

Central Access: Umbilical Artery & Vein 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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Acknowledgements

This Respiratory Therapy Clinical Best Practice Guideline was developed by a working group of the College of Respiratory Therapists of Ontario's (CRTO) Registration Committee comprised of practicing Registered Respiratory Therapists.

A search for related articles was performed on PubMed, MD Consult, Ovid Medline, and CINAHL (Cumulative Index to Nursing & Allied Health Literature). On Ovid, three evidence-based medicine review databases were searched. These included ACP Journal Club (ACP), Cochrane Database of Systematic Reviews (CDSR), and Database of Abstracts of Reviews of Effects (DARE). Relevant electronic books on MD Consult and Ovid were reviewed. The following terms were used: umbilical vessel, umbilical cord, umbilical vein, umbilical artery, umbilical vein cannulation/ catheterization, and umbilical artery cannulation/catheterization. A general search engine web search was conducted on "Google" and "Google Scholar", using the same terms identified above. A structured web site search was conducted on the Public Health Agency of Canada (PHAC), and the Centers 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.

Working Group Members

Gabriel Cardenas, RRT
*Professional Practice Leader &
Clinical RT Student Coordinator
Trillium Health Centre, Mississauga*

Michael Finelli, RRT
*NRCP Neonatal Respiratory Care Practitioner
Clinical Ed. Respiratory Therapy, NICU
Sick Children's Hospital, Toronto*

Cynthia Harris, BSc RRT
*ICU Charge Therapist, Respiratory Therapy
Mount Sinai Hospital, Toronto*

Dave Jones, B.Sc., RRT
*Assistant Manager
Western ProResp, London*

CRTO Staff:
Carole Hamp, RRT, *Professional Practice Advisor*

Ginny Martins, RRT
*Professional Practice Advisor
CRTO Staff &
Charge Respiratory Therapist
St. Joseph's Health Centre, Toronto*

Myron Steinmann, RRT BEd
*Clinical Educator - Respiratory Therapy
London Health Science Centre, London*

Kevin Taylor, RRT
*Manager, Academic Affairs (Health Disciplines)
Practice Leader - Respiratory Therapy
St. Michael's Hospital, Toronto*

Danny Veniott, BSc EMT-PCP RRT
*Professional Practice Leader; Senior Respiratory
Therapist & Anaesthesia Assistant, CVICU/CVOR
St. Mary's General Hospital &
Regional Cardiac Care Centre, Kitchener*

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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. Umbilical artery and vein 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.

Umbilical artery cannulation was first described as a route for blood gas analysis in 1959. Since that time, umbilical artery and vein cannulation have become two of the most commonly performed procedures in the neonatal intensive care unit during the first hours of a neonate’s life (Nash, 2006^{LOE7}). As Registered Respiratory Therapists continue to expand their practice role and utilize their full scope of practice in the neonatal intensive care unit, on specialized neonatal transport teams, and within the peri-operative environment, a greater number of RRTs will be performing these advanced procedures. As umbilical artery and vein cannulation have many shared elements, they are presented together in this document.

This Respiratory Therapy best practice guideline 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/ processes which are required for the performance of advance prescribed procedures below the dermis under Ont. Reg. 596/ 94. **RRTs may use this guideline as the learning package for their 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/ppg.aspx>.**

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 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 UMBILICAL CANNULATION FOR UMBILICAL ARTERY AND UMBILICAL VEIN

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: <http://www.crto.on.ca/ppg.aspx>

Below is a **suggested** content list to be used in the development of a certification program for umbilical artery & vein cannulations. 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
- B. Nature and Purpose of the Procedure
- C. Learning Objectives
- D. Anatomy
- E. Indications and Contraindications
- F. Risk Factors, Complications and their Management
- G. Technique
- H. References & Bibliography
- I. Appendix
- J. Certification Log
- K. Competency Checklist
- L. Test
- M. Policy and Procedure

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 umbilical artery and vein 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 a 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, 2008).

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) are, 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 already been approved by the CRTO, and/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 umbilical artery and vein cannulation performed by the Registered Respiratory Therapist based on good technique, clinical expertise and evidence-based practice.
2. To guide infection control practice related to umbilical artery and vein cannulation, in order to minimize the incidence of catheter-related line infections.
3. To expedite patient care by improving timeliness of establishing venous access in situations where the physician is not immediately available.
4. To increase the numbers of qualified clinicians available to perform the procedure in order to expedite patient care.
5. 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.
6. To increase the skill of the RRT when assisting health care professionals during umbilical artery and/or umbilical vein cannulation. 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.

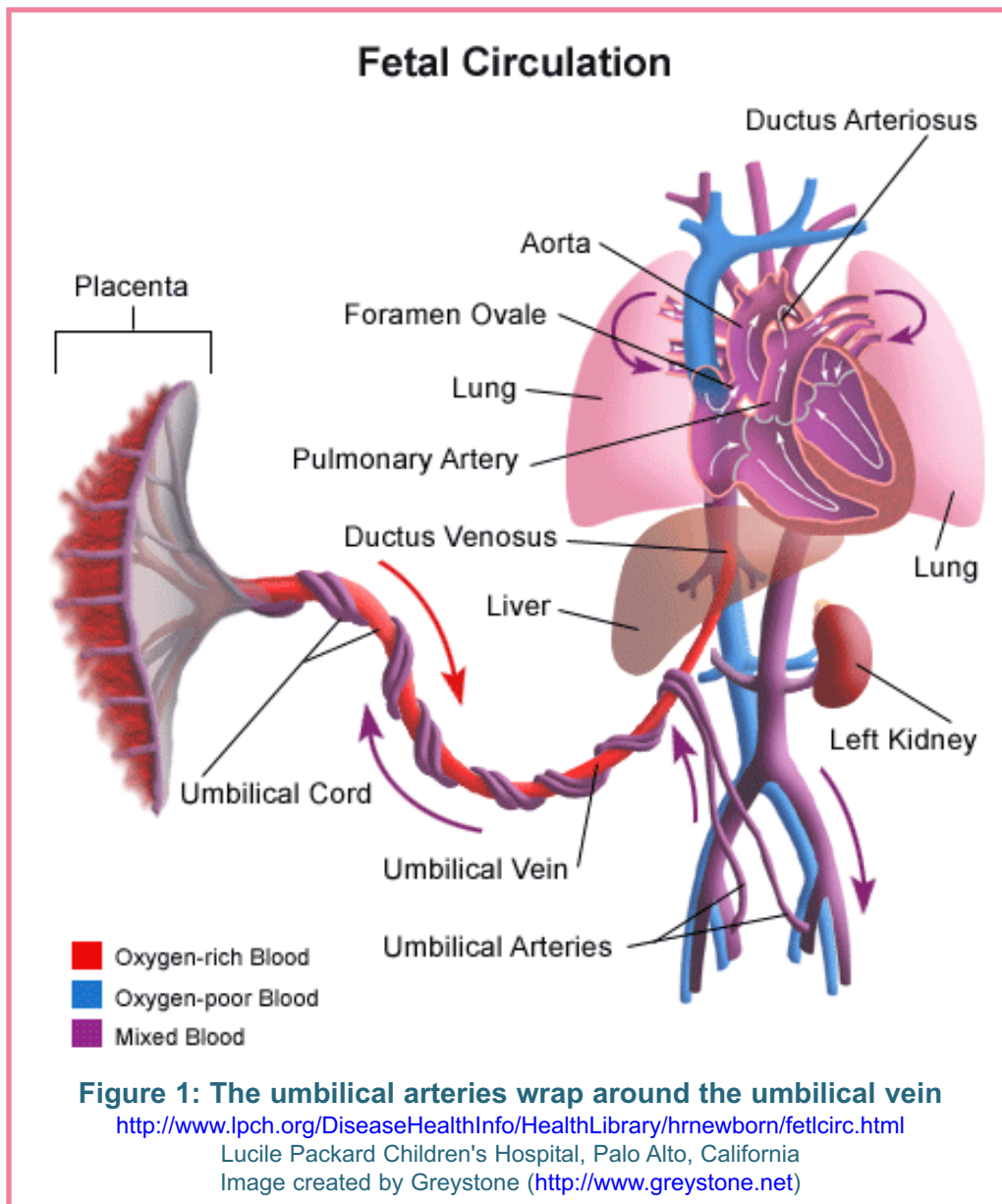
1. State the standard/policy and medical directive (if applicable).
2. Demonstrate familiarity with the equipment used.
3. Describe the indications and contraindications.
4. Assess patient appropriateness for procedure.
5. Demonstrate appropriate knowledge of the anatomy.
6. List the potential complications 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 umbilical arteries and veins are blood vessels that are present during fetal development. There are two umbilical arteries and one umbilical vein. On occasion however, only one umbilical artery is noted. This occurs in approximately 1% of live births, is more common in multiple births and can be associated with structural or congenital anomalies or intrauterine growth restriction (IUGR).

Umbilical arteries are small muscular-walled vessels that carry deoxygenated blood from the fetus to the placenta; the umbilical vein is larger, thin-walled, and carries oxygenated blood from the placenta to the fetus. The three vessels coil around one another in the umbilical cord and enter the abdomen at the umbilicus. The umbilical arteries course downward to the internal iliac arteries before entering the aorta. They supply the buttocks and the lower extremities via the latter part of the internal iliac arteries. The umbilical vein courses upward along the falciform ligament to the underside of the liver. Here it divides into two vessels, the portal vein and the ductus venosus. The ductus venosus joins with the inferior vena cava.

The umbilical vein remains patent for approximately one week after birth. Closure of the umbilical vein usually occurs after the umbilical arteries have closed. Umbilical arteries begin to constrict within seconds after birth and functionally close within a few minutes of birth. They can however, often be dilated and cannulated within in the first few days of life. The umbilical arteries later become the medial umbilical ligaments and the umbilical vein becomes the ligamentum teres. (Roberts, 2004^{LOE8}; Furdon et al^{LOE7}, 2006; Nash, 2006^{LOE7}) Insertion of umbilical catheters can be attempted as long as the umbilical stump is attached, preferably within 3 to 4 days of life. After the first 24 hours, insertion is made easier by placing saline gauze on the stump for an hour. (Georgiadis, 2007^{LOE8})



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E. Indications and Contraindications

Umbilical artery catheter (UAC) and umbilical venous catheter (UVC) placement have become the standard of care in the neonatal intensive care unit. These catheters allow for rapid and reliable access to the vascular system of critically ill neonates (Nash, 2006^{LOE7}).

The umbilical artery is cannulated for frequent blood gas sampling to measure blood gases and pH, especially in very ill and/ or low birth weight (LBW) infants. It provides an invasive form of continuous beat-to-beat blood pressure monitoring as well as a route for exchange transfusion. One of the two umbilical arteries can be cannulated for resuscitative purposes, but the umbilical vein is generally catheterized for this indication because it is technically easier to perform than umbilical artery catheterization. The major indications for UVC is for the infusion of hypertonic solutions (e.g., >12.5% dextrose) and/or vasoactive drugs. (Georgiadis, 2007^{LOE8}) It also can be used for central venous pressure monitoring when positioned appropriately across the ductus venosus; venous blood gas monitoring; exchange transfusion; and short-term central venous access for fluid administration, medications or nutrition (Roberts, 2004^{LOE8}; Weinstein, 2007^{LOE8}). Both the umbilical arteries and vein can be used for parenteral nutrition or antibiotic therapy in the vascularly compromised neonate; however the artery is not commonly used for these indications (Weinstein, 2007^{LOE8}; Nash, 2006^{LOE7}).

Relative contraindications for both vessels include local infections and malformations or deformations that may distort vascular anatomy (Roberts, 2004^{LOE8}). With umbilical artery cannulation, caution must be exercised when there is evidence of vascular compromise in the lower limbs or buttocks. An assessment of circulation can include palpation of femoral pulses for their presence and equality, and an observation of colour (asymmetry, bruising, insufficiency) in the legs, feet and toes (Furdon et al, 2006^{LOE7}). It is important to note that if the catheter is already in place and these conditions emerge, it should be removed. (Georgiadis, 2007^{LOE8})

INDICATIONS	RELATIVE CONTRAINDICATIONS	ABSOLUTE CONTRAINDICATIONS
<p>UAC & UVC</p> <ul style="list-style-type: none"> • Exchange transfusion (Roberts, 2004^{LOE8}; Weinstein, 2007^{LOE8}) <p>UVC</p> <ul style="list-style-type: none"> • Administration of fluids and total parenteral nutrition (TPN) • Emergency vascular access during resuscitation • Drug administration • Central venous pressure (CVP) monitoring • Delivery of blood & blood products <p>UAC</p> <ul style="list-style-type: none"> • Frequent arterial blood gas sampling • Moderate- severe and worsening respiratory failure • When non-invasive measurements are unreliable • Continuous arterial blood pressure monitoring • Volume expanders & medication 	<p>UAC & UVC</p> <ul style="list-style-type: none"> • Local infections • Malformations or deformations that may distort vascular anatomy (Roberts, 2004^{LOE8}) • Evidence of vascular compromise in the lower limbs or buttocks (Furdon et al, 2006^{LOE7}) • Bleeding and thrombotic tendency (Georgiadis, 2007^{LOE8}) • Intestinal hypoperfusion (Roberts, 2004^{LOE8}; Hopkins, 2005^{LOE8}) 	<p>UAC & UVC</p> <ul style="list-style-type: none"> • Abdominal wall defects (e.g., omphalitis, omphalocele, peritonitis and necrotizing enterocolitis)

F. Risk Factors, Complications and their Management

UAC and UVCs are associated with numerous risk factors and complications and these risks and benefits should be considered prior to insertion and on an ongoing basis until removal. (Georgiadis, 2007^{LOE8}) The factors that influence the risk of complications include insertion procedure, catheter location, catheter size and material, catheter care, number of manipulations and length of time catheter remains in situ (Nash, 2006^{LOE7}). Sources report a complication rate of 10% to 50% for central venous catheterization, which includes umbilical vein cannulation. (Roberts, 2004^{LOE8}) UAC complications are reported to be in the range of 5.5% to 32% (Furdon et al 2006^{LOE7}).

Both umbilical vein and artery cannulation share the following complications: accidental line/dislodgement; vessel perforation; haemorrhage; infection and catheter thrombosis (Roberts, 2004^{LOE8}). Catheter thrombosis is caused by the presence of the catheter, which damages the vascular endothelium resulting in the formation of a fibrin sheath (Furdon et al, 2007^{LOE7}). To decrease the incidence of catheter-related thrombosis, heparin can be used. A Cochrane review that investigated the effects of heparin in umbilical artery cannulation found that the rate of catheter-related thrombosis can be lowered by using concentration of heparin as low as 0.25 units/mL (Barrington, 1999^{LOE7}).

Umbilical vein cannulation is associated with hepatic necrosis related to the infusion of solutions into the liver, (e.g. Dextrose 20); portal hypertension; portal vein thrombosis; air embolism; right atrium arrhythmias, and perforation, or pericardial effusion if the catheter tip is placed high in the right atrium (Roberts, 2004^{LOE8}; Nash, 2006^{LOE7}). Umbilical artery cannulation complications include aortic, mesenteric, or renal artery thrombosis resulting in visceral infarction or subsequent necrotizing enterocolitis (NEC); vasospasm; peritoneal perforation; hypertension; hyper or hypoglycemia; lower limb ischemia; hematuria; renal insufficiency and intraventricular haemorrhage (IVH) from retrograde blood flow, transient increases in blood pressure and microemboli (Roberts, 2004^{LOE8}; Weinstein, 2007^{LOE8}; Nash, 2006^{LOE7}).

Catheter Material and Design

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 of these complications than catheters made of polyvinyl chloride (PVC) or polyethylene (PHAC, 1997^{LOE7}; CDC, 2002^{LOE7}). However, given that these complications exist, all umbilical catheters should only be placed for definite therapeutic or diagnostic indications and should be discontinued as soon as possible.

The 2002 CDC (Centers for Disease Control and Prevention) guideline on intravascular catheter-related infections recommends umbilical artery catheters be left in place no more than 5 days, and umbilical vein catheters no longer than 14 days. A randomized controlled trial that compared long-term (up to 28 days) and short-term (7-10 days) use

of umbilical venous catheters in premature infants less than 1251 grams, showed an overall incidence of catheter infection of 13% in the short-term group and 20% in the long-term group (Butler O'Hara et al, 2006^{LOE2}). This supports the recommendations made by the CDC, and suggests that umbilical vein catheters may be left in place beyond the current advice.

Currently, most umbilical vessel catheters are made of polyvinyl chloride (PVC). A Cochrane review of umbilical artery catheter design showed that there are no clinically relevant differences in frequency of ischemic events, aortic thrombosis, mortality or necrotizing enterocolitis in newborn infants when PVC catheters were used over heparin-bonded polyurethane. Other materials such as silastic that are available require greater study (Barrington, 1999^{LOE7}). Another Cochrane review looked at umbilical catheter design, that is, end versus side-hole catheters. The review concluded that end-hole catheters are associated with a decreased risk of aortic thrombosis compared to side-hole catheters (Barrington, 1999^{LOE7}).

In addition to umbilical catheters being available with side or end-holes, these catheters also come with single or multiple lumens. **Catheters with multiple lumens are used exclusively for umbilical vein cannulation.** Studies have shown that multiple lumens do not carry a greater risk of complications than single lumens (Nash, 2006^{LOE7}; PHAC, 1997^{LOE7}) however, sources recommend that the number of lumens be kept to a minimum in order to limit the number of sites available for possible contamination.

Umbilical Artery Catheter Tip Placement

There is debate as to the appropriate position of the umbilical artery catheter. The tip of the umbilical artery catheter is referred to as a low or high position (Furdon et al, 2006^{LOE7}). A Cochrane database systemic review concluded that high lying umbilical artery catheters (positioned above the diaphragm between the 6th and 9th thoracic vertebrae) rather than low lying umbilical artery catheters (positioned just above the aortic bifurcation between 3rd and 4th lumbar vertebrae), results in fewer ischemic and thrombotic complications, longer duration of catheter usability and no increase in other serious complications such as intraventricular haemorrhage and necrotizing enterocolitis in newborn infants (Barrington, 1999^{LOE7}). High lying umbilical artery catheters are associated with hypoglycemia and hyperglycemia, which resolves if the catheter is pulled back to a low position (Nash, 2006^{LOE7}).

Arterial Vasospasm

Vasospasm related to umbilical artery cannulation results in blanching or cyanosis of the toes, feet, legs or buttocks and has a greater association with low-lying catheters. It can cause thrombus formation and extensive ischemic injury (Nash, 2006^{LOE7}).

Vasospasm can be treated by warming the opposite limb to trigger reflex vasodilation in the affected limb, and repositioning or removal of the catheter (Nash, 2006^{LOE7}; Weinstein, 2007^{LOE8}).

Hemorrhage

Haemorrhage can result from vessel perforation, umbilical cord site bleeding around the catheter, and disconnection of the catheter at any point in the system, which can include a stopcock left in the open position, catheter disconnection from infusion line, or catheter slippage out of the vessel.

Catheter-Related Infections (CRIs)

The CDC (Centers for Disease Control and Prevention) and JCAHO (Joint Commission on Accreditation of Healthcare Organizations) defines a central line as a vascular access device that terminates at or close to the heart or one of the great vessels (CDC, 2002^{LOE7}). An umbilical artery or vein catheter is therefore considered to be a central vascular device.

The majority of serious catheter-related infections are associated with central venous catheters, including the umbilical vein catheter (CDC, 2002^{LOE7}; PHAC, 1997^{LOE7}). The incidence of CR-BSIs (catheter-related blood stream infections) is similar for umbilical vein and artery catheters at approximately 5%. Similarly, umbilical artery cannulas placed in either the high or low position have similar rates of CR-BSIs (CDC, 2002^{LOE7}). Infections associated with intravascular devices appear to result from contamination of the catheter lumen from microorganisms in the fluid path and contamination of external catheter surfaces from migration of insertion site flora along the exterior surfaces of the cannulae. These catheters disrupt the integrity of the skin, making infection with bacteria and/or fungi possible. Infection may spread to the bloodstream and may result in haemodynamic changes and organ dysfunction, e.g. severe sepsis (PHAC, 1997^{LOE7}; CDC, 2002^{LOE7}).

Infants should be evaluated daily for evidence of infectious complications (PHAC, 1997^{LOE7}). This may include palpation of the insertion site through the dressing or visual inspection through a transparent dressing (CDC, 2002^{LOE7}). If there is an unexplained fever, pain or tenderness at the insertion site then the site must be visually inspected (PHAC, 1997^{LOE7}).

Infection can be prevented by following routine infection control practices and using additional precautions. Routine practice includes hand hygiene and the use of personal protective equipment (PPE). Hand hygiene reduces the transmission of microorganisms. It includes hand washing, maintaining hand health, avoiding nail polish, artificial nails or jewelry and keeping nails trimmed and clean as the fingernail area can harbour considerable flora and other microorganisms. Additionally, umbilical vessel cannulation requires the application of maximal sterile-barrier precautions. (CDC, 2002^{LOE7}; PHAC, 1999^{LOE7}) This includes long-sleeved sterile surgical gown, sterile gloves, mask, and sterile drapes. The CDC (2002)^{LOE7} and Safer Healthcare Now! (2007)^{LOE7} also recommend wearing a cap to cover all hair, and using a sterile drape with a small opening for the site of insertion.

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^{LOE2}). When choosing a product for antisepsis, there should be consultation with the manufacturer as some equipment may be incompatible with alcohol preparations (PHAC, 1997^{LOE7}).

For more information on good infection control practices please see the CRTO's *Clinical Best Practice Guideline on Infection Prevention & Control* available on our web site at: <http://www.crto.on.ca/cbpg.aspx>.

Also, the Provincial Infectious Diseases Advisory Committee (PIDAC) has a new document entitled *Best Practices for Hand Hygiene in All Health Care Settings* (MOHLRC – May 2008) which can be accessed at: http://www.health.gov.on.ca/english/providers/program/infectious/diseases/ic_hh.html.

G. Practice Considerations and Technique

Unless immediate vascular access is required, insertion of the more technically difficult UAC prior to the UVC insertion may be preferable. Occasionally the cord stump has to be re-cut to facilitate UAC insertion. (Georgiadis, 2007^{LOE8}) Correct placement of umbilical catheterization is verified by an abdominal and chest radiograph (Furdon et al, 2006^{LOE7}; Hopkins, 2005^{LOE8}).

Size 3.5F catheters for UACs is preferable to allow sufficient blood flow in the descending aorta. Generally, a 3.5 Fr catheter is used for neonates < 1500 g and between 3.5 -5 Fr. catheters may be used for neonates >1500 g (Miller, 2005^{LOE8}). Side hole catheters should be avoided for umbilical arterial catheterization. The size of the catheter selected is based on the birth weight (i.e., < or > 1,500 g.). Double or triple lumen UVCs should be used for critically ill neonates requiring simultaneous multiple infusions. (Georgiadis, 2007^{LOE8})

Common Elements of UAC & UVC

The following are common element of both UAC and UVC cannulation. Aspects that are particular to one or the other will be dealt with separately later on in the document.

Preparation

- Document bruising of lower extremities and/ or feet and toes prior to placement. (Georgiadis, 2007^{LOE8})
- All catheters must be attached to appropriate stopcock or syringe, flushed and filled with normal saline before insertion to avoid air emboli. (Georgiadis, 2007^{LOE8})
- Drape around the umbilical stump with sterile towels, taking care not to obscure infant's face and upper chest. (Georgiadis, 2007^{LOE8})
- Assure that the infant's heart rate, temperature and respiratory rate are being adequately monitored.
- Tie a cord tie of the cord secure enough to prevent bleeding, but not so tight as to block passage of the catheter. (Georgiadis, 2007^{LOE8}).

Equipment

1. Umbilical catheter size 3.5 or 5.0
2. Scalpel
3. Curved iris forceps
4. 3.0 silk and needle
5. 3 way stopcock
6. 3 ml syringe
7. 0.9% normal saline
8. Sterile water
9. Sterile q-tips
10. Sterile gauze 2 x 2's
11. Amp. of heparinised saline (10 units per ml)
12. Disinfectant of choice (e.g., Chlorhexidine 0.5%)
13. Appropriate PPE
14. Tape

Sterile/Aseptic Field

- Aseptic technique must be employed. (Georgiadis, 2007^{LOE8})
- The optimal duration for hand washing is unknown. Good hand hygiene combined with maximal sterile-barrier precautions, provide protection against infection. (PHAC, 1997^{LOE7}; PIDAC,2008^{LOE7})
- Maximal sterile-barrier precautions include a long-sleeved sterile surgical gown, sterile gloves, mask, and sterile drapes (PHAC, 1997^{LOE7}; CDC, 2002^{LOE7}). The CDC (2002) and Safer Healthcare Now! (2007)^{LOE7}, also recommend wearing a cap to cover all hair, and draping the patient head to toe with a sterile drape with a small opening for the site of insertion.

- The umbilical stump and the surrounding skin should be cleaned with an antiseptic (2% chlorhexidine, 70% alcohol) and let dry for 1-2 minutes before catheter insertion.
- Particular care should be taken with premature infants that the antiseptic solution does not dribble onto adjacent areas of skin. Entire site should be cleaned off afterwards with sterile water or saline to prevent chemical burns. (Georgiadis, 2007^{LOE8}; Weinstein, 2007^{LOE8})
- Should avoid tincture of iodine due to its effect on the neonatal thyroid. Other iodine-containing products (e.g. providone-iodine) can be used. (Georgiadis, 2007^{LOE8}; CDC, 2002^{LOE7})
- Once sterile technique is broken, the line may not be advanced. Therefore, it is better to position the catheter too high and withdraw as necessary according to location on the x-ray (Roberts, 2004^{LOE8}; Nash, 2006^{LOE7}). Never advance catheter further in once it is secured as this will introduce contaminated catheter. (Georgiadis, 2007^{LOE8})

Procedure

- With a scalpel cut the cord horizontally about 1 – 1.5 cm from the skin. (Georgiadis, 2007^{LOE8})
- Identify vessel to be cannulated and immobilize cord as described in sections for both UAC and UVC catheterization. (also see illustration on page 21 & 25)

Securing the Site

- Once positioned correctly, an x-ray should be taken to confirm placement. To facilitate this, a medical directive that empowers the Respiratory Therapist to order the x-ray on behalf of the physician, can be developed. Alternatively, a written order can be obtained. Note that Medical Radiation Technologists can only accept orders from a member of the College of Physicians and Surgeons of Ontario. To view the *Medical Radiation Technology Act* go to: http://www.e-laws.gov.on.ca/html/statutes/elaws_statutes_91m29_e.htm
- The catheter is sutured to the umbilical cord and taped to the abdominal wall, to prevent dislodgement. (Nash, 2006^{LOE7}; Weinstein, 2007^{LOE8})
- Secure catheters by placing a purse string through Wharton's jelly (a gelatinous substance within the umbilical cord) and not through the skin of vessels. Remove needle and wrap ends of suture in opposite directions around catheter and tie. A separate suture is recommended for each catheter. (Georgiadis, 2007^{LOE8})
- Secure well with tape bridge prior to running infusions. (Georgiadis, 2007^{LOE8})
- UACs and UVCs are to be removed as soon as they are no longer needed or when there are signs of complications. (Georgiadis, 2007^{LOE8})

Umbilical Artery Cannulation

The umbilical arteries are the direct continuation of the internal iliac arteries. A catheter passed into an umbilical artery will usually (but not always) enter the aorta via the internal iliac artery.

Insertion Technique & Establishing the UAC line.

- Using a small iris forceps one of the two arteries is dilated (Nash, 2006^{LOE7}; Roberts, 2004^{LOE8}). Insert one point of curved iris forceps into lumen and probe gently. Remove forceps, bring points together and re-introduce probe gently (up to the curved “shoulder” of forceps. (Georgiadis, 2007^{LOE8})
- Allow points to spring apart and maintain in this “open” position about 15 seconds to dilate artery. (Georgiadis, 2007^{LOE8})
- Grasp catheter 1 cm from tip by hand or with curved forceps and insert into dilated lumen. (Georgiadis, 2007^{LOE8})
- Advance with a firm steady motion. Mild upward traction of cord toward head of infant while advancing may facilitate passage of catheter. (Georgiadis, 2007^{LOE8})
- After advancing catheter about 5 cm verify intraluminal position by checking for easy withdrawal of blood and “pulseation” of blood/ saline in the catheter, then clear with flush solution. Advance UAC to the pre-determined length. (Georgiadis, 2007^{LOE8})
- After dilation, a 3.5 to 5 Fr catheter attached to a 3-way stopcock flushed with sterile solution (with or without heparin) is inserted into the artery. (Miller, 2005^{LOE8}; Roberts, 2004^{LOE8})
- Central umbilical artery access requires advancement of the catheter to either a low or high position. A low line lies just above the aortic bifurcation between 3rd and 4th lumbar vertebrae, and a high line lies above the diaphragm between the 6th and 9th thoracic vertebrae. (Furdon et al, 2006^{LOE7}; Roberts, 2004^{LOE8})
- The catheter should be directed caudal or towards the feet. A properly placed line enters into the descending aorta, through the internal iliac and common iliac arteries. (Nash, 2007^{LOE7})
- Most unsuccessful cannulations fail because the catheter meets resistance at the arterial wall 1 cm below the umbilical stump, causing a false tract where the umbilical artery begins curving toward the feet. Gentle but steady pressure along with tension applied caudally to the cord should help overcome this. (Roberts, 2004^{LOE8})

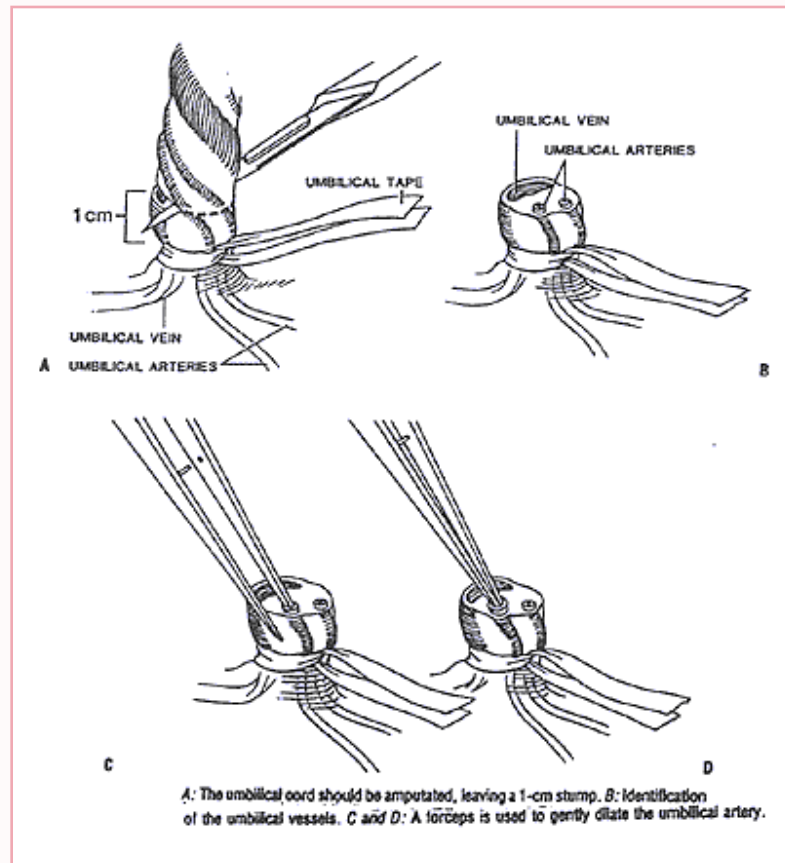


Figure 3: Umbilical Artery Catheterization

Gormella, T., Cunningham, M. (1999) *Neonatology*, (4th edition). New York: McGraw Hill
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- To determine the optimal position for high or low catheter locations, formulas or graphs which require the shoulder-to-umbilicus length measurement can be used. (Nash, 2006^{LOE7}; Hopkins, 2005^{LOE8}; Roberts, 2004^{LOE8})
- Once in position, ensure patency by confirming that there is good blood return and lack of resistance to flushing (Nash, 2006^{LOE8}). In rare circumstances, urine is seen. If this occurs, the neonate has a patent urachus; the catheter should be withdrawn slightly and redirected (Weinstein, 2007^{LOE8}). Once insertion is complete, attach a transducing system and ensure an appropriate waveform is present on the monitor.
- UAC fluids and blood pressure measuring can be commenced before the radiograph is taken.
- Add low dose heparin (0.5 – 1.0 U/ml) to the fluid infused through the UAC. A commonly used solution is 0.45% Na Cl with 0.5 to 1 IU heparin/ ml running at 1 ml/hr. (Georgiadis, 2007^{LOE8})
- Optimal duration of a UAC line is 5 – 7 days. (Georgiadis, 2007^{LOE8})

Umbilical Artery Catheter Insertion Distance

There are several ways in which the insertion distance for umbilical catheters can be measured. Two of the methods for each UAC and UVC insertion are outlined in this document.

Umbilical Arterial Catheter

1. Measure the distance between shoulder to umbilicus and refer to the graph below. This will provide insertion distances for both high and low UAC canalization.

Note: There appears to be no evidence to support the use of the low-position UAC (L3 – 4). A high-position UAC should be used preferentially (T6 – 9), which places the tip of the arterial catheter in the descending aorta above the origin of the mesenteric and renal arteries. (Georgiadis, 2007^{LOE8})

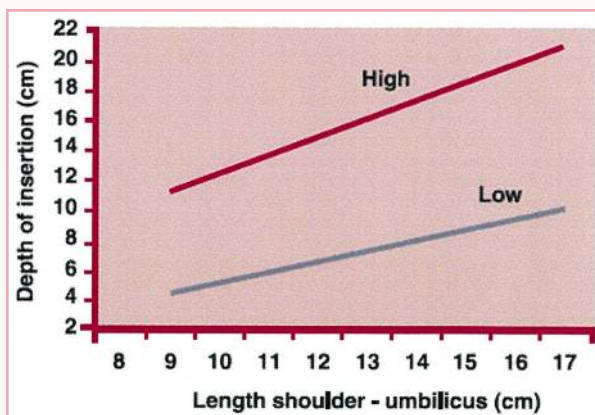


Figure 2 Relationship between shoulder-umbilicus length measurement and the depth of insertion needed to achieve an umbilical arterial catheter tip placement in the low or the high position. Adapted from Dunn PM. Localization of the umbilical catheter by post-mortem measurement. Arch Dis Child 1966;41:69–75.

Original by Dunn, P. (1966) *Localization of the Umbilical Catheter by Post-mortem measurement*. Arch. Dis. Childhood., 41, 69.
Modified in Kirpalani, H., Moore, A. and Perlman, M. (2007) *Residents Handbook of Neonatology*.

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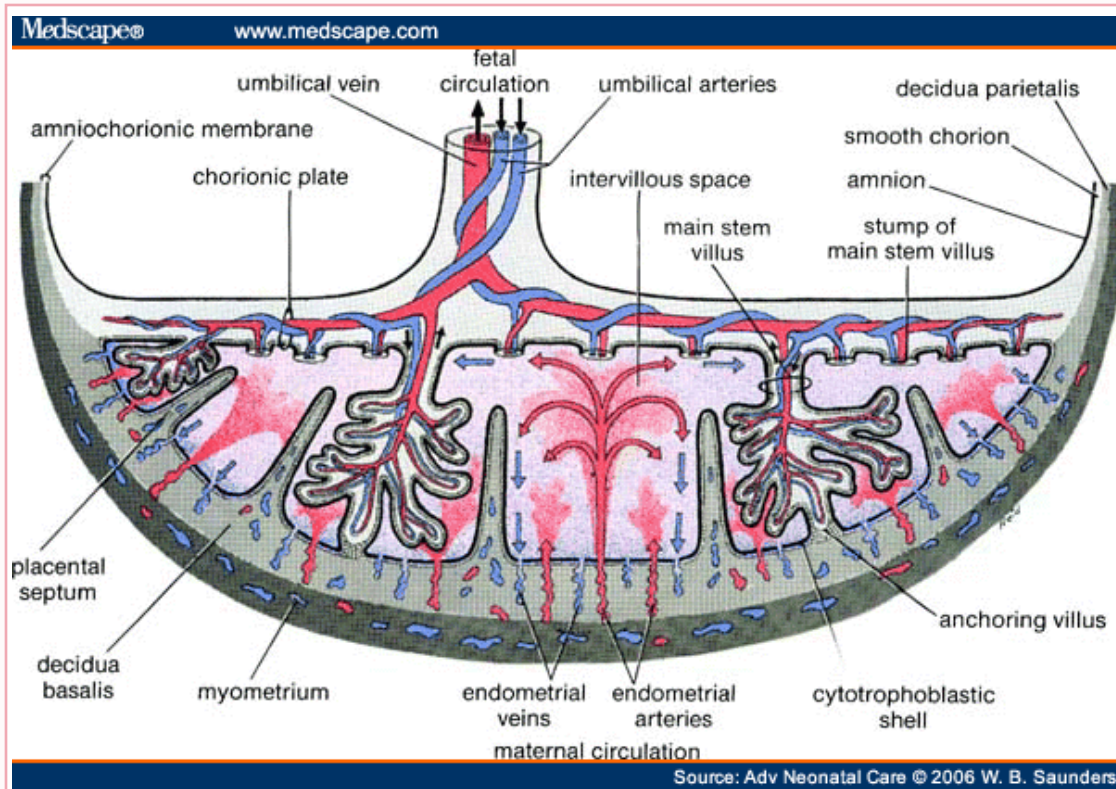
Umbilical Arterial Catheter

2. Another option is to calculate the insertion distance using the **birth weight** with the formula below. Remember to add the length of the cord stump.

$$\text{UAC distance (cm)} = \text{birth weight (kg)} \times 3 + 9.$$

Note: It generally does no harm to insert the line a centimeter further than calculated, as the line can be pulled back slightly if needed. However, you should avoid inserting the UAC so far that it needs to be removed from the carotid or subclavian arteries.

Umbilical Vein Cannulation



Umbilical Venous Catheter

http://www.medscape.com/viewarticle/550544_print

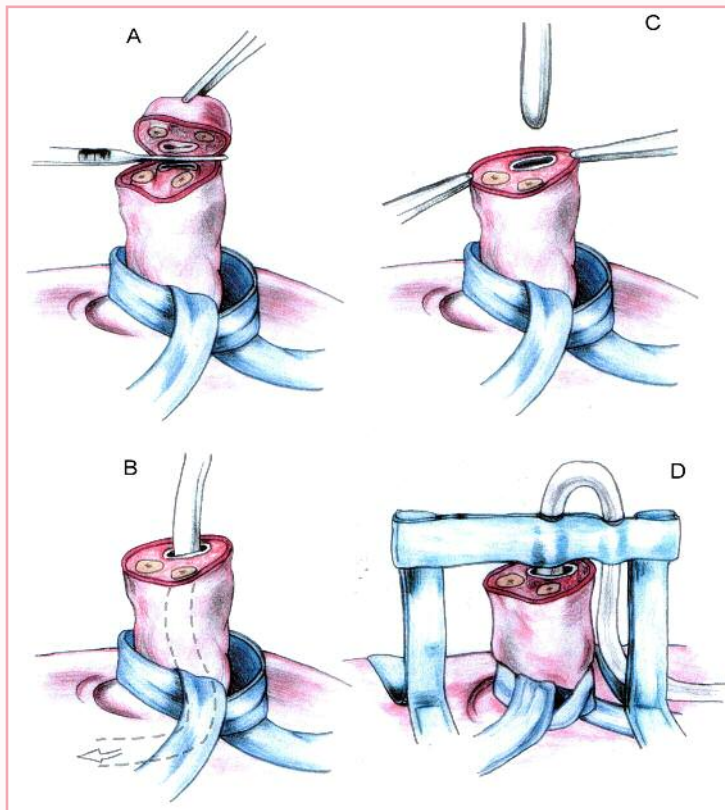
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The umbilical vein is 2 – 3 cm long and 4 – 5 mm in diameter. From the umbilicus it passes cephalad and a little to the right. It then joins the left branch of the portal vein and the ductus venosus arises from the point where the UV joins the left portal vein. The umbilical vein is the larger and thinner-walled of the vessels and is usually at the 11 to 12 o'clock position (CPS, 2006^{LOE8}). The position of the vessel differs however, depending on where the cord is cut as the vessels circle around the cord.

For resuscitative measures, as in a cardiac or respiratory arrest, an umbilical vein is only cannulated to approximately 2 to 4 cm beyond the muco-cutaneous junction and only until adequate blood return is obtained (CPS, 2007^{LOE8}). In non-emergencies, the catheter is advanced until it is in the inferior vena cava above the level of the ductus venosus and hepatic veins, and below the level of the right atrium. (Hopkins, 2005^{LOE8}; Roberts, 2004^{LOE8})

Insertion Technique & Establishing the UVC line.

- Prior to inserting UVC, especially in late insertions, it may be necessary to gently insert tips of iris forceps into lumen of vein to remove any clots. (Georgiadis, 2007^{LOE8})
- Introduce flushed, fluid-filled UVC and advance to predetermined length. (Georgiadis, 2007^{LOE8})
- Direct the catheter cephalad or towards the head as the vein lies in this direction. (Nash, 2006^{LOE7}; CPS, 2006^{LOE8})
- For resuscitative measures, advance the catheter only until there is adequate blood return. This should be 2 to 4 cm in a term infant. (CPS, 2006^{LOE8}; Nash, 2006^{LOE7})
- Once in position, ensure patency by confirming that there is good blood return and lack of resistance to flushing (Nash, 2006^{LOE7}). Attach a transducing system and ensure an appropriate waveform is present on the monitor. Fluids should not be administered until there is radiological confirmation. **Note:** do not leave the catheter open to atmosphere as there is a danger of air emboli.
- There is little data to support the use of UVC heparinization. (Georgiadis, 2007^{LOE8})
- The CDC recommends a 14 day duration for a UVC but some data suggests up 28 days is not unreasonable. (Georgiadis, 2007^{LOE8})
- Alternatively, a larger catheter or a double-catheter technique can be used. The double-catheter technique involves leaving the original catheter in place and inserting a second catheter of equal or smaller size along side the original (Nash, 2006^{LOE7}). **It is important to note that using this technique there is a greater risk of perforation. For this reason, the double-catheter technique is sometimes used in venous cannulation but not arterial.**



Umbilical Vein Catheterization

<http://www.emedicine.com/ped/images/2630PED2885-09.JPG>

eMedicine. Instant Access to the Minds of Medicine (2006).

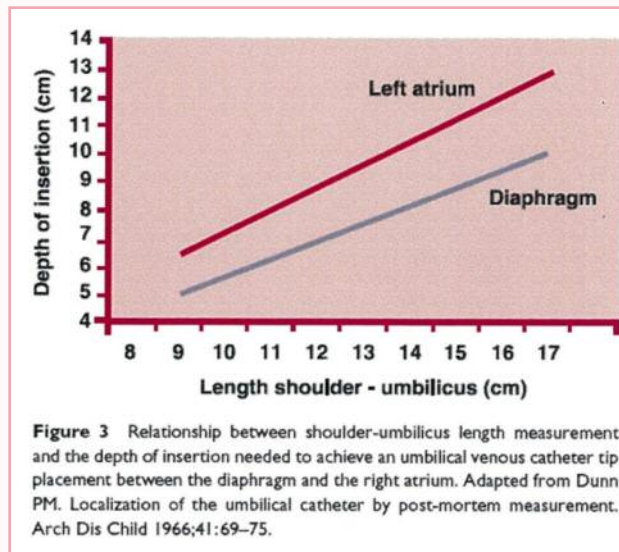
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Umbilical Venous Catheter Insertion Distance

Umbilical Venous Catheter

The preferred position of the UVC catheter tip is in the inferior vena cava (IVC) above the level of the diaphragm (usually at T9). (Georgiadis, 2007^{LOE8})

1. Measure the **distance between shoulder to umbilicus** and refer to the graph below to calculate the insertion distance.



Original by Dunn, P. (1966) *Localization of the Umbilical Catheter by Post-mortem measurement*. Arch. Dis. Childhood., 41, 69.
 Modified in Kirpalani, H., Moore, A. and Perlman, M. (2007) *Residents Handbook of Neonatology*.

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2. As with UACs, another method is to calculate the distance according to the **weight of the baby** using one of the following formulas:

$$\text{UVC length (cm)} = 3 \times \text{birth weight (kg)} + 9 \text{ divided by } 2 + 1$$

or

$$\text{UVC length (cm)} = 1.5 \times \text{birth weight (kg)} + 5.5$$

or

$$\text{UVA length (cm)} = \frac{1}{2} \text{ the UVC length} + 1$$

Note: It is important to check catheter position prior to performing an exchange transfusion. During emergency resuscitation, however, a catheter may be placed just beyond the umbilicus to give resuscitation medications, volume expanders, and blood without previously confirming the location of the catheter tip. (Georgiadis, 2007^{LOE8})

H. References & Bibliography

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

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 CRTO's 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	Assesses appropriateness for the procedure. Checks for order, allergies, patient identification, and any contraindications. Assesses need for pain prevention and management.	
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.	
Guidewire Use (Femoral Cannulation only)	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. Confirmation of correct cannula placement.	
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. **Note: 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
<p>SUBJECT:* Describes the site of cannulation and the patient population to which the procedure will apply.</p> <p><u>Umbilical Vein Cannulation</u> or <u>Umbilical Artery Cannulation</u> in Neonates</p> <p>ISSUING BODY: Department or Program, e.g., Respiratory Therapy Services</p> <p>EFFECTIVE DATE: Date Policy is accepted and put into effect</p> <p>According to the <i>Respiratory Therapy Act</i>, 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.</p>

Policy & Procedure Template (continued)

PURPOSE:

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

1. To standardize the approach to, e.g. umbilical vein cannulation performed by Registered Respiratory Therapists.
2. To optimize patient care by, e.g. improving the timeliness of venous access for fluid administration in the neonate.

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

Glossary of Terms

Exchange Transfusion	An extracorporeal process (apheresis) that separates out either the red blood cells or platelets and then replaces them with transfused blood products. It is used in a number of diseases including serious jaundice and hemolytic disease of the newborn.
Low Birth Weight	Infants born under 2.5 kg.
Omphalitis	An inflammation or infection of the umbilical cord.
Omphalocele	An abdominal wall defect in which the organs such as the intestines and liver remain outside the abdomen in a sac that protrudes through the umbilicus.
Peritonitis	An inflammation of the peritoneum, the serous membrane that lines part of the abdominal cavity and some of the organs it contains.
Necrotizing Enterocolitis	Death of intestinal tissue. Initial symptoms include feeding intolerance, abdominal distension and bloody stools. It can progress rapidly to intestinal perforation and systemic hypotension.
Urachus	An embryological canal connecting the bladder of the fetus to a structure (the allantois) that contributes to the formation of the umbilical cord. By birth, this becomes a solid cord which is functionless.

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Notes:

Notes:



College of Respiratory Therapists of Ontario
Ordre des thérapeutes respiratoires de l'Ontario

Phone	416 591-7800
Toll Free	1 800 261-0528
Fax	416 591-7890
E-mail	questions@crto.on.ca

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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:

Professional Practice Advisor

College of Respiratory Therapists of Ontario
180 Dundas Street West, Suite 2103
Toronto, Ontario
M5G 1Z8

Tel (416) 591 7800
Fax (416) 591-7890

Toll Free 1-800-261-0528
E-mail questions@crto.on.ca