The Endovascular Approach to Abdominal Aortic Aneurysm Repair

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The endovascular approach to the treatment of abdominal aortic aneurysms (AAAs) is no longer a new technique. Recent advances in stent devices, imaging equipment, and interventional techniques have made it possible for patients with a wider range of clinical characteristics to receive this treatment with a much lower incidence of aneurysm rupture than when the procedure was first introduced in the 1990s.[1] As a result, endovascular aneurysm repair (EVAR) of AAAs now can be performed in multiple hospital settings, under various forms of anesthesia, and using a variety of access techniques. Perioperative nurses who are educated about the procedure and understand the pros and cons of each treatment approach can, as a part of a multidisciplinary team, help make decisions that best serve patients regarding the use of EVAR for AAA repair.

Preoperative Preparation for EVAR Procedures

Regardless of the setting in which an EVAR is performed, perioperative nurses need to be aware of the necessary preoperative work-up and intraoperative equipment required to help make the procedure a success. Preoperatively, the nurse should evaluate the patient's medical history and review all medications that the patient takes routinely at home. The use of blood thinners, for example, is significant because of the risk of excessive blood loss during these procedures, especially if it becomes necessary to convert the endovascular procedure to an open surgical repair. It is important for the perioperative nurse to note the presence of certain medical conditions (eg, cardiac dysfunction) that may affect the use of anesthetic medications, and the use of large doses of IV contrast dyes might be contraindicated in patients with renal insufficiency.

The nurse must understand the need to review the patient's cardiac clearance values and laboratory results (eg, blood urea nitrogen, creatinine levels) (Table 1). Irregularities in these values can alert health care team members to problems that could affect clinical outcomes after EVAR. For instance, coagulopathy problems such

ABSTRACT

Endovascular aneurysm repair (EVAR) affords patients the opportunity to undergo a less invasive method of repairing abdominal aortic aneurysms. The EVAR procedure results in a shorter hospital stay, less pain, and less chance of morbidity. This procedure can be performed in a variety of settings (eg, OR, interventional radiology suite, cardiac catheterization laboratory), each of which has its own benefits and challenges. Recently, hybrid ORs have been designed to perform both endovascular and open procedures.

AORN has many applicable recommended practices to guide perioperative nurses in the safe provision of care during EVAR procedures.

Key words: ***Endovascular aneurysm repair, EVAR, endovascular, abdominal aortic aneurysm, AAA, aneurysm repair. AORN J* 89 (February 2009) 289-302.**

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as low platelet count can lead to additional blood loss. This, paired with a low hemoglobin or hematocrit level either preoperatively or intraoperatively, can cause life-threatening volume deficiency. Increased creatinine levels may indicate renal insufficiency, which may cause the surgeon to limit the use of contrast during the procedure, thus making placement of the stent graft device more difficult. Patients with renal insufficiency may excrete medications and anesthetic agents more slowly, possibly leading to the need for ventilation assistance postoperatively.

The preoperative period is a vital time to educate the patient about the procedure and what to expect postoperatively. The perioperative nurse's ability to answer questions and allay fears can help make this time much easier for the patient.

No matter the setting, the perioperative nurse must understand the steps of the EVAR procedure so he or she can educate and care for the patient and properly prepare the room for the procedure (Table 2). In all settings where EVAR is performed, it is necessary to have a radiolucent OR bed that allows radiologic access to the patient from the nipple line to knee level. Other interventional vascular procedures may

TABLE 1
Normal Laboratory Test Values[1]

Red blood cells	3.8 M/mcL to 5.6 M/mcL
White blood cells	3.8 K/mm² to 11.0 K/mm²
Hemoglobin	11 g/dL to 18 g/dL
Hematocrit	34% to 54%
Blood urea nitrogen	6 mg/dL to 23 mg/dL
Bilirubin, direct	0.0 mg/dL to 0.4 mg/dL
Bilirubin, indirect	Total minus direct bilirubin
Bilirubin, total	0.2 mg/dL to 1.4 mg/dL
Creatinine	0.6 mg/dL to 1.5 mg/dL
Prothrombin time	10 seconds to 14 seconds
Partial thromboplastin time	32 seconds to 45 seconds
Activated coagulation time	90 seconds to 130 seconds

1. Normal lab values. Medtronic Transcription World. http://www.mtworld.com/tools_resources/lab_values.html. Accessed December 12, 2008.

TABLE 2
Endovascular Aortic Aneurysm Repair Preference Card

Basic supplies
Endovascular pack with basins for irrigation and dye
Sterile drape of choice—often laparotomy drape in case of conversion
Sterile gowns/gloves*
Medication labels*
Electrosurgical device*
Radiolucent 4 x 4 sponges*
Suction tubing and tip*
Sterile light handles*
Sharps holder*
Vessel loops if performing groin dissection instead of percutaneous technique
Suture boots
Vascular and closing sutures
Dressings

Endovascular supplies
7-Fr and 8-Fr introducers
16-Fr and 22-Fr introducers
Soft and stiff guide wires (0.35 cm x 180 cm)
Angiogram catheters with markers
High pressure tubing for IV dye injector
Stent grafts of choice
Optional: snare kit and balloons of various sizes

Instrumentation
Minor vascular instrument set if performing groin dissection
Conversion instruments on standby to include major abdominal instrument set
Arterial tray if abdominal approach

Equipment
High pressure IV contrast injector
Radiolucent OR bed
Imaging equipment (eg, fluoroscopy unit and monitor)
Lead aprons

** These are packed together in several custom packs.*

require additional radiologic access, and the perioperative nurse must be familiar with what is required. A fluoroscopy unit (ie, C-arm) and a device for delivering IV contrast dye under high pressure are needed. Measurement of internal vessel lumens with intravascular ultrasound also may be necessary. It is the nurse's responsibility to verify the availability of necessary angiographic supplies (eg, guide wires, introducer sheaths, catheters); intraoperative medications (eg, heparinized irrigation, IV contrast dye); and the chosen stent grafts to be implanted. All supplies for conversion to an open procedure (eg, major vascular tray) should be available in the room and ready to open.

Overview of EVAR Procedures

All EVAR procedures are performed similarly, regardless of the chosen setting. The surgeon identifies the femoral artery, either under direct vision through groin dissections (Figure 1) or percutaneously with the assistance of a Doppler device, and uses the Seldinger technique to access the femoral artery. This technique, which is viewed as a critical advancement in interventional radiology and cardiac catheterization, was developed in 1953 by Swedish radiologist Sven-Ivar Seldinger, MD.[2] The Seldinger technique is an effective alternative to traditional surgical access, which can result in damage to the femoral nerves, lymphocele formation, hemorrhage, and pain.

The surgeon passes a soft-tipped guide wire through the needle. For patients with aortoiliac disease, a specially coated guide wire may be required to traverse severely atherosclerotic or calcified portions of the artery. The surgeon then removes the needle and passes a sheath with a dilator over the guide wire. After removing the dilator from the sheath over the wire, the surgeon removes the wire. The practitioner may flush the sheath with heparinized solution (eg, 1:100 units) or sterile, injectable normal saline initially to remove air and after each use to prevent blood clotting in the lumen.

The stent graft devices for the EVAR procedure come in several pieces:

- a bifurcated main body,
- an iliac limb,
- cuffs, and
- an extension (Figure 2).

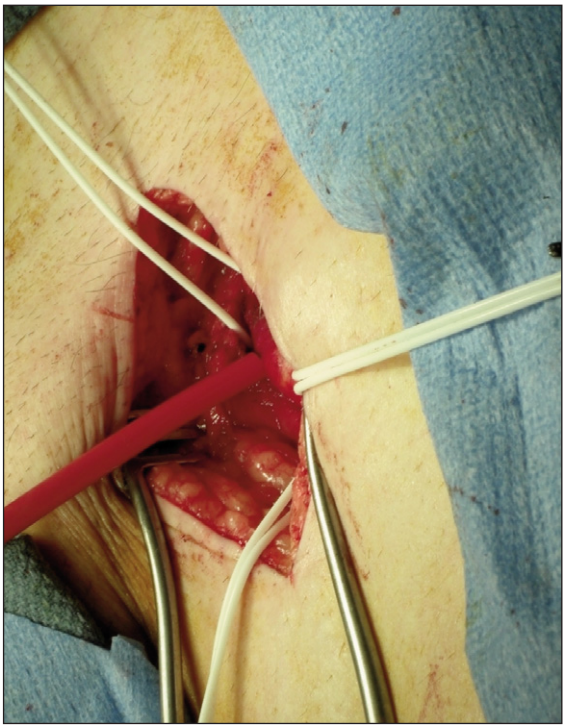


Figure 1 • Traditional surgical access groin dissection used to introduce the stent graft device.

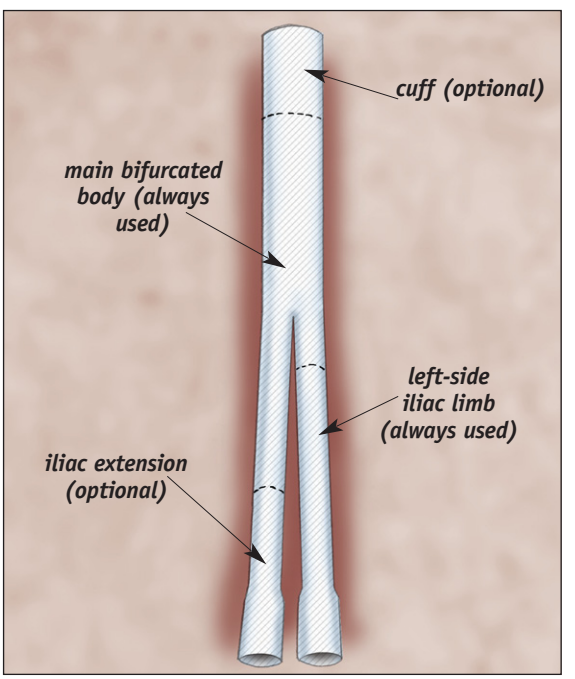


Figure 2 • The stent graft devices are placed in pieces, each within its own introducer, and are tailored to the patient's aneurysm.

These pieces allow the surgeon to choose which graft combination best suits the patient's needs.

The surgeon performs the Seldinger technique on both of the patient's common femoral arteries, starting on the side in which the main bifurcated body of the graft will be placed. The surgeon chooses this side based on the condition of the femoral vessels. The surgeon places a stiff guide wire on this side and uses it to introduce the stent graft. These guide wires are long; therefore, the scrub person must ensure the sterility of the external portion of the guide wire. Figure 3 shows a typical room setup for an EVAR procedure with an extension table to increase the length of the sterile field and facilitate maintaining the sterility of the guide wire.

The surgeon places an angiographic catheter in the patient's opposite groin so that intraoperative angiograms may be performed during deployment of the stent to verify its placement inside the aneurysm. Intravascular ultrasound also may be employed to measure the internal diameters and anatomic angles of the vessels.

> *Using advanced imaging methods, the surgeon guides the catheter carrying the stent graft to the area of the aneurysm inside the aorta. Once the stent graft is in position, the surgeon deploys it into place and removes the catheter.*[3]

When the main body of the graft is in place, the surgeon replaces the catheter on the opposite side with another long, stiff guide wire and uses this to introduce the iliac limb of the graft under fluoroscopy. He or she repeats this process until all of the necessary stent grafts are placed (Figure 4).

Often, the surgeon places the proximal and distal ends of the graft with an angiographic balloon to ensure proper fit and to prevent leaks around the graft (ie, endoleaks).[4] Endoleaks can occur whenever blood is allowed to continue to flow into the aneurysm's sac. The types of endoleaks that can occur include attachment site leaks,

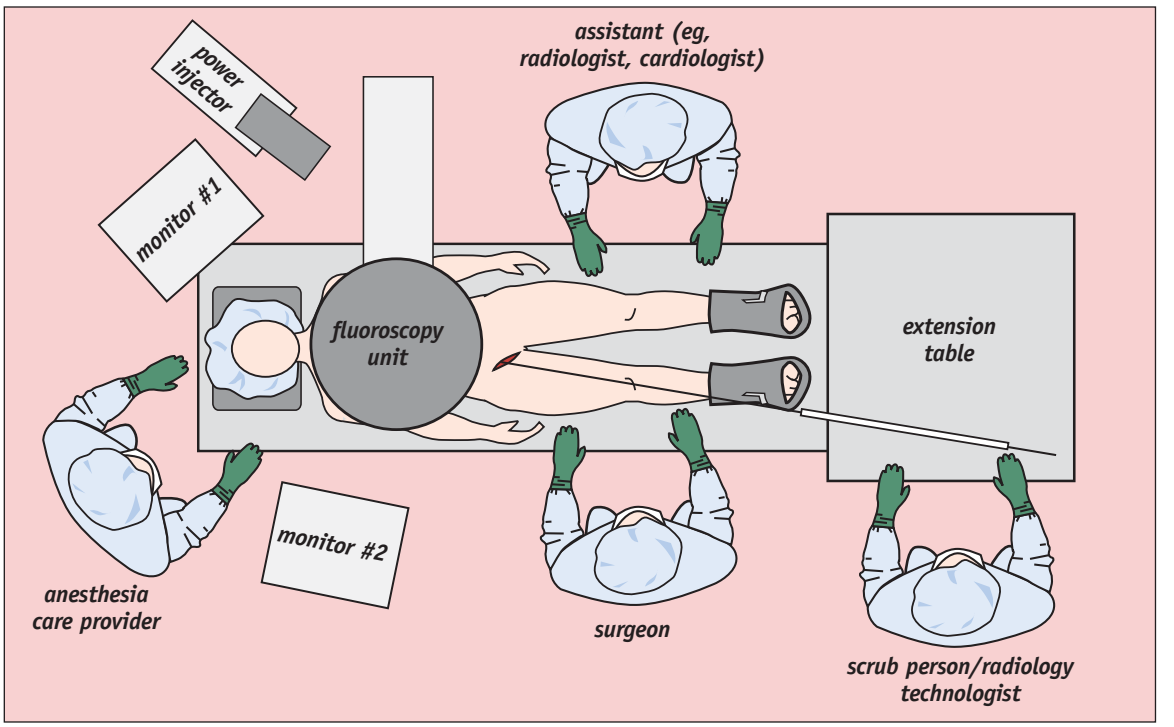


Figure 3 • Typical placement of personnel and equipment in the suite during an endovascular aneurysm repair of an abdominal aortic aneurysm.

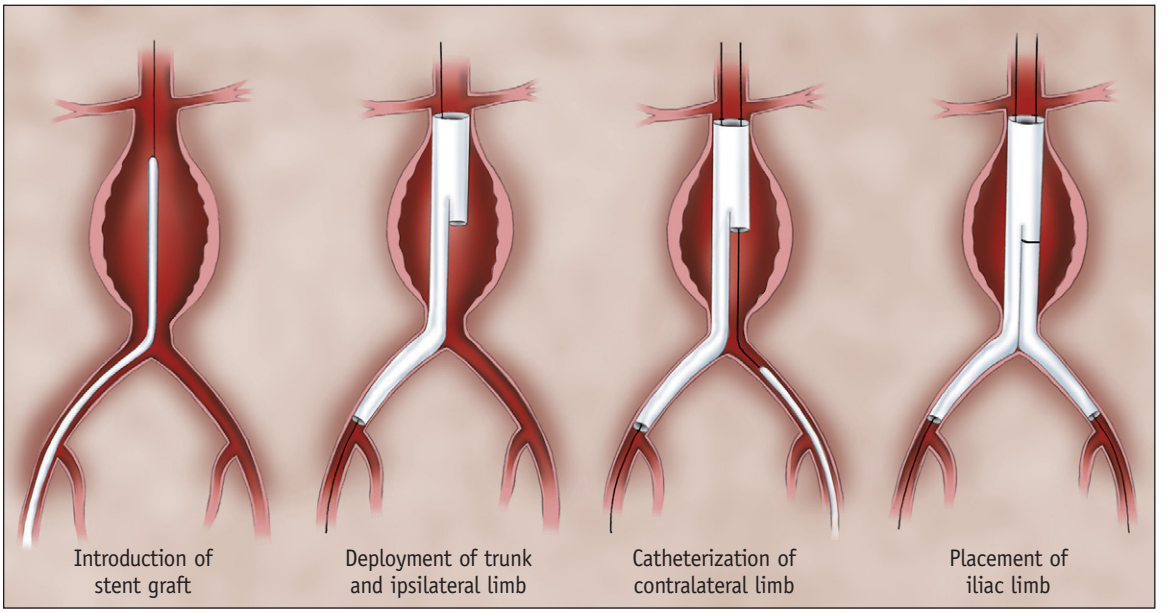


Figure 4 • Main steps involved in the placement of the aortic aneurysm stent graft. After the iliac limb is placed, additional pieces are placed as necessary.

branch leaks, and other defects in the stent graft (Figure 5).[4] Based on the type of endoleak (Table 3), the surgeon decides whether it will resolve on its own or whether it requires immediate treatment. Unresolved endoleaks can cause the aneurysm to continue to grow in size and rupture, which may cause a life-threatening situation.[4]

When the procedure is completed, the surgeon removes the sheath and closes the puncture site. The anesthesia care provider and circulating nurse transfer the patient to the postanesthesia care unit (PACU). The PACU nurse monitors the patient's vital signs, laboratory test results, and surgical sites for postoperative complications.

Performing EVAR in the OR

Endovascular AAA repair often is performed in the OR under general anesthesia because of the potential need for emergency conversion to an open repair. This prevents having to move the patient from the interventional radiology suite (IRS) or cardiac catheterization suite (CCS) to the OR or requiring a surgical team and an unused OR to remain on standby. A vascular surgeon may perform the dissection and closure to help minimize the risk of hemorrhage and hematoma of the femoral or iliac arteries, which can occur with both open and percutaneous techniques. A direct closure technique also may allow the patient to ambulate sooner. The risk of infection may be reduced when the procedure is performed in the OR because ORs are designed to

- restrict traffic flow;
- reduce the entrance of outside contaminants; and
- provide specific air exchanges, room temperature, and humidity levels,

all of which reduce the risk of contamination and infection for the surgical patient. Often, an IRS or CCS does not have these built-in controls, and maintaining the same type of aseptic environment offered in the OR may be more difficult, although it is achievable.[5]

There are disadvantages, however, to performing these procedures in the OR. In many facilities, EVAR procedures are not performed in the OR as often as in the IRS or CCS, so ready access to all the necessary interventional supplies may be less than ideal in the OR. "This may include balloons, stents, snares, and wires as well as more expensive capital items, such as intravascular ultrasound, and mechanical thrombectomy units."[5(p2)] Costly duplication of capital equipment and supplies that are not used routinely in other vascular surgical procedures does not serve the patient or

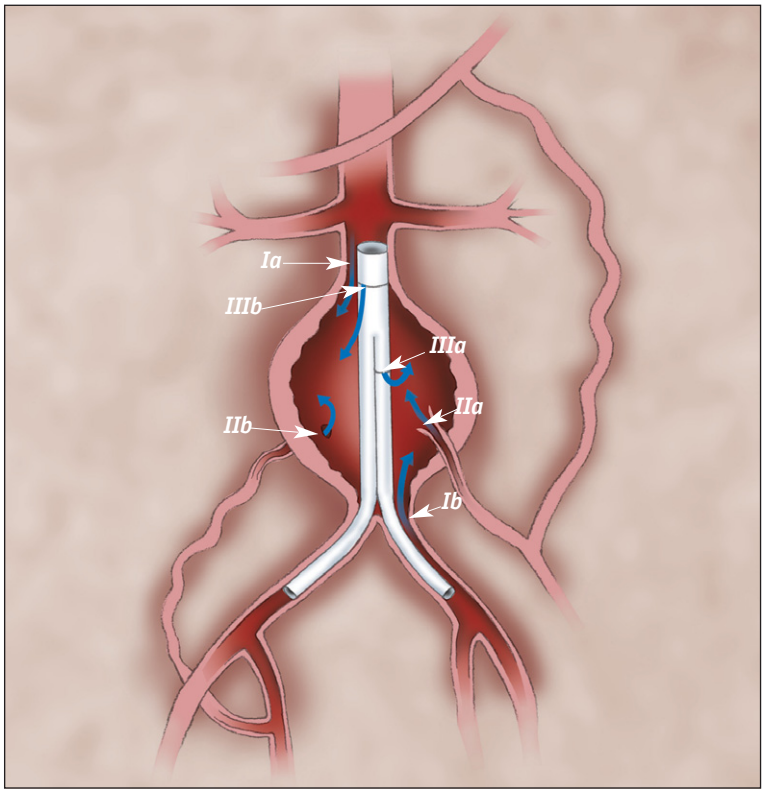


Figure 5 • Classification of endoleaks: proximal fixation site (Ia), distal fixation site (Ib), inferior mesenteric artery (IIa), lumbar artery (IIb), disjunction (IIIa), and fabric (IIIb). Type IV endoleaks (ie, graft wall porosity) can occur anywhere on the graft.

health care facility well; therefore, nurses may have to identify the items or carts that contain these supplies so they can be quickly accessed and support collaboration. Nurses also must be between the OR and the IRS or CCS team members to provide all necessary equipment wherever the EVAR procedure is performed.[5]

Another option is a hybrid OR suite specially created for endovascular procedures. Hybrid operating suites provide the best of both worlds. These rooms are more spacious than the typical IRS or CCS but have built-in, ceiling-mounted radiological equipment and radiolucent OR beds that are appropriate for endovascular procedures and standard surgical procedures.

Many surgical suites do not have dedicated endovascular rooms; however, optimal imaging equipment and a "vascular software package that

TABLE 3
Classifications and Treatments of Endoleaks[1]

Endoleak type	Location	Treatment
I: Attachment site leak	Leaks at the proximal or distal ends of the endograft	• Requires urgent intervention via dilation of the ends of the endograft with angiographic balloons and placement of extensions or stent cuffs.
II: Branch leak	Back flow from run-off vessels, usually the inferior mesenteric or lumbar vessels	• Some may resolve on their own. • In the interim, monitoring, coil embolization, and ligation of inferior mesenteric and lumbar arteries may be required. • May require conversion or revision at a later date.
III: Graft defects	Modular disconnect or fabric disruption (eg, tears or suture holes)	• May require urgent intervention via extensions or cuffs at the fabric disruption. • May require open conversion if not repairable.
IV: Graft wall porosity	Leaks through the endograft	• Usually resolves on its own.

1. *Katzen BT, Dake MD, MacLean AA, Wang DS. Endovascular repair of abdominal aortic aneurysms.* Circulation. *2005;112(11):1663-1675.*

allows for digital subtraction and road mapping"[5(p2)] must be available. The radiological software and continuous fluoroscopy allow the surgeon to see the vessel in which the contrast dye is being injected. It provides a roadmap of the vessel that is being manipulated and allows the surgeon to more precisely advance wires and other devices while subtracting the images of surrounding vessels.

If the imaging equipment is not mobile, it is helpful to have it ceiling mounted so that it can be moved out of the way if conversion to a open procedure becomes necessary.[5] In the past, poor resolution of mobile imaging devices such as C-arms caused difficulties in ORs, but this is no longer the case.

> *The evolution of mobile imaging equipment now allows excellent resolution, a wide range of functionality, and in short, the ability to perform any endovascular intervention in the OR setting.*[6(p44)]

Some of the newer mobile C-arms even allow the surgeon to control tasks from the sterile field using a joystick.[6]

Finally, the vascular surgeon and OR staff members must be educated to properly use the needed endovascular supplies. Many of the skills needed to ensure the success of these procedures relate to surgical team members' ease with wires and catheters. Although the Seldinger technique is commonly used for balloon pump and other vascular insertions in cardiac ORs, this technique may not be used commonly in other vascular surgical procedures. The skills involved can easily be learned by collaboration with team members who are familiar with the use of the supplies and equipment during endovascular procedures.

Performing EVAR in the IRS or CCS

Because the incidence of emergency conversions have dropped dramatically over time, performing EVAR in an IRS or CCS with the percutaneous approach has become more common. Although hemostasis using the Seldinger technique usually is not a problem, a vascular surgeon may be required to perform the closure if hemostasis cannot be achieved.

A completely percutaneous approach only requires two small needle punctures rather than two groin incisions. This has proven quite successful with proper patient selection and when the technique is performed properly. For the best results, it is helpful to get "a detailed evaluation of the [patient's] common femoral artery to its bifurcation for size, calcium deposits, and the presence of atheroma or thrombus."[7(p39)] Combined with this less invasive technique, some surgeons have opted for the use of local anesthesia or conscious sedation only rather than employing general anesthesia. This is particularly beneficial for patients who cannot tolerate the additional risks of general anesthesia. In addition, it allows the patient to resume a normal diet more quickly, experience less pain, and be discharged earlier.[8]

Although the percutaneous approach is a less invasive technique, it is not without drawbacks, such as damage to the vessel that can result in hemorrhage, hematoma, and infection. Closure of the percutaneous entry sites is dependent on the use of fibrin plugs or suture-mediated or clip-closure devices (Table 4). These devices can be very effective but require skill to use and do not always provide adequate hemostasis. Because the vessels in which the introducers are placed are not actually opened in the percutaneous technique, the vessels must be dilated up to a 20 Fr-sized diameter, which can rupture these vessels.[8] If the vessel ruptures, the patient may require transfer to the OR for open repair.[8] The PACU nurse must monitor the patient closely for any signs of increased pain, hemorrhage, or hematoma that could signal damage to the operative vessel or a poor seal from the closure device.

Finally, patient compliance after percutaneous EVAR during the recovery phase also may be an issue. Some closure devices require the patient to remain in bed for four to six hours with his or her legs in a straight position for hemostasis to occur.[7] This positioning can be quite uncomfortable for the patient, especially if he or she experiences back pain. If hemostasis is not achieved with bed rest, it may be necessary to place sandbags over the surgical sites to achieve proper clotting. These sandbags normally weigh from 2.3 kg to 4.5 kg (5 lbs to 10 lbs) each, and must remain in place until hemostasis occurs, which can be

TABLE 4
Closure Devices[1]

Device name	Type	Usage
Arterial suture-mediated, closure device (eg, Perclose A-T [auto-tie], Proglide, Prostar)[2]	Suture	● Automated knots ● Available in 5 Fr to 10 Fr depending on the product
Circumferential clip-based extravascular closure device (eg, Starclose)[3]	Clip	● Provides rapid hemostasis
Conformable, water-soluble, extravascular sealant (eg, Mynx)[4]	Plug	● Seals puncture and dissolves within 30 days ● Provides added patient comfort
Bioabsorbable anchor and collagen sponge mechanical sealant device (eg, AngioSeal VIP, STS Plus)[5]	Plug	● Consists of suture and collagen ● Dissolves within 90 days
Low-profile, site-specific, compression disc (eg, Boomerang)[6]	Plug	● Coated coil device ● Minimizes scarring
Suture-based vascular closure device (eg, SuperStitch)[7]	Suture	● Uses 6-Fr to 8-Fr sheath ● Does not make puncture site larger
Dual balloon catheter/procoagulant vascular sealing device (eg, Duett Pro)[8]	Plug	● Uses thrombin and collagen with a balloon catheter ● Can be used when the patient's activated coagulation time is < 400 (ie, a measure of heparin levels during procedures in which large amounts of aniticoagulants are used) and glycoprotein IIb/IIIa (ie, needed for clotting and platelet aggregation)

1. *Closure update 2008.* Endovascular Today. *http://www.evtoday.com/PDFarticles/0208/EVT0208_04.pdf. Accessed December 12, 2008.*
2. *Perclose A-T suture mediated closure. Abbott Vascular. http://www.abbottvascular.com/av_dotcom/url/content/en_US/10.10.400.10:10/general_content/Abtdiv_General_Content_0000153.htm. Accessed December 12, 2008.*
3. *Abbott receives FDA approval for StarClose™ vascular closure system. Angioplasty.org. http://www.ptca.org/pr_abbott/20051222.html. Accessed December 12, 2008.*
4. *Mynx sealant. Mynx. http://www.mynx.com. Accessed December 12, 2008.*
5. *AngioSeal™ vascular closure device. St Jude Medical. http://www.sjmprofessional.com/EN-US/ProductLibrary/Pages/Angio-Seal-Vascular-Closure-Device.aspx. Accessed December 12, 2008.*
6. *Boomerang Catalyst™ system. Cardiva Medical Inc. http://www.cardivamedical.com/pages/page.asp?s=442&ss=458. Accessed December 12, 2008.*
7. *SuperStitch. Sutura. http://www.sutura.us/content/blogcategory/8/8. Accessed December 12, 2008.*
8. *Duett Pro. Vascular Solutions. http://www.vascularsolutions.com/products/duett. Accessed December 12, 2008.*

quite painful. These techniques are not necessary with the open surgical repair. The PACU nurse should be mindful of these issues and make every effort to keep the patient comfortable. Administering pain medication as ordered, providing the patient with comfort measures such as warm blankets, and answering all of his or her questions can help to calm and reassure the patient, as well as to lessen his or her discomfort.

AORN RECOMMENDED PRACTICES APPLICABLE TO EVAR

AORN's *Perioperative Standards and Recommended Practices* includes several recommended practices that apply to EVAR regardless of the setting in which it is performed. Table 5 provides a list of guidelines or recommended practices that may apply, although this list is by no means exhaustive. All are important to consider when caring for a patient undergoing any surgical or invasive

procedure. Five of these recommended practices are particularly relevant to achieve the best patient outcomes for EVAR:

- reducing radiological exposure,
- maintaining the sterile field,
- ensuring safe medication practices,
- preventing malignant hyperthermia (MH), and
- prevention of venous stasis.

AORN has developed the Perioperative Nursing Data Set[9] (PNDS) to identify nursing diagnoses, interventions, and outcomes that apply to perioperative nursing, which can help nurses provide better care for their patients. Table 6 is a care plan, which includes some, but not all, of the PNDS codes relevant to patients undergoing EVAR. Nurses are encouraged to consult the PNDS for further explanations of the interventions.

TABLE 5

AORN Recommended Practices and Guidelines Pertinent to Endovascular Aortic Aneurysm Repair[1]

AORN malignant hyperthermia guideline

AORN guideline for prevention of venous stasis

AORN guidance statement: Safe medication practices in perioperative settings across the life span

Recommended practices for sponge, sharp, and instrument counts

Recommended practices for documentation of perioperative nursing care

Recommended practices for electrosurgery

Recommended practices for selection and use of surgical gowns and drapes

Recommended practices for surgical hand antisepsis/hand scrubs

Recommended practices for the prevention of unplanned perioperative hypothermia

Recommended practices for managing the patient receiving local anesthesia

Recommended practices for managing the patient receiving moderate sedation/analgesia

Recommended practices for product selection in the perioperative practice setting

Recommended practices for reducing radiologic exposure in the perioperative setting

Recommended practices for preoperative patient skin antisepsis

Recommended practices for maintaining a sterile field

1. Perioperative Standards and Recommended Practices. *Denver, CO: AORN, Inc; 2008.*

RISK FOR INJURY RELATED TO RADIOLOGIC EXPOSURE. "Recommended practices for reducing radiological exposure in the perioperative practice setting" states that it is the nurse's role to protect patients and staff members from exposure to large amounts of radiation during fluoroscopy procedures because high doses of radiation have been linked to cancer.[10] Protecting patients and staff members from excess radiologic exposure is particularly important during endovascular procedures because of the length of time fluoroscopy is used and how close staff members are in proximity to the radiologic device during the procedure. These recommended practices give 11 suggestions on how to protect fellow team members and the patient. These recommendations are primarily focused on

- proper positioning of the patient so that only necessary areas are exposed to radiation;
- proper use of shielding devices (eg, lead, radiation monitors); and
- having an appropriate care plan so that only the minimal amount of radiation necessary is used.[10]

For this reason, it is important for the circulating nurse to record the total fluoroscopy time in the patient's record.

In addition to protecting the patient from excess radiological exposure, surgical team members must protect themselves as well. Using wrap-around lead protection is vital to help shield most of the vulnerable organs, especially for the circulating nurse, who often must turn

TABLE 6
Nursing Care Plan for a Patient Undergoing Endovascular Aneurysm Repair of an Abdominal Aortic Aneurysm [applicable PNDS code]

Diagnosis	Nursing interventions	Outcome indicator	Outcome statement
Risk for injury [X29] related to radiologic exposure	• Assesses history of previous radiation exposure [I142]. • Provides care in a nondiscriminatory, nonprejudicial manner regardless of the setting in which care is given [I79]. • Implements protective measures (eg, radiology protective apparel) to prevent injury due to radiation sources [I74]. • Uses supplies and equipment within safe parameters [I122]. • Evaluates for signs of radiation injury to skin and tissue [I43].	Staff members use appropriate radiological protective equipment to avoid unnecessary radiological exposure of the patient or staff members.	The patient is free from signs and symptoms of radiation injury [O7].

Risk for infection [X28]	• Assesses the patient's baseline tissue perfusion [I60], susceptibility to infection [I21], and risk for ineffective tissue perfusion [I15].
	• Minimizes the length of the procedure by planning care [I85].
	• Maintains continuous surveillance [I128] and institutes aseptic technique [I70] by
	  ◦ ensuring that all personnel strictly adhere to aseptic technique to restrict microorganisms in the environment and on equipment,
	  ◦ controlling OR traffic to keep the number of personnel entering and exiting the room at a minimum and keeping the OR door closed, and
	  ◦ cleaning the OR after the procedure to remove infectious organisms and ensuring that all cleaning personnel wear appropriate personal protective equipment.
	• Performs appropriate skin preparation [I94].
	• Administers prescribed antibiotic therapy [I7].
	• Classifies the surgical wound [I22] and provides care to the wound site [I4].
	• Evaluates response to the plan of care [I147], phases of wound care [I49], instruction [I50], and postoperative tissue perfusion [I46].
		Staff members adhere to principles of asepsis.	The patient is free from signs and symptoms of infection [O10].

his or her back to the field and the fluoroscopy unit. Using x-ray badges also is necessary to monitor staff members' radiological exposure and limit it, if necessary, before the individual is exposed to hazardous levels.

RISK FOR INFECTION. Prevention of infection is vital, whether the EVAR is performed via a percutaneous technique or through a groin dissection. Groin incisions are more prone to contamination because of the increased risk of contamination with the patient's own skin flora. The risk for infection increases when a foreign body, such as a stent graft, is implanted in the patient. "Recommended practices for maintaining a sterile field" discusses the use of proper hand antisepsis, gowning, and gloving of surgical team members, and proper draping and monitoring of the sterile field.[11] There are seven recommendations given

TABLE 6 (CONTINUED)
Nursing Care Plan for a Patient Undergoing Endovascular Aneurysm Repair of an Abdominal Aortic Aneurysm [applicable PNDS code]

Diagnosis	Nursing interventions	Outcome indicator	Outcome statement
Potential for ineffective therapeutic regimen management [X33] related to medication safety	• Verifies patient's identity and allergies (I123). • Administers prescribed medications [I9]. • Prescribes medications within scope of practice [I141] and provides instruction about prescribed medications [I104]. • Evaluates response to medications [I51]. • Evaluates response to instruction about prescribed medications [I48].	The correct patient receives the correct medication(s) in accurate doses, at the correct time, and via the correct route throughout the surgical experience	The patient receives appropriate medication(s), safely administered during the perioperative period. [O9].
Ineffective thermoregulation [X58]	• Assesses for risk of inadvertent hypothermia [I131] or malignant hyperthermia (MH). • Assesses for signs of hypothermia (eg, shivering, piloerection) or MH (eg, muscle rigidity, hypercapnia, tachycardia). • Implements thermoregulation measures [I78] and protective measures to prevent skin or tissue injury due to thermal sources [I76]. • Monitors body temperature [I86]. • Evaluates response to thermoregulation measures [I55].	The patient's core body temperature remains in the expected range.	The patient is at or returning to normothermia at the conclusion of the immediate postoperative period [O12].

Ineffective tissue perfusion [X61]	• Identifies risk factors for thrombolic disease (eg, venous stasis, deep vein thrombosis) and ineffective tissue perfusion [I15].
	• Identifies baseline tissue perfusion [I60].
	• Maximizes mechanical prophylaxis by
	  ◦ taking accurate measurements to ensure that properly fitting thromboembolic device (TED) stockings are ordered,
	  ◦ assisting the patient in donning the TED stockings properly,
	  ◦ educating the patient about the importance of TED stockings and the significance of wearing them as prescribed, and
	  ◦ suggesting that the patient use stockinettes or socks under foot pumps for comfort.
	• Administers pharmacologic agents as ordered.
	• Evaluates postoperative tissue perfusion [I46] and response to venous stasis prophylaxis.
		The patient does not exhibit signs or symptoms of venous stasis.	The patient has wound/tissue perfusion consistent with or improved from baseline levels established preoperatively [O11].

for maintaining a sterile field, such as requiring that nonsterile team members remain at least 12 inches away from the sterile field and knowing the specific areas of the scrub gown that are considered sterile. Finally, it is also recommended that the sterile field be opened only when it is ready to be used and monitored for any breaks in technique that would compromise its sterility.[11] Although some facilities actually set up for an open procedure and perform all surgical counts before beginning the EVAR procedure, this may not be advisable if the setup cannot be continuously monitored.

INEFFECTIVE THERAPEUTIC REGIMEN MANAGEMENT RELATED TO MEDICATION SAFETY. There are several risks involved with the use of medications commonly administered to patients during EVAR procedures. For instance, large doses of contrast dye

may be used to enable intraoperative angiograms to be taken, and this can place the patient with compromised renal function at risk for renal failure. The AORN "Guidance statement: safe medication practices in perioperative settings across the life span" provides perioperative nurses with recommendations and strategies to prevent patient injury through the use of the five "rights" of medication administration: the right patient, the right medication, the right dose, the right time, and the right route.[12(p337-338)] The nurse can help prevent medication errors and their complications by assessing the patient's medical history, currently prescribed medications, and over-the-counter medication use and accurately documenting any medications administered to the patient. It is the circulating nurse's responsibility during endovascular procedures to track the total amount of contrast dye administered and inform the surgeon to prevent a toxic dosage from being administered, especially if the patient has renal insufficiency.

Another medication used in EVAR with potential medication error or complication risks is heparin. Patients undergoing endovascular procedures are given IV heparin, usually 100 units/kg of the patient's body weight, to prevent clotting during the procedure. The operative area also is irrigated with a heparinized saline solution. An incorrect dose or concentration of the medication can be life threatening. Any patient who has received heparin, even if the effects are reversed, is at increased risk for blood loss during the procedure, as well as hemorrhage and clotting factor alterations postoperatively. For this reason, it is important to monitor the patient's prothrombin, partial thromboplastin time, and activated coagulation time levels during his or her recovery phase.

Ineffective thermoregulation. Any patient undergoing surgery is at risk of experiencing unplanned perioperative hypothermia. Furthermore, patients undergoing general anesthesia also are at risk for malignant hyperthermia.

Inadvertent hypothermia. Thermoregulation is the balance between heat loss and heat gain, which determines the body's core temperature.[13(p358)] There are many causes if hypothermia, such as the cold temperature maintained in most ORs, infusion of cold IV fluids and blood products, use of cool irrigating solutions and skin preparations, length of surgery, and the effects of general anesthesia. Perioperative nurses have the ability to control the environment, supplies, and equipment and implement procedures to keep the patient warm. For instance, preoperative nurses can institute prewarming of the patient in the preoperative area and provide socks and caps to maintain the patient's temperature. Circulating nurses can ensure that the patient remains covered as much as possible, implement use of upper- or lower-body temperature-regulating blankets, and ensure use of warmed IV and irrigation solutions. Postanesthesia care unit nurses can continue use of the temperature-regulating blankets in the PACU.

Malignant hyperthermia. Awareness of the potential for MH is particularly important if EVAR is performed in the OR under general anesthesia. Malignant hyperthermia is a

> *biochemical chain reaction response "triggered" by commonly used general anesthetics and the paralyzing agent succinylcholine within the skeletal muscles of susceptible individuals.*[14]

Malignant hyperthermia is a life-threatening condition during which the patient demonstrates a rapid heart rate, muscle rigidity, and extreme elevation in body temperature.[14] Because MH seems to have genetic links, it is very important during the preoperative assessment for the circulating nurse to identify whether the patient has a personal or family history of anesthetic problems or MH crises. AORN's "Malignant hyperthermia guideline" provides the perioperative nurse with a list of medications that commonly trigger MH as well as a checklist of the necessary actions to perform when dealing with an MH crisis.[15]

Risk for venous stasis. Venous stasis is a concern for all patients undergoing EVAR. The Surgical Care Improvement Project (SCIP) was formed to help prevent surgical complications and deaths.[16] The third focus area in this project is venous thromboembolism (VTE). "A VTE results from collection of red blood cells, fibrin, and platelets, which forms a clot, typically within the veins of the pelvis or in a lower extremity."[16(p97)] Patients undergoing EVAR can be at risk for VTE as well as its complication, pulmonary embolism, because of the surgical site and the length of time

Patient Education

Endovascular Repair of an Abdominal Aortic Aneurysm[1]

Overview
An aneurysm is an area of weakness or dilation that forms in the wall of a blood vessel. The vessel often contains fatty deposits or plaque. Over time, the weakened area can enlarge, causing the vessel wall to become thin. This can cause the aneurysm to rupture, which is a life-threatening situation. The abdominal aorta is a very large artery in your abdomen.

Signs and symptoms
You may not feel any symptoms with an abdominal aortic aneurysm (AAA). You may feel a pulsating mass in your abdomen, or you may have back pain.

Risk factors
Heredity may play a part in the development of an AAA, but lifestyle factors, such as smoking, high cholesterol, and high blood pressure also may contribute to AAA formation.

Diagnostic tests
Usually, an AAA is discovered when a health care provider performs a physical examination in conjunction with imaging studies, such as an x-ray or computed tomography (CT) scan. These tests help your surgeon decide when it is time for surgery.

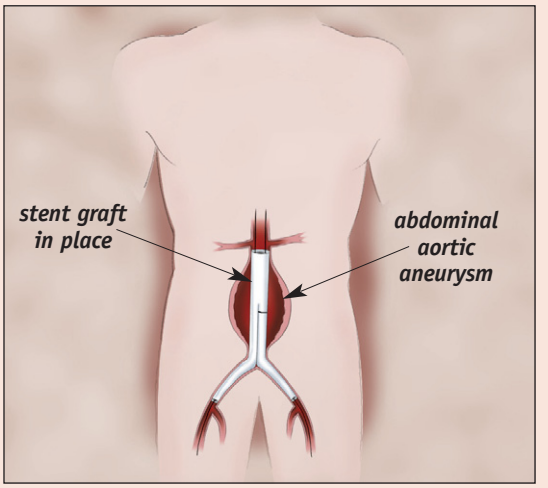
Treatment options
If you are having symptoms, if your aneurysm is larger than 5 cm to 6 cm (2 inches to 2.4 inches), or if the aneurysm is growing more than 1 cm (0.4 inches) per year, surgery may be your best option. This can be performed by a conventional open procedure with a large abdominal incision or by a minimally invasive procedure called endovascular aneurysm repair (EVAR).

The EVAR procedure
You will probably have general (asleep) or regional (numb below your nipples) anesthesia for surgery. The EVAR procedure can be performed through one or two groin (upper thigh area) incisions or with a needle insertion in one or both groins. For the groin incision, the surgeon makes an incision in one or both groins. Using a type of x-ray, the surgeon watches as he or she puts a catheter (a very thin tube) into the arteries in the groin and pushes the catheter up the artery to the aneurysm in your abdomen. With the needle insertion, the surgeon inserts a large needle in one or both groins and uses a tool to widen the opening in the artery. When the surgeon has the catheter in the correct position, he or she releases the stent graft and it expands to a set size. The surgeon then removes the catheter. The surgery may take two to four hours to complete.

Postoperative care
- You may have to lie flat for four to six hours after surgery to let the wounds heal in your groin arteries and to ensure that the arteries remain closed.
- After the initial recovery phase, you may spend a day or more in the hospital but should be discharged to home within a few days.
- While you are recovering from surgery, you may
  - feel tired or uncomfortable;
  - have throbbing or pain in your leg or swelling in your upper thigh;
  - not have a bowel movement for several days; or
  - lose your appetite or have nausea or vomiting.

Call your physician immediately if you experience any of the following postoperative complications:
- swelling or excessive bleeding from the surgical site;
- coldness or numbness in your legs;
- sudden weakness or dizziness; or
- back, chest, abdominal, or groin pain.

1. Aortic aneurysms. Society of Thoracic Surgeons; American College of Surgeons. http://www.sts.org/sections/patientinformation/aneurysmsurgery/aorticaneurysms/index.html. Accessed December 12, 2008.



the patient must remain immobile postoperatively. Perioperative nurses, therefore, must institute any preventive methods ordered (eg, pneumonic compression stockings) preoperatively, intraoperatively, and postoperatively. AORN's "Guideline for prevention of venous stasis" provides perioperative nurses with samples of high-risk surgeries, medical issues for which he or she should assess the patient, a table showing the different classes of risk, and a description of which prophylactic treatments are best suited for patients at risk for venous stasis.[17]

Conclusion

Endovascular aneurysm repair is an effective treatment option for a patient with an AAA. The procedure can be performed in a variety of settings with similar overall surgical outcomes. Regardless of where the procedure is performed, patients undergoing EVAR usually do not experience large amounts of blood loss or serious complications. Most patients are discharged to home one to two days postoperatively. Vascular surgeons, interventional radiologists, cardiologists, and staff members can effectively and efficiently participate in EVAR procedures with the proper training in their respective settings. A multidisciplinary team approach is the best for the patient.[5] A mix of team members from each area performing the tasks for which they are best educated in a dedicated endovascular suite appears to provide the best results. – AORN –

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Examination 3.4 e

The Endovascular Approach to Abdominal Aortic Aneurysm Repair

Purpose/Goal

To educate perioperative nurses about participating in endovascular aneurysm repair (EVAR) of abdominal aortic aneurysms (AAA) in a variety of surgical settings.

Behavioral Objectives

After reading and studying the article on EVAR for AAA repair, nurses will be able to

1. discuss preoperative preparation of a patient undergoing an EVAR procedure,
2. describe the EVAR procedure for AAA repair,
3. discuss EVAR procedures performed in various perioperative settings, and
4. identify AORN recommended practices applicable to EVAR.

Questions

1. The use of large doses of IV contrast dyes might be contraindicated in patients undergoing EVAR of AAAs if the patient has preexisting
   a. renal insufficiency.
   b. pulmonary disease.
   c. abnormal thyroid activity.
   d. peripheral vascular disease.

2. In all settings where EVAR is performed, the perioperative nurse ensures the availability of
   1. a device for delivering IV contrast dye under high pressure.
   2. a radiolucent OR bed and fluoroscopic imaging equipment.
   3. intraoperative medications.
   4. intravascular ultrasound.
   5. necessary angiographic supplies and the chosen stent grafts to be implanted.
   6. supplies for conversion to an open procedure.

   a. 1, 3, and 5
   b. 2, 4, and 6
   c. 2, 3, 4, 5, and 6
   d. 1, 2, 3, 4, 5, and 6

3. The Seldinger technique is preferred to traditional surgical access, which can result in
   1. damage to the femoral nerves.
   2. hemorrhage.
   3. lymphocele formation.
   4. pain.

   a. 1 and 3
   b. 2 and 4
   c. 1, 2, and 3
   d. 1, 2, 3, and 4

4. To allow the surgeon to choose which graft combination best suits the needs of the patient, the stent graft devices for an EVAR come in several pieces:
   1. a bifurcated main body.
   2. a popliteal limb.
   3. an extension.
   4. an iliac limb.
   5. cuffs.

   a. 2 and 3
   b. 1, 4, and 5
   c. 1, 3, 4, and 5
   d. 1, 2, 3, 4, and 5

5. To measure the internal diameters and anatomic angles of the vessels, the surgeon may employ
   a. echocardiography.
   b. intravascular ultrasound.
   c. fluoroscopy.

d. intraoperative magnetic resonance imaging.

6. Types of endoleaks include
1. attachment site leaks.
2. branch leaks.
3. defects in the stent graft.

a. 1 and 2
b. 1 and 3
c. 2 and 3
d. 1, 2, and 3

7. An interventional radiology suite or cardiac catheterization suite may not have the same built-in controls as an OR, so maintaining the same type of aseptic environment offered in the OR may be more difficult.
a. true
b. false

8. Closure of the percutaneous entry sites is dependent on the use of
1. clip-closure devices.
2. fibrin plugs.
3. a self-sealing process.
4. suture-mediated devices.

a. 1 and 3
b. 2 and 4
c. 1, 2, and 4
d. 1, 2, 3, and 4

9. The advantage of closure devices is that they no longer require the patient to remain in bed for four to six hours with his or her legs in a straight position for hemostasis to occur.
a. true
b. false

10. An open vascular setup should be prepared and all surgical counts performed before beginning the EVAR procedure, in anticipation of the need for an emergency conversion even if the setup cannot be continuously monitored.
a. true
b. false

The behavioral objectives and examination for this program were prepared by Rebecca Holm, RN, MSN, CNOR, clinical editor, with consultation from Susan Bakewell, RN, MS, BC, director, Center for Perioperative Education. Ms Holm and Ms Bakewell have no declared affiliations that could be perceived as potential conflicts of interest in publishing this article.

Answer Sheet

3.4 CE

The Endovascular Approach to Abdominal Aortic Aneurysm Repair

Event #09096
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4	A B C D E		9	A B C D E	
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The Endovascular Approach to Abdominal Aortic Aneurysm Repair

THIS EVALUATION is used to determine the extent to which this continuing education program met your learning needs. Rate these items on a scale of 1 to 5.

PURPOSE/GOAL

To educate perioperative nurses about participating in endovascular aneurysm repair (EVAR) of abdominal aortic aneurysms (AAA) in a variety of surgical settings.

OBJECTIVES

To what extent were the following objectives of this continuing education program achieved?

1. Discuss preoperative preparation of a patient undergoing an EVAR procedure.
2. Describe the EVAR procedure for AAA repair.
3. Discuss EVAR procedures performed in various perioperative settings.
4. Identify AORN recommended practices applicable to EVAR.

CONTENT

To what extent

5. did this article increase your knowledge of the subject matter?
6. was the content clear and organized?
7. did this article facilitate learning?
8. were your individual objectives met?
9. did the objectives relate to the overall purpose/goal?

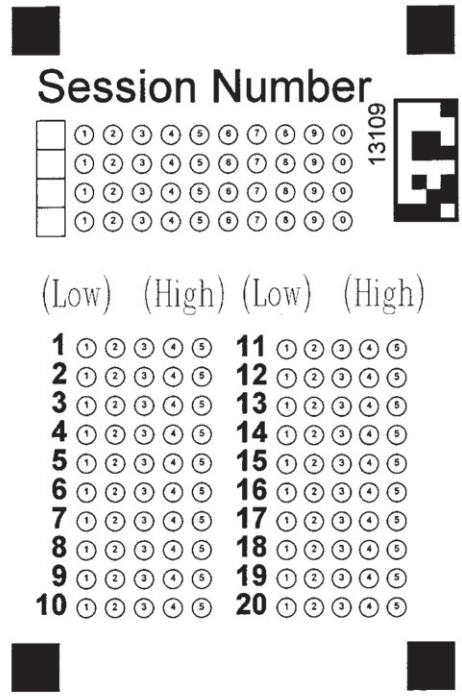
TEST QUESTIONS/ANSWERS

To what extent

10. were they reflective of the content?
11. were they easy to understand?
12. did they address important points?

LEARNER INPUT

13. Will you be able to use the information from this article in your work setting?
    a. yes
    b. no
14. I learned of this article via
    a. the *AORN Journal* I receive as an AORN member.
    b. an *AORN Journal* I obtained elsewhere.
    c. the *AORN Journal* web site.
15. What factor most affects whether you take an *AORN Journal* continuing education examination?
    a. need for continuing education contact hours
    b. price
    c. subject matter relevant to current position
    d. number of continuing education contact hours offered



What other topics would you like to see addressed in a future continuing education article? Would you be interested or do you know someone who would be interested in writing an article on this topic?

Topic(s): _____

_____

Author names and addresses: _____

_____

_____