CE

2.0
ANCC
CONTACT HOURS

Abdominal wall reconstruction

Enhancing outcomes for patients

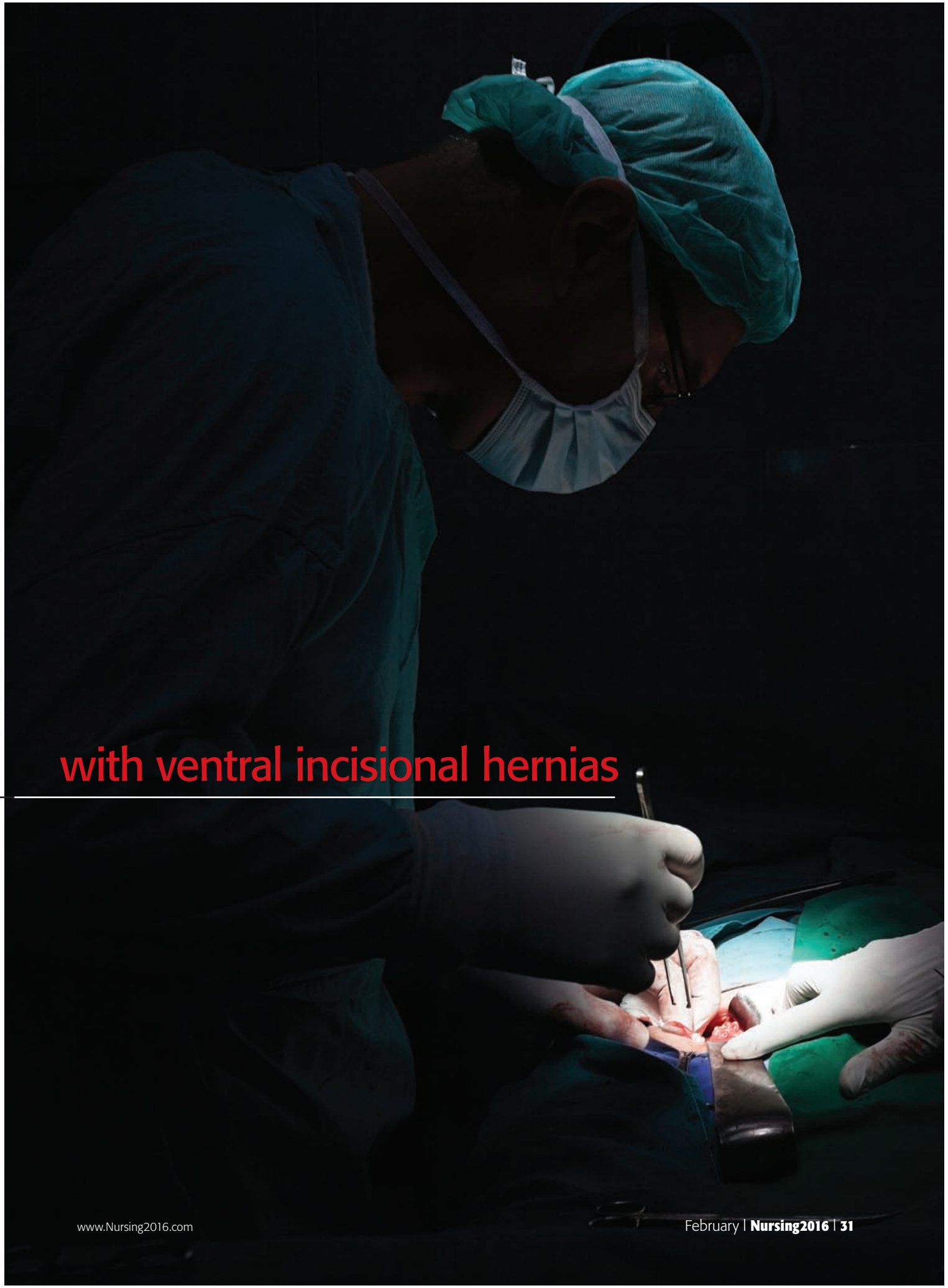
By Maurice Y. Nahabedian, MD, FACS, and Anissa G. Nahabedian, BSN, RN

IMPROVING SURGICAL outcomes to reduce unplanned surgeries, untoward events, and hospital costs and to improve patient satisfaction is a priority in healthcare. One of the most challenging situations associated with an increased rate of hospital readmission and hernia recurrence is the surgical management of patients with a ventral incisional hernia (VIH) following laparotomy. (See *Sorting out hernias.*) Over 350,000 ventral hernia repairs are performed in the United States each year.[1]

Many patients with VIHs have underlying comorbidities, such as cardiopulmonary disease, obesity, diabetes mellitus (DM), and tobacco use. Many patients with VIHs are also considered high risk because of the increased incidence of complications such as surgical site occurrence (SSO), which includes surgical site infection (SSI), seroma, wound dehiscence, and enterocutaneous fistulae at the site of the hernia repair. These patients are also at increased risk for hernia recurrence and hospital readmission.[1,2]

Most studies that have evaluated long-term outcomes in patients following VIH repair have reported hernia recurrence rates of up to 40% at 2 years and adverse events in over

PhotoGraphyKM/iStock



with ventral incisional hernias

50% of patients.[3,4] As a result, various strategies for preoperative optimization, intraoperative technical innovations, and postoperative care have been developed to enhance surgical outcomes following abdominal wall reconstruction (AWR). This article reviews some of these strategies.

Preoperative considerations

The preoperative evaluation of the patient with an abdominal wall hernia, including VIH, is important. Many factors can affect postoperative outcomes. For example, tobacco use, DM, obesity, pulmonary disorders, and poor nutritional status can impede wound healing, predispose the patient to infection, and lead to hernia recurrence. A classification system that addresses these comorbidities and stratifies the risk of an adverse event following surgery can help to improve outcomes. (See *VIH repair: Determining SSO risk.*)[5,6]

Tobacco cessation. The untoward effects of tobacco use in surgical patients are well known.[7,8] Nicotine is a powerful vasoconstrictor and carbon monoxide in tobacco binds to hemoglobin with much greater affinity than oxygen, impairing oxygen transport and utilization and creating a hypoxic environment.[9-11]

Both vasoconstriction and hypoxia contribute to poor wound healing. Wound-related complications are more likely to occur and compromise the surgical outcome. Patients must be well informed of these risks and the need for smoking cessation before surgery.

The nurse's role is to educate patients about the risks associated with tobacco use. Patients should be free from tobacco products for 1 month before surgery and for 2 weeks following surgery.[7] Various strategies have been proposed to assist with smoking cessation, including nicotine-containing chewing gum, smokeless tobacco, nicotine patches, nicotine lozenges, and nicotine sprays. Behavioral counseling has also been shown to be effective.[12,13]

Dimick demonstrated that overall costs associated with pulmonary complications can increase by $52,000 per surgery in patients who smoke.[8] Coon found that patients using tobacco products had significantly higher overall complication and tissue necrosis rates and were more likely to require reoperation.[14]

Glycemic control. Poorly controlled DM is associated with poor wound healing.[15] Hyperglycemic states can interfere with normal wound healing and contribute to increased infection rates, especially in patients undergoing AWR.[15] Patients with DM being considered for AWR should have a thorough lab assessment, including a fasting blood glucose and A1C.

Endara and colleagues conducted a study on 79 patients undergoing primary wound closures (mostly lower extremity) and found that the risk of dehiscence increased as the patient's maximum preoperative blood glucose level increased.[15] Patients who had a preoperative blood

VIH repair: Determining SSO risk[4]

The patient's comorbidities and wound classification are used to help determine the patient's risk for SSO after VIH repair.

Grade 1, Low risk (SSO = 14%)
- Low risk of complications
- No history of wound infection

Grade 2, Comorbid conditions (SSO = 27%)
- Smoker
- Obese
- Chronic obstructive pulmonary disease
- Diabetes mellitus
- Prior wound infection

Grade 3, Contaminated wounds (SSO = 46%)
- Clean contaminated wound
- Contaminated wound
- Dirty wound

Sorting out hernias

- **A hernia** is a protrusion, bulge, or projection of an organ or part of an organ through the body wall that normally contains it, such as the abdominal wall.

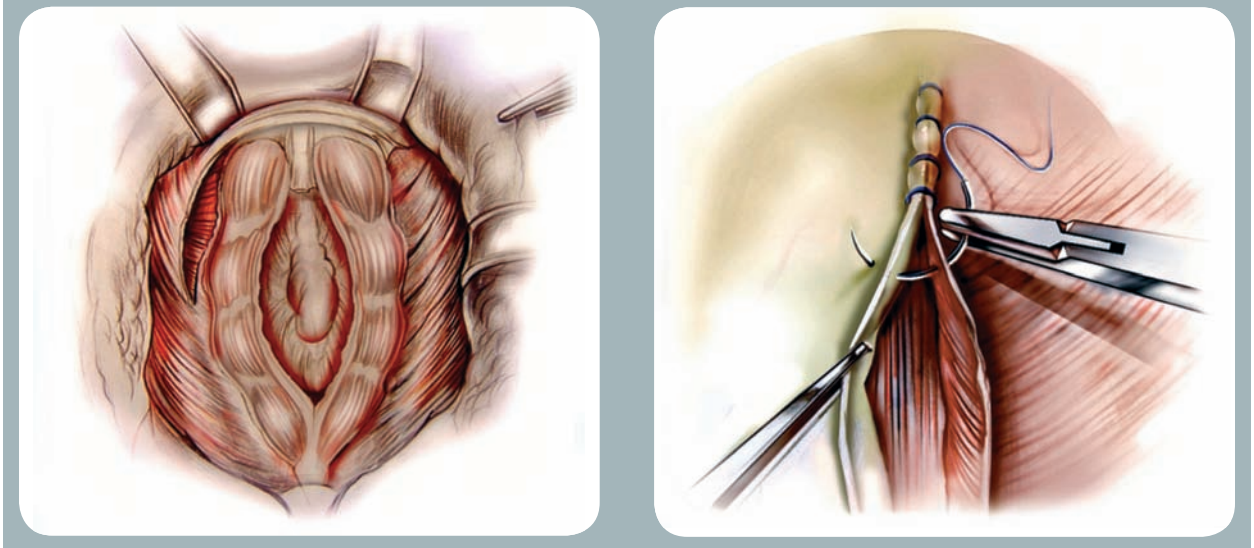
Abdominal wall hernias are broadly classified according to the region of the abdominal wall in which they occur:

- **Ventral hernias** occur anteriorly and include epigastric, umbilical, spigelian, parastomal, and most incisional hernias.
- **Groin hernias** include inguinal and femoral hernias.
- **Pelvic hernias** can protrude through the pelvic foramina, as with sciatic and obturator hernias, or through the pelvic floor as perineal hernias.
- **Flank hernias** protrude through weakened areas of back musculature and include the superior and inferior lumbar triangle hernias.

Abdominal wall hernias can also be classified by etiology:

- **Congenital hernias** involve defects in the abdominal wall that have been present from birth.
- **Acquired hernias** develop as the result of a weakening or disruption of the fibromuscular tissues of the abdominal wall due to connective tissue abnormalities, abdominal wall trauma, or possibly drug effects.

Open and shut: Hernia defect and fascial closure



Left. A ventral incisional hernia is illustrated with a large central fascia defect between the paired rectus abdominis muscles. *Right.* In fascial closure, the anterior and posterior rectus sheath is sutured to provide additional support to the repair and to minimize recurrence.

Artwork by Bill Haney provided courtesy of LifeCell

glucose level of less than 200 mg/dL had a 19.3% dehiscence rate after surgery compared with a 43.5% dehiscence rate in patients who had a preoperative blood glucose level greater than 200 mg/dL.[15]

In the same study of patients with DM and extremity wounds, Endara and colleagues found that elevated A1C levels were associated with compromised wound healing. A1C levels in excess of 6.5 demonstrate a statistically significant association with increased rates of incisional dehiscence (55.6% versus 26.1%). An A1C level of 6.5 was also associated with a trend toward increased rates of reoperation (33% versus 17.4%).[15]

Other comorbidities. Patients with a body mass index (BMI) greater than 30 are at higher risk for adverse events such as delayed wound healing, seroma, infection, and incisional dehiscence.[16] Weight loss is recommended before elective surgery. Patients with a BMI between 30 and 39 are carefully selected, and decisions about surgery are based on the number of comorbidities and a risk evaluation. Many patients with a BMI greater than 40 have demonstrated higher rates of reoperation and recurrence, leading to poor surgical outcomes.[17]

Although obese and morbidly obese patients may appear adequately nourished, many are actually malnourished based on serum albumin levels.[18] Certain nutritional supplements, such as arginine and fish oil, have been shown to reduce infections and length of hospital stay.[19]

Pulmonary disorders can be life-threatening in patients undergoing AWR. Placing the abdominal viscera back into the peritoneal cavity increases intra-abdominal pressure and elevates the diaphragm, causing extrinsic compression of the lungs. This increases the risk of complications such as atelectasis and decreased oxygen diffusion, ultimately leading to tissue hypoxia and poor wound healing.

Operative strategies

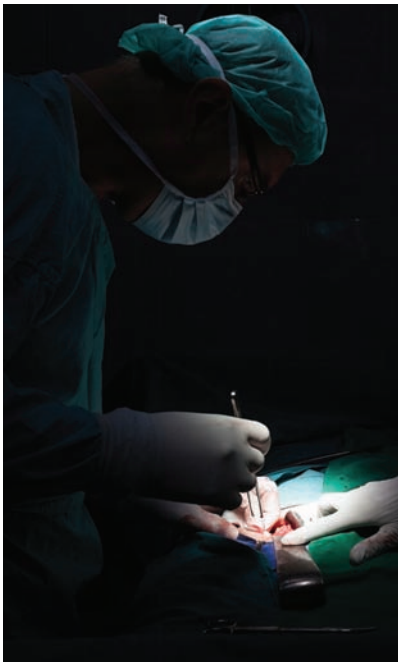
Optimizing surgical outcomes for patients undergoing VIH repair and AWR depends on patient selection, surgical technique, and surgeon judgment. Because of the patient's increased susceptibility to SSO, the perioperative team must ensure the highest level of care.

The size of fascial defects in abdominal wall hernia varies, ranging from as small as 1 cm to as large as 50 cm. One of the primary surgical tenets for AWR success is to achieve fascial closure. (See *Open and shut: Hernia defect and fascial closure.*) Primary fascial closure reduces the incidence of recurrence and SSO.[20] Reinforcement of the repair with a surgical mesh is superior to suture repair alone.[21] The mesh provides fascial support, counteracts the forces creating the hernia, and helps to reduce hernia recurrence.

What constitutes the optimal mesh material has created significant controversy over the past decade. The ideal mesh should promote

tissue incorporation, minimize the incidence of SSO and SSI, be long-lasting and painless, and reduce the rate of hernia recurrence. Surgical mesh products for AWR include synthetic, biologic, and resorbable materials.[22]

- Synthetic materials composed of polypropylene or polytetrafluoroethylene are typically used for fascial reinforcement. These permanent and relatively inexpensive materials are usually considered for patients at low risk of adverse events.[5]
- Biologic materials may be composed of human, porcine, or bovine tissues that are usually of dermal origin and permanent. They're often considered for patients at higher risk of adverse events. The rationale for biologic mesh is that it revascularizes and recellularizes into the adjacent tissues to provide long-term support. Widespread use of biologic mesh is limited because of its high cost.[5]
- The newest category of surgical mesh includes the resorbable materials. These may be composed of polyglycolic acid, collagen, or silk protein. Resorbable mesh typically provides support for variable periods of time ranging from 1 to 12 months before it transitions to scar tissue.[23]



Many patients with hernias have comorbidities such as cardiopulmonary disease, obesity, DM, and tobacco use.

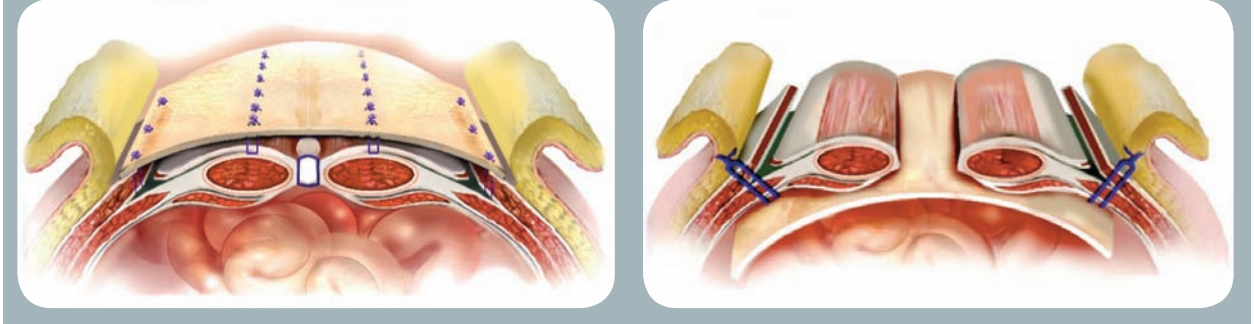
Location, location, location

One of the most important aspects of hernia repair using mesh is the location of mesh placement.[24] Techniques and locations for mesh placement include the following:

- the onlay technique, characterized by placement of the mesh directly on top of the fascia[24]
- the inlay technique (interposition), characterized by mesh placement between the fascial edges[24]
- the underlay technique, characterized by placement on the undersurface of the anterior abdominal wall or peritoneum (see *On top or underneath: Mesh placement*)[24]
- the retrorectus technique, characterized by placement of the mesh between the posterior rectus sheath and the rectus abdominis muscle[24]
- the expanded retrorectus technique (or transversus abdominis release), where the mesh is placed between the posterior rectus sheath and the rectus abdominis and the transversus abdominis muscle.[24]

The success of these options depends on the presence of patient comorbidities, size of the defect, type of repair, and surgeon experience. In a systematic review evaluating the efficacy of mesh location, it was demonstrated that onlay mesh placement was associated with fewer SSIs but had the highest rates of recurrence, seroma, and explantation.[24] Interposition mesh placement was associated with the highest

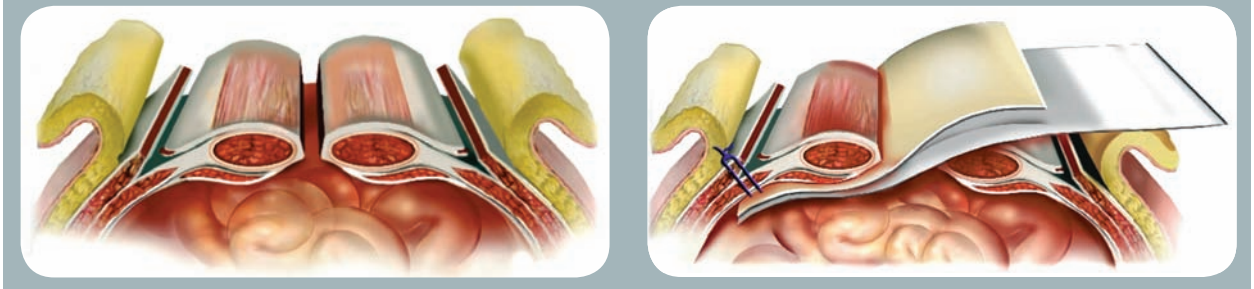
On top or underneath: Mesh placement



Left. With the onlay technique, the midline fascial defect is closed primarily to repair the hernia defect. A mesh material is then applied in an onlay fashion to reinforce the fascial closure. *Right.* In some situations, the midline fascial defect can't be closed primarily and an underlay mesh is placed to reinforce the hernia repair.

Artwork by Bill Haney provided courtesy of LifeCell

Component separation, with and without underlay



Artwork by Bill Haney provided courtesy of LifeCell

Left. In the component separation technique illustrated here, the external oblique aponeurosis is incised and undermined, permitting the central rectus abdominis muscles to be advanced toward the midline. *Right.* This illustration highlights the technique of component separation and underlay mesh placement. When underlay mesh is placed, it must be sutured to prevent migration.

complication, SSI, and recurrence rates. Underlay mesh placement had the fewest complications and a low recurrence rate. Retrorectus mesh placement was associated with the lowest infection, seroma, explantation, and recurrence rate.[24]

Other successful strategies for VIH repair and AWR include component separation, tissue expansion, and autologous tissue flaps.[25,26] These techniques are used when the width of the midline defect is beyond the limits of primary closure. Component separation is a technique for dissociating the rectus abdominis muscle from the external oblique muscle, allowing for medial excursion. This can be performed bilaterally or unilaterally to facilitate the closure of midline defects that are up to 15 cm wide. Component separation is usually performed in conjunction with underlay mesh placement.[25] (See *Component separation, with and without underlay.*)

The use of tissue expanders can be considered in situations in which component separation isn't possible or the excursion of the muscle isn't adequate. These devices are placed between the external and internal oblique muscles and gradually expanded with saline to stretch the overlying and underlying tissues. Once expanded, these devices are removed, and the expanded tissues are advanced to close the defect.[27]

The final option is to use muscle or skin flaps from adjacent or remote sites. This option is usually considered in severe cases in which the patient has had radiation therapy and the local tissue is damaged, inelastic, and fibrotic.[28]

Many patients with abdominal hernias are obese, with a moderate to large abdominal pannus.[29-31] Performing a panniculectomy either simultaneously or on a delayed basis can contribute to the short- and long-term success of the repair and improve outcomes. A large pannus, often a nidus for infection, is associated with delayed healing because of its weight as well as the tissues' poor vascularity. A panniculectomy reduces the likelihood of SSO. Panniculectomy can be performed with techniques such as a horizontal wedge excision, vertical wedge excision, or a horizontal and vertical excision known as the *fleur-de-lis technique*.[29-31]

Improving outcomes

Outcome measurement for AWR is challenging primarily because of patient selection and comorbidities, hernia dimensions, surgical technique, prior repair attempts, and length of follow-up. Smaller hernias are technically less challenging; however, recurrence rates are higher than expected based on long-term follow-up. This is multifactorial and may be related to intra-abdominal forces, patient comorbidities, and technical factors related to the repair. A prospective study by Luijendijk demonstrated a 46% recurrence rate at 3-year follow-up for hernias less than 6 cm in diameter when repaired without surgical mesh and a 23% recurrence rate for those repaired with surgical mesh.[21] Ten-year follow-up of the same cohort of patients demonstrated an increase in the recurrence rates to 32% and 63% when repaired with and without mesh, respectively.[4]

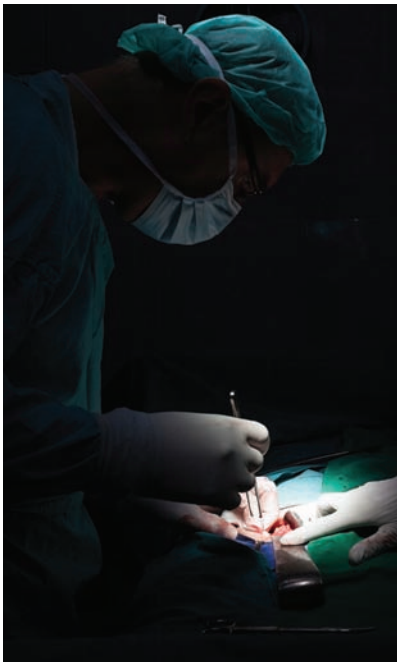
Over the past decade, surgical techniques have evolved, primarily because surgeons have been confronted with more complex and challenging hernias that require advanced techniques for AWR. Surgical outcomes have improved moderately as surgeons have become more adept at selecting surgical candidates, using appropriate surgical techniques, and incorporating specific materials to assist with closure to optimize surgical outcomes.

One of the current controversies in AWR complicated by wound contamination or infection is whether or not to use a biologic or synthetic mesh. In a recent study evaluating biologic mesh in contaminated AWR, Garvey and colleagues demonstrated

a recurrence rate of 10.1%, a less than 30-day SSI rate of 8%, a mesh explantation rate of 1%, and a reoperation rate of 11.2%, with a mean follow-up of 26 months.[32] In a similar cohort, Carbonell and colleagues, using synthetic mesh in contaminated AWR, have demonstrated a recurrence rate of 7%, a less than 30-day SSI rate of 14%, a mesh explantation rate of 4%, and a reoperation rate of 12% with a mean follow-up of 10.8 months.[33] In general, biologic mesh is thought to be advantageous for contaminated cases, but for clean cases, a synthetic mesh placed in the proper location may be preferable based on cost considerations.

After the surgery

Postoperative care and short- and long-term recovery pathways are important to the well-being of the patient following AWR. The emergence of the Enhanced Recovery After Surgery pathway has improved the postoperative course of these patients by reducing pain, facilitating recovery of the gastrointestinal tract, reducing morbidity, and shortening hospital stay.[34,35] (See *What's Enhanced Recovery After Surgery?*)



One of the simplest strategies for optimizing postoperative pain management is to administer I.V. acetaminophen.

Optimizing postoperative pain management is a primary goal. Heavy opioid use tends to slow down recovery, prolong intestinal ileus, and increase length of stay.[36] Newer strategies have been implemented to minimize these occurrences.

One of the simplest strategies is to administer I.V. acetaminophen, which provides good to excellent analgesia without restricting bowel motility. In addition, it isn't associated with other common adverse reactions to opioids, such as sedation or respiratory depression. I.V. acetaminophen has a boxed warning about the risk of hepatotoxicity; this drug is contraindicated in severe hepatic impairment or severe active liver disease.[37]

Gabapentin is an analgesic and antiepileptic drug that reduces opioid use following surgery.[34] It works by attenuating afferent sensory stimuli to diminish late postoperative pain; however, its use for this indication is off-label.[34] Diazepam has also demonstrated success in AWR by providing antispasmodic pain relief and muscle relaxation. Multimodal strategies for pain relief can also be considered.

Transversus abdominis plane (TAP) blocks can be highly effective. The TAP is located between the internal oblique and transversus abdominis muscles, which is where the primary innervation to the abdominal wall is located. TAP blocks anesthetize the intercostal, subcostal, ilioinguinal, and iliohypogastric nerves. Specific agents include bupivacaine as well as liposomal bupivacaine. TAP blocks can reduce postoperative pain, opioid use, and hospital length of stay.[38]

The importance of resuming gastrointestinal motility after abdominal surgery can't be overemphasized. Alvimopan is an opioid antagonist that has specific action on the receptors located in the gastrointestinal tract

What's Enhanced Recovery After Surgery?

Enhanced Recovery After Surgery, or ERAS, is a multimodal perioperative care pathway designed to achieve early recovery for patients undergoing major surgery. Use of the ERAS pathway has been shown to reduce care time by more than 30% and reduce postoperative complications by up to 50%.

ERAS represents a paradigm shift in perioperative care in two ways. First, it reexamines traditional practices, replacing them with evidence-based best practices when necessary. Second, it's comprehensive in its scope, covering all areas of the patient's journey through the surgical process.

The key factors that keep patients in the hospital after surgery include the need for parenteral analgesia, the need for I.V. fluids secondary to gut dysfunction, and bed rest caused by lack of mobility. The central elements of the ERAS pathway address these key factors, helping to clarify how they interact to affect patient recovery. In addition, the ERAS pathway provides guidance to all involved in perioperative care, helping them to work as a well-coordinated team to provide the best care. The ERAS Society is a global network of experts that examines the literature for best care and provides evidence-based guidelines for such pathways.

Reprinted with permission of the ERAS Society. www.erassociety.org/.

but not on the centrally acting opioid receptors responsible for pain management. It can reduce the duration of the postoperative ileus and reduce the incidence of postoperative nausea and vomiting.[39] Alvimopan has a boxed warning about the increased incidence of myocardial infarction in patients taking the drug for long-term use; consequently, the drug is available only through a restricted program for short-term use.[26] Alvimopan is contraindicated in patients who've taken therapeutic doses of opioids for more than 7 consecutive days immediately before starting alvimopan.[39]

Other important postoperative interventions include early enteral feeding, judicious administration of I.V. fluids, early and aggressive ambulation, and nutritional supplementation. Postoperatively, the nurse needs to monitor the patient for potential postoperative complications, such as bleeding, incisional dehiscence, and SSI.

Some patients may have incisional vacuum-assisted closure devices placed to minimize edema. An abdominal binder or compression garment may be used to assist in reducing edema and the amount of internal pressure placed on the incisional repair.[40]

Many patients have postoperative drains to reduce the incidence of seroma. The drains are usually placed in the subcutaneous layers or along the surgical mesh and are usually removed after 1 week of continuous suction.

Nurses need to ensure that the drains are functional and the dressings are clean and dry, and that the patient has adequate pain relief. The nurse should encourage early, aggressive ambulation to promote the return of bowel function and decrease complications of immobility including venous thromboembolism.

However, the nurse's most important role is to educate the patient about important health aspects, such as proper nutrition and exercise. This is especially true in patients undergoing AWR because they're often malnourished and/or obese and have other comorbidities.

Moving forward

Over the past decade, significant advancements in AWR have been made. Perioperative considerations have evolved so that surgeons and nurses can provide optimal preoperative and postoperative care to enhance patient outcomes. Newer materials and improved techniques have enabled surgeons to repair many of these complex ventral hernias with greater success. Refinements of biologic and synthetic materials provide greater reinforcement for success in clean and contaminated settings. Moving forward, greater collaborative efforts between surgeons and nurses (as well as among institutions) should help identify trends and track outcomes with greater accuracy, with the ultimate goal of making AWR a more successful and predictable procedure. ■

REFERENCES

1. Brahmbhatt R, Carter SA, Hicks SC, Berger DH, Liang MK. Identifying risk factors for surgical site complications after laparoscopic ventral hernia repair: evaluation of the Ventral Hernia Working Group grading system. *Surg Infect (Larchmt).* 2014;15(3):187-193.

2. Holihan JL, Alawadi Z, Martindale RG, et al. Adverse events after ventral hernia repair: the vicious cycle of complications. *J Am Coll Surg.* 2015;221(2):478-485.

3. Itani KM, Rosen M, Vargo D, et al. Prospective study of single-stage repair of contaminated hernias using a biologic porcine tissue matrix: the RICH Study. *Surgery.* 2012;152(3):498-505.

4. Burger JW, Luijendijk RW, Hop WC, Halm JA, Verdaasdonk EG, Jeekel J. Long-term follow-up of a randomized controlled trial of suture versus mesh repair of incisional hernia. *Ann Surg.* 2004;240(4):578-585.

5. Breuing K, Butler CE, Ferzoco S, et al. Incisional ventral hernias: review of the literature and recommendations regarding the grading and technique of repair. *Surgery.* 2010;148(3):544-558.

6. Kanters AE, Krpata DM, Blatnik JA, Novitsky YM, Rosen MJ. Modified hernia grading scale to stratify surgical site occurrence after open ventral hernia repairs. *J Am Coll Surg.* 2012;215(6):787-793.

7. Khullar D, Maa J. The impact of smoking on surgical outcomes. *J Am Coll Surg.* 2012;215(3):418-426.

8. Dimick JB, Chen SL, Taheri PA, Henderson WG, Khuri SF, Campbell DA Jr. Hospital costs associated with surgical complications: a report from the private-sector National Surgical Quality Improvement Program. *J Am Coll Surg.* 2004;199(4):531-537.

9. Giardina E-G. Cardiovascular effects of nicotine. UpToDate. 2015. www.uptodate.com.

10. Clardy PF, Manaker S, Perry H. Carbon monoxide poisoning. UpToDate. 2015. www.uptodate.com.

11. Sørensen LT. Wound healing and infection in surgery: the pathophysiological impact of smoking, smoking cessation, and nicotine replacement therapy: a systematic review. *Ann Surg.* 2012;255(6):1069-1079.

12. Rigotti NA. Overview of smoking cessation management in adults. UpToDate. 2015. www.uptodate.com.

13. Thurgood SL, McNeill A, Clark-Carter D, Brose LS. A systematic review of smoking cessation interventions for adults in substance abuse treatment or recovery. *Nicotine Tob Res.* [e-pub Jun. 11, 2015]

14. Coon D, Tuffaha S, Christensen J, Bonawitz SC. Plastic surgery and smoking: a prospective analysis of incidence, compliance, and complications. *Plast Reconstr Surg.* 2013;131(2):385-391.

15. Endara M, Masden D, Goldstein J, Gondek S, Steinberg J, Attinger C. The role of chronic and perioperative glucose management in high-risk surgical closures: a case for tighter glycemic control. *Plast Reconstr Surg.* 2013;132(4):996-1004.

16. Martindale RG, Deveney CW. Preoperative risk reduction: strategies to optimize outcomes. *Surg Clin North Am.* 2013;93(5):1041-1055.

17. Regner JL, Mrdutt MM, Munoz-Maldonado Y. Tailoring surgical approach for elective ventral hernia repair based on obesity and National Surgical Quality Improvement Program outcomes. *Am J Surg.* [e-pub Sep. 14, 2015]

18. Martindale RG, McClave SA, Taylor B, Lawson CM. Perioperative nutrition: what is the current landscape? *JPEN J Parenter Enteral Nutr.* 2013;37(5 suppl):5S-20S.

19. Drover JW, Dhaliwal R, Weitzel L, Wischmeyer PE, Ochoa JB, Heyland DK. Perioperative use of arginine-supplemented diets: a systematic review of the evidence. *J Am Coll Surg.* 2011;212(3):385-399.

20. Richmond B, Ubert A, Judhan R, et al. Component separation with porcine acellular dermal reinforcement is superior to traditional bridged mesh repairs in the open repair of significant midline ventral hernia defects. *Am Surg.* 2014;80(8):725-731.

21. Luijendijk RW, Hop WC, van den Tol MP, et al. A comparison of suture repair with mesh repair for incisional hernia. *N Engl J Med.* 2000;343(6):392-398.

22. Ibrahim AM, Vargas CR, Colakoglu S, Nguyen JT, Lin SJ, Lee BT. Properties of meshes used in hernia repair: a comprehensive review of synthetic and biologic meshes. *J Reconstr Microsurg.* 2015;31(2):83-94.

23. Kim M, Oommen B, Ross SW, et al. The current status of biosynthetic mesh for ventral hernia repair. *Surg Technol Int.* 2014;25:114-121.

24. Albino FP, Patel KM, Nahabedian MY, Sosin M, Attinger CE, Bhanot P. Does mesh location matter in abdominal wall reconstruction? A systematic review of the literature and a summary of recommendations. *Plast Reconstr Surg.* 2013;132(5):1295-1304.

25. Ko JH, Wang EC, Salvay DM, Paul BC, Dumanian GA. Abdominal wall reconstruction: lessons learned from 200 "components separation" procedures. *Arch Surg.* 2009;144(11):1047-1055.

26. Wong CH, Lin CH, Fu B, Fang JF. Reconstruction of complex abdominal wall defects with free flaps: indications and clinical outcome. *Plast Reconstr Surg.* 2009;124(2):500-509.

27. Carlson GW, Elwood E, Losken A, Galloway JR. The role of tissue expansion in abdominal wall reconstruction. *Ann Plast Surg.* 2000;44(2):147-153.

28. Mathes SJ, Steinwald PM, Foster RD, Hoffman WY, Anthony JP. Complex abdominal wall reconstruction: a comparison of flap and mesh closure. *Ann Surg.* 2000;232(4):586-596.

29. Harth KC, Blatnik JA, Rosen MJ. Optimum repair for massive ventral hernias in the morbidly obese patient—is panniculectomy helpful? *Am J Surg.* 2011;201(3):396-400.

30. Cooper JM, Paige KT, Beshlian KM, Downey DL, Thirlby RC. Abdominal panniculectomies: high patient satisfaction despite significant complication rates. *Ann Plast Surg.* 2008;61(2):188-196.

31. Butler CE, Reis SM. Mercedes panniculectomy with simultaneous component separation ventral hernia repair. *Plast Reconstr Surg.* 2010;125(3):94e-98e.

32. Garvey PB, Martinez RA, Baumann DP, Liu J, Butler CE. Outcomes of abdominal wall reconstruction with acellular dermal matrix are not affected by wound contamination. *J Am Coll Surg.* 2014;219(5):853-864.

33. Carbonell AM, Criss CN, Cobb WS, Novitsky YW, Rosen MJ. Outcomes of synthetic mesh in contaminated ventral hernia repairs. *J Am Coll Surg.* 2013;217(6):991-998.

34. Fayezizadeh M, Petro CC, Rosen MJ, Novitsky YW. Enhanced recovery after surgery pathway for abdominal wall reconstruction: pilot study and preliminary outcomes. *Plast Reconstr Surg.* 2014;134(4 suppl 2):151S-159S.

35. Segelman J, Nygren J. Evidence or eminence in abdominal surgery: recent improvements in perioperative care. *World J Gastroenterol.* 2014;20(44):16615-16619.

36. Ketwaroo GA, Cheng V, Lembo A. Opioid-induced bowel dysfunction. *Curr Gastroenterol Rep.* 2013;15(9):344.

37. Mallinckrodt Hospital Products Inc. Ofirmev (acetaminophen) injection prescribing information. 2014. http://ofirmev.com/Prescribing-Information.aspx.

38. Baeriswyl M, Kirkham KR, Kern C, Albrecht E. The analgesic efficacy of ultrasound-guided transversus abdominis plane block in adult patients: a meta-analysis. *Anesth Analg.* 2015;121(6):1640-1654.

39. Cubist Pharmaceuticals, Inc. Alvimopan (Entereg) capsules, for oral use, prescribing information. 2013. www.accessdata.fda.gov/drugsatfda_docs/label/2013/021775s010lbl.pdf.

40. Rothman JP, Gunnarsson U, Bisgaard T. Abdominal binders may reduce pain and improve physical function after major abdominal surgery—a systematic review. *Dan Med J.* 2014;61(11):A4941.

In Washington, D.C., Maurice Y. Nahabedian is a professor of plastic surgery at Georgetown University and Anissa G. Nahabedian is a registered nurse at Sibley Hospital.

Dr. Nahabedian is a speaker and consultant for LifeCell Corporation in Bridgewater, N.J. The illustrations are courtesy of LifeCell. The planners and authors have disclosed no other potential conflicts of interest, financial or otherwise.

This article has been updated and adapted from "Abdominal Wall Reconstruction: Strategies to Enhance Outcomes," which was originally published in *OR Nurse* in November 2015.

DOI-10.1097/01.NURSE.0000476227.49890.ec