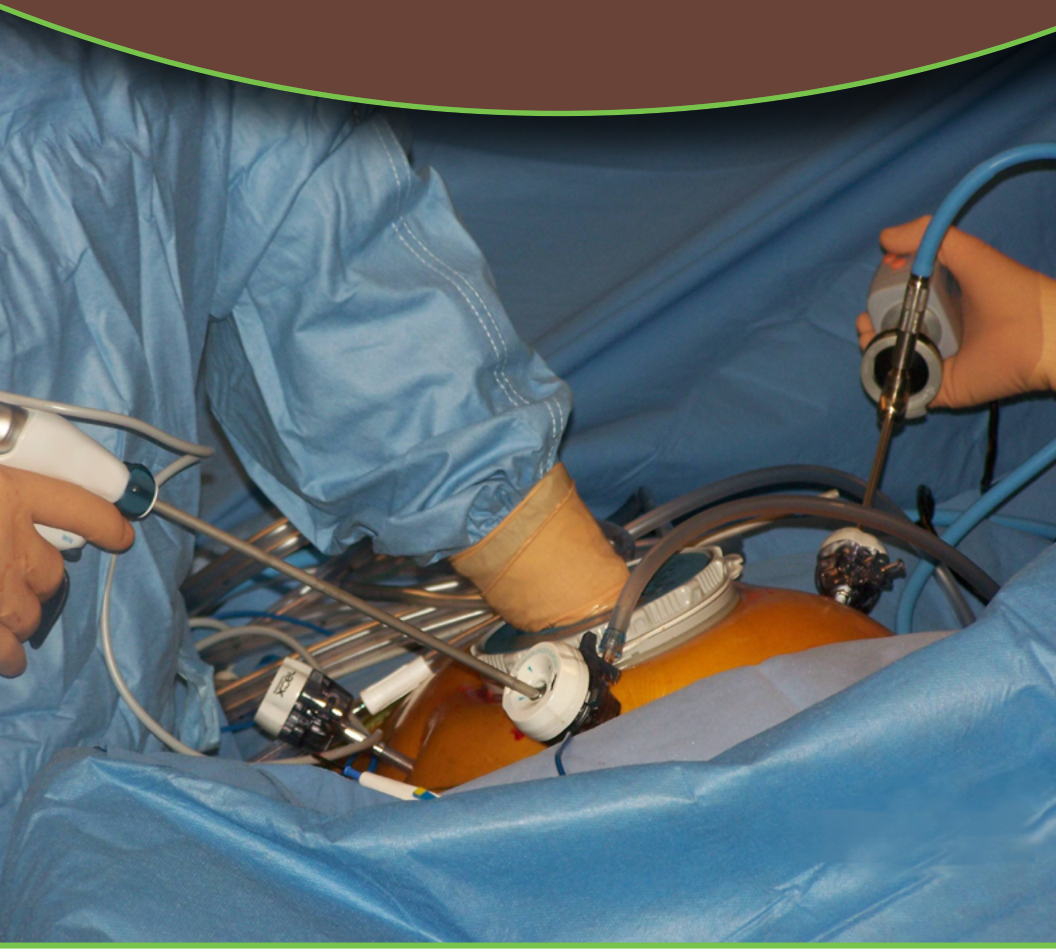
MIS: A Team Approach

(An Online Continuing Education Activity)



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MIS: A TEAM APPROACH

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CONTACT INFORMATION:

Pfiedler Enterprises

2101 S. Blackhawk Street, Suite 220
Aurora, CO 80014-1475
Phone: 720-748-6144
Fax: 720-748-6196
Website: www.pfiedlerenterprises.com

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OVERVIEW

Since their inception, minimally invasive surgical (MIS) techniques continue to evolve, offering exciting new treatment options for many patients. It is important that nurses remain aware of the current techniques in order to maximize patient benefits and promote optimal patient outcomes. This self-study activity provides a historical overview and outlines the economic secrets to success of MIS. Patient benefits and nursing considerations are outlined. Successful surgical intervention is reliant on an interdisciplinary team that possesses the technical as well as interpersonal skills that enhances the overall outcome. The value of the team is described including the TeamSTEPPS resource competencies.

OBJECTIVES

Upon completion of this continuing nursing education activity, the participant should be able to:

1. Describe the evolution of MIS.
2. Describe the economic benefits derived from the current trend towards MIS.
3. Discuss the patient benefits associated with minimally invasive surgical techniques.
4. Identify the perioperative nursing considerations for the patient experiencing MIS.
5. Explain the benefits of instituting a team approach to MIS.

INTENDED AUDIENCE

This continuing education activity is intended for nurses who are members of the team involved in performing minimally invasive surgical procedures.

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AUTHORS/PLANNING COMMITTEE/REVIEWERS

Julia A. Kneedler, RN, MS, EdD **Aurora, CO**
Director of Education
Pfiedler Enterprises

Judith I. Pfister, RN, BSN, MBA **Aurora, CO**
Program Manager
Pfiedler Enterprises

Rose Moss, RN, MN, CNOR **Elizabeth, CO**
Nurse Consultant

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Activity Planning Committee/Authors/Reviewers:

Julia A. Kneedler, RN, MS, EdD
Co-owner of company that receives grant funds from commercial entities

Judith I. Pfister, RN, BSN, MBA
Co-owner of company that receives grant funds from commercial entities

Rose Moss, RN, MN, CNOR
No conflicts of interest

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Phone: 720-748-6144

Email: tonia@pfiedlerenterprises.com

Postal Address: 2101 S. Blackhawk Street, Suite 220
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THE EVOLUTION PROCESS OF MIS[1,2,3]

Historical Evolution

Despite physicians' desire to visualize the interior of the body organs, the development of endoscopy and minimally invasive surgery was relatively slow. Early scopes were used as specula for inspection of natural body orifices. The first recorded minimally invasive procedure was performed around 400 BC when Hippocrates described the use of a primitive speculum and resectoscope to evaluate hemorrhoids; his contemporaries were using vaginal specula. Since Hippocrates, numerous surgeons have experimented with MIS techniques. Archigenes from Syria, who practiced in Rome from 95-117 BC, developed a vaginal speculum and also wrote instructions about patient positioning for optimal use of the instrument. This idea was later embellished when Abul Kasim (AD 936-1013), an Arabian physician, used a series of mirrors to enhance illumination for inspection of the vagina and cervix.

With each generation of surgeons, surgical techniques and devices were continually advanced and refined. Technology was limited and surgeons typically practiced new techniques on animals while developing new equipment, particularly light sources used to illuminate dark body cavities. In the early 1800s, endoscopic surgery began to take on new meaning when Philip Bozzini (1773-1809) developed the Lichtleiter, which was a modified light conductor made from mirrors, tin, and leather; illumination was provided by a candle. This device was the forerunner of the modern endoscope. A French surgeon, Antonin Jean Desormeaux (1815-1894), introduced a cystoscope that burned alcohol and turpentine for illumination around 1853; he considered using electricity for the device, but thought that the fuel-burning model was more portable. Desormeaux has been referred to as the "Father of Endoscopy". A few years later, a dentist, Julius Bruck, developed the first internal light source composed of looped platinum wire heated to glowing brightness by electricity. The inherent risks were obvious because surrounding structures were frequently burned by the intense heat. Bruck subsequently developed a series of water-cooling covers, but these increased the size of the device, making it awkward to handle.

It was not until the early nineteenth century, when Maximilian Nitze (1848-1906), an Austrian urologist, developed a urologic instrument that became the basis of modern endoscopy. Nitze used the light source developed by Bruck and, assisted by an optician, created a tri-lensed endoscope that allowed a greater field of vision with an internal illumination source. By 1880, his cystoscope was featured in medical catalogs. Next, the entire concept of internal illumination for endoscopy was revolutionized by Thomas Edison's invention of the incandescent light bulb. By 1886, miniature light bulbs were placed in the cystoscopes for internal examination of the bladder.

In the early 1900s, Dr. Chevalier Jackson of Philadelphia further improved endoscopy by the development of a laryngoscope and bronchoscope. Introduced in 1902, endoscopic inspection of the human abdominal cavity was enhanced in 1910 by Swedish surgeon Hans Christian Jacobaeus (1879-1937) when he first introduced the concept of creating a working space by insufflating air into the peritoneum and viewing the abdominal contents with the Nitze cystoscope. The first use of carbon dioxide (CO_2) as a means of creating a working space in the abdomen was described by Richard Zollikofer of Switzerland around 1924. Zollikofer demonstrated that CO_2 was not explosive within the abdomen and also that it was readily absorbed without event. Later, this was supported in the literature by a German surgeon, Roger Korbsh. Korbsh found that the intra-abdominal pressure should be maintained at 15 cm H_2O or lower in order to avoid the physiologic complications associated with pressure on the diaphragm. Initially, the delivery of CO_2 into the peritoneal cavity was done through the sheath for the cystoscope. Then, around 1938, a spring-loaded needle which had been developed by a Hungarian surgeon, Janos Veress, for the purpose of draining ascites, was used for insufflation. This needle, which is referred to as the Veress needle, is still the preferred method of insufflation. Because CO_2 is nonflammable, tubal ligation using electrocoagulation was possible in the 1950s and then popularized by gynecologic surgeons Raoul Palmer from France and Frangenheim from Germany.

In England in the late 1960s, Professor Harold Hopkins developed the rodless system of rigid endoscopes that improved clarity and brightness. Hopkins traveled to Germany to work with Karl Storz on his prototype; thus, the fiberoptic system for illumination was born, allowing color photography of the body's internal surface to be performed clearly.

By the late 1970s, gynecologic surgeons embraced laparoscopy and thoroughly incorporated these techniques into their practice. In the late 1970s to early 1980s, endoscopic surgery moved from the category of diagnostic to operative. Semm termed his pioneering work pelviscopy; his work led to many technological advances in instrumentation, equipment, and practices. Flexible and rigid endoscopic procedures were also increasing for other surgical specialties. In the 1970s, orthopedic surgeons began to develop the art of arthroscopy. The first laparoscopic-assisted appendectomy was performed in 1977; the first recorded liver biopsy was performed in 1982. In France, surgeons reported the first surgical laparoscopic cholecystectomy in 1987. Surgeons in both the United States and United Kingdom began performing these procedures laparoscopically in 1988.

Thus, the "laparoscopy revolution" began in earnest in the United States in the late 1980s. Surgeons developed and refined techniques to perform procedures using the laparoscope, thereby eliminating the need for a large incision. Since the 1990s, equipment, instrumentation, surgical skills, and perioperative nursing knowledge have markedly expanded as MIS has become a safe approach for a multitude of surgical interventions.

THE SECRETS TO THE SUCCESS OF MIS: THEN AND NOW

The early advances in MIS occurred long before the modern concerns of decreasing surgical costs and reducing the patient's length of stay. However, the benefits of MIS take on greater significance today in the face of escalating health care costs in today's current economic crisis.

It is well known that health care costs have been rising for several years.[4] Expenditures in the United States on health care surpassed $2.2 trillion in 2007, more than three times the $714 billion spent in 1990, and over eight times the $253 billion spent in 1980. Curtailing this growth has become a major policy priority as the government, employers, and consumers increasingly struggle to keep up with health care costs. In 2007, health care spending in the United States was about $7,421 per resident and accounted for 16.2% of the nation's Gross Domestic Product (GDP); this is among the highest of all industrialized countries. Total health care expenditures grew at an annual rate of 6.1% in 2007, a slower rate than recent years, yet one that is still outpacing inflation and the growth in national income.

To further complicate these staggering cost increases, the current economic crisis is also taking a toll on patients, communities, and hospitals alike. A rapid response survey (data gathered from 736 hospitals in 30 states) released by the American Hospital Association (AHA) in November 2008 concluded that hospitals posted negative profit margins of 1.6% in the quarter ending September 30, 2008; according to the survey, hospitals ended the same quarter in 2007 with a positive 6.1% margin.[5] Furthermore, due to the nation's continued economic troubles, fewer patients are seeking hospital care, while at the same time a growing proportion of patients need help in paying for their care. Many hospitals are beginning to see the effects of this ongoing economic downturn, with more than 30% of the survey respondents reporting a moderate to significant decline in patients seeking elective procedures; nearly 40% of the respondents reported an overall decrease in patient admissions.

There are several factors that contribute to the initial and ongoing success of MIS surgery.[6,7,8] Technology is often blamed for increasing health care costs; however, some medical advances such as minimally invasive surgery, have demonstrated effectiveness in improving the efficiency of health care, enhancing the quality of care provided, and reducing overall expenses. The clinical advantages of MIS – smaller incisions, reduced bleeding, decreased postoperative pain, shorter hospital stays, lower rates of surgical site infections, and faster recuperation – are well documented. Additionally, patients report higher quality of life scores after minimally invasive surgery when compared to traditional, open procedures; the need for overnight stay is eliminated and patients are able to return to work sooner. These are not only advantages for the patients, health care facilities, insurers, surgeons, and health care plans, but to the overall health care economy as well (see Table 1).

Table 1 – Benefits of Minimally Invasive Surgery

Patient	➢ Less scarring ➢ Reduction in postoperative pain ➢ Shorter recovery ➢ Quicker return to activities of daily living and work
Employers	➢ Lower total cost of care ➢ Employees recover and return to work faster ➢ Improved productivity ➢ Lower replacement and overtime costs
Surgeon	➢ Better clinical outcomes ➢ Improved quality of care ➢ Differentiate and appeal to patients
Health care Facility	➢ Reduced costs through reduced lengths of stay ➢ Improved clinical outcomes ➢ Leverage for improved reimbursement ➢ Differentiation ➢ Growth potential
Insurers	➢ Lower medical costs ➢ Lower disability costs ➢ Improved clinical outcomes
Health care Plans	➢ Reduced total health care costs to employees ➢ Improved clinical care ➢ Competitive differentiation ➢ Measurable quality improvements ➢ Member satisfaction

TODAY'S MIS TECHNIQUES

Since the widespread introduction of MIS techniques in the late 1980s, current trends in surgery are increasingly moving toward minimal access approaches, including reducing both the size as well as the number of access sites. The reduction of the number of trocars, and therefore port site incisions, is one way to minimize the invasiveness of the surgical intervention. Three emerging techniques: hand-assisted laparoscopy (HAL), single site laparoscopy (SSL), and natural orifice transluminal endoscopic surgery (NOTES) offer patients the least invasive surgical approach. These techniques are described in greater detail below.

Hand-Assisted Laparoscopic Surgery (HALS)

The laparoscopic-assisted approach continues to gain popularity in many surgical specialties and has evolved to include not only "pure" laparoscopic techniques, but also hand-assist devices. Hand-assisted laparoscopic surgery can be used as a bridge for surgeons who are not completely familiar with laparoscopic techniques. The use of a hand-assist device has several advantages, including[9]:

- A decrease in the learning curve associated with laparoscopy;
- The provision of tactile feedback for the surgeon; and

- Reduction of operating time, while still preserving many of the advantages of laparoscopic surgery.

By combining laparoscopic surgery with the tactile feedback of a hand-assist device, surgeons can not only reduce operating time, but also have a lower procedure conversion rate. The technique involves making an incision the width of a hand and placing a simple, ring-like hand-assist device to facilitate laparoscopic dissection. New hand port devices facilitate this technique without the loss of pneumoperitoneum, which is essential for performing laparoscopic procedures. The latest generation of hand-assist devices allows the surgeon to insert the device at the beginning of the procedure and then use it as either a hand port or laparoscopic instrument port throughout the remainder of the procedure. The insertion site of the hand-assist device also provides a useful location for performing extracorporeal anastomosis.

HALS appears to maintain the short-term benefits of minimally invasive surgery, while affording the surgeon with the ability to carry out complex cases across many surgical specialties. In colorectal surgery, HALS is most suited for laparoscopic procedures that will require an opening to remove an organ or specimen, or for extracorporeal anastomosis, including:

- Left colectomy;
- Sigmoidectomy;
- Low anterior resection;
- Abdominoperineal resection;
- Total abdominal colectomy; and
- Total proctocolectomy.

For these indications, HALS facilitates splenic flexure mobilization, inferior mesenteric vein and artery ligation, omental release, and rectal dissection. This technique is not indicated for right colectomy, ileocolic resection, ileal resection, or rectopexy without colon resection.[10]

In general surgery, HALS is also used for splenectomy.[11] Large spleens are difficult to handle laparoscopically because of the risk of bleeding, fragmentation of the spleen, and the subsequent need for conversion to an open procedure; not having the surgeon's hands inside the abdominal cavity makes it difficult to manipulate and retract the spleen. Therefore, hand-assisted laparoscopic techniques facilitate the procedure through enhanced vascular control, easier retraction and manipulation, as well as manual guidance of endostaplers and clip appliers.

HALS has also been used successfully in urologic surgery.[12] Indications for HAL include radical, donor, and partial nephrectomies, nephroureterectomy, and, most recently, dismembered pyeloplasties. HALS utilizes all the principles of standard transperitoneal laparoscopy; the only difference between standard laparoscopy and HALS is that the surgeons are also able to introduce their hand into the operative field. This technique has allowed the laparoscopist to maintain use of the most versatile instrument available, the surgeon's hand, for exposing, retracting, dissecting, and maintaining hemostasis. The hand may assist in more advanced laparoscopic techniques such as intracorporeal suturing and knot tying. Furthermore, by maintaining the tactile sense, the surgeon is able to palpate vessels and adjacent organs, thereby minimizing the chance of injury to vital structures, especially in difficult laparoscopy dissections. Essentially, HALS combines the advantages of laparoscopy and open surgery. Compared with standard laparoscopic techniques HALS may be better in certain instances, including donor nephrectomies, nephroureterectomies, and the removal of very large specimens. Though originally evaluated for extirpative surgery, HAL is beginning to be utilized as a minimally invasive technique to perform complex reconstructive urologic surgery.

Laparoscopic Techniques

Laparoscopic techniques involve the use of specially designed instrumentation, including telescopes, trocars with cannulas, suction and irrigation devices, retractors, electrosurgery, **carbon dioxide** (CO_2) insufflators, stapling instruments and appliers, and video imaging equipment.[13] The technique involves making the initial entry into the periumbilical region with percutaneous puncture with an insufflation (Verres) needle (ie, closed technique) or a sharp trocar in a sheath (ie, direct technique). A cut-down technique (ie, Hasson technique) may also be used with a small incision down to the fascia with a #15 blade. The trocar is then inserted through and into the peritoneal cavity. In the direct optical technique, an optical trocar is inserted to visualize trocar placement prior to insufflation. Pneumoperitoneum is established with insufflation of 3 to 4 liters of CO_2 into the peritoneal cavity to achieve an intra-abdominal pressure of 12–15 mm Hg. The needle is then removed and replaced with a 10 mm or 11 mm trocar. A rigid laparoscope, with a video camera and cord coupled to the telescope eyepiece end, is inserted into the port for visualization. Two to six additional ports may be established in order to facilitate the entry and use of the various endoscopic instruments. These port sites are selected to permit all of the instrument tips to converge at the primary surgical site, thereby maximizing the surgeon's ergonomics and enhancing performance. Once the surgical procedure has been completed, the CO_2 is exhausted and the ports are removed; the umbilical incision is closed with a 3-0 or 4-0 nonabsorbable synthetic suture; the remaining port incisions are closed with the same suture, adhesive strips, or skin-bonding adhesives; and all incision sites are covered with a small dressing or bandage.

Laparoscopic techniques are used in virtually all surgical specialties[14,15,16]:

- General surgery: Nissen fundoplication, cholecystectomy, common bile duct exploration, liver resection, right hemicolectomy, left hemicolectomy, appendectomy, inguinal hernia repair, splenectomy.
- Obesity surgery: gastric bypass, adjustable gastric banding, duodenal switch.
- Urologic surgery: live donor nephrectomy, prostatectomy, diagnostic laparoscopy with lymphadenectomy for prostate cancer.
- Thoracic surgery: video-assisted thoracoscopic surgery, thoracoscopic lung resection.

- Vascular surgery: aortic surgery, endoluminal vascular surgery.
- Orthopedic surgery: arthroscopic procedures.
- Neurosurgery: microsurgical techniques applied to cranial, spinal, and peripheral nerve procedures; neuroendoscopy, including endoscopic tumor removal or diversion of cerebrospinal fluid; endovascular procedures; and stereotactic procedures.

Single Site Laparoscopy

Single site laparoscopy (SSL) is an innovative approach to minimally invasive surgery. SSL may also be referred to as laparoendoscopic single-site surgery (LESS) and single-port-access (SPA) surgery. Traditional laparoscopic surgery enables surgeons to perform minimally invasive procedures through three to five small incisions in a patient's abdomen, through which the endoscope and instrumentation are inserted. Single site laparoscopy involves making one small incision (about 2 cm) in the umbilicus area and inserting multiple instruments through a single deployment device.

SSL is currently being used in various general surgery (eg, gall bladder, hernia, spleen, colorectal), gynecologic, and urologic procedures.[17] While the multidisciplinary applications of SSL are expanding, the potential significance of the technique is yet to be recognized. Safety and efficacy studies of SSL are currently underway in many institutions. The technique has potential incremental advantages over traditional MIS for cosmesis, wound infection, postoperative pain (especially in upper abdominal surgery), and recuperation. Specialized disposable and reusable instruments are being produced to facilitate SSL; however, no major capital expenditures are required. Many advanced laparoscopic procedures are being performed via SSL using traditional laparoscopic instruments, thus keeping costs competitive with those for traditional MIS. Traditional laparoscopic 2-handed dissection, ablation, and suturing techniques are also utilized, so surgeon training in SSL should be a much easier transition than that which occurred from open surgery to traditional laparoscopic surgery in the early 1990s. Most procedures are currently being performed using a 5 mm camera trocar and two 5 mm working trocars, all introduced through a single access device in one periumbilical incision.

Specialized equipment for SPA surgery falls into two broad categories: access ports and hand instruments. A typical SSL access port consists of two 5 mm seals and a larger 15 mm seal in a low profile design that allows surgeons to use a wide variety of instrumentation (eg, straight, angled, curved) across several different procedures. Some of these devices are available with 360 degree rotation of the seal cap that enables quick re-orientation of instruments during procedures and reduces the need for instrument exchanges. Standard hand instruments are rigid in design and were developed over the last 30 years for use in laparoscopy. Articulation is designed to overcome one of the challenges inherit in SSL, decreased triangulation of instruments. A number of factors influence a surgeon's decision to use standard or articulating hand instruments including which access port they use, their own surgical skills, and cost, as articulating instruments are significantly more expensive than standard instruments.

The benefits of SSL in multiple surgical specialties are well documented in the literature. Most recently, Curcillo, et al,[18] reported on the first 297 cases in a multi-institutional and multi-national review of laparoscopic cholecystectomy performed via a single portal of entry (ie, single-port-access [SPA]); the review included operative time, blood loss, incision length, length of hospital stay (LOS), necessary additional trocars, and other parameters important to cholecystectomy. The results showed that the average operative time was 71 minutes, and the average LOS was one to two days. The average blood loss was minimal. The use of additional port sites outside the umbilicus occurred in 34 of the cases. Of the 35 intraoperative cholangiograms performed, 34 were successful. No significant complications occurred except for seromas and minor postoperative wound infections. These results are comparable with those for standard multiport cholecystectomy. In addition, no access site hernias occurred. The authors concluded that these findings demonstrate that single-port-access laparoscopic surgery is an alternative to multiport laparoscopy with fewer scars and better cosmesis. However, one factor that may affect the rate for adoption of SPA surgery among other surgeons is the reproducibility of this new procedure. Although this study had insufficient data to fully determine the benefits of SPA surgery, the feasibility of this procedure with safe, acceptable results was demonstrated in this initial large series across multinational institutions.

Fader and Escobar[19] assessed the feasibility of laparoendoscopic single-site surgery (LESS) for the surgical treatment of various gynecologic cancers or precancerous conditions through both laparoscopic and robotic-assisted approaches through a retrospective review of patients treated with LESS on a gynecologic oncology service in 2009. Patients underwent surgery through a single 2 to 3 cm umbilical incision with a multi-channel port for laparoscopic cases or a single-channel port for robotic cases. All procedures were successfully performed via a single incision and no postoperative complications occurred; in addition, the majority of patients required no narcotics postoperatively. The authors concluded that LESS is feasible in select patients by laparoscopic or robotic-assisted techniques.

Teixeira, et al.,[20] studied the safety and feasibility of LESS surgery for placement of an adjustable gastric band. From December 2007 to June 2008, LESS surgery to place an adjustable gastric band via a transumbilical incision was performed for ten patients with institutional review board approval. Essentially, multiple ports were placed through a single incision in the umbilicus to allow for liver retraction, visualization, and placement of working instruments. All critical steps using a standard pars flaccida technique were performed without alteration. For this study, ten patients (nine women and one man) were carefully selected; these patients ranged in age from 32 to 61 years (mean was 47 years) and had a mean body mass index (BMI) of 42 kg/m^2 (range was 35-45 kg/m^2). The patients were selected for absence of both hepatomegaly and central obesity. Superobese patients were not considered for inclusion in the study. The mean operative time was 1 hour and 10 minutes (the range was 53 minutes to 1 hour, 48 minutes). The results showed that all of the patients were discharged home within 23 hours of admission, and no perioperative complications were noted. In addition, no wound-related complications occurred. Notably, only two out of the ten patients required the use of narcotic analgesia after discharge from the postanesthesia care unit (PACU).

Kaouk and Palmer[21] reported their initial experience in children undergoing single-port laparoscopic varicocelectomy (SPLV) performed through a multichannel single laparoscopic port inserted in the umbilicus rather than the traditional LV performed through three abdominal ports. In their study, transumbilical SPLV was completed in three consecutive adolescents (aged 13, 15, and 16 years) without placing any additional ports or conversion to open surgery. All procedures were performed for left-sided grade III varicoceles. The operative duration was less than one hour for each procedure. All patients were discharged on the same day as their surgery and none required re-hospitalization. At a mean follow-up of 8.7 (the range was 6 to 10) weeks, the authors reported that there were good cosmetic results, with no varicocele recurrence, or intraoperative or postoperative complications including wound infection, hydrocele, or incision site herniation.

NOTES[22,23,24]

Another advanced minimally invasive technique is NOTES: natural orifice transluminal endoscopic surgery, in which the surgeon operates almost exclusively through a single entry point, typically the patient's umbilicus, mouth, or vagina. This technique, which is presently experimental and being studied at research hospitals and facilities around the world, has the potential for more significant improvements in cosmesis, skin infections, hernias, postoperative pain, and recuperation. NOTES must, however, be distinguished from fully endoluminal, natural orifice surgery (NOS), such as cystoscopic, colonoscopic, transanal, and endoscopic procedures performed within a hollow structure. The NOTES technique, by contrast, is designed to produce an opening in an unrelated organ which must be safely and reliably repaired at the conclusion of the procedure. In NOTES, a highly specialized, sophisticated instrument is passed through an incision in the stomach, vagina, bladder, or colon to access the peritoneal cavity, thus increasing the potential severity of complications as a result of this entry method. Animal studies are underway in many institutions in order to evaluate the risks of this type of transluminal entry and also to develop the optimal endoscopic closure technique, along with the ideal endoscopic vehicle and instrumentation. It is widely recognized that substantial technological development and years of experience in dedicated centers will be needed to evaluate and perfect the NOTES technique. As the instrumentation evolves, safety and efficacy studies will be needed, followed by extensive outcome studies comparing NOTES results with those for traditional MIS.

It is apparent to see why the NOTES technique has the potential to reduce or even eliminate some of the complications associated with surgical and/or invasive procedures. Surgical site infection is always a risk for the surgical patient. The skin is the most common source for bacterial surgical site infections; therefore, clinicians hypothesize that the absence of transabdominal incisions with a NOTES approach may decrease postoperative infections.[25] An early NOTES trial following an incompletely closed gastrotomy found an intra-abdominal abscess and suppurative peritonitis, though not involving a skin infection; this highlights the critical significance of the viscerotomy closure.[26] Most early animal (swine) NOTES studies do not show a high rate of postoperative intra-abdominal infections; however, the rate of intra-abdominal infection has not been studied in large trials. While abdominal wall infections should not be seen with NOTES procedures, it is not clear whether the overall postoperative infection rate will be decreased.

Incisional hernia formation is another common complication of abdominal surgery. Patient presentations involving incisional hernias range from mild pain to recurrent discomfort with cough or expiratory effort to incarceration and strangulation necrosis of abdominal viscera. A laparoscopic approach decreases hernia formation; however, in certain patient populations (eg, those undergoing bariatric surgery), up to 5% of patients may still develop trocar site hernias.[27] Many patients will require elective, and some cases emergent, repeat surgery to correct the hernia and/or the related complications. A NOTES approach would eliminate this surgical complication.

Formation of adhesions is another common late complication of abdominal surgery. Adhesion formation commonly involves the abdominal wall incision; early experimental studies suggest that laparotomy is associated with more adhesion formation than laparoscopy.[28,29] If the abdominal wall incision is the most common point for adhesion formation,[30] a NOTES approach may decrease postoperative adhesions and subsequent small bowel obstruction. This hypothesis has not been tested in the NOTES setting; however, in an early NOTES report, adhesions were observed at autopsy in the setting of intra-abdominal infection.[31] Adhesions were also seen in four of six swine subjects in a NOTES setting where a transcolonic approach was used for peritoneoscopy and abdominal exploration.[32] Eliminating one or more transabdominal wall incisions should help to decrease adhesion formation; however, the extent of adhesion formation that will be seen with NOTES viscerotomies is not clear from the present studies.

NOTES may also be applicable in settings where traditional surgical approaches are undesirable or even contraindicated. By avoiding the subcutaneous fat layers, NOTES procedures may have an advantage in patients who are morbidly obese. A NOTES approach might also allow controlled access to intra-abdominal or retroperitoneal structures, thereby eliminating the deep dissection required in an open procedure.[33]

Surgery in children is always an area of concern for parents, including worries related to a lifetime risk of incision-related complications and potentially prominent cosmetic issues; thus there is a potential for NOTES to offer unique benefits to this patient population.

Lastly, for patients with contraindications to general anesthesia, it may be possible to perform NOTES procedures with deep sedation.

PERIOPERATIVE NURSING CONSIDERATIONS IN MIS

As the surgical patient's advocate, the perioperative nursing considerations for the patient undergoing MIS include those for all surgical patients, as well as some specifically related to the techniques used in MIS, as noted below.[34]

- Preoperative:
    - All patients – both the healthy as well as the complex laparoscopic patient – should receive a thorough preoperative evaluation. During the

preoperative nursing patient assessment, the perioperative registered nurse should identify unique patient considerations that require additional precautions or contraindications related to MIS procedures, fluid management, and the medications that may be added to irrigation fluids. This assessment includes, but is not limited to, the following:

- Age-specific risk factors;
- Cardiovascular compromise;
- Respiratory compromise;
- Pregnancy;
- Increased intraocular or intracranial pressure;
- Patient or family history that reflects a need for increased surveillance for deep vein thrombosis (including family history of blood clotting disorders, thrombosis, or pulmonary embolism; smoking; leg swelling; or sedentary lifestyle greater than 72 hours);
- Skin color and turgor;
- Weight;
- Allergies and sensitivities to medications; and
- Conditions, diseases, or medications that predispose or exacerbate the seriousness of hyponatremia or hypervolemia.

- Intraoperative:
    - Patient positioning. Extreme patient positioning to displace the viscera and enhance visibility for the surgical team may be required for MIS procedures. Proper positioning requires application of the principles of body mechanics, ongoing assessment throughout the perioperative period, and coordination with the entire surgical team. Consideration must be given to preexisting conditions such as poor nutritional status, extremes of age, vascular insufficiency, diabetes, and impaired nerve function. The length of the procedure and the type of anesthetic may also contribute to positioning injury. The team has the responsibility of assessing each patient and position according to the procedure being performed.
    - Personnel should take additional precautions when using electrosurgery units (ESUs) during MIS and computer-assisted procedures. MIS procedures using electrosurgery present unique patient safety risks, such as direct coupling, insulation failure, and capacitive coupling; furthermore, tissue damage associated with these risks may be out of the field of vision. Therefore, ESUs, accessories, and distention media that minimize the risks related to electrosurgery should be selected.
    - Infection prevention. Considerations to prevent surgical site infection should be implemented with all MIS procedures. Specialized cells line the peritoneal cavity and serve as the first line of defense for the immune

system in the abdomen; the defense system of the peritoneum may be adversely affected by the pneumoperitoneum used for MIS procedures. This is a key point, because intra-abdominal infections often begin in the peritoneal cavity. The mechanical distension changes the peritoneal structure, thereby allowing passage of bacteria. This systemic response, coupled with the amount of tissue damage and the duration of the procedure may potentially lead to an increased risk for infection.
    - Injuries related to the gas distention media. Potential injuries and complications associated with gas distention media used during MIS procedures should be identified, and practices that reduce the risk of injuries and complications should be established. The use of CO_2 to establish pneumoperitoneum increases the risk of hypercarbia, hypoxemia, subcutaneous emphysema, pneumothorax, and other hemodynamic changes, depending on the patient's medical history. End-tidal CO_2 is closely monitored in order to detect the onset of hypercarbia, especially for patients with compromised pulmonary function.
    - Injuries related to irrigation fluid. Potential injuries and complications associated with fluid used for irrigation or as distention media during MIS procedures should be identified and practices should be established to reduce the risk. Many MIS procedures require irrigation fluid to clear the operative field of blood and debris or fluid used as distention media to create a broader visual operative field inside a cavity. Patient outcomes could be adversely affected if fluids used for irrigation or as a distention media are not managed appropriately. Fluid extravasation, hyponatremia, hypervolemia, cardiovascular and peripheral vascular complications, pulmonary air or fluid emboli, and hypothermia are a few examples of complications that could result from mismanagement of distention media or irrigation fluids. Therefore, monitoring and early recognition of these associated complications are key interventions for maintaining patient safety and quality control for MIS procedures.

- Postoperative:
    - The patient should be monitored postoperatively for any signs of complications. This includes observing for signs and symptoms of injury as a result of positioning or electrosurgery use.
    - The patient's physiologic response, including core temperature and potential fluid retention, should be evaluated. Nausea and vomiting are common postoperative complaints following laparoscopic surgery and can delay the patient's discharge. Abdominal pain accompanied by hypotension and decreased urinary output may be indicative of extravasation of fluid.

THE VALUE OF THE TEAM APPROACH IN MIS

Expanding MIS technologies often require innovative problem solving, new relationships between diverse teams, and additional learning requirements for all members of the perioperative team.[35] In this new era of surgery, as the surgical practice environment becomes more technologically complex, the value of teamwork in MIS is even more important in providing safe and effective care. While teams play an important role in providing patient care in almost every health care practice setting, in the OR, teamwork is essential.[36] However, the quality and effectiveness of care can vary greatly, depending on how well the team functions. A truly effective health care team will maximize the use of information, as well as the skills and resources of the team members to achieve optimal outcomes, thereby resulting in increased patient safety and improved health care quality.

It is helpful to first explore the concept of teamwork in the OR by examining the definition of a team. The word "team" has been used so loosely and for so long in the health care field that in many ways, it has lost its true meaning; for example, six individuals in a room, each performing his or her own job, can be called a group, but not necessarily a team, since a team is defined by its members' interactions, interdependence, and shared goals.[37] The traditional hierarchical culture of the operating room (OR) has been blamed for the failure of individuals to function as teams in this environment.[38] In the perioperative practice setting, as with all of health care, there is a close correlation between communication and safe care.[39] An ethnographic study of OR functioning classified 30% of procedurally relevant communications between team members as communication failures; over one-third of these communication failures led immediately to noticeable and potentially dangerous effects on system processes, such as inefficiency, team tension, resource waste, work-around, delay, patient inconvenience, and procedural error.[40] Poor teamwork and communication are latent human failures within an organization that must be addressed to achieve an effective safety program.[41]

Successful surgical intervention depends on interdisciplinary teamwork, which is becoming increasingly specialized, particularly in the field of minimally invasive surgery. However, this teamwork consists of both technical and non-technical skills, defined as follows[42]:

- Technical skills consist of knowledge of anatomy and pathology, dexterity, hand-eye coordination, and technical proficiency.
- Non-technical skills include significant cognitive and interpersonal skills of health care professionals, such as communication, teamwork, leadership, situational awareness, and decision-making.

It has been shown that many of the underlying causes of errors stem from the non-technical aspects of care, rather than a lack of technical expertise; furthermore, it is stated that improving non-technical skills could decrease the number of errors during surgery and therefore, improve patient safety.

One way that the MIS team can improve patient safety through enhanced communication and other teamwork skills is with the use of a flexible, evidence-based tool kit.[43] TeamSTEPPS is one such resource for training health care providers in better teamwork practices.[44,45] This tool was developed to train health care professionals who work in high-stress areas and is designed to guide users through the implementation process. A TeamSTEPPS initiative occurs in three continuous phases: assessment; planning, training, and implementation; and sustainment. Each of these phases incorporates the following key actions: set the stage, decide what to do, make it happen, and make it stick. TeamSTEPPS is based on four core competencies:

- Team leadership – the ability to direct and coordinate the activities of team members, assess team performance, assign tasks, develop team knowledge and skills, motivate team members, plan and organize, and establish a positive team atmosphere.
- Situation monitoring – the capacity to develop common understandings of the team environment and apply appropriate strategies to monitor teammate performance accurately.
- Mutual support – the ability to anticipate other team members' needs and to shift workload among members to achieve balance.
- Communication – including the efficient exchange of information and consultation with other team members.

Despite the challenges facing MIS teams, there is increasing evidence that effective teamwork has an impact on improving patient safety and clinical outcomes; moreover, there is evidence that teamwork training has had a positive effect on hospital staff.[46] One study reported a 19% increase in OR staff satisfaction after teamwork training.[47]

It is clear that the perioperative care of the MIS patient is much more than just technical skills and knowledge. A well-trained, well-organized, dedicated specialty MIS team is needed to promote positive surgical outcomes for all patients undergoing minimally invasive surgical procedures. All team members must remain aware of the current advancements in the evolving techniques of minimally invasive surgical procedures. The surgeon must be an expert in the specialty of these existing and emerging techniques in order to perform the procedures safely. In addition, perioperative nurses, scrub assistants, and surgical technologists must also develop and maintain expertise in all aspects of perioperative care for this patient population.

SUMMARY

Historically, surgery was performed through traditional, open incisions. As a result of the ingenuity and efforts of many pioneering surgeons, minimally invasive surgical techniques were born. MIS techniques have expanded dramatically since the early, rudimentary endeavors. With the advent of minimally invasive surgery, many procedures in almost every surgical specialty are performed through small incisions and are more effective treatment options for the patient. Today, emerging techniques such as SSL and NOTES offer exciting new treatment options for many patients. Compared to open surgical procedures, minimally invasive surgery offers distinct benefits for the patient including decreased postoperative pain, less trauma to the tissues, a shorter recovery period and length of hospital stay, and potentially lower risk of infection. Therefore, it is imperative that all members of the perioperative team remain aware of the latest developments in MIS techniques, as well as their role in patient care, as this highly technical, highly specialized field continues to evolve. Surgeons and perioperative nurses must continually work to acquire and update the requisite knowledge and skills in order to safely integrate the latest minimally invasive surgical techniques into their daily practice. In addition, because the practice environment for advanced minimally invasive surgical procedures is technologically more complex, successful surgical intervention and patient outcomes will depend heavily on interdisciplinary teamwork. The ongoing development of non-technical skills, such as communication, situational awareness, and leadership, supplements the technical skills necessary for effective teamwork. Through the enhancement of technical expertise as well as non-technical skills, the MIS team can maximize the benefits of the latest MIS techniques by providing safe, quality perioperative care, ultimately promoting optimal patient outcomes.

GLOSSARY

Endoscopy	Examination of a body part or cavity with an optical system in a tubular structure.
Hand-Assisted Laparoscopy (HAL)	A technique that involves making an incision the width of a hand and placing a simple, ring-like, hand-assist device to facilitate laparoscopic dissection.
Insufflation	The act of filling a body cavity with gas; the state of being distended with gas for the purpose of visualization. Laparoscopy is performed with carbon dioxide.
Laparoscopy	Endoscopic examination of the peritoneal body cavity through a percutaneous access portal, placement of expansion medium to create a working space, and manipulation of intra-abdominal organs.
Minimally Invasive Surgery	Surgical procedure performed through one or more small incisions using endoscopic instruments, computer-assisted devices, robotics, or other emerging technologies.
Natural Orifice Transluminal Endoscopic Surgery (NOTES)	An advanced minimally invasive surgery technique in which the surgeon operates almost exclusively through a single entry point, typically the patient's umbilicus, mouth, or vagina.
Pneumoperitoneum	The state of the peritoneal cavity being filled with gas, often induced for diagnostic or therapeutic purposes.
Single Site Laparoscopy (SSL)	The use of one incision, rather than several incisions, to insert laparoscopic instrumentation. Also referred to as LESS: laparoendoscopic single-site surgery and SPA: single port access.
Trocar	A surgical instrument that consists of a sheath with a sharp (or blunt) obturator used to puncture or penetrate multiple layers of tissue. The sheath remains in place as the obturator is removed. Additional instruments are passed through the sheath.

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