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III. Arterial Access Devices

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A. Description and types of devices (Martin, 2002)

1. Arterial therapy delivers medication directly into an organ or tumor via the main supply artery, or in the case of metastatic hepatic tumors, through the common hepatic gastroduodenal arteries.
2. Three types of access are used (Martin, 2002).
 - a) Short-term percutaneous catheters inserted via the femoral or brachial artery
 - b) Long-term catheters placed during surgery and either used as an external catheter or attached to an implanted port or pump
 - c) Implanted ports for long-term therapy
3. Catheters and ports: Catheters composed of polyethylene, Pebax® nylon (a nylon derivative) (ATOFINA Chemicals, Philadelphia, PA), or Silastic® (Dow Corning, Midland, MI) materials with internal diameters ranging from 0.5–1.5 mm and outer diameters ranging from 2.7–9.6 French are used. Catheter openings may be at the end or have a closed end with a side hole (Seki et al., 1999). Portal bodies are described in Section II-H.
4. Silastic beaded catheter has raised circular rings placed approximately 1 to 2 cm apart. For surgical placement of catheter, sutures are positioned around the catheter and between the beads to secure the catheter in place and prevent it from migrating out of the artery (Martin, 2002).
5. Arterial catheter gauge has a smaller internal diameter and thicker catheter wall compared to a venous catheter because of slower arterial administration times, higher vascular arterial pressures, plus it acts as a safety measure to reduce blood backflow.

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6. Catheters are available with one-way valves to prevent retrograde blood flow.
7. Procedural and overall costs vary.
 - a) Costs for placement: Surgical placement of catheter with direct access to artery, with or without a port, is initially more costly than percutaneous insertion of catheter (Zanon et al., 1998). However, depending on the number of percutaneous reinsertions of catheter, this procedure may become more expensive than surgical placement.
 - b) Discussion continues on the clinical and economic benefits of arterial therapy versus systemic therapy (Cole, 1996; Haller, 2000; Kemeny & Fata, 2001). An initial comparison of costs for hepatic arterial therapy, systemic therapy, and symptom control for colorectal liver metastases revealed hepatic arterial therapy to be the most costly. The cost-effectiveness of hepatic arterial chemoembolization for the treatment of colorectal liver metastases varies considerably according to the anticipated survival benefit (Abramson et al., 2000).
8. Table 7 lists the advantages and disadvantages of an arterial catheter (long-term and short-term) versus an arterial port for arterial infusions.

B. Advantages and disadvantages of arterial therapy

1. Advantages
 - a) Regional perfusion is useful only

when the entire tumor is perfused and infusate can be confined to a specific area (Weinstein, 2001). Efforts are being made to further restrict systemic circulation of infusate using techniques such as arterial, mechanical, or chemical embolization (Alsowmely & Hodgson, 2002).

- b) Only in the case of hepatic perfusion may access be achieved through the hepatic artery, as well as through the portal vein, and consideration is being given to use both accesses for drug delivery to the tumor (Paku, Bodoky, Kupcsulik, & Timar, 1998).
 - c) Increased exposure of tumor to drug increases tumor response, whereas less systemic circulation and exposure to infusate decreases risk of systemic side effects (Dizon & Kemeny, 2002; Goodman, 2000; Haller, 2000; Kemeny, 2000).
- ### 2. Disadvantages
- a) Less systemic circulation and exposure to infusate increases the risk for distant metastasis.
 - b) Positive outcomes from arterial therapy, such as improved survival and quality of life, remain under continued investigation (Haller, 2000; Kemeny, 2000).

C. Patient selection criteria

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TABLE 7. ADVANTAGES AND DISADVANTAGES OF ARTERIAL CATHETERS AND PORTS

DEVICE	ADVANTAGES	DISADVANTAGES
Arterial catheter	<p>Long-term catheter</p> <ul style="list-style-type: none"> Easily accessed One incision for care Long- or short-term use Lower incidence of device-related complications compared to short-term catheter (Arru et al., 2000) <p>Percutaneous short-term catheter</p> <ul style="list-style-type: none"> Quick access to ascertain if treatment effective prior to long-term catheter placement No device in place after each drug treatment Indicated for palliative or neoadjuvant therapy (Arru et al., 2000) 	<p>Long-term catheter</p> <ul style="list-style-type: none"> Regular care for patency Need for patient or other to perform site care Cost of supplies <p>Percutaneous short-term catheter</p> <ul style="list-style-type: none"> Frequent insertions cause complications and complete tumor or regional perfusion is not always obtained. Costly because of repeated hospitalization for infusion and catheter reinsertion Higher risk of complications, such as catheter tip dislodgment, compared to surgical placement, although results vary among studies
Arterial port	<ul style="list-style-type: none"> Totally implanted under skin Less effect on body image than percutaneous external catheter Minimal self-care unless continuous infusion Long-term use Cost effective 	<ul style="list-style-type: none"> Potential discomfort with needle sticks Higher initial cost with insertion Special noncoring, single-use needle required With continuous infusions: site care, dressing, and needle changes required

- Devices are available for children and adults.
 - Assess patient condition, venous and arterial infusion device history, and type and duration of all antitumor therapy (Intravenous Nurses Society [INS], 2000).
 - Consider any age-related factors and comorbidities for the procedure, surgery, or drug administration.
 - Indications for arterial access device placement are as follows.
 - Regional perfusions for adjuvant, cure, control, and palliative therapies
 - Accessible artery supplying entire tumor
 - Indications for long-term catheter placement
 - Disease is confined to area of perfusion.
 - Patient has adequate performance status and ability to tolerate surgical procedure.
 - Percutaneous hepatic artery temporary catheter placement (Habbe et al., 1998)
 - The liver is the focal point of disease, although extrahepatic metastatic disease may be present (Bergsland & Venook, 2000).
 - Patient's clinical status precludes undergoing surgery.
 - Evaluate tumor response before placing a permanent device.
 - Check for sites of organ or regional perfusion for malignant disease with arterial access (see Table 8).
 - Consider contraindications for arterial access.
 - Acute infection, prolonged fever, and absolute neutrophil count < 1,500 mm³
 - Severe coagulopathy
- D. Patient setting**
- Percutaneous placements and infusions usually are performed as an inpatient procedure, but they may be performed as an outpatient procedure.
 - Bolus injections/infusions through a long-term catheter or port may be performed in an ambulatory setting, including the home, if nursing support is provided.
- E. Insertion procedures and perfusion checks (Arru et al., 2000)**
- Direct arterial access can be performed at the time of initial tumor resection or during a second surgical procedure.
- 3. Homecare and visiting nurses must be knowledgeable about the following.**
- Arterial infusions and administration techniques
 - Chemotherapy and side effects
 - Safe handling of cytotoxic drugs by family and healthcare professionals
 - Twenty-four-hour on-call assistance for pump failure or complications

TABLE 8. PERFUSION SITES (LISTED IN DECREASING FREQUENCY OF USE) AND ARTERIAL ACCESS

PERFUSION SITE	ARTERIAL ACCESS
Brain	Cerebral, internal carotid, or vertebral artery via femoral artery
Head and neck region	External carotid artery via femoral artery
Liver	Hepatic artery via brachial, femoral, axillary, or subclavian arteries
<ul style="list-style-type: none"> Used mainly for metastatic disease Primary hepatocellular carcinoma less responsive to regional therapy 	Portal vein (currently minimally used)
Pelvic	Internal iliac or hypogastric arteries

Note. Infusates for all regions are continually being tested and updated; these include cytotoxic agents, immunotherapy, and others. Consult a drug or chemotherapy handbook for specific infusates.

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Although commonly viewed as a permanent catheter, it may be removed if a specific surgical technique is used (Maruyama, Takamatsu, Nagahama, & Ebuchi, 1999).

a) Advantages of catheter placement during the initial surgery include the following.

- (1) Catheter can be sutured in place, reducing the risk of catheter migration and displacement.
- (2) Vessels can be viewed directly.
- (3) Accessory vessels can be ligated (i.e., during hepatic perfusion, the right gastric artery is ligated to prevent perfusion of cytotoxic drugs to the stomach with resultant erosion).
- (4) Gallbladder can be removed before hepatic arterial perfusion to prevent biliary sclerosis and cholangitis.

b) Disadvantages of surgical catheter placement involve the stress and recovery period because of surgery.

2. Percutaneous access with a local anesthetic is accomplished in the radiology department.

a) Percutaneous access provides the advantage of excluding a surgical procedure and its cost and potential postoperative complications.

b) Accessory vessels also can be ligated successfully (Habbe et al., 1998).

c) A newer technique uses a fixed-tip catheter, reducing migration (Irie, 2001; Seki et al., 1999). In the fixed-tip catheter placement, the open end of the catheter is attached to the gastroduodenal artery with microcoils that also discontinue blood flow to this artery and occlude the open end of the catheter. A side hole in this catheter is located in the hepatic artery, which is the desired location for drug administration.

d) Catheter may be inserted percutaneously and connected to a subcutaneous (SC) port (Seki et al., 1999).

e) Disadvantages to percutaneous access include the following.

- (1) An inability to suture the catheter to the vessel exists, increasing the potential for catheter migration.
- (2) Catheter is not long-term, so percutaneous access may require repeated catheter inser-

tions for subsequent treatment.

(3) It possibly precludes ability to ligate other vessels.

3. Port placement (see Section II-H)

a) Port is attached or preconnected to a long-term catheter.

b) Port is placed in SC pocket and sutured to underlying fascia.

c) The port pocket usually is placed over a bony prominence in the upper chest wall area or in the lower abdomen, but it can be placed anywhere on the trunk.

d) Pocket incision should not transverse the septum.

4. Perfusion check

a) Intraoperatively, adequacy of hepatic perfusion is checked to ensure absence of extrahepatic or accessory organ perfusion using intra-arterial injection of fluorescein dye and Woods lamp (Curley, Chase, Roh, & Hohn, 1993).

b) Perfusion checks confirm permanent catheter patency and extent of perfusion. Checks are performed postoperatively, before cytotoxic therapy, and every three months (Martin, 2002).

F. Postoperative care

1. Surgically placed external catheter

a) Assess exit site for drainage, edema, erythema, and catheter connections. Assess patient for pain.

b) Measure external catheter length to obtain baseline measurement. This measurement is used to determine if the catheter is becoming dislodged.

c) Ensure catheter connections or cap are Luer-locked and firmly connected.

2. Surgically placed internal catheter connected to port or implanted pump

a) Assess port or pump site for drainage, edema, and erythema. Assess patient for pain.

b) Antibiotics are given intravenously, prophylactically before and after surgery.

3. Percutaneous arterial catheter insertion

a) Heparin may be continuously infused to maintain artery patency. Blood coagulation values, such as partial thromboplastin time, should be monitored closely.

b) Catheter migration or dislodgment may impede blood supply to the limb. Assessment is made of the limb, which is supplied by the artery used for the catheter inser-

tion, such as the leg if the femoral artery is used.

(1) The involved limb is assessed for pulse, color, temperature, capillary refill, numbness or tingling, edema, or hematoma. The specific insertion site determines any additional observations (i.e., a carotid artery insertion indicates the patient's neurologic signs are monitored for potential seizures) (West, 1998).

(2) Assess the catheter and exit site for catheter kinking, leaking, or migration; site bleeding; or hematoma.

(3) Frequency of assessment varies, and further research is warranted. Assessment frequency ranges from every four hours to every 15 minutes for one hour, every 30 minutes for three hours, every one hour for four hours, and then every four hours (Almadrones, Campana, & Dantis, 1995; Lynes, 1993).

4. Dressing: If oozing, use gauze and change every 24 hours or more frequently. If dry, use transparent semipermeable dressing. No ointments are applied to the site (Centers for Disease Control and Prevention, 2002).

5. Brachial access—arm is secured in sling

6. Femoral artery access

a) To decrease the chance of dislodgment, patient may be required to lie flat with a pressure dressing over insertion site. Use a loose restraint around ankle to remind patient not to move leg, and provide appropriate care for immobilization. Careful ambulation may be permitted in some settings (Habbe et al., 1998).

b) Antiembolic stockings are recommended to decrease risk of thrombus (West, 1998).

c) Hemodynamic monitoring and venipuncture should not be performed on the involved extremity except with physician order (INS, 2000).

d) Ensure catheter connections or cap are Luer-locked and firmly connected.

G. Removal

1. Long-term external catheter: May be in place indefinitely. The catheter may be removed by a surgeon. The catheter is tied off and buried SC by surgeon (Maruyama et al., 1999).

2. Port: May be in place indefinitely. The port may be removed using a local anesthetic, and the catheter is tied off and buried subcutaneously by a surgeon.
 3. Percutaneous catheter: The catheter is removed in radiology or at the bedside with close observation by a surgeon. It is usually removed after four days or, at the maximum, seven days.
 - a) Apply pressure for 10 minutes over exit site or until bleeding stops.
 - b) Apply povidone-iodine ointment or a triple-antibiotic ointment to the site, cover with gauze, and apply an adhesive, occlusive pressure dressing.
 - c) Place a small sandbag over the site for eight hours.
 - d) Monitor for bleeding or edema at site, and check extremity pulse, skin color, and temperature changes every 10 minutes six times, then every 30 minutes two times, and then hourly six times. After eight hours, change the pressure dressing to an occlusive bandage (INS, 2000).
- H. Drug delivery with arterial access
1. Determine catheter placement and perfusion area.
 - a) If sutured, perform perfusion check every three months or more frequently if regional side effects exist, suggesting catheter migration.
 - b) If not sutured, perform perfusion check every course or every other course unless regional side effects exist, suggesting catheter migration.
 2. Laboratory studies are conducted to monitor regional and systemic side effects of the infused drug.
 - a) Area of perfusion and drugs used dictate type of studies that need to be conducted to monitor regional side effects (e.g., liver function tests for hepatic artery infusion).
 - b) Monitoring for systemic side effects follows a similar pattern as if the drug was given systemically; thus assessment depends on the drug given.
 3. Infusates used in regional therapy include cytotoxic agents, lymphocytes, and tumor necrosis factor. Any drug can be delivered through an implanted port without concerns about drug-device biocompatibility because of the limited time of contact with the drug and port (Graham & Holohan, 1994).
 4. Administration schedule depends on specific protocol.
 - a) Drugs may be given as a bolus, intermittent, or continuous long-term infusion using either external or implanted pumps. The drug administration may continue for a specified number of cycles or indefinitely until there is response or disease progression (Lorenz & Muller, 2000).
 - b) Hepatic arterial infusions through a temporary percutaneous catheter often are for four days, then the catheter is pulled. The cycle is frequently repeated for several months (Copur et al., 2001).
 5. A pump is required for arterial infusions; this may be an implantable pump or an external pump (see Section VII).
 6. Arterial access devices are not to be used for other therapies (e.g., total parenteral nutrition, lipid administration).
 - I. Access, flushing, and dressing (see Table 9)
 1. For proper use of these devices, the nurse should be familiar with the device, its features, patient- and drug-related considerations, and precautions provided by the manufacturer.
 2. Use aseptic technique for all care provided.
 3. Catheter access is at the hub.
 - a) Clean catheter connection with 70% alcohol or povidone-iodine.
 - b) Clamp catheter during tubing or cap changes.
 4. Port access
 - a) See Section II-H-5 on accessing a port.
 - b) Flush port to verify patency. The port should have a brisk blood return, allow easy flow of fluids, and cause no edema, pain, or erythema.
 - c) Clinicians are divided on the practice of aspirating blood to verify needle placement because of the risk of occlusion after repeated aspirations. Research is needed in this area.
 - d) Blood cannot be aspirated from catheters with a one-way valve design.
 - e) When administering vesicants

TABLE 9. MAINTENANCE AND USE OF ARTERIAL ACCESS DEVICES

DEVICE	FLUSHING	EXIT SITE CARE AND DRESSINGS
Catheter	Before and after each drug: 5–10 ml normal saline Final flush (if catheter capped): <ul style="list-style-type: none"> • Amount is at least two times the catheter plus add-on set volume • 5,000 units heparin/ml, usually 3–5 ml every day 	Perform usual incisional care post-op. Continue exit site care for external catheters or for port with needle access during continuous infusions. <ul style="list-style-type: none"> • Apply sterile, occlusive dressing. • Change dressing every two days for gauze and at least weekly for transparent semipermeable dressing (Centers for Disease Control and Prevention [CDC], 2002).
Port	Before and after each drug: 20 ml normal saline (West, 1998) Final flush: <ul style="list-style-type: none"> • Amount is 5 ml • 1,000 units heparin/ml or 5,000 units heparin/ml* weekly 	<ul style="list-style-type: none"> • Change port needle every seven days. • Use alcohol, povidone-iodine, or 2% chlorhexidine-based skin prep (CDC, 2002). • Do not use topical antibiotic ointment or cream on insertion sites; potential to promote fungal infections and antimicrobial resistance (CDC, 2002). Gauze wrap occasionally is used to protect the catheter and keep patient from bending or pulling catheter within involved extremity.

* If 1,000 units/ml is used, aspirate heparin solution from catheter before infusion and monitor coagulation values.

through a port: If no blood return or perfusion, radiographic check needs to be obtained to verify catheter placement.

f) Interventions for painful needle sticks during port access are described previously (see Section II-B-4 on peripheral IVs).

5. Flushing to maintain patency

a) Controversy exists related to the type, amount, and concentration of final flush solutions.

b) For information on port flushing, see Table 9.

c) Flushing for external catheters (see Table 9)

(1) Post-surgery: Usually instilled with 1,000 units of heparin/ml using 2 ml.

(2) During continuous drug infusions or for “keep open” purposes when drug infusion is completed, the type and amount of solution and rate may be the following.

(a) Use continuous normal saline.

(b) Flush with heparin solution as ordered by physician to maintain catheter patency (Martin, 2002).

J. General practice issues

1. Use pressure tubing, positive pressure pumps, and stopcocks with Luer locks.

2. Always use positive pressure when withdrawing needle or clamp before withdrawing needle from injection cap.

3. Never leave open to air; maintain a closed system.

4. If external catheter is capped, keep clamped to avoid retrograde blood flow.

5. Make sure dressing is secure. Loop catheter to dressing, and tape securely so catheter loop is not exposed to accidental pulling.

6. Arterial access devices for regional cytotoxic therapy are not used for blood sampling. Other arterial catheters (pulmonary artery catheter or radial artery catheter) often are used for blood sampling using specific

techniques (Schallom & Bisch, 2001).

K. Complications

1. For more information on major complications, see Table 10.

2. Less frequent complications are as follows.

a) Percutaneous arterial catheter leak or break.

b) Hepatic artery injury (dissection) (Habbe et al., 1998)

c) Arterial spasm during insertion or infusion of an irritating drug (Cho, Andrews, Williams, Doenz, & Guy, 1989; Perdue, 1995)

d) Cerebral vascular accident from a brachial percutaneous catheter (Habbe et al., 1998)

e) Migrating embolization coils or microcoils (Habbe et al., 1998)

3. Skin reaction: Redness, rash, or blistering of skin around port could be a reaction to tape or dressing.

L. Education and documentation (see Section VIII)

M. For a practicum on arterial catheter care, see Appendix 7.

TABLE 10. MAJOR COMPLICATIONS ASSOCIATED WITH ARTERIAL ACCESS DEVICES

COMPLICATIONS/INCIDENCE	PREVENTION	PRESENTATION	INTERVENTION	SOURCES
Infection: (septicemia, 1%) All type catheters: Long-term 25% Ports 7.6%	Aseptic technique Sterile, occlusive dressings Keep duration of percutaneous arterial catheters less than six days	Tenderness at site Drainage Fever Erythema	Administer oral or IV antibiotics. Evaluate need to stop infusion and remove device.	Raad, Abi-Said, Carrasco, Umphrey, & Hill, 1998
Catheter migration/dislodgment: Percutaneous catheters: 12% migration rate (36 migrations per 300 catheters) Surgically placed catheters: 6.4% migration rate (10 migrations per 157 catheters)	Surgical placement of catheter, sutured in place Beaded catheter to secure vessel Fixed-tip percutaneous catheter placement*** Regular check of tip placement and flow study	Epigastric pain Nausea or vomiting Diarrhea Other systemic effects: • Edema • Weak or absent peripheral pulse • Inability to infuse or discomfort during infusion	Differentiate between chemotherapy-related and perfusion of ancillary organs. Stop infusion, hang saline, or cap line. Obtain perfusion study. Evaluate need to remove device.	Grosso et al., 2000* Habbe et al., 1998* Irie, 2001*** Kemeny, 2000** Seki et al., 1999*** Zanon et al., 1998**
Occlusion/thrombosis: Percutaneous catheters: 7% rate (21 occlusions per 300 catheters) Surgically placed catheters: 3.8% rate (6 occlusions per 157 catheters)	Positive pressure when de-accessing catheter/port Flushing with saline between drugs Use of heparinized solution flushes Use of positive pressure pump Continuous flushing after chemotherapy infused	Unable to flush or withdraw fluid Percutaneous catheter: change in color, pulse, and temperature of involved extremity Abdominal pain	DO NOT force flush: catheter will rupture. Use tissue plasminogen activator according to directions. Evaluate need to remove device and replace.	Doughty, Keogh, & McArdle, 1997
Bleeding at exit site	Baseline assessment of dressing Frequent observation of exit site	Some serous or bloody drainage after placement expected; excessive drainage considered a complication	Apply pressure dressing. Apply sandbags to site.	Almadrones et al., 1995

* Percutaneous catheter; ** surgically placed catheter; *** fixed-tip catheter placement

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