 596/94. **RRTs may use this guideline as the learning package for your certification program. For more information on this process, please see the CRTO professional practice guideline (PPG) Certification Programs for Advanced Prescribed Procedures Below the Dermis at http://www.crto.on.ca/pdf/ppgcertprog.pdf**

The advanced procedures of radial and femoral artery cannulation are currently the most common arterial cannulation procedures being performed by Registered Respiratory Therapists. They have many shared elements and so are discussed in together in this document for ease.

This best practice guideline contains evidence-based clinical resources to support respiratory therapy practice in order to make informed patient care decisions and provide the best care possible. Evidence-based practice is the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients/clients. The practice of evidence-based medicine means integrating individual clinical expertise and experience with the best available clinically relevant evidence from systematic research. (Sackett et al, 2005 [LOE8])

## INTERPRETATION OF EVIDENCE

References used throughout the body of the document will have a level of evidence (LOE) cited to indicate the quality and strength of the literature used. For example, a randomized clinical trial, will have LOE1 as a superscript, to identify it as having a Level of Evidence of 1 which is considered the strongest evidence available. The table below provides a description of each LOE.

### Levels of Evidence (LOE)

| | |
|---|---|
| **Level 1** | Randomized clinical trials or meta-analyses of multiple clinical trials with substantial treatment effects. |
| **Level 2** | Randomized clinical trials with smaller or less significant treatment effects. |
| **Level 3** | Prospective, controlled, nonrandomized cohort studies. |
| **Level 4** | Historic, nonrandomized cohort or case-control studies. |
| **Level 5** | Case-series; patients compiled in serial fashion, control group lacking. |
| **Level 6** | Animal studies or mechanical model studies. |
| **Level 7** | Extrapolations from existing data collected for other purposes, theoretical analyses, e.g. critical reviews. |
| **Level 8** | Rational conjecture (common sense); common practices accepted before evidence-based guidelines. This includes material from textbooks, and editorials. |

*Adapted from the American Heart Association (AHA), Evidence Evaluation Process Used for the development of cardiopulmonary resuscitation (CPR) and Emergency cardiovascular care guidelines (ECC), 2005.*

## CERTIFICATION PROGRAM TEMPLATE FOR PERIPHERAL ARTERY CANNULATION - RADIAL & FEMORAL ARTERIES

The CRTO requires that certain components be included in the certification program. The required content is described in the CRTO professional practice guideline (PPG) on *Certification Programs for Advanced Prescribed Procedures Below the Dermis. For further information the following link will take you to a list of available practice guidelines on the CRTO's Web site:* *www.crto.on.ca/html/profpractguidelines.htm*

Below is a **suggested** content list to be used in the development of a certification program for radial and/or femoral artery cannulation. Items **A through G are required content,** as described in the *Certification Programs for Advanced Prescribed Procedures Below the Dermis PPG*. All other items further support the information to be incorporated into a certification program.

**Contents:**

## A. Certification and Recertification Requirements

**Only Registered Respiratory Therapists (RRT) who hold a general certificate of registration, without terms and conditions, are authorized to perform an advanced prescribed procedure below the dermis, such as radial and femoral artery cannulation.** Although authorized to perform the procedure, the *Respiratory Therapy Act* details the requirement of an order to enable the RT to proceed with the cannulation. An order can be in the form of a direct order or a medical directive based on the specific needs and policies of the organization or practice/setting environment.

To obtain initial certification the RRT must complete the CRTO approved certification program (O.Reg 596/94). In order to maintain certification or to be considered recertified, competence must be demonstrated under direct supervision at a minimum of every two years. This may include a review of related experience, verbal and/or written evaluation of knowledge (CRTO Certification Programs for Advanced Prescribed Procedures Below the Dermis professional practice guideline).

### A certification program is made up of three components:

I. Knowledge Component
II. Observation Component
III. Demonstration Component

The purpose of a certification package is to help the learner navigate the required theory and to provide a foundation for the clinical portion which will solidify understanding of all aspects of the procedure.

**Knowledge Component –** The knowledge component can be evaluated by a written or verbal examination. It is recommended that a minimum mark be required in order to proceed to the observation component. An estimate of the time required to complete this portion should be described.

**Observation Component –** After successful completion of the knowledge component the RRT will advance to review of the skill in a simulated setting under the direction of a certified clinician. The intent of this portion of the program is to provide a safe setting for the review of the skill and competencies required in order to be successful in performing the procedure on a patient. An estimate of the time required to complete this portion should be described.

**Demonstration Component –** This portion requires that the procedure be performed on a patient, under direct observation by a clinician certified in the procedure and who has the skills required to teach effectively. The decision as to who the clinician(s) should be determined based on internal resources. There is no evidence to support the decision of how many times the procedure should be repeated in order to determine competence. There is only an understanding that proficiency does come with practice and that ongoing evaluation is needed in order to ensure competency.

## B. Nature and Purpose of the Procedure

Each facility will have a rationale for having an RRT assume the added responsibility of performing this advanced procedure. The reasoning provided here has been described in certification programs that have been already approved by the CRTO, or have been described in literature.

Describing the nature and purpose helps establish the foundation for performing the procedure so that all readers understand its merits.

1. To standardize the approach used to perform radial and femoral artery cannulation performed by the Registered Respiratory Therapy based on good technique, clinical expertise and evidence-based practice.

2. To guide infection control practice related to peripheral arterial access in order to minimize the incidence of catheter-related line infections.

3. To expedite patient care by improving timeliness of establishing arterial access in situations where the physician is not immediately available.

4. To decrease the cost of patient care in situations where the physician would need to be called in to perform the procedure (Gronbeck & Miller, 1993 LOE5).

5. To provide a greater success rate for initial placement of arterial lines due to varying levels of training of the physician (Gronbeck & Miller, 1993 LOE5).

6. To increase the numbers of qualified clinicians available to perform the procedure in order to expedite patient care.

7. To improve utilization of specialized personnel that is in-house and immediately available. This offers the advantage of a larger team trained to assist in emergency-related circumstances such cardiac and respiratory arrests, disasters and pandemics.

8. To increase the skill of the RRT when assisting medical residents during arterial line insertion. The RRT can provide clinical expertise and enhanced technical troubleshooting advice.

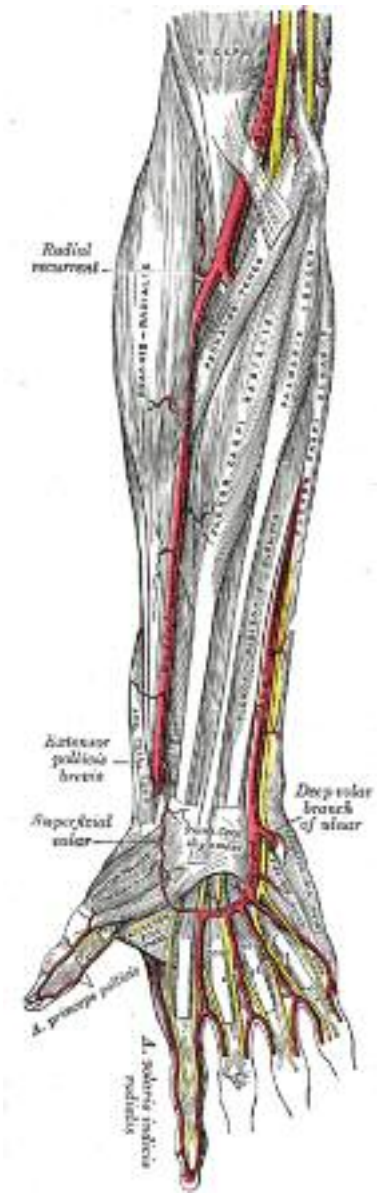
## C. Learning Objectives

Objectives should be clear, concise and measurable. They should reflect back on curriculum content and focus on key take-away messages. Below is a list of possible objectives that may be included in the development of your certification program.

1. State the standard/policy and medical directive (if applicable).
2. Demonstrate familiarity with the equipment used.
3. Describe the indications and contraindications.
4. Assess patient appropriateness for procedure, and the need for prevention and management of pain.
5. Demonstrate appropriate knowledge of the anatomy.
6. List the potential complications and discuss their prevention and management.
7. Demonstrate an understanding of pharmacology associated with the procedure.
8. Demonstrate appropriate infection control measures.
9. Demonstrate and discuss proper technique for cannulation.
10. Demonstrate successful assessment and cannulation on patient(s)/client(s).

## D. Anatomy

The use of peripheral arterial catheters for haemodynamic monitoring is widespread. Arterial cannulation is performed on a number of vessels including the radial, femoral, axillary, brachial, ulnar, dorsal pedis, tibial posterior and temporal arteries.




**The radial and ulnar arteries**
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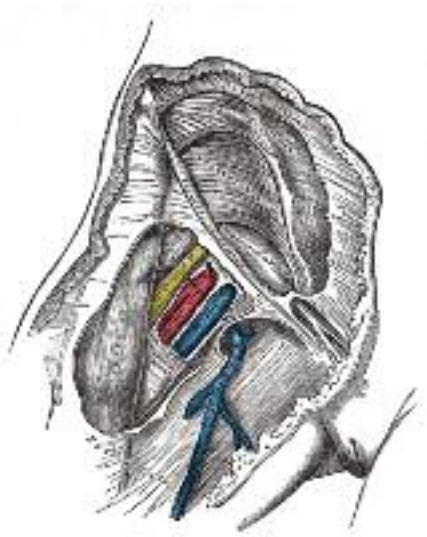
### The Radial Artery

The radial artery is the most frequently used site for direct arterial cannulation and blood pressure measurement because it is technically easy to cannulate and has a low complication rate, in part due to the good collateral circulation of the hand (Martin et al, 2001[LOE3]; Scheer et al, 2002[LOE7]; Miller, 2005[LOE8]). In neonates and small children insertion of an arterial catheter into the radial artery may be difficult due to the small diameter of this peripheral artery (Schindler et al, 2005[LOE4]).

The radial waveform is subject to inaccuracy inherent to its distal location and may underestimate central pressure in certain clinical situations such as excessive vasopressor administration (Cousins & O'Donnell, 2004[LOE7]).

The radial artery appears to be the continuation of the brachial artery. It arises at the bend of the elbow in the antecubital fossa and passes along the radial side of the forearm to the wrist. It is just lateral to the flexor carpi radialis tendon on the thumb side. Extensive collateral circulation is provided via the ulnar artery and palmar arch (Cousins & O'Donnell, 2004 [LOE7]). Pulsations can be readily palpated at approximately two centimeters from the wrist, where the artery becomes superficial due to its passage above the radius bone. The radial artery anastomoses with the ulnar artery in the hand forming the deep palmar arch, the dorsal arch and the superficial palmar arch (Malley, 2004[LOE8]).



**Femoral sheath laid open to show its three compartments**
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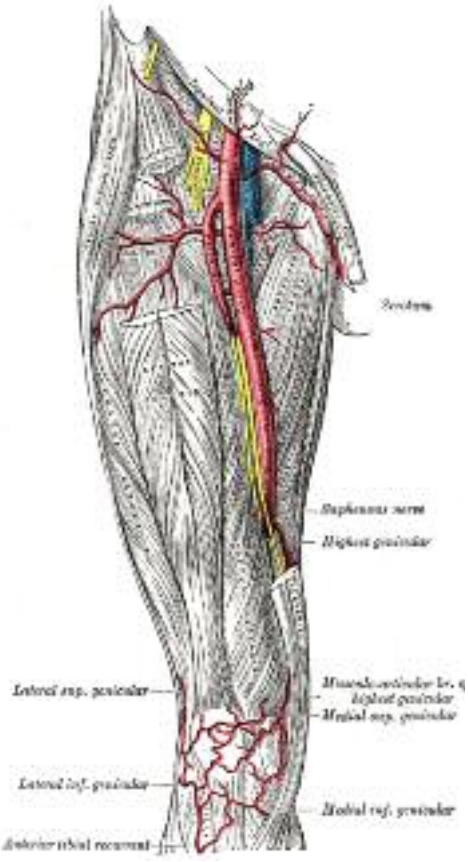

**The femoral artery and vein**
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## Femoral Artery

The femoral artery is the second most cannulated artery for haemodynamic monitoring because of its accessibility and large size. The blood pressure waveform provides a more accurate estimation of central (aortic) pressure than the radial artery even in hypovolemic, vasoconstricted and central shunting states (Scheer et al, 2002 LOE7; Cousins & O'Donnell, 2004 LOE7). Femoral artery catheter complications are infrequent but are more complicated than that of the radial artery (Cousins & O'Donnell, 2004 LOE7). It has been previously recommended that lower extremity insertion sites be avoided because the density of microbes. Sites such as the femoral artery were thought to be difficult to maintain asepsis and increase the risk of infection however this has not been corroborated (Scheer et al, 2002 LOE7; PHAC, 2002 LOE7).

The femoral artery lies in a neurovascular bundle lateral to the femoral vein and median to the femoral nerve (Cousins & O'Donnell, 2004 LOE7). It begins immediately behind the inguinal ligament, midway between the anterior superior spine of the ilium and the symphysis pubis. The femoral artery passes down the front and medial side of the thigh and ends as the popliteal artery in the lower third of the thigh. In the upper third of the thigh the femoral artery is contained in the femoral triangle which is bound laterally by the Sartorius, Adductor longus and Inguinal ligament. Collateral circulation exists via a number of anastomoses. Just below the inguinal ligament, the artery is closest to the surface of the skin and easily accessible. This is the optimal location of cannulation (Hopkins, 2005 LOE8).

## E. Indications and Contraindications

Arterial cannulation provides an uninterrupted display of pulse contour and continuous beat-to-beat haemodynamic measurement. This data can be invaluable for effective clinical management, such as the reliable titration of supportive medications (Tegtmeyer et al, 2006 LOE8; Miller, 2005 LOE8). Numerous patient conditions, including morbid obesity, burn extremities and shock can cause non-invasive blood pressure measurements to be inaccurate and so necessitate invasive blood pressure monitoring (Miller, 2005 LOE8). The procedure of arterial cannulation however comes with risk and so the need for the device must be weighed against the risk to the patient (Cousins & O'Donnell, 2004 LOE7; Miller, 2005 LOE8).

Contraindications described for radial and femoral artery cannulation draws attention to local site selection and quality of collateral circulation. When selecting a site for placement of an arterial line circulation distal to the placement site should not be compromised. This means those sites with known problems in collateral circulation should be avoided (Tegtmeyer et al, 2006 LOE8).

Contraindications vary from site to site. The contraindications listed in the table that follows, have all been described in CRTO approved certification programs and have been included to help the clinician in discussions with the physicians who will be reviewing the practice and procedure with the RRT, and helping to decide what the policy or standard will be. The decision should be made based on the evidence available, what is collectively determined to be the safest practice for the patients/clients being served, and given the unique circumstances under which each centre operates.

The most common site of placement of an indwelling arterial catheter is the radial artery. The femoral artery is the next most common site of choice. The ulnar artery, being the dominant artery to the hand in the majority of cases, should not be routinely used for cannulation. (Stafford 2003 LOE8) Other sites which may be used include the doralis pedis, axillary, and brachial arteries.

## Verification of collateral circulation

There are a variety of techniques used to assess the ability of the ulnar artery to provide adequate perfusion to the hand in the event of radial artery thrombosis. The most commonly used test is the modified Allen's test; however its ability to predict potential ischemic damage after cannulation of the radial artery is very controversial. The controversy lies in the fact that the test has been shown to have high false positive and false-negative rates (Starnes et al, 1999 LOE5). Numerous studies have been able to demonstrate adequate perfusion with the use of other techniques that contradict the results of Allen's or modified Allen's tests (Martin et al, 2001 LOE3). Many reports of permanent ischemic complications note that a normal modified Allen's test result was present before catheterization (Miller, 2005 LOE8; Slogoff, 1983 LOE5). The Allen's test has practical limitations as it cannot be performed on uncooperative or unconscious patients. However, if choosing to use this *qualitative test* to assess collateral circulated, the modified Allen's test should be used rather than the Allen's test as it avoids hyperextension of the wrist and fingers, and allows better evaluation of the dual palmar arterial circulation (Fuhrman & McSweeney, 1992 LOE5; Martin et al, 2001 LOE3).

Other techniques used to assess ulnar collateral circulation include: the digital systolic blood pressure method, the pulse oximeter modified Allen's test, flow measurement with photoplethysmography, segmental pressure measurements, laser Doppler flowmetry, and the modified Allen's test with Doppler ultrasonography (US). The modified Allen's test with Doppler ultrasonography (US) is the only test available to provide *quantitative* information on blood flow (Fuhrman & McSweeney, 1995 LOE5; Levinsohn et al, 2001 LOE5; Zimmerman et al, 2001 LOE8).

How collateral circulation is verified is an organizational decision. Whatever method is used, it should be documented accordingly in the patient's records.

| INDICATIONS | RELATIVE CONTRAINDICTION | ABSOLUTE CONTRAINDICATION |
|---|---|---|
| • Continuous haemodynamic monitoring in the operating room during major surgery involving fluid shifts and/or blood loss and in critically ill patients (Scheer et al, 2002 LOE7; Martin et al, 2001 LOE3; Schindler et al, 2005 LOE4; Roberts, 2004)<br>• Multiple blood gas sampling and blood gas analysis (Scheer et al, 2002 LOE7; Martin et al, 2001 LOE3; Schindler et al, 2005 LOE4)<br>• Continuous monitoring of blood pressure for patients with haemodynamic instability requiring inotropic or vasopressor medications (Tegtmeyer et al, 2006 LOE8)<br>• To facilitate the reliable titration of supportive medications (Tegtmeyer et al, 2006 LOE8)<br>• For patients with significant ventilatory deficits in order to provide information on gas exchange (Tegtmeyer et al, 2006 LOE5)<br>• Failure or inability to use indirect blood pressure monitoring as in those with severe burns or morbid obesity (Roberts, 2004 LOE8) | • Large haematoma at the insertion site<br>• Anticoagulation<br>• Thrombolytic therapy<br>• Coagulation disorders, e.g., haemophilia, von Willebrand's Disease, disseminated intravascular coagulation (DIC), thrombocytopenia<br>• Peripheral vascular disease (PVD)<br>• Signs of infection (Tegtmeyer et al, 2006 LOE8), rash or open skin at the insertion site<br>• Inadequate collateral circulation (Roberts, 2004 LOE8)<br>• Previous surgery or grafts at the insertion site | • Patient/client or guardian does not consent<br>• Traumatic injury in close proximity to the insertion site (Tegtmeyer et al, 2006 LOE8)<br>• Arterio-Venous Fistula<br>• Inadequate circulation to the extremity (Roberts, 2004 LOE8)<br>• Raynaud's phenomenon (Tegtmeyer et al, 2006 LOE8; Roberts, 2004 LOE8)<br>• Thromboangiitis obliterans or Buerger's disease (Tegtmeyer et al, 2006 LOE8; Roberts, 2004 LOE8)<br>• Full thickness burns (Roberts, 2004 LOE8) |

## F. Risk Factors, Complications and their Management

There are numerous risk factors and complications associated with arterial cannulation. They include and are not limited to: arterial spasm, haematoma, haemorrhage, temporary occlusion, thrombosis, permanent ischemic damage, local infection, sepsis, pseudoaneurysm, arteriovenous formation, nerve damage, and retained guidewire (Scheer et al, 2002 LOE7; Miller, 2005 LOE8)

The rate of serious complications, such as permanent ischaemic damage, sepsis, arteriovenous fistula formation, and pseudoaneurysm formation are low and similar for the radial and femoral arteries. They occur in fewer than 1% of cases (Scheer et al, 2002 LOE7). Other possible complications, such as retained guidewire requiring surgical extraction and fatal hemorrhage after difficult femoral artery cannulation is also rare (Miller, 2005 LOE8). There are however a number of factors that may increase the risk including vasospastic arterial disease, previous arterial injury, thrombocytosis, protracted shock, high-dose vasopressor administrations, prolonged cannulation and infection (Miller, 2005 LOE8).

### Catheter Material

The materials that intravascular devices are made of may be related to thrombogenicity and infections complications. Teflon® or polyurethane catheters have been associated with fewer complications than catheters made of polyvinyl chloride or polyethylene. (PHAC, 1997 LOE7; CDC, 2002 LOE7; Lambert, 1991 LOE2)

### Large cannulas

Thrombus formation and occlusion of the artery appear to be caused by changes in the integrity of the vessel wall caused by the presence of the catheter. The incidence of thrombus appears to be related to the degree to which the catheter fills the arterial lumen. This has lead to a preference for 20-gauge catheters for radial artery cannulation in adults (Scheer et al, 2002 LOE7).

### Arterial Spasm

Arterial spasm after the puncture and usually following multiple attempts can predispose to thrombus formation and even lead to ischemic changes (Roberts, 2004 LOE8). For this reason, attempts should be minimized and skilled clinicians should perform the procedure.

### Temporary Occlusion and Thrombosis

There are six thrombotic risk factors: larger catheter sizes, hypotension, smaller arterial dimension, multiple arterial punctures, duration of cannulation, and administration of vasopressor and inotropic agents. Temporary occlusion is the most common complication of radial artery cannulation and is reported to be between 1.5 – 35%, depending on the source cited. As long as there is adequate collateral flow via the ulnar artery, this is of little concern. (Cousins et al, 2004 LOE7)

The incidence of temporary occlusion and thrombosis in femoral artery cannulation is much lower than that of the radial artery, perhaps due to the larger vessel diameter-to-catheter ratio (Scheer et al, 2002 LOE7; Cousins et al, 2004 LOE7). A higher incidence of occlusion is found in the presence of a haematoma (Scheer et al, 2002 LOE7). Radial vessels 2.0 mm or less in diameter have a higher incidence of thrombosis than those with diameters greater than 2.25 mm. Not surprisingly, the incidence of thrombosis is greater in women than in men (Cousins et al, 2004 LOE7). The incidence of temporary occlusion and thrombosis may be minimized by choosing using larger arteries, proper flushing and decreasing the duration of catherization (Roberts, 2004 LOE8). In the rare circumstances when thrombosis cannot be resolved by these methods, surgical embolectomy or thrombectomy may be required (Roberts, 2004 LOE8).

### Catheter-Related Infections (CRIs)

Patients/clients should be evaluated daily for evidence of infections complications and palpation of the insertion site should be performed. If there is an unexplained fever, pain or tenderness at the insertion site, then it should be inspected visually (PHAC, 1997 LOE7). Infections associated with intravascular devices are related to contamination of the catheter lumen from microorganisms in the fluid path and contamination of the external catheter surface with skin flora at the insertion site (PHAC, 1997 LOE7; CDC 2002 LOE7). Infection can be prevented by following routine infection control practice and using additional precautions. Routine practice includes hand hygiene and the use of personal protective equipment (PPE). Personal protective equipment includes but is not limited to such items as gloves, eye protection, gowns and masks (PHAC, 1999 LOE7; CDC, 2002 LOE7). Please refer to the Ministry of Health directives and own organization policies and procedures regarding the use of PPE.

Hand washing remains the cornerstone of infection prevention and control (PHAC, 1997 LOE7; CDC, 2002 LOE7). Hand hygiene reduces the transmission of micro-organisms. It includes hand washing, maintaining hand health, avoiding nail polish, artificial nails or jewelry and keeping nails trimmed and clean. The fingernail area can harbour considerable flora and other micro-organisms (CDC, 2002 LOE7; PHAC, 1999 LOE7).

Preparation of the site with good skin cleansing and antisepsis is considered one of the most important measures for preventing infections associated with intravascular devices (PHAC, 1997 LOE7; CDC 2002 LOE7). Skin must be clean, that is free of soil, dust and organic material prior to applying the antiseptic (CDC, 2002 LOE7; PHAC, 1999 LOE7). Studies have shown that 2% chlorhexidine gluconate solution significantly lowers catheter-related infections when compared to povidone-iodine and 70 % alcohol (Chaiyakunapruk et al, 1991 LOE7; Humar et al, 2000 LOE2; Maki et al, 1991). The skin should be prepared for at least 30 seconds and allowed to air dry before catheter insertion. As some equipment may be incompatible with alcohol preparations, it is recommended that the manufacturer be consulted (PHAC, 1997 LOE7).

The characteristics and properties the catheter materials may be related to thrombogenicity and infectious complications. Resultantly, radial and femoral catheters should only be placed for definite therapeutic or diagnostic indications, and should be discontinued as soon as possible (PHAC, 1997 LOE7; CDC, 2002 LOE7). For adults, peripheral arterial catheters may be left in place for up to 6 days (PHAC, 1997 LOE7) In paediatric patients, they may be left in place for even longer; however no upper limit for this population has been established. In patients suspected of having a catheter-related infection the catheter should not be replaced using a guidewire technique, but instead an alternative site be used to re-establish vascular access (CDC, 2002 LOE7).

*For more information on good infection control practices please see the CRTOs Clinical Best Practice Guideline on Infection Prevention & Control.*

## G. Practice Considerations and Technique

Prior to performing the cannulation, the need for prevention and management of pain should both be assessed. There are many pharmacological and non-pharmacological interventions that can be used in order to achieve a reduction in pain and anxiety that may be associated with the procedure. Some options that are available include local anaesthesia, sedation, and for the neonatal population, oral sucrose. For more information on pain prevention for the neonatal and paediatric patient populations, please see the references # 2, 3 and 5 in the Reference section of this document.

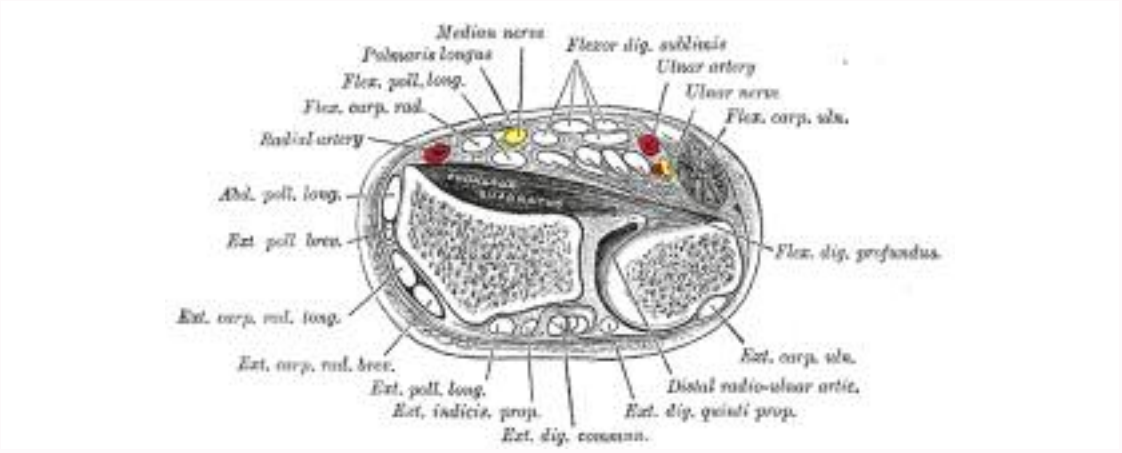
There have been numerous articles comparing direct cannulation to the guidewire-assisted technique. Choice of method depends primarily on equipment availability and clinician experience and preferences. Many clinician use a combination of catheter-over-needle with an integral guidewire. The guidewire-assisted technique provides easy, safe and quick cannulation and allows for long-term satisfactory blood pressure monitoring and blood sampling. This is believed to be because of the longer length of the Teflon catheter advanced into the artery over the guidewire, and a lower rate of dissection of the radial artery. (Vildririm 2005 LOE3)

## Radial Artery Cannulation

### Landmarking & Positioning

- It is important to secure the limb flat and not rotated. Any rotation can result in a shift of the desired artery from the expected anatomical position, causing difficulties in cannulation (Roberts, 2004 LOE8).
- The hand should be placed in moderate dorsiflexion, which brings the artery closer to the skin (Tegtmeyer et al, 2006 LOE8; Malley 2004 LOE8). A flexible board or roll under the wrist can facilitate this. Immobilizing the wrist and hand may help maintain optimum position (Miller, 2005 LOE8).
- Identify the landmarks and palpate the radial artery for a pulse with the non-dominant hand 1 to 2 cm from the wrist (Malley 2004 LOE8; Tegtmeyer et al, 2006 LOE8). Cannulation site should take into consideration flexion of the wrist.

**Major Landmarks include:** the bony head of the distal radius laterally (radial notch), the flexor carpi radialis tendon and the median nerve.




**Transverse section across distal ends of radius and ulna**
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### Local Anaesthetic

- The use of local anaesthesia can be considered in the appropriate clinical setting and may help relieve pain, anxiety and vessel spasm (Bauman et al, 2005 LOE8; Miller, 2005 LOE8). Either subdermal or topical agents can be used.
- At this time, topical agents such as EMLA are recommended to only be used on intact skin (Crystal & Blankenship, 2005 LOE8).
- In a randomized trial EMLA, a topical anesthetic, was compared to subcutaneous lidocaine in 538 adults scheduled for coronary angiography. The results showed that cannulation was more successful in the EMLA group and pain was less severe, perhaps due to reduced arterial spasm and limitation of hand movements (Joly et al, 1998 LOE8).

**1% or 2% Lidocaine without Epinephrine**

- For subcutaneous local anaesthesia, a 1 or 2 % solution without epinephrine should be used.
- 1% Lidocaine is the most commonly used local anesthetic because if has a fast onset of action, is inexpensive and is available in a variety of concentrations. (Smith, 1999 LOE7)
- A 1% solution without epinephrine has an average duration of action approximately 1.5 hours (Crystal & Blankenship, 2005 LOE8).
- The use of a small needle and slow administration of the anesthetic (30 seconds per mL) in a proximal to distal direction tend to lessen the pain of injection (Crystal & Blankenship, 2005 LOE8).
- Inject the lidocaine intradermally and subcutaneously alongside the artery with a 25-27 gauge needle (Miller, 2005 LOE8).
- True allergic reactions to amide local anesthetics are rare. If, however it is found that a patient is in fact allergic to one class of anesthetic, another class can be substituted. (Smith 1999 LOE7)

**EMLA**

- EMLA is an abbreviation for eutectic mixture of local anaesthetic. It is a 5% emulsion preparation that contains 2.5% lidocaine and prilocaine which produces dermal cutaneous anaesthesia (Crystal & Blankenship, 2005 LOE8).
- Skin penetration is time-dependent. Studies have shown that 60 minutes is insufficient to produce effective anaesthesia (Joly et al, 1998 LOE2).
- EMLA should only be applied to intact skin (Crystal & Blankenship, 2005 LOE2).
- In infants less than 3 months of age, there is a theoretical risk of methemoglobinemia due to inadequate levels of methemoglobin reductase (Crystal & Blankenship, 2005 LOE2).

**Sterile/Aseptic Field**

- The optimal duration for hand washing is unknown but a minimum of 15 seconds is recommended (CDC, 2002). Good hand hygiene before catheter insertion for short (<6 cm) peripheral catheters, combined with proper aseptic technique during catheter manipulation, provide protection against infection (CDC, 2002 LOE7).
- Prepare the insertion site with an antiseptic of proven efficacy. Clean the site for at least 30 seconds, and allow to air dry before cannulation (PHAC, 1997 LOE7; CDC, 2002 LOE7).
- Sterile gloves should be worn for insertion of arterial catheters (CDC, 2002 LOE7).

**Insertion Technique & Establishing the line**

- There are several methods that can be used to cannulate. Two common approaches are “over-the-needle” and “over-the-wire” (modified Seldinger). The “over-the-wire” or modified Seldinger technique can often rescue a failed “over-the-needle” cannulation attempt (Miller 2005 LOE8; Roberts, 2004 LOE8).

- There are numerous commercially available sets featuring guidewire and reservoir attachments to an over-the-needle catheter assembly. Some have suggested that these will improve success rates in some patients; however success seems to be more dependent on operator experience and personal preference (Miller, 2005 LOE8).
- There is some evidence to suggest that the direct puncture technique is associated with a higher failure rate in critically ill patients (Beards et al, 1994 LOE3). In neonates and in small children, cannulation may be difficult because of the small diameter of the artery. A guidewire-assisted radial artery cannulation technique rather than a direct puncture technique may be more successful (Yildirim et al, 2006 LOE3; Schindler et al, 2005 LOE4).
- The pulse should be palpated proximal to the insertion site and the needle penetrates the skin at a 30 to 45 degree angle directly over the palpated pulse. The catheter should be advanced slowly toward the pulse (Tegtmeyer, 2006 LOE8; Malley, 2004 LOE8; Miller 2005 LOE8).
- Insert needle at 45 degree angle, directing it towards the point of palpation. Upon blood flashback, the needle is lowered to a 30 degree angle and advanced another 1-2 mm to make certain that the tip of the catheter is well into the vessel lumen. (Murray, 2003 LOE8)
- The catheter should never be advanced unless blood is flowing into the collecting reservoir, which confirms that the catheter tip is within the arterial lumen (Miller, 2005 LOE8).
- If unsuccessful, redirection of the needle should only occur when the needle has been retracted to just below the dermis (Roberts, 2004 LOE8).
- Once the catheter has been placed successfully, it should be advanced until the hub is in contact with the skin (Roberts, 2004 LOE8).
- Withdraw guidewire (if used) and remove the needle.
- Apply pressure over the artery proximal to the catheter, to prevent further blood loss (Tegtmeyer et al, 2006 LOE8).
- Attach to a pressurized fluid-filled system of sodium chloride with or without heparin and ensure an appropriate waveform is present on the monitor (Roberts, 2004 LOE8; Miller, 2005 LOE8).

**Securing the Site**

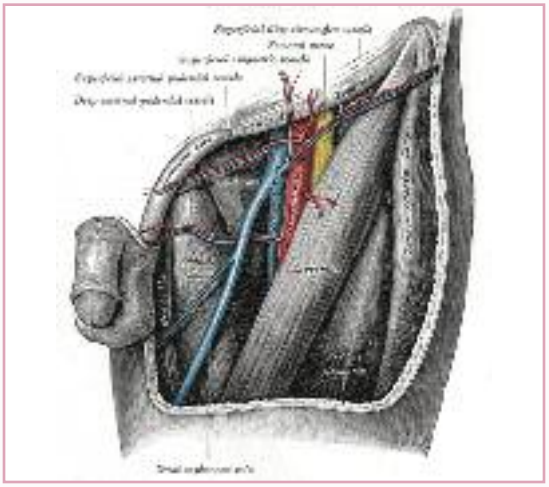
- Secure the line by suturing or applying tape and an appropriate dressing (Tegtmeyer et al, 2006 LOE8; Roberts, 2004 LOE8).
- More recent clinical evidence from the CDC cite catheter securement devices (e.g. Statlock®) as being advantageous over sutures in reducing bloodstream infections in patients and accidental needlestick injury in clinicians. (CDC, 2002 LOE7; Bierman, 2002 LOE8)
- Sterile gauze should be used but a transparent semi-permeable dressing may be considered. Transparent dressings reliably secure the device, and permit continuous visual inspection of the catheter site (PHAC, 1997 LOE7; CDC, 2002 LOE7).
- The dressing can be left in place until the catheter is removed, unless it becomes wet, loosened or visibly soiled (PHAC, 1997 LOE7; CDC, 2002 LOE7).

## Femoral Artery Cannulation

### Landmarking & Positioning

- Position the selected leg with hip flexed and abducted to allow for maximal access to the site. Immobilizing the leg may help maintain optimum position. In some situations, it may be necessary to sedate the patient/client (Hopkins, 2004 LOE8).
- A small towel or diaper placed under the buttocks of an infant can help flatten the inguinal area and make the angle of entry less acute (AHA, 2005 LOE7)
- From the lateral to the medial, the structures are nerve, artery, and vein. Palpate the femoral artery just below the inguinal ligament.

**Major landmarks include:** The boundaries of the femoral triangle. The three boundaries of the femoral triangle are the inguinal ligament at the base, sartorius at the lateral side and the adductor longus at the medial side.



**The left femoral triangle**
http://www.bartleby.com/107/illus549.html
Gray (2000). Anatomy of the Human Body.
Reproduced with permission.

### Local Anaesthetic

- The use of local anaesthesia can be considered in the appropriate clinical setting and may help relieve pain, anxiety and vessel spasm (Bauman et al, 2005 LOE8; Miller, 2005 LOE8).
- For subcutaneous local anaesthesia, a 1 or 2 % Lidocaine Hydrochloride solution without epinephrine should be used.
- A 1% Lidocaine solution without epinephrine has an average duration of action of approximately 1.5 hours (Crystal & Blankenship, 2005 LOE8).
- The use of a small needle and slow administration of the anesthetic (30 seconds per mL) in a proximal to distal direction tend to lessen the pain of injection (Crystal & Blankenship, 2005 LOE8).
- Inject the lidocaine intradermally and subcutaneously alongside the artery with a small needle, such as 25-27 gauges (Miller, 2005 LOE8).

**Sterile/Aseptic Field**

- The optimal duration for hand washing is unknown (PHAC, 1997 LOE7). Good hand hygiene before catheter insertion for short (<6 cm) peripheral catheters, combined with proper aseptic technique during catheter manipulation, provide protection against infection (CDC, 2002 LOE7).
- Prepare the insertion site with an antiseptic of proven efficacy. Clean the site for at least 30 seconds, and allow to air dry before cannulation (PHAC, 1997 LOE7; CDC, 2002 LOE7).

**Insertion Technique & Establishing the line**

- The site of entry is described differently depending on the source, but should be at least 1 cm below the inguinal ligament in order to avoid entering the abdomen (Hopkins, 2005 LOE8; Roberts, 2004 LOE8). Additionally, if the insertion site is established at least **5 cm** below the inguinal crease the area most heavily colonized with bowel organisms and yeasts is avoided, and application of a dressing will be facilitated (APIC, 2005 LOE8).
- The general course of the needle is in a line directed toward the umbilicus (Roberts, 2004 LOE8).
- The guidewire (modified Seldinger) technique is preferred when catheters are inserted into a femoral vessel (Roberts, 2004 LOE8).
- The pulse should be palpated proximal to the insertion site and the needle penetrates the skin at a 30 to 45 degree angle to avoid entering the abdomen (Hopkins, 2005 LOE8).
- When blood return is noted, pass the wire gently through the needle into the vessel. If there is resistance to the passage of the wire, it should be removed to assess the needle's position within the vessel (Roberts, 2004 LOE8).
- If unsuccessful, redirection of the needle should only occur when the needle has been retracted to just below the dermis (Roberts, 2004 LOE8).
- Once the catheter has been placed successfully, it should be advanced until the hub is in contact with the skin (Roberts, 2004 LOE8).
- Apply pressure over the artery proximal to the catheter, to prevent further blood loss (Tegtmeyer et al, 2006 LOE8).
- Attach to a pressurized fluid-filled system of sodium chloride with or without heparin and ensure an appropriate waveform is present on the monitor (Roberts, 2004 LOE8; Miller, 2005 LOE8).

**Securing the Site**

- Secure the line by suturing or applying tape and an appropriate dressing (Tegtmeyer et al, 2006 LOE8; Roberts, 2004 LOE8).
- A sterile gauze should be used but a transparent semi-permeable dressing may be considered. Transparent dressings reliably secure the device, and permit continuous visual inspection of the catheter site (PHAC, 1997 LOE7; CDC, 2002 LOE7).
- The dressing can be left in place until the catheter is removed, unless it becomes wet, loosened or visibly soiled (PHAC, 1997 LOE7; CDC, 2002 LOE7).

## H. References

All sources used in the development of the certification program should be cited. This should include the CRTO professional practice guideline on Certification Programs for *Advanced Prescribed Procedures Below the Dermis* and *Infection Control.*

## I. Appendix

An appendix is a reference section. It can be used to describe information not included in the body of the certification program, but that is considered as a valuable resource to enhance understanding of the topic. It could cover such topics as medications or disease processes that are cited for example.

## J. Certification Log

The CRTO Professional Practice Guideline, *Certification Programs for Advanced Prescribed Procedures Below the Dermis*, describes record keeping requirements. A certification log is one method that can be used to chronicle when a cannulation procedure has been performed. It is a document, that at minimum captures the date when the procedure was performed, patient data, and the signature of the certifying clinician. It can take many forms, for example, a blank sheet can be used to manually enter the information, or a table can be created that lists the required information and contains space for documentation of each cannulation.

Certification information, such as a certification log, can be incorporated in the CRTOs Quality Assurance (QA) professional portfolio. The patient identifiers need only be removed.

## K. Competency Checklist

A competency checklist is a tool that can be used to guide both the certifier and the learner and to ensure that the objectives of a certification program are met. It contains specific measurable components that need to be met 100% of the time when the procedure is performed.

| Area/Item | Criteria | Complete Yes (√) or No (X) |
|---|---|---|
| **Patient/Client Assessment** | Checks for order, allergies, patient identification, and any contraindications. | |
| **Policy & Procedure** | Knows the indications, contraindications, common complications their prevention and management. | |
| **Infection Control** | Adheres to good hand washing and aseptic technique. | |
| **Anatomy** | Demonstrates knowledge of the landmarks. | |
| **Local Anaesthetic** | For subdermal lidocaine ensures no flash back and waits for medication to take effect. For topical waits for medication to take effect. | |
| **Guidewire Use** | Demonstrates knowledge of equipment and the steps required for success. | |
| **Cannulation Technique** | Appropriate local site selection for entry of the vessel and angle of approach. | |
| **Documentation** | Content documented as described in policy and signature with professional designation. | |

## L. Test

A test is an objective method employed to gauge the learner's ability to retain and apply information. It is a common educational tool used to help measure competency (knowledge, skills and judgment). A test can help reinforce key take away messages and act as a means of enforcing the objectives of a certification program.

## M. Policy & Procedure

To support practice and ensure consistency between practitioners, each facility develops policies and procedures. Some facilities use the terms standard or protocol to describe the same. When a certification program is submitted to the CRTO for consideration, the organization's policy and procedure should also be tendered because it serves as part of the curriculum that must be reviewed by the learner undertaking the certification program. **Even if this practice guideline is to be utilized as the learning package for the certification program, it is still necessary to submit the facilities policy to the CRTO.**

A policy and procedure may contain a purpose statement and will include standards by which each Respiratory Therapist who performs the procedure will be held to. The following is a **suggested** template that can be used in order that all pertinent information is captured when developing a policy and procedure. An **asterisk*** identifies content that must be included in a policy and procedure in order to meet the minimum requirements of legislation and the criteria described in the *Certification Programs for Advanced Prescribed Procedures Below the Dermis* CRTO professional practice guideline.

### Policy & Procedure Template

**SUBJECT:***
Describes the site of cannulation and the patient population to which the procedure will apply.

Radial or Femoral Artery Cannulation in e.g., neonates.

**ISSUING BODY:**
Department or Program, e.g., Respiratory Therapy Services

**EFFECTIVE DATE:**
Date Policy is accepted and put into effect

According to the *Respiratory Therapy Act, 1991* only those Registered Respiratory Therapists (RRTs) who hold a **general** certificate of registration can perform the controlled act of "a prescribed procedure below the dermis". This is further described in the "Prescribed Procedures Regulation" made under the Act, which requires that RRTs, who will be performing this procedure, complete a certification program that has been approved by the Registration Committee of the College of Respiratory Therapists of Ontario within two years before the procedure is performed.

## Policy & Procedure Template (continued)

### PURPOSE:

Describes the reason for the development of this policy and procedure.

1. To standardize the approach to, e.g., radial artery cannulation performed by Registered Respiratory Therapists.
2. To optimize patient care by, e.g., improving the timeliness of arterial access for continuous haemoddynamic monitoring and blood sampling.

### STANDARDS:

Standards of Care outline the minimum expectations for patient care delivery in a specific area, within a discipline(s), or across the facility. They provide specific direction to the clinicians referred to in the standard. Standard statements contain expectations against which actual performance can be judged and must be met 100% of the time. The following three statements are the minimum that need to be included in a policy & procedure to meet the requirements of the CRTO.

1. Only a Registered Respiratory Therapists (RRT) who holds a general certificate of registration and has completed a certification program that has been approved by the Registration Committee of the CRTO can perform _____.*

2. Initial certification will include observation of ____ cannulations under direct supervision by _____.*

3. In order to maintain competency and certification status, the skill of _____ must be observed under direct supervision by _____ _____times at minimum every two years.*

### PROCEDURE:

Outlines step-by-step how a certain task or procedure should be completed. It provides direction for day-to-day practice related to the procedure.

### DOCUMENTATION:

Describe how the procedure must be captured in the patient/client chart.

### DEVELOPED IN CONSULTATION WITH:

Lists all the stakeholders consulted during the development of the standard/policy and procedure. This may include individual(s) and committees.

### REFERENCES:

Details all the resources used to support the narrative.

*Source: St. Joseph's Health Centre, Toronto, Standards of Care Template, 2006*

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This practice Guideline will be updated as new evidence emerges or as practice evolves. Comments on this practice guideline are welcome and should be addressed to:

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