

Perioperative Fluid Management

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In the late 1980s, advances in technology began changing how traditional surgical procedures were performed. Procedures performed using older modalities evolved as new, minimally invasive techniques were developed. The perioperative team's approach to surgical patient care took a parallel journey as minimally invasive techniques were adapted to specific surgical specialties. Surgeons learned new approaches to traditional procedures. Anesthesia personnel monitored the patient for changes that could occur with increased intra-abdominal and intrathoracic pressures caused by insufflation. Scrub personnel familiarized themselves with new equipment and instrumentation, and perioperative RNs recognized the need for revised discharge instructions. The entire surgical team became experts at monitoring patient outcomes associated with insufflation, the insufflation media used, and the equipment employed.

Acquiring new skills required cognitive shifts and heightened critical thinking to effectively monitor the patient and manage new technological interfaces (eg, pressurized fluid delivery systems, fluid warmers). The clinical knowledge needed to safely care for patients has changed as the use of fluid

media in multiple surgical specialties has increased. Fluid management has become a key element in providing a safe patient care environment during minimally invasive procedures.

As members of the Fluid Management Task Force updating the fluid management portion of AORN's recommended practices for minimally invasive surgery, we performed an extensive literature review and collated the evidence. Much of the research was not new and although the research supported the value of fluid monitoring, no new guidelines were developed to address perioperative practice. We believe that it is time to translate the research into practice. This article provides general considerations for patients undergoing minimally invasive surgery and more specific considerations for patients undergoing arthroscopic, liposuction, gynecologic,

ABSTRACT

Technological advances have changed how traditional surgical procedures are performed. New knowledge and surgical skills are required to effectively monitor the patient and manage fluids administered perioperatively.

Today, selective fluids are used in a variety of surgical specialties. Complications of fluid therapy can occur that are intrinsic to each procedure within a specialty.

This article provides perioperative nurses with the information needed to evaluate different fluid media and their applications and identify patient care considerations. Possible complications and important postanesthesia care concerns also are discussed.

Key words: *gynecology, hysteroscopy, urology, transurethral resection of the prostate, arthroscopy, liposuction, tumescent solutions. AORN J 89 (January 2009) 167-178. © AORN, Inc, 2009.*

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The use of large amounts of fluid as distention media may exacerbate hypothermia. Products are being developed to warm fluids for procedures requiring large amounts of fluid for distention.

and urologic procedures. Technological changes place greater significance on fluid media guidelines and patient monitoring requirements.

GENERAL CONSIDERATIONS FOR PATIENTS UNDERGOING MINIMALLY INVASIVE SURGERY

In all perioperative specialties, nursing care and interventions should be individualized to the patient's needs. A thorough understanding of the patient's baseline status enhances the RN's ability to assess for complications during the intraoperative and postoperative phases of patient care. For patients undergoing any type of endoscopic surgery, a thorough patient history in the preoperative phase should include

- preexisting conditions (eg, coagulopathies, neuropathies);
- diseases (eg, adrenal insufficiency, brain tumors, cirrhosis, congestive heart failure, hypothyroidism, lung cancer, meningitis, pneumonia, renal disease, tuberculosis); and
- injuries (eg, head trauma)

that can predispose the patient to hyponatremia (ie, serum sodium ≤ 125 mEq/L).¹ The preoperative RN also should document prescribed and over-the-counter medications that the patient is currently taking, any medications previously discontinued, or complementary therapies being used that may predispose the patient to hyponatremia (eg, excessive use of tap water enemas).² The RN should review the patient's baseline laboratory test values, including serum sodium level, and ensure that

they are recorded in the patient's medical record. To help identify mental status changes or complications that may occur postoperatively, the RN should document the patient's mental status immediately before surgery and before administering any sedative medication.

Patient selection is influenced by the patient's health status, the planned and actual length of the scheduled procedure, equipment availability, and recommendations or guidelines from the surgeon and specialty organizations. The perioperative RN advocates for the patient to ensure that patient care meets procedural criteria, the surgical setting promotes patient safety, and appropriate equipment is available for the planned procedure.

Minimally invasive procedures may be performed under monitored anesthesia care, spinal anesthesia, or general anesthesia. The circulating nurse reviews the preoperative assessment and documentation to help identify potential perioperative risks to the patient. Having knowledge of fluid distention media (Table 1) and tumescent fluid and ensuring proper equipment functioning are important for preventing complications.

Hypothermia is always a perioperative concern, and the use of large amounts of fluid as distention media may exacerbate this condition. Research has addressed the effect of perioperative hypothermia on the cardiopulmonary system and the importance of using warming devices (eg, IV fluid and irrigation warmers, forced-air warming units) to minimize perioperative hypothermia.² Sessler² indicates that current research and emerging literature is limited on the significance of solution warming, but products are being developed to warm fluids for procedures requiring large amounts of fluid for distention. Patients undergoing some procedures benefit from vasoconstriction so fluids are not warmed in those instances. Examples of such procedures may include liposuction, arthroscopy, and hysteroscopy.³

During the postoperative report to the postanesthesia care unit (PACU) RN, the circulating nurse includes the type and amount of fluid medium used and the total volume instilled and returned. The circulating nurse or anesthesia care provider reports the patient's intraoperative vital signs, including temperature,

TABLE 1
Fluid Distention Media

Solution	Osmolality (mOsm/kg H ₂ O)	Sodium concentration (mEq/L)	Metabolism	Implications	Procedure
0.9% sodium chloride ^{1,2}	308	154	Not applicable (NA)	Fluid shift from intracellular to extracellular compartment	General irrigation
Lactated Ringer's solution ³	273 to 275	130	NA	Fluid shift from intracellular to extracellular compartment	General irrigation
5% Mannitol ⁴	275 to 280	0	Excreted by the kidneys	Plasma expansion with fluid absorption (ie, congestive heart failure [CHF])	Urologic irrigation
3% Sorbitol ⁵	185	0	Carbon dioxide (CO ₂), glucose, and water (H ₂ O) in the kidneys	Diuresis when absorbed intravascularly; hyperglycemia in patients with diabetes mellitus, hyperlactatemia in patients who are compromised metabolically; CHF as a result of extracellular fluid expansion; hyponatremia	Urologic irrigation
1.5% Glycine ⁶	200	0	Ammonia, H ₂ O, glycolic acid	Decreased liver function may contribute to increased ammonia in blood	Urologic irrigation
2.7% Sorbitol/ 0.5% mannitol ⁷	178	0	NA	NA	Urologic irrigation
Water ²	NA	0	NA	Hemolysis	General irrigation
5% Glucose ²	NA	0	CO ₂ and H ₂ O	Impaired renal function may result in increased levels of aluminum	NA

1. 0.9% sodium chloride irrigation USP [product label]. Bethlehem, PA: B. Braun Medical, Inc.

2. AORN. Drug Information Handbook for Perioperative Nursing. Hudson, OH: Lexi-Comp; 2006.

3. Lactated Ringers [product label]. Bethlehem, PA: B. Braun Medical, Inc; nd.

4. 5% Mannitol Irrigation [package insert]. Bethlehem, PA: B. Braun Medical, Inc; 2002.

5. 3% sorbitol irrigation [package insert]. Bethlehem, PA: B. Braun Medical, Inc; 2003.

6. 0.5% glycine [package insert]. Bethlehem, PA: B. Braun Medical, Inc; 2003.

7. Sorbitol 3%/mannitol 0.5% [product label]. Bethlehem, PA: B. Braun Medical, Inc; nd.

which are important indicators of the patient’s general status.

The PACU RN monitors laboratory values and observes the patient for electrolyte imbalances (eg, hyponatremia, hypervolemia). Table 2 presents the signs and symptoms of hyponatremia, which occurs when the sodium level in the blood is too low. Table 3 describes the signs and symptoms of hypervolemia (ie, fluid overload), which occurs when there is too much fluid in the blood.

Morbidity is affected by the preexisting health issues of each patient. Potential complications affecting patients in all specialties include vascular and neurological injury; fluid extravasation (ie, a shift of fluids into surrounding tissues with increased swelling near and around the surgical site); fluid intravasation; and equipment failure.⁴ Patients also may develop complications from fluid overload and present with signs and symptoms of congestive heart failure, cardiac arrhythmias, myocardial infarction, increase in peritoneal fluid, or cerebrovascular accident. The PACU RN notes any assessment findings that indicate a change from baseline mental status, which may signal emerging complications, and reports these changes to the surgeon.

The PACU RN provides postoperative discharge instructions to the patient and a responsible adult caregiver. Instructions may include, but are not limited to, instructing the patient

or caregiver to observe for and report swelling, bleeding, neurological compromise, and pain.

ORTHOPEDIC CONSIDERATIONS

Arthroscopy has changed exponentially over the decades from a diagnostic tool to a surgical procedure. Arthroscopy requires a high, continuous flow of fluid so the surgeon can see, diagnose, or treat pathology within an anatomical joint. The

TABLE 3
Signs and Symptoms
of Hypervolemia¹⁻⁴

- Anemia
- Apprehension
- Brain stem hernia, especially in women
- Chest pain
- Cyanosis
- Disorientation
- Electrocardiogram changes, specifically widening of the QRS complex, T-wave inversion, and ST elevation
- Hypertension
- Irritability
- Nausea
- Progressing to seizures, coma, and death
- Pulmonary edema
- Shortness of breath associated with bradycardia
- Transient blindness/visual changes
- Twitching
- Vomiting

1. Boyd HR, Stanley C. Sources of error when tracking irrigation fluids during hysteroscopic procedures. *J Am Assoc Gynecol Laparosc.* 2000;7(4):472-476.
2. Propst AM, Liberman RE, Harlow BL, Ginsburg ES. Complications of hysteroscopic surgery: predicting patients at risk. *Obstet Gynecol.* 2000;96(4):517-520.
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4. Collins JW, MacDermott S, Bradbrook RA, Drake B, Keeley FX, Timoney AG. The effect of the choice of irrigation fluid on cardiac stress during transurethral resection of the prostate: a comparison between 1.5% glycine and 5% glucose. *J Urol.* 2007;177(4):1369-1373.

TABLE 2
Signs and Symptoms
of Hyponatremia¹

- Headache
- Anorexia
- Nausea
- Vomiting
- Diarrhea
- Tachycardia
- General malaise
- Muscle cramps
- Weakness
- Lethargy
- Changes in mental status and personality
- Disorientation
- Seizures
- Death

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oints most commonly treated arthroscopically are the knee, shoulder, ankle, wrist, elbow, and hip. Arthroscopic complications are minimal, but when exhibited they are primarily related to iatrogenic tendon, vascular, or neurologic injury; fluid extravasation; joint stiffness or discomfort after a period of inactivity; decreased or loss of range of motion; and equipment failure.⁴

The perioperative RN should be aware of potential complications during patient assessment, paying particular attention to the preoperative condition of the surgical site and noting any redness, swelling, or other abnormalities. The nurse should reassess these same parameters before applying the dressing.

A synopsis of complications related to fluid distention is included in Table 4. The most common intraoperative complication is fluid extravasation, which may result from the delivery of fluids under pressure. When automated fluid delivery systems are used, pump pressures should comply with manufacturer's recommendations to prevent complications. The potential for complications related to extra-articular fluid migration is likely to increase in relation to the duration and complexity of the arthroscopic procedure. In particular, prolonged use of high irrigation flow rates and pressures (eg, 100 mm Hg for 60 to 90 minutes) may increase the risk of complications.⁵ Clinicians should be aware of the amount of pressure used and the length of time the pressure is maintained; however, a very long procedure at lower pressures also could cause enough extravasation to result in compartment syndrome of the leg.⁶

During shoulder arthroscopy, cardiac and airway complications are an immediate concern because of airway shift or pneumothorax. The anesthesia care provider closely observes for changes in the patient's intraoperative cardiopulmonary status related to fluid being infused into the shoulder joint at a high pressure.⁵

During knee arthroscopy, the surgeon pays close attention for signs of fluid extravasation, particularly when no tourniquet is used. Fluid may accumulate in fascial planes of the thigh or calf and may even enter the retroperitoneal space or the peritoneal cavity.⁷ The most potentially life-threatening complication after knee arthroscopy is deep vein thrombosis as a result of extravasation or compartment syndrome, with development of potentially fatal pulmonary emboli.⁸ Complications specific to irrigation

fluid additives may include lidocaine toxicity and epinephrine reactions (eg, anaphylaxis, tachycardia), and the anesthesia care provider and circulating nurse constantly assess for these complications.⁹

There is a paucity of literature related to warming arthroscopic irrigants. A study by Kelly et al¹⁰ showed no significant difference in core body temperature for patients who received arthroscopically administered warmed fluids. Subsequent infusion of warm irrigation solution into the knee joint actually may increase heat loss by exacerbating or extending the duration of vasodilation associated with spinal anesthesia (ie, induced sympathectomy). If irrigation fluids are warmed,

caution should be exercised to prevent thermal injury. Documentation of the irrigant temperature should be in compliance with facility policy and existing regulatory or accreditation standards.

POSTOPERATIVE CARE. Specific nursing implications for postoperative arthroscopic assessment include monitoring the reabsorption of extravasated fluid and assessing for nerve palsies, vascular injuries, pain, and compartment syndrome. Assessing for compartment syndrome is crucial because of the need for urgent treatment. Treatment for both acute and chronic compartment syndrome is usually surgery to release the pressure building inside.

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TABLE 4
Complications Caused by Fluid Distention Media¹⁻⁸

Complications	Shoulder	Knee	Hip	Ankle	Wrist	Elbow
Fluid extravasation	✓	✓	✓	✓	✓	✓
Neuropraxia	✓	✓	✓	✓	✓	✓
Compartment syndrome	✓	✓	✓	✓	✓	✓
Vascular injuries	✓	✓	✓	✓	✓	✓
Tachycardia	✓	With epinephrine (epi)	With epi	With epi	With epi	With epi
Airway compromise	✓					
Pneumothorax	✓					
Tissue tearing	✓				✓	

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3. Romero J, Smit CM, Zanetti M. Massive intraperitoneal and extraperitoneal accumulation of irrigation fluid as a complication during knee arthroscopy. *Arthroscopy*. 1998;14(4):401-404.

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5. Rodosky M. Fluid management systems for arthroscopy; a clinical perspective. *Business Briefing: Global Surgery*. 2004;1-3.

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7. Williams JS, Hulstyn MJ, Fadale PD, et al. Incidence of deep vein thrombosis after arthroscopic knee surgery: a prospective study. *Arthroscopy*. 1995;11(6):701-705.

8. Kelly JA, Doughty JK, Hasselback AN, Vacchiano CA. The effect of arthroscopic irrigation fluid warming on body temperature. *J PeriAnesth Nurs*. 2000;15(4):245-252.

Initial treatment, however, consists of elevating the limb above the level of the heart. If a cast has been applied, it is removed. A surgical fasciotomy may be used to open the membrane leading to the affected muscles to relieve pressure so the blood flow can return to normal. If the diagnosis of compartment syndrome is made and surgical release is performed promptly, the outlook is excellent for recovery of the muscles and nerves inside the compartment.

The PACU nurse pays special attention to potential complications of the anesthesia block. The PACU nurse provides discharge instructions that

are specific to arthroscopy including the need to

- elevate the affected extremity to minimize swelling;
- apply ice for comfort; and
- report any extreme increases in swelling, bleeding, or pain to the surgeon.

LIPOSUCTION CONSIDERATIONS

Liposuction is performed to sculpt areas of the body (eg, buttocks, thighs, neck, chin) by removing excessive adipose tissue resistant to traditional weight-loss and exercise programs.¹¹ This procedure is not recommended as a weight loss modality, but rather an enhancement to

lifestyle changes including diet modifications and a life-long exercise plan.

LIPOSUCTION TECHNIQUES. In 1985, Jeffrey Klein, MD, and Patrick Lillis, MD, developed the original (Klein) tumescent technique for liposuction.¹² This technique differs from previous methods because normal saline and anesthetic solution are injected into the site to be sculpted. Lipoplastic techniques currently in use include the tumescent technique; the super-wet technique; ultrasound-assisted lipoplasty (UAL); and most recently, laser-assisted liposuction.¹¹

The tumescent technique is a method using IV solutions of lactated Ringer's solution or saline solution mixed with lidocaine and epinephrine. This technique facilitates adipose tissue removal, controls bleeding, and provides analgesia postoperatively. The amount of infusate varies and is determined by the surgeon based on patient needs. Large-volume liposuction may require increased tumescent fluid injection. Depending on surgeon technique, injected tumescent fluid may be as much as three times the amount of tissue to be removed.¹¹

The super-wet technique is similar to the tumescent technique except that smaller quantities of tumescent fluids are used. The amount of infusate is equal to the amount of tissue to be removed.¹¹

Ultrasound-assisted lipoplasty is a technique in which tumescent fluid is used with a special cannula (ie, an ultrasonic wand) that pulverizes the adipose tissue. The liquefied tissue is aspirated from the body using traditional liposuction techniques.

The laser-assisted technique was approved for use by the US Food and Drug Administration in 2006.¹³ This technique uses injected infusate and low-level laser energy to liquefy adipose tissue that is then aspirated from the body via suction.¹⁴ This technique minimizes recovery time, limits the quantity of infusate used, and decreases intraoperative and post-

operative complications. Neira et al¹⁵ suggest that laser assistance allows for easier fat extraction with a reduction in surgical complications (eg, eccymosis, hematomas) and facilitates the patient's recovery. Prado et al¹⁴ performed a subsequent study in 2005, however, that failed to show any advantages of laser-assisted liposuction over other techniques.

PATIENT SELECTION. The best candidates for liposuction are of normal weight and have firm, elastic skin with minimal anatomical pockets of excess adipose tissue.¹¹ The patient should be

physically healthy, psychologically stable, and have realistic expectations of end results. Liposuction carries a greater risk of complications in patients

- who are immunocompromised (ie, acute or chronic);
- with medical problems (eg, diabetes, heart or lung disease, poor blood circulation, renal insufficiency); or
- who have had recent surgery near the site of liposuction.¹¹

Risk factors increase for patients who are older than 60. Furthermore, liberal IV hydration during the intraoperative or postoperative phases of care places patients at additional risk for fluid and electrolyte imbalance.¹¹

SURGICAL SETTINGS. Surgical settings for liposuction may vary based on patient need and the amount of adipose tissue to be removed. Patients requiring large volume liposuction (ie, more than 5,001 mL of aspirate) may require an overnight hospital stay for increased monitoring in the immediate postoperative period¹⁶ because of the relationship of high-volume aspirate removal and extremes in fluid shifts leading to hypovolemia, pulmonary edema, and congestive heart failure.¹¹

LIPOSUCTION PROCEDURE. The surgeon starts the surgical procedure by making small incisions in the areas targeted for tissue removal. The surgeon then plumps and firms the tissues by injecting a tumescent medium.¹⁷ The resulting "tumescent effect"

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The circulating nurse and anesthesia care provider assess the patient for signs and symptoms of lidocaine toxicity, including light-headedness, restlessness, drowsiness, tinnitus, a metallic taste in the mouth, slurred speech, and numbness of the lips and tongue.

- enables greater control of tissue removal,
- provides hemostasis through vasoconstriction, and
- promotes more effective pain management.

The surgeon inserts a blunt, hollow cannula with multiple openings that is connected to a suction device into the incision site. The cannula is moved back and forth along the axial plane, parallel to the skin surface, to bluntly dissect and aspirate adipose tissue and fluid from the space.¹⁸ To prevent shock and postoperative complications of hypovolemia and acid-base imbalances, the anesthesia care provider closely monitors IV fluid hydration throughout the procedure and intravenously replaces fluids lost along with adipose tissue.

The surgeon instills the tumescent medium and then waits 10 minutes to ensure maximal hemostasis.¹⁷ Additives to the tumescent medium may vary based on surgeon preference and patient need. Varying combinations of lidocaine, epinephrine, bupivacaine, or atropine may be added to provide analgesia and control blood loss. Although the exact formulas of tumescent media remains individualized, it is generally agreed that the maximum safe dosage of lidocaine is 35 mg/kg.¹⁷

COMPLICATIONS. Mortality, though rare, often is related to lidocaine toxicity. The circulating

nurse and anesthesia care provider assess the patient for signs and symptoms of lidocaine toxicity that include: "light headedness, restlessness, drowsiness, tinnitus, a metallic taste in the mouth, slurred speech, and numbness of the lips and tongue."^{19(p1482)} The patient may progress to shivering, muscle twitching, tremors, convulsions, central nervous system depression, and coma as the plasma levels of lidocaine increase. Respiratory depression and cardiac arrest can occur at plasma levels greater than 10 mcg/mL. Plasma levels may peak 10 to 12 hours after infiltration when epinephrine is added to the solution.¹⁹ The addition of epinephrine to the infiltrate results in vasoconstriction to provide hemostasis and prolonged absorption of the lidocaine. Epinephrine doses should not exceed 10 mg/kg, although the recommended dosage is 0.07 mg/kg. Higher doses may affect hepatic blood flow and alter the metabolism of the anesthetic.¹⁹ Hypertension may be related to the effects of epinephrine or anesthesia.

Another complication of liposuction is hypoxia. Hypoxia may be caused by fat embolism, pneumothorax, severe acute bronchopneumonia, acute pulmonary edema, third-space phenomenon, or marked dependent edema or bruising. Bruising and edema can lead to clot formation, which can contribute to pulmonary embolism, which in turn leads to hypoxia.

The risk for complications may increase with greater infusate volume and the removal of adipose tissue from multiple anatomical sites. It is important for perioperative RNs to be familiar with the solution and additives used to accurately assess potential complications. Although there are no current, published guidelines for fluid management during liposuction, it is important to balance the amount of IV fluid administered with the amount of infiltrate solution and the resultant urinary and suction output.¹⁹

POSTOPERATIVE CARE. Immediate postoperative fluid management in the PACU is patient-specific based on intraoperative input and output, both IV and infusate, and the amount of adipose tissue removed from the patient. Nursing actions to ensure appropriate fluid management outcomes include

- monitoring vital signs for stability;
- confirming normal breath sounds in which

no rales or wheezing are present;

- monitoring urinary output to ensure adequate volume (ie, a minimum rate of 30 mL/hour);
- assessing skin color;
- observing blood count and electrolyte levels to confirm they are within normal limits; and
- maintaining IV therapy as needed.²⁰

UROLOGIC AND GYNECOLOGIC CONSIDERATIONS

Although urologic and gynecologic procedures and complications are similar in regard to the use of fluid for distention, the characteristics of the involved organs are dissimilar. The capacity, shape, muscle strength, function, vascularity, and peritoneal access of the bladder and uterus are almost exactly opposite of one another, so different nursing interventions are required.

The most significant safety issues related to irrigation fluids for these patients are hyponatremia and hypervolemia, which may occur simultaneously or independently.²¹⁻²³ Each type of irrigation has slightly different manifestations if absorbed. Patients may manifest signs and symptoms hyponatremia or hypervolemia earlier under local or spinal anesthesia.

An important intraoperative nursing intervention is to monitor the amount of irrigation recovered and subtract that from the amount of irrigation used.²¹ The total of the irrigation used minus the irrigation recovered is referred to as the volume deficit. If the cause for the deficit cannot be identified (eg, trapped in the drapes, spilled on the floor), it should be considered absorbed, placing the patient at high risk for complications. Weighing the fluid used and captured provides a more accurate measurement of volume deficit.

Boyd et al²⁴ reported that the actual amount of fluid contained in an irrigation bag or bottle is up to 10% more than stated on the label. In addition, the measure on the collection canisters can be +/- 20%. If these errors align, manual measurement might be incorrect by as much as 30%. When large volumes of fluid are used, the error can be further compounded, and it is possible to have as much as a 1 L deficit when using three to four 3-L bags of irrigation.²⁴ When gravity is used to deliver low-viscosity fluids, the fluid pressure can be approximated by observing the height of the continuous column of fluid

to the level of the organ and multiplying each 12-inch increment by 25 mm Hg.²²

The patient should be placed in the lithotomy position and draped to maximize the collection of irrigation. The buttocks should be positioned slightly off the break in the table to provide a barrier to fluid escaping down the perineum and under the patient. The drapes should be applied in a manner that prevents pooling or loss of fluids.

Although mortality is rare, a delay in recognizing the symptoms of electrolyte imbalance and fluid overload can be catastrophic. It may take several hours before symptoms are exhibited when fluids are absorbed through the peritoneal cavity from a perforation or egress through the fallopian tubes.²⁵

UROLOGIC FACTORS. Transurethral resection of the prostate (TURP) commonly is performed on older men. A variety of irrigants can be used to aid in visualization and cauterization during TURP. According to Helminiak, "Irrigation solutions may be absorbed directly through the prostatic venous plexus and over time from the perivesical and retroperitoneal spaces."^{26(p44)} Depending on the type and amount of medium used, several complications collectively known as TURP syndrome may occur. In TURP syndrome, a patient experiences more than two signs or symptoms of complications, with the two most common problems being hyponatremia and hypervolemia.

GYNECOLOGIC FACTORS. The uterus is a small-capacity cavity within a very strong muscle, so pressurized distention is required to enable visualization. As irrigation is delivered into the uterus, it creates pressure within the cavity (ie, intrauterine pressure). When intrauterine pressure exceeds the mean arterial pressure, irrigation fluid can be forced into open vessels inside the uterus or through the fallopian tubes into the peritoneal cavity.^{22,27} Depending on the type of irrigation solution used, fluid and electrolyte shifts may occur.^{22,27,28} Some women also may be predisposed to uterine perforation and fluid absorption.²¹ Dilation may be a challenge in a patient

- with a severely retroverted or anteverted uterus;
- with a stenotic cervix (ie, postmenopausal or status postcervical cone biopsy);
- who has undergone pretreatment with

gonadotropin-releasing hormone (GnRH) agonists;

- who is nulliparous or who has had cesarean births;
- who has a myoma or adhesion in the lower segment of the uterus; or
- who has a history of cervical cone biopsies.^{21,22}

Cervical dilation also can be challenging for inexperienced surgeons.

Hysteroscopy is a common gynecologic procedure that has been performed for decades to diagnose and treat a variety of intrauterine pathologies including menorrhagia, uterine polyps, and uterine fibroids. For many patients, operative hysteroscopy is a less-invasive, effective alternative to a hysterectomy. During operative hysteroscopy, visualization is achieved by distending the uterus with pressurized fluid media. Uterine perforation occurs most frequently during cervical dilation, before insertion of the hysteroscope.^{21,22} If the procedure is prolonged or if uterine perforation goes unrecognized by the perioperative team, the patient is at risk for severe complications. If the perforation is not recognized, the risk of the patient absorbing large volumes of fluid is increased. Consequently, fluid monitoring is suggested for all diagnostic and operative hysteroscopic procedures.

Premenopausal women undergoing hysteroscopy have 25 times greater risk of brain damage with resultant hyponatremic encephalopathy than postmenopausal women undergoing hysteroscopy or men undergoing TURP.^{22,29} According to Witz et al²⁷ and Propst et al,³⁰ patients treated with GnRH agonists preoperatively have seven times greater risk of surgical complications. Premenopausal women release antidiuretic hormone as a response to anesthesia.²⁷ Consequently, they do not respond as well to diuretics. It is better and easier to prevent fluid and electrolyte imbalances than it is to treat them. Witz et al²⁷ recommend that anesthesia care providers keep patients undergoing hysteroscopy less hydrated than patients undergoing other gynecological procedures. The patient history should include gestational parity and type of delivery (ie, vaginal versus cesarean birth) to anticipate potential complications during cervical dilation.

An automated fluid-monitoring system increases the accuracy of deficit measurement intraoperatively and is not subject to human error³¹ (eg, the potential for inaccurately labeling the irrigation container or collection device).²⁴ Automated systems use the weight of the fluid to determine the amount of fluid used and collected and then calculate the deficit. In addition, automated systems allow the user to set and monitor the delivery pressure to the uterus. By controlling the intrauterine pressure at or below the mean arterial pressure, it is less likely that fluid will be absorbed through the vasculature of the uterus.^{21-23,28}

Adequate visualization can generally be obtained with a maximum pressure required of 75 mm Hg to 100 mm Hg when using either gravity or a hysteroscopic pump (minimum pressures required for good visualization should always be used).^{32(p167)}

In addition,

mechanical monitoring is highly desirable since it removes the human factor in measuring fluid deficit, allows for early warning of excessive extravasation by real-time totals, and indicates the rapidity with which the loss is occurring.^{32(p168)}

Guidelines from the AAGL, formerly known as the American Association of Gynecologic Laparoscopists, suggest that an “operating room person should be dedicated to [monitoring] intake, output, and deficit”^{32(p168)} if a mechanical system is not available. Isaacson advocates for the education of perioperative clinicians to “recognize and treat these complications to ensure the best possible patient outcome.”^{23(p50)}

DOCUMENTATION

Documentation is crucial in all perioperative phases and areas. The baseline assessment, intraoperative events, and postoperative assessment should be documented and reported during patient hand offs (ie, transitions between care providers). The first sign of any complication should be reported to the surgeon for further evaluation. Perioperative nurses should descriptively document all observances of

edema, bleeding, neurological compromise, and pain, noting any improvement or degradation of conditions with time and nursing interventions.

RECOMMENDATIONS FOR FUTURE RESEARCH

The use of fluid media for surgical interventions is a rapidly evolving technology that warrants continued investigation. Specific areas identified for research include evaluating the effect of fluid warming and the value of monitoring fluids during urology procedures. Research supports the need to monitor fluids during urology procedures. Commercially available systems for the automated calculation of fluid volume deficit occurring during minimally invasive urology procedures should be developed and then evaluated in the practice setting.

MINIMALLY INVASIVE TECHNIQUES REQUIRE VIGILANCE

Although considered by most to be less invasive than traditional surgical methods, minimally invasive techniques require vigilance of the perioperative RN. The nursing assessment should identify patients who are at risk for fluid deficit and the perioperative nurse should develop and implement a care plan to identify and deal with early manifestations of fluid absorption. Perioperative nurses should work with a multidisciplinary team to develop procedures to accurately monitor fluid deficit in all procedures to avoid risks. — **AORN** —

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Perioperative Fluid Management

PURPOSE/GOAL

To educate perioperative nurses about perioperative management of fluids used for distention during orthopedic, liposuction, and gynecologic/urologic procedures.

BEHAVIORAL OBJECTIVES

After reading and studying the article on perioperative fluid management, nurses will be able to

1. discuss potential risks/complications of the use of fluid distention media during any minimally invasive surgical procedure,
2. identify perioperative fluid management factors relevant to orthopedic surgery,
3. discuss the use of fluid media during liposuction procedures, and
4. describe fluid management issues in relation to gynecologic/urologic procedures.

QUESTIONS

1. To minimize the risk of hyponatremia, the preoperative RN should
 1. document prescribed and over-the-counter medications that may predispose the patient to hyponatremia.
 2. review the patient's baseline laboratory values (eg, serum sodium level).
 3. document the patient's mental status immediately before surgery and before administering any sedative medication.
 - a. 1 and 2
 - b. 2 and 3
 - c. 1, 2, and 3
2. The distention media fluids for all patients undergoing endoscopic minimally invasive surgery should be warmed before infusion.
 - a. true
 - b. false
3. Use of _____ as a fluid medium can result in hemolysis.
 - a. lactated Ringer's solution
 - b. water
 - c. 5% glucose
 - d. 0.9% sodium chloride
4. The most common intraoperative complication related to fluid distention during arthroscopy is
 - a. airway compromise.
 - b. fluid extravasation.
 - c. neuropraxia.
 - d. vascular injuries.
5. Complications specific to irrigation fluid additives may include
 1. anaphylaxis.
 2. epinephrine reactions.
 3. lidocaine toxicity.
 4. tachycardia.
 - a. 1 and 3
 - b. 2 and 4
 - c. 1, 2, and 3
 - d. 1, 2, 3, and 4
6. During liposuction, the relationship of high-volume aspirate removal and extremes in fluid shifts may lead to
 1. anemia.
 2. congestive heart failure.
 3. hypovolemia.
 4. pulmonary edema.
 - a. 1 and 3
 - b. 2 and 4
 - c. 2, 3, and 4

- d. 1, 2, 3, and 4
7. The maximum safe dosage of lidocaine in tumescent solutions is
 a. 35 mg/kg.
 b. 40 mg/kg.
 c. 45 mg/kg.
 d. 50 mg/kg.
8. The total of the irrigation used minus the irrigation recovered is referred to as the volume deficit.
 a. true
 b. false
9. Manual measurement of fluids used for irrigation could be incorrect by as much as
 a. 30%.
 b. 35%.
 c. 40%.
 d. 50%.
10. Using an automated fluid-monitoring system is advantageous because the system
 1. increases the accuracy of deficit measurement intraoperatively.
 2. is not subject to human error.
 3. uses the weight of the fluid to determine the amount of fluid used and collected and then calculates the deficit.
 4. allows the user to set and monitor the delivery pressure to the uterus.
 5. controls the intrauterine pressure at or below the mean arterial pressure.
 a. 2 and 3
 b. 1, 4, and 5
 c. 2, 3, 4 and 5
 d. 1, 2, 3, 4, and 5

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.

This program meets criteria for CNOR and CRNFA recertification, as well as other continuing education requirements.

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Perioperative Fluid Management

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Mark only one answer per question.

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| 4 A B C D E | 9 A B C D E |
| 5 A B C D E | 10 A B C D E |

Perioperative Fluid Management

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 perioperative management of fluids used for distention during orthopedic, liposuction, and gynecologic/urologic procedures.

OBJECTIVES

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

1. Discuss potential risks/complications of the use of fluid distention media during any minimally invasive surgical procedure.
2. Identify perioperative fluid management factors relevant to orthopedic surgery.
3. Discuss the use of fluid media during liposuction procedures.
4. Describe fluid management issues in relation to gynecologic/urologic procedures.

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?
 1. yes
 2. no
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(Low) (High) (Low) (High)

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2	1	2	3	4	5	12	1	2	3	4	5
3	1	2	3	4	5	13	1	2	3	4	5
4	1	2	3	4	5	14	1	2	3	4	5
5	1	2	3	4	5	15	1	2	3	4	5
6	1	2	3	4	5	16	1	2	3	4	5
7	1	2	3	4	5	17	1	2	3	4	5
8	1	2	3	4	5	18	1	2	3	4	5
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